

# Information Technologies for Development of Specific Regions of Poland in Assessment of the Analytic Hierarchy Process Method

**Stanisław W. Ceran**

University of Warsaw, Poland

---

## Abstract

*The article presents the role of information technologies in the process of development of the economically weak regions of Poland. The state and the dynamics of the process of information technologies, in relation with the digitization, mobility and cloud computing processing trends in the areas of public administration and economics as well as functioning of individual households show vast diversification in those areas. The aim is formulating an answer to the question concerning the efficiency of the solutions being introduced in the area of public administration and the level of the IT implementation within the range of the basic economic activities, as well as the services provided to the inhabitants. The state of completion of the regional programs, the national strategies for IT implementation, the Digital Agenda for Europe as well as infrastructural investments are subject to assessment with use of the Analytic Hierarchy Process method. An important part of the process is the factor of user willingness to adopt the technologies, skills and competences necessary for their effective use and that problem was assessed with utilization of the comparison method.*

**Keywords:** computerization, digitization, analytic hierarchy process, outermost regions

## Introduction

The report “Poland 2030”<sup>1</sup> says that Poland, although centrally located on the European continent, maintains its position as a peripheral country. This is very bad for Polish regions, for example those located in the east of Poland. Opportunity for integration or competition with the global or European economies is seen only in metropolitan areas of western border regions and some regional centers. Furthermore, in the structural transformations and development of modern economies a very important role is played by both information and communication technologies. Studies indicate that from the start, technological implementations in the ICT field confirm the ratio of the global digitization factor for social and economic effects. In fact, it appears to be a legitimate view that this factor has become an impulse in the transformation processes of the economies in some Polish regions. The purpose of this article is to indicate the factors shaping digital transformation and development of these areas among economically weak, low income level population and human capital, in the predominantly rural areas, with limited availability and poor communication infrastructure. On top of that, a very slow development of both e-Government, and e-Economy besides digital literacy provides a strong barrier for building stable grounds for creation of the Information Society. Herewith, the article describes the problem of selecting the appropriate model of IT development for the Polish peripheral regions which refers to both a quantitative and spatial approach with hierarchical analysis.

---

1. See: Polska 2030. Wyzwania rozwojowe. Zespół Doradców Strategicznych Prezesa Rady Ministrów. Warszawa 2009. [@:] [https://www.mpips.gov.pl/gfx/mpips/userfiles/\\_public/1\\_NOWA%20STRONA/Aktualnosci/seniorzy/badania%20aktywne%20starzenie/pl\\_2030\\_wyzwania\\_rozwojowe.pdf](https://www.mpips.gov.pl/gfx/mpips/userfiles/_public/1_NOWA%20STRONA/Aktualnosci/seniorzy/badania%20aktywne%20starzenie/pl_2030_wyzwania_rozwojowe.pdf).

## 1 Computerization and digital development issues

The newly established Ministry of Administration and Digitization (in 2011) has assessed implementation of projects in a report titled *Government 2.0.*<sup>(2)</sup> The division is into projects fully implemented and those which are not, but which required both improvement and correction of assumptions and organizational design. The list of completed projects has proved to be very short. The bidding document describing the problems is a long-term *Development Strategy through 2030.*, which was adopted in 2013 by the Council of Ministers (*Polska 2030. Trzecia... 2013*). The strategy identified the areas of the State's direct action, its objectives and also development priorities associated with digitization. At the same time it is difficult to assess how the existing framework for the creation of this kind of society in Poland corresponds to the tasks set by the European Commission in the recent *Digital Agenda for the current Financial Perspective.*<sup>3</sup> On top of that, in the ratings in the digital development report, Poland is placed in the last row of underdeveloped countries.<sup>4</sup> In conclusion, the implementation of the idea of an Information Society and digitalization of all areas of state and society of our country is still insufficient. Certain regions of Poland, as the low-rated regions within the European Union, require special attention as far digitization is concerned. Assessment of the success and failure factors, as well as the economic development model which would guarantee improvement of the position of our country among the other regions of the European Union, seems to be advisable.

