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MODEL OF INFORMATION SOCIETY MEASUREMENT – FRAMEWORK AND SELECTED OUTCOMES

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ABSTRACT. An increasing role of information and knowledge in countries' and regions' economic development can be found in interdisciplinary conceptions of knowledge-based economy (KBE) and information society (IS). This paper tackles the issues of information society measurement. Its main goals are: presentation of an original proposal of measuring information society development and on the basis of this methodology, determining the level of IS development in one of the best economically developed Polish regions, i.e. the Silesian Voivodeship. Developing the information society has become one of the priority issues for the Silesian Voivodeship. Critical success factors (CSFs) for the development of the IS in the Silesian Voivodeship were identified. The calculated value of the regional information society index (RISI) indicates that the level of IS development in this Voivodeship is one third (0.33) of the hypothetical development pattern. Diagnosing the level of information society development is a prerequisite for efficient and effective policy development in the field of information society, both at the regional and national levels.

JEL Classification: D8, A12, O18

Keywords: information society, measurement, Silesian Voivodeship, Poland.

Introduction

The term *information society* emerged in Japanese social sciences in the 1960s. Despite the passing of more than 50 years, there are, to date, many definitions and research approaches of in this field. This results in difficulties for the attempts to measure phenomena within this category which can be and are understood differently. However, in the literature there are many methods for the quantitative description of information society. They characterise the level of IS development either by using the sets of indicators, whose number and type are a derivative of the author's preferences or they construct methods based on arbitrarily selected indicators of so-called composite indices (CI), which are aggregate measures. The research goals of this paper are the development of a new method of measuring the information society and determining on its basis, the IS development level in the Silesian Voivodeship.

The approach to measuring information society developed by the author is based on the following research tasks:

1. proposing an IS definition;
2. identifying the main critical success factors (CSFs) determining effective and efficient ICT adoption, separately for people, business and public administration;
3. a description of each identified CSFs by a relevant indicator;
4. working out a sub-index of ICT adoption by people (pICT), sub-index of ICT adoption by business (bICT) and the sub-index adoption of ICT by public administration (gICT) in the Silesian Voivodeship;
5. working out the regional information society index (RISI) for the Silesian Voivodeship based on pICT, bICT and gICT sub-indices.

For the implementation of specific research tasks the following research methodologies were used:

Task 1. A review of the literature (including author's doctorial dissertation), methods of logical deduction and creative thinking.

Task 2. A review of the literature, brainstorming sessions of the research team, practical experience of the author, Delphi method, statistical analysis, online survey applying the CAWI (Computer-Assisted Web Interview) method and employing the Survey Monkey platform, analyzing the collected data using Statistical Package for Social Science (SPSS) and Microsoft Excel software.

Task 3. Literature studies, logical reasoning, correlation analysis between the identified CSFs for people, business and public administration, and the evaluation of the ICT adoption level by people, enterprises and public administration using Statistical Package for Social Science (SPSS) and Microsoft Excel software.

Task 4. Hellwig's (1968) method of the taxonomical measure of development using Microsoft Excel software.

Task 5. Estimating the RISI value using Microsoft Excel software.

The paper consists of three parts. The first part reviews the literature on methods of the information society measurement. It is followed by the interpretation of the original method of measuring information society development. The third part presents the results of empirical research and the value of regional information society index (RISI) for the Silesian Voivodeship. The research was conducted within the project 'Designing a system approach is sustainable development of the information society – on the example of Poland' financed by the National Science Centre in Poland, 2011/01/B/HS4/00974, 2011-2014. The author was a member of the project research team.

1. Information society as a subject of measurement – a literature review

Categories such as information and knowledge as well as relationships between them, have not yet been clearly defined in economics. Part of the economic analysis is based on the assumption of the semantic identity of the categories of information and knowledge. The other part makes, clear distinction between them. In my opinion there is a need to distinguish between a conceptual knowledge and information in economics as well as between information society, knowledge-based economy and knowledge society (Żelazny, 2015a). The term information society is ambiguously defined in the literature (Drucker, 1968; Bell, 1973; Drucker, 1993; Karvalics, 2007; Mansel, 2009). In this paper information society means a society in which people, enterprises and public administration using information and communication technologies (ICT) rationally managing information for the effective and efficient achievement of their own goals. ICT include ICT infrastructure, i.e. hardware, networks and telecommunication and software, i.e. system software and application software.