## 2 The digital development factors

The current formal document indicating the strategic directions of Poland's development through 2030 is a long-term *National Development Strategy*. The document both determines and defines all planned development tasks and challenges called the Polish "Third Wave." It simply means that it's high time for the third wave of modernity where the targets set out new competitive advantages to prevent a deepening peripheral status of Poland with the ambition of becoming a leader in many areas in the future. On the whole, by creating conditions for development through innovation and creativity, the strategy includes the dissemination of innovative attitudes in all areas of life and the economy with the application of the accelerated momentum of Polish Digital (*Polska 2030. Trzecia... 2013*).<sup>5</sup> Digital development processes and computerization occur in many domains of public space, including economic and social sectors. The processes create conditions for the transformation and development of the country and its respective regions. This tendency relates in particular to peripheral economies, where one of the most important tasks is to create effective and functional systems with tools which allow acceleration of the process of modernization. In addition, the mechanism itself for raising people's standard of living and the efficiency of the economy and its public institutions matters a lot, but also as a comprehensive civilization project that goes beyond the purely material matters covering education, quality of life and health, the safety of citizens and even social capital resources.

Further on, the digitalization process broken down by areas takes place in three domains: GOVERNMENT–ECONOMY–HUMAN. In the article five basic types of factors and criteria for the initial evaluation of the course of this process are assumed for these domains (see fig. 1). These include:

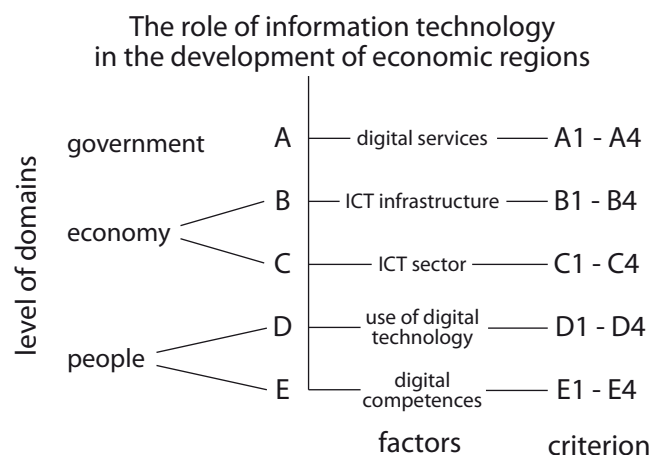
- in the GOVERNMENT sector—digital services
- in the ECONOMY sector—infrastructure and information sector
- in the HUMAN sector—the use of technology and digital skills

2. See: *Polska 2030. Wyzwania rozwojowe...*

3. See: *Europejska Agenda Cyfrowa w pracach i planach polskich instytucji rządowych*. Wydanie I. MSWiA. Departament Społeczeństwa Informacyjnego. [@:] [http://www.umwd.dolnyslask.pl/fileadmin/user\\_upload/spoleczenstwo\\_informacyjne/dokumenty/Europejska\\_Agenda\\_Cyfrowa.pdf](http://www.umwd.dolnyslask.pl/fileadmin/user_upload/spoleczenstwo_informacyjne/dokumenty/Europejska_Agenda_Cyfrowa.pdf).

4. See: *Polska 2030. Wyzwania rozwojowe...; Europejska Agenda Cyfrowa w pracach i planach polskich instytucji rządowych*. Wydanie I. MSWiA. Departament Społeczeństwa Informacyjnego. [@:] [http://www.umwd.dolnyslask.pl/fileadmin/user\\_upload/spoleczenstwo\\_informacyjne/dokumenty/Europejska\\_Agenda\\_Cyfrowa.pdf](http://www.umwd.dolnyslask.pl/fileadmin/user_upload/spoleczenstwo_informacyjne/dokumenty/Europejska_Agenda_Cyfrowa.pdf).

5. See also: *Europejska Agenda Cyfrowa w pracach...; Polska 2030. Wyzwania rozwojowe...*



**Fig. 1.** The hierarchy model of the transformation and digital development

The analysis method applied in this particular study does not only take into account the specifics of the processes of evaluation factors but also criteria with their relational and hierarchical character. (see fig. 2). The elements assessed in varying degrees shape the final image and development effect. The theoretical framework for assessing the effectiveness of computerization focuses mainly on ICT products. These are the applications that allow for implementation of e-services, systems and platforms bringing together information and content systems for collection, processing and data transfer. The quality and application of products besides usage and meeting the requirements determine their applicability, scalability and security. This allows you to achieve the purpose of providing electronic services (online) with a minimum participation of human factors in a fully automated fashion. On top of that, in the analysis of a hierarchical level relative to the second main branch it was spun off as a factor marked with the letter A. It is a structure responsible for the smooth functioning of the state, both (central government and local government, public institutions, financial, banking, science, and culture sectors). The size and appropriate level of supply of electronic services allows full electronic errands, transactions, observation and control processes and monitoring imaging and tracking objects in space.<sup>6</sup> The equivalent of a domain specified for digital services in this analysis is known as GOVERNMENT.

Criterion forming the branches of the third level are four elements identified as:

- A1 — the supply of e-services
- A2 — interoperability
- A3 — access to public information
- A4 — effectiveness and efficiency of market operators

The condition for use of e-services is the ICT infrastructure. In addition to computer hardware, peripherals and other devices, processing and storing of information requires network infrastructure for communication and transfer of data and content beyond the place of their creation and storage. A central element is the Internet. Access to a global network creates location-independent resource sharing of information and allocated services. To ensure standards of authenticity, security and uniqueness essential information has interoperability of systems. The availability of all participants and systems for the primary source of information is an absolute condition to the effectiveness of communication, interactivity and transactional functionality.

ICT infrastructure is a hierarchical branch marked with the letter B. In the analysis this create the following criteria:

- B1 — penetration and availability of the network (on the fourth level will be a hierarchical sub-criteria nature of indicators available in detailed studies for all levels of the territorial division of the country:<sup>7</sup> an indicator of broadband accessibility, the broadband service penetration rate,

6. See: Ocena dostępności usług eGovernment na terenie województw „ściany wschodniej” i porównanie z dostępnością tych usług w wybranych województwach Polski północnej i środkowej. Instytut Łączności. Nr pracy: 02 30 003 6. Warszawa 2006. [@:] [http://www.itl.waw.pl/publikacje\\_pliki/statutowe/pliki/265.pdf](http://www.itl.waw.pl/publikacje_pliki/statutowe/pliki/265.pdf).

7. See: Moduł Analityczny do wyznaczania obszarów interwencji publicznych w obszarze rozwoju Internetu

a broadband infrastructure competition indicator and a sustainable indicator of broadband accessibility (Polska 2030. Trzecia... 2013)

- B2—the quality and range of communication
- B3—efficiency data processing
- B4—to sustain the technological needs

The public, economic and social sphere each country or region should aim for the completion of the computerization process function as a coupled system in a relational manner which is efficient, economical and secure. The economic sector which determines the size and importance of information and communication technologies in each area is the information sector (ICT). According to Dziuba (1998, 28), the information sector is the totality of activities within the manufacture, use, preservation, collection, storage, transmission, and transmitting of information. It consists of all those employed in these processes and the entities and people creating the information infrastructure.