Chronologically, Machlup (1962) led the pioneering work in the field of measuring the role of *knowledge* (identified with *information*) in the US economy. He calculated the share of *knowledge industry* in the US GNP and the shares of knowledge-producing occupation in the labour force in the US economy. A few years later, attempts to measure the role of so-called *information flows* and the amount of consumed information were undertaken in Japan. The Research Institute of Telecommunications and Economics (RITE) developed the Johoka index – the composite index indicating the degrees of informationisation of Japanese and other societies on the basis of ten indicators in four areas (Duff, 2000; Taylor, 2006). Research works designed to measure the amount of information flow in different media, and the volume and vehicles of information in circulation in a society were led by the Information Study Group of the Association for Economic Planning, Japanese Ministry of Posts and Telecommunications and Information Flow Census (Ito, 1981; Duff, 2000). At the end of the 1970s, Porat (1977) introduced the concept of separation and measurement of primary and secondary information sectors in the US GNP. Further work towards defining the ICT sector and calculating the contribution of the ICT sector in GDP was carried out by the OECD and by The Working Party on Indicators for the Information Society (OECD, 2002) created in 1997. In 2004, the Partnership on Measuring ICT for Development was established during the UNCTAD conference. This multi-stakeholder initiative developed core lists of ICT indicators that are the basis for the collection of internationally comparable ICT statistics worldwide (ITU, 2004). Currently, one of the members of the Partnership on Measuring ICT for Development is the International Telecommunication Union (ITU) – the UN specialised agency for ICT. ITU collects data from the field of ICT and information society from most countries of the world. Based on selected indicators ITU has prepared several proposals of composite indices, i.e. The Digital Access Index, the ICT Opportunity Index, the Digital Opportunity Index or ICT Development Index (IDI). IDI values have been systematically published since 2009. This is a composite index of 11 indicators combining them into a benchmark measure that serves to monitor and compare developments in ICT across countries (ITU, 2014). Another popular composite index measuring conditions for the information society development is the Networked Readiness Index (NRI). This composite index has been systematically calculated since 2002 by the World Economic Forum. Currently, the NRI is composed of four sub-indices divided into the pillars which are described by 54 indicators (Bilbao-Osorio *et al.*, 2014).

In addition to the presented approaches to IS measuring at the national level efforts were also undertaken in this regard at the regional level. The project BISER – Benchmarking the Information Society: eEurope Indicators for European Regions identified a list of 20 basic so-called key indicators for the creation of IS foundation and they were divided into two groups – so-called population side indicators and establishment side indicators (BISER, 1998-2002). Research into the IS measurement and adjustment of an indicator description to an adequate IS development phase for the investigated region was postulated. Under UNDERSTAND project – European Regions UNDER way towards STANDard indicators for benchmarking information society were selected 75 indicators in four areas in order to compare and assess the development of the IS in 10 European regions (UNDERSTAND, 2004-2006). The project ESPON 1.2.3 – identification of relevant spatial aspects of information society – analysed three components of IS, i.e. technological, economic and social development. ESPON 1.2.3 IS index based on 12 indicators was prepared contingent upon the IS life-cycle concept with readiness, intensity and impact phases (ESPON, 2004-2006).

Analysing the identified methods of measuring different dimensions of the information society development, the following restrictions should be pointed out:

- generality, i.e. assuming a possible use of these methods in a universal way, regardless of the level of the IS development in a given country or region (with the exception of ESPON 1.2.3. IS index),
- arbitrariness, i.e. identifying determinants of IS development, indicators characterising them and the weights adopted for the calculation mainly stem from individual researchers' beliefs and are not based on empirical research,
- imbalance between supply-side approach and demand-side approach, manifesting itself in the prevailing use of indicators characterising access to ICT and information in relation to the use of ICT and information for the effective and efficient implementation of the IS stakeholder objectives.

These restrictions resulted in the need for a new approach to measuring the level of the information society development.

2. Framework of information society measurement

In the information society, people, business and public administration **through the use of information and communication technologies (ICT)** reasonably manage information for effective and efficient attainment of their own goals. It is recommended that the basis for IS measurement model was the identification of critical success factors determining effective and efficient ICT adoption, separately for people, business and public administration. *'CSFs point at these areas of people, business and public administration which should be focused on primarily in order to achieve the most satisfying results of ICTs adoption'* (Ziemba, 2015).

The process of exploring these CSFs consists of several steps. During the first stage based on the literature studies and the knowledge of the research team, dozens of CSFs conditioning ICT adoption, separately for people, business and public administration were identified. During these studies Polish and English-language items were used. Then, combining the theoretical knowledge and practical experience of the research team, an initial set of CSFs for ICT adoption in Poland was developed. To establish a prototype set of CSFs, brainstorming sessions, deductive and inductive reasoning, and creative thinking were implemented at this stage. These factors were highlighted in four dimensions (economic, socio-cultural, technological and organizational) and at three development stages (ICT access, ICT competences and ICT use). In the next step, a verification of the prototype set of CSFs using the Delphi method was carried out wherein thirty four experts participated in a few rounds of the research. The experts were – 16 managers of the local and state government responsible for e-government in Poland; 6 professors of Polish universities who conduct studies and have empirical experience in the fields of information society; 4 IT managers managing IT in 4 enterprises; 4 managing directors of 4 enterprises; 4 people using ICT in their personal and professional life and acting for digital inclusion (Ziemba, 2015). Consequently, the sets of CSFs were verified. In the last round of the Delphi study, the experts evaluated the strength of influence of particular CSFs on ICT adoption by people, business and public administration. The questionnaire received by the experts was based on a five-point Likert scale (1 – disagree strongly, 2 – disagree, 3 – neither agree nor disagree, 4 – agree, and 5 – agree strongly). Received data was statistically analysed using Statistical Package for Social Science (SPSS) and Microsoft Excel software. The following values were calculated: mean, coefficient of variation and Cronbach's alpha coefficient. These sets of CSFs become one of the components of the survey questionnaires for people, enterprises and public administration. The questionnaires also included operant questions diagnosing the level of ICT adoption by people, enterprises and government units. At least one diagnostic question was prepared for each identified critical success factor. All questions were closed and a five-point Likert scale was used fro most of them. Some questions required 'Yes', 'No' or 'Neither yes nor no' answers. Monkey platform