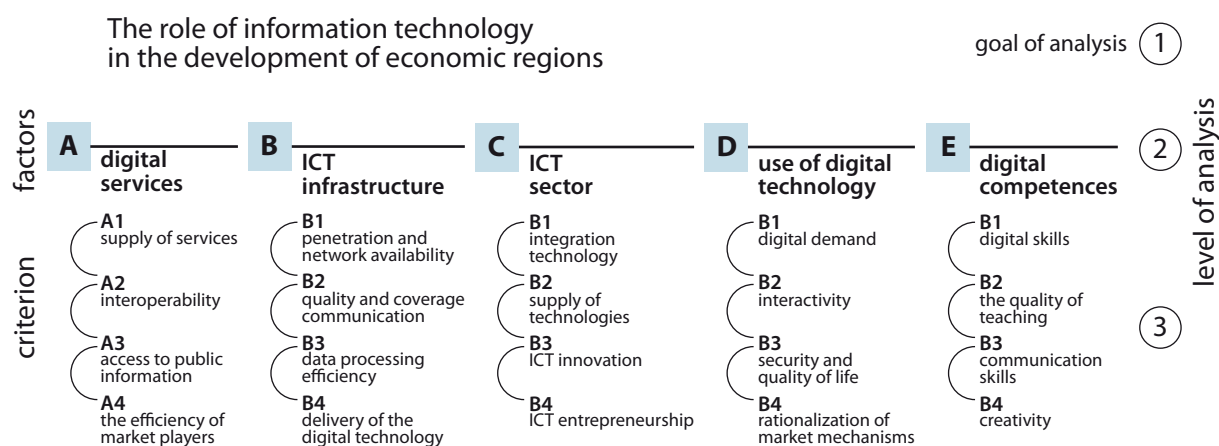


Fig. 2. Three-level hierarchy model for evaluation analysis

This sector is steadily expanding thanks to the great variety of dissemination tools and data communications, telecommunications, the media present in almost all of life and the economy (*Rocznik Statystyczny Województw* 2013; Saaty 2008).<sup>8</sup> For this analysis, the criteria that characterize this factor are

- C1—technological integration, this is an absolute condition for the provision of services by electronic means. The complexity of information systems supporting e-services requires a fusion of data located in multiple locations, consistency technological solutions like applications, networks, databases to meet the conditions of standardization, compatibility of the requirements of security, efficiency, and business procedures contained in the architecture of ICT products. Again, technological integration leads to many economic and social dimensions through synergies. This factor within the framework of technological integration can be characterized by criteria: use of electronic document circulation, electronic customer relationship management, cloud computing services and even access to public data.
- C2—supply of technology or market presence for the information sector, i.e. hardware, software, networking solutions, wired and wireless mobile communication tools, collection and processing which includes cloud computing, semantic technologies, expert systems and so on.
- C3—innovation in the ICT sector expressed by patent applications, ideas implemented in many centers and centers of growth and by promoting cluster cooperation in innovative businesses.
- C4—entrepreneurship in the information sector as an added value created by emerging consortia or groups of companies, their competitiveness on local and global levels as well as the nonprofit sector institutions, business support organizations, etc.

szerokopasmowego umożliwiający szacowanie kosztów niezbędnych inwestycji realizowany w ramach projektu „Budowa i utrzymanie portalu Polska Szerokopasmowa”. System Informacyjny Polska Szerokopasmowa. Projekt: POIG.07.01.00–00–019/09. UKE. Warszawa 2015 r.

8. See also: Polska 2030. Wyzwania rozwojowe...

One of the main drivers of economic mechanisms through the use of ICT systems is their widespread application. This branch is represented in the analysis by the following criteria at the hierarchical third level:

- D1—digital demand describing the possibilities of using information and communication technologies in all areas of public activity, economic and social life. At the fourth level it describes such elements as: demand for broadband services (such as content delivery services as online, e-mail, instant messaging and communication tools for distance telework services, monitoring services and even geolocation-GPS); demand access to content resources, such as digital libraries, virtual museums, portals providing multimedia content and so on.; participation in social networks and banking services.
- D2—interactivity
- D3—safety and quality of life
- D4—improvement of market mechanisms

In the last pillar analysis factors were very important because of the nature of taking into account the demand side of the process. Like branch D—the use of technology is associated with the domain HUMAN since it refers to a broad spectrum of dependent variables and feedback affecting to a decisive extent technological reception adoption. Digital competence—E—is therefore an essential factor for use of the possibilities offered by technology. In this case these are:

- E1—digital skills characterized by a fourth level sub-criteria: skill preparation and processing of digital information (such as e-mail, multimedia tools, office tools or instant messaging); network participation, participation in forums and discussion groups, the presence of social networks; basic skills to use digital tools; search information, the use of search engines, browsers, etc.
- E2—the quality of teaching
- E3—communication efficiency
- E4—creativity

The analysis omitted those factors which express high-level skills, professional and vocational education. Causative factors discussed above on digital development are generally presented in table 1.

**Tab. 1.** Factors and criteria used in the model

Factors		Criteria	
Full name	Symbol	Full name	Symbol
Digital services	A	<ul style="list-style-type: none"> <li>• supply of e-services</li> <li>• interoperability</li> <li>• access to public information</li> <li>• the efficiency of market players</li> </ul>	A1 A2 A3 A4
ICT infrastructure	B	<ul style="list-style-type: none"> <li>• penetration and network availability</li> <li>• quality and coverage communication</li> <li>• data processing efficiency</li> <li>• delivery and provision of digital technology</li> </ul>	B1 B2 B3 B4
ICT sector	C	<ul style="list-style-type: none"> <li>• integration technology</li> <li>• supply of technologies</li> <li>• ICT innovations</li> <li>• ICT entrepreneurship</li> </ul>	C1 C2 C3 C4
Use of digital technology	D	<ul style="list-style-type: none"> <li>• digital demand</li> <li>• interactivity</li> <li>• security and quality of life</li> <li>• rationalization of market mechanisms</li> </ul>	D1 D2 D3 D4
Digital competences	E	<ul style="list-style-type: none"> <li>• digital skills</li> <li>• the quality of teaching</li> <li>• communication skills</li> <li>• creativity</li> </ul>	E1 E2 E3 E4

### 3 Research test procedure

The analysis was carried out using the Analytic Hierarchy Process (AHP) method. To achieve this the issue of IT-implementation, as discussed in section 2, was decomposed, with attention paid to the socio-economic conditioning of the analyzed regions, namely their demography, unemployment, weakness of infrastructure, development level of their main branches of economy, the functioning of the public institutions, material status and households. For the analysis, the following assumptions were mostly taken into account:

- defined as the main objective, namely the role of information technology in the development of Polish regions and hierarchically subordinate to factors
- factors are grouped in relation to the areas of development, the main domains of subjects (GOVERNMENT–ECONOMY–HUMAN) specifying their value and relevance in the process of achieving and selecting the appropriate model to attain it
- hierarchically organized groups of factors are summarized in the scale vector of comparisons between each other pair of criteria
- the procedure of comparing on a nine-point scale applied Saaty's method by assigning each numerical assessment comparisons and a verbal description (Saaty 1980).

**Tab. 2.** The scale comparisons by Saaty

Indicator	Term significance	Verbal rating
1	same significance	we compare factors equally contributing to the objective, they are equivalent
3	small, poor advantage	moderate importance factor compared to the second factor
5	overwhelming	majority of large preponderance of one factor over another
7	a very big advantage	meaning dominant factor of the first over the second
9	absolute advantage	absolute greater importance of the first factor over the other, at the highest possible level to determine
2, 4, 6, 8	intermediate values	where there is a need to express the assessment in numerical form and the problem of assigning a pointer to any of the above

Final remarks. The analysis was performed in three steps:

Step 1. Data collection on the expert assessment of the significance of individual factors digital development. Gathering the expert data for the assessment of the significance of the individual digital development factors. The assessment was performed by a group of eight experts representing wide ranges of the information and communication technologies.<sup>9</sup> The examination was performed after recognizing the aim and the criteria for the analyzed hierarchical structure with use of the form establishing the points given for the individual criteria. A synthetic group assessment of the parameter values and the comparison results was established as the arithmetic mean of the individual grades assigned by the individual experts.<sup>10</sup>

Step 2. Analysis of the problematic aspects and the construction of the three-level hierarchical structure (see fig. 2), which covered the vital criteria for the issues presented in section 2.

9. The experts of the following specializations were involved in the examination: information and communication technology—3, sociology of the Internet—1, computer education—2, electronics in the economy—2. Those specialists possessed a wide range of interdisciplinary knowledge and long-term experience of evaluation activities within the framework of the Innovative Economy Operational Programme, priorities 7 and 8, for the period from 2007 to 2013. They were accompanied by expert candidates from the list of the Operational Program Digital Poland for the period from 2014 to 2020.

10. The drawback of such an approach was that the values of the assessed parameters were considerably varied. In this particular case—owing to the uniformity of the selected expert domains—the diversification of grades was minimal.

Step 3. Pair comparison of the aggregated criteria within the matrix formulated for the purpose of the analysis and recognizing the relative relevance of the factors and the level of their reciprocal dominance. The results were formulated with utilization of a spreadsheet and Expert Choice application (Prusak and Stefanów 2014, 241). The vector value and the weight calculations were performed and the priorities were ranked according to the importance of the second level criteria, which enabled achievement of the assumed examination aims. The range of the acceptable values indicated by the expert was placed within the basic scale from 1 to 9 (see tab. 2).

## 4 Results

The grade results indicated by the experts, after they were averaged, were input in pairs into the comparison square matrix, which constituted the basis for further calculations (Prusak and Stefanów 2014, 101–107). Upon the diagonal of the A matrix composed of n elements equivalent to the number of factors and the criteria for the hierarchical analysis there is the same number of values 1, equivalent to the number of comparisons (the rule of uniqueness of a mutually compared same element)

$$(1) \quad A = \begin{bmatrix} 1 & a_{12} & \cdots & a_{1n} \\ 1/12 & 1 & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ 1/1n & 1/2n & \cdots & 1 \end{bmatrix}.$$

**Tab. 3.** Numerical results of the comparison factors in pairs on the second level\*

	A	B	C	D	E
A	1	1	0,5	0,33	0,25
B	1	1	2	0,33	0,25
C	2	0,5	1	0,5	0,33
D	3	3	2	1	0,2
E	4	4	3	5	1
$\sigma_j$	11	9,5	8,5	7,16	2,03

*Note:* Symbols described in table 1

\* [In the journal European practice of number notation is followed—for example, 36 333,33 (European style) = 36 333.33 (Canadian style) = 36,333.33 (US and British style).—Ed.]

Pairwise comparison matrices show rear elements, which means factors represented at every level of the hierarchical structure. Matrices are created for determining the significance of criterion within one of the branches indicating the degree of validity important when choosing a model or digitalization option. Sum ( $\sigma_j$ ) given in the last line of the statement was created by the addition of ratings ( $a_{ij}$ ) in each column of the matrix comparisons. The next step specifies the weight values and priorities to verify data integrity (2) and correctness of calculations. The bottom line shows the values to verify the correctness of the calculations:

$$(2) \quad \lambda_{\max} = \sum_{i=1}^n \lambda_i,$$

where  $\lambda_{\max}$  is the value of the eigenvector matrix, confirming its consistency.

Others according to validate the analysis come from formulas

$$(3) \quad CI = \frac{\lambda_{\max} - n}{n - 1}$$

and

$$(4) \quad CR = \frac{CI}{RI},$$

where:

$n$  — the number of criteria (rows of the matrix),

RI — random compliance rate ratio of 1.11 for  $n = 5$ .

**Tab. 4.** Results of pairwise comparison calculated factors and their weight on the second level

Factors	A	B	C	D	E	Scores	Weights (in %)
A	0,0909	0,1053	0,0588	0,0461	0,1232	0,084848	18,2
B	0,0909	0,1053	0,2353	0,0461	0,1232	0,465713	25,8
C	0,1818	0,0526	0,1176	0,0698	0,1626	0,120142	25,1
D	0,2727	0,3158	0,2353	0,1397	0,0985	0,116898	45,6
E	0,3636	0,4211	0,3529	0,6983	0,4926	0,212400	100,0

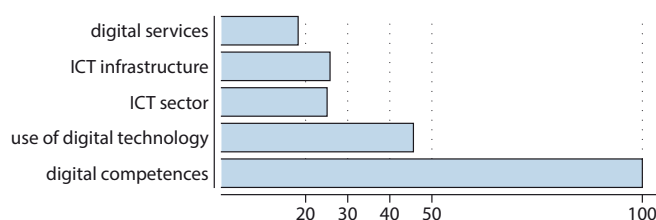
$$\lambda_{\max} = 0,074038; CI = 0,0185; CR = 0,01667$$

The value of CI (3), which is an index of conformity and CR (4)—the compatibility factor must satisfy the condition  $0,10 < CI; CR > 0$  (they should not be higher than 0,10). The factors constitute elements of the evaluation values calculated by weight in the form of: a weighted average of the geometric mean given in table 5. The comparison generated in the analysis of indicators clearly showed the dominant role of the digital literacy factor (100%) for the success of the transition and development processes who are based on digital technologies (see fig. 3).

**Tab. 5.** The values calculated weights for the digital development factors

Factors	Average	Weights (in %)	Geometric mean	Weights (in %)
A	0,084848	18,2	0,079597	17,7
B	0,120142	25,8	0,105029	23,3
C	0,116898	25,1	0,105029	23,3
D	0,212400	45,6	0,194568	43,2
E	0,465713	100,0	0,450665	100,0

A slightly less significant factor here was the use of information and communication technologies (45,6%), the smallest weighing values were noted in ICT infrastructure (25,8%) and e-services (18,2%).



**Fig. 3.** Main determinants of digital development

Because of the great importance of the digital competence factor, the diagram shows the course of the analysis in the third hierarchical level along with the chart criteria.

The comparison of the criteria factor of digital skills indicates a high rank of quality teaching criterion (E2) in the shaping of a sufficiently high level ICT skill development in society. These indicators also confirm the role of the following criteria, i.e. creativity (68,6%) and digital literacy (63,9%) as a critical component in the transformation based on digital technologies. For confirmation of this notion, the spatial distribution of the results of the significance criterion of the quality of education in the county system on Polish territory was examined. These are the data contained in its report on the problem areas of the country (Bartkiewicz et al. 2009). Eastern Polish counties predominantly characterized themselves by low levels of education.



**Tab. 6.** Numerical results of the comparison criteria for digital literacy at the third level

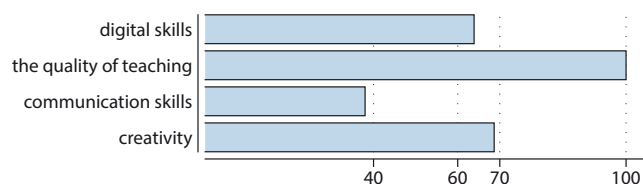
	E1	E2	E3	E4
E1	1	1	2	0,5
E2	0,5	1	2	3
E3	0,5	0,5	1	0,5
E4	2	0,3	2	1
$\sigma_j$	4	2,83	7	5

Note: Symbols described in table 1

**Tab. 7.** Results of pairwise comparisons calculating the criteria and their weights at the third level

Factors	E1	E2	E3	E4	Scores	Weights (in)%
E1	0,2500	0,4286	0,2500	0,0909	0,25490	69,1
E2	0,1250	0,4286	0,2500	0,5455	0,36850	100,0
E3	0,1250	0,2143	0,1250	0,0909	0,13880	37,6
E4	0,5000	0,1429	0,2500	0,1818	0,26870	72,9

$$\lambda_{\max} = 0,1028; \text{CI} = 0,0343; \text{CR} = 0,0385$$

**Fig. 4.** Distribution of weight value for the criterion of digital literacy

For example, Eastern Poland representing a quarter of the land is 34 counties with the rating of low and very low; the remaining territories, which is 3/4 of this area, have predominantly medium or high level of education indicators and the number of counties with low and very low indicator is 39. Comparative figures testify to the overlapping hierarchical analysis of official statistics in the field of digital literacy (*Rocznik Statystyczny Województw* 2013; *Spółeczeństwo informacyjne w Polsce...* 2013). Education changes dynamically when faced with the technological and social changes, so its purpose is also to shape and educate the inhabitants of the regions with a weak economy, who learn and prepare to teach “themselves” for the rest of their lives. New media, such as the Internet, digital television or cellular telephony, do not condition the quality of education itself, but they decrease its quality when implemented without prior preparation. Without introduction of new educational methods the effective solutions and the digital educational equipment adjusted to the specific educational requirements of various social groups makes the knowledge available in the electronic form lose its educational qualities, which reduces its meaning to a mere source of information of unspecified quality and low usability. Statement summarizing the analysis undertaken hierarchical shown in table 8.

## Conclusions

The observations of the development processes supported with the digital communication equipment in Poland from 1995 to 2015 show an evident lack of effects. Our country is far behind the group of countries where the mechanisms of efficient public operations with the use of information technologies were introduced successfully. Thus, a proper diagnosis of the factors and the criteria for digitalization development is the main priority. The factor of digital competence—along with the supply of services and the infrastructure—has proven to be the most important among the factors influencing the picture of the economy and development in certain areas of Poland. The Analytic Hierarchy Process method has proven its high practical value for establishing the

**Tab. 8.** A summary of results of the hierarchical analysis for digital development

Criterion of 3 level hierarchical analysis				Factors of digital development 2 level analysis			
Descriptions and symbols	Average	%	Priorities	%	Normalized priority weights	%	Symbols
Supply of e-services	A1 0,26948	64,7	0,26948	64,7	0,264170	63,9	
Interoperability	A2 0,4168	100,0	0,4168	100,0	0,413450	100,0	digital
Access to public information	A3 0,12094	29,0	0,12094	29,0	0,119350	28,9	A
The efficiency of market players	A4 0,19277	46,3	0,19277	46,3	0,186790	45,2	services
Penetration and network availability	B1 0,43019	100,0	0,34415	100,0	0,373590	100,0	
Quality and coverage communication	B2 0,19237	44,0	0,15389	44,0	0,157070	42,0	B
Data processing efficiency	B3 0,26055	60,0	0,20844	60,0	0,222140	59,5	ICT infrastructure
Delivery of the digital technology	B4 0,35207	81,0	0,28165	81,0	0,222140	59,5	
Integration technology	C1 0,27617	81,0	0,22094	81,0	0,222140	76,0	
Supply of technology	C2 0,33725	100,0	0,2698	100,0	0,292350	100,0	
ICT innovation	C3 0,30884	91,0	0,24707	91,0	0,264170	90,4	C
ICT entrepreneurship	C4 0,18912	56,0	0,15129	56,0	0,168790	57,7	ICT sector
Digital demand	D1 0,39894	100,0	0,31915	100,0	0,314150	100,0	
Interactivity	D2 0,21509	53,0	0,17207	53,0	0,186790	59,5	
Security and quality of life	D3 0,2918	73,0	0,23344	73,0	0,264170	84,1	D
Rationalization of market mechanisms	D4 0,21509	53,0	0,17207	53,0	0,186790	59,5	use of digital technology
Digital skills	E1 0,25487	69,0	0,20389	70,0	0,222140	63,9	
The quality of teaching	E2 0,3685	100,0	0,2948	100,0	0,347660	100,0	E
Communication skills	E3 0,13879	37,0	0,11103	38,0	0,132080	38,0	digital competences
Creativity	E4 0,26866	72,0	0,21493	74,0	0,238700	68,7	

aims and indicating the achievement model. The digital competence factor analysis results coincide with the statistics and provide the evidence for the great significance of this aspect of the economy functioning in the era of the globalized society. The level of information technologies use is largely proportional to the quality of education at every stage, while the competences of the digital education leaders result in the achieved range of infrastructure and use of system instruments, or access to the provided digital content. It should be stated that the applied hierarchical method of problem analysis showed a high level of fidelity of its results to the results presented in the reports and the statistical data analysis and, as such, it can be applied as a useful analytic instrument.

## References

- BARTKIEWICZ, P. et al. 2009. *Identyfikacja i delimitacja obszarów problemowych i strategicznej interwencji w Polsce. Wnioski z analiz, Raporty/Ministerstwo Rozwoju Regionalnego Instytut Badań Strukturalnych*. Warszawa: Ministerstwo Rozwoju Regionalnego.
- DZIUBA, D. 1998. *Analiza możliwości wyodrębniania i diagnozowania sektora informacyjnego w gospodarce polskiej*. Warszawa: Wydawnictwa Uniwersytetu Warszawskiego.
- Polska 2030. Trzecia fala nowoczesności. Długookresowa Strategia rozwoju Kraju. 2013. Warszawa: Ministerstwo Administracji i Cyfryzacji.
- PRUSAK, A., and P. STEFANÓW. 2014. *AHP — analityczny proces hierarchiczny. Budowa i analiza modeli decyzyjnych krok po kroku*. Warszawa: Wydawnictwo C.H. Beck.
- Rocznik Statystyczny Województw 2013*. 2013. Warszawa: Główny Urząd Statystyczny.
- SAATY, T.L. 1980. *The Analytic Hierarchy Process: Planning, Priority Setting, Resource Allocation*. New York-London: McGraw-Hill International Book Co.
- . 2008. “Decision Making with Analytic Hierarchy Process.” *International Journal of Services Sciences* no. 1 (1):83–98.
- Spółeczeństwo informacyjne w Polsce. Wyniki badań statystycznych z lat 2009–2013. 2013. Informacje i opracowania statystyczne*. Warszawa: Główny Urząd Statystyczny, Urząd Statystyczny w Szczecinie.