was used in order to develop the electronic versions of survey questionnaires. The study was conducted by the CAWI (Computer-Assisted Web Interview) method. The sample consisted of 3,500 people, 2,000 enterprises and 2,711 government units in Poland. Selected non-probability sampling research methods (purposeful and voluntary selection) were used. The data was collected between 22 December 2013 and 15 April 2014 for government units and between 22 December 2013 and 30 April 2014 for people and enterprises. 751 correct and complete responses from people, 322 correct and complete responses from enterprises and 409 correct and complete responses from government units were received (Ziemba, 2015). Given the number of complete questionnaires both in the part concerning CSFs and the diagnostic one on the level of ICT adoption by people, enterprises and government units in the Silesian Voivodeship, 499 (people), 261 (enterprises) and 67 (government units) responses were obtained respectively.

Based on the received responses, after calculating the arithmetic mean, a list of 10 most important factors determining the effective use of ICT by people, enterprises and government units in the Silesian Voivodeship (a total of 30 factors) was developed. Then, based on logical reasoning and correlation analysis between the identified CSFs for people, business and public administration, and the evaluation of the ICT adoption level by these stakeholders each factor was described by relevant indicators. The primary data for most of these indicators was collected during CAWI study. The collected data was subject to standardisation procedure according to the following formula (Żelazny, 2015b):

$$z_{ij} = \frac{x_{ij} - \bar{x}_j}{S(x_j)} \qquad (1)$$

where:
z_{ij} – the normalised value of the variable *j* for the object *i*,
x_{ij} – the value of the variable *j* for the object *i*,
$\bar{x}_j$ – the arithmetic mean of the variable *j*,
$S(x_j)$ –the standard deviation of the variable *j*.

During the next step the coordinates of the reference object on the basis of the following formula were calculated:

$$z_{0j} = \begin{cases} \max\{z_{ij}\} \text{ when } z_j \text{ is stimulant} \\ \min\{z_{ij}\} \text{ when } z_j \text{ is destimulant} \end{cases} \qquad j = 1,2,\ldots k \qquad (2)$$

where:
z_{0j} – the normalised maximum value of the variable z_{ij} when the variable is a stimulant (or minimum, when it is a destimulant) – the so-called pattern.

After determining the coordinates of the reference object, weights were assigned to the respective variables based on the participation of the CSF arithmetic mean in the total average of the 10 CSFs (in case of two or more indicators describing given CSF, the weight was calculated proportionally). Then, the Euclidean distance of the object from the development pattern was determined according to the following formula:

$$d_{i0} = \sqrt{\sum_{j=1}^{k} (z_{ij} - z_{0j})^2 w_j} \qquad (3)$$

where:
z_{ij} – the standardised value of the variable *j* for the object *i*,
z_{0j} – the standardised maximum value of the variable z_{ij} when the variable is a stimulant (or minimum, when it is a destimulant),
k – number of variables,
w_j – weight of the variable *j* satisfying conditions $0<w_j<1$ and $\sum_{j=1}^{k} w_j = 1$.

To determine the relative measure of development for people, enterprises and public administration from the Silesian Voivodeship the following formula was used:

$$d_i = 1 - \frac{d_{i0}}{d_0} \qquad (4)$$

where:
d_i –the synthetic development measure,
d_{i0} – the Euclidean distance of the object from the pattern object,
d_0 –distance of the object from the pattern, determined in accordance with the formula (5) to normalize d_i in the interval [0,1].

$$d_0 = \bar{d}_0 + 2S_d \qquad (5)$$

where:
$\bar{d}_0$ – the average distance between objects and the development pattern,
S_d – standard deviation d_0.

The values of the synthetic development measure di are in the interval [0,1], and a higher value of the measure means that the object is closer to the pattern. The regional information society index (RISI) was defined based on the calculated di for people (pICT), businesses (bICT) and public administration (gICT) from the Silesian Voivodeship according to the following formula:

$$\text{RISI} = \frac{1}{3}\text{pICT} + \frac{1}{3}\text{bICT} + \frac{1}{3}\text{gICT} \qquad (6)$$

RISI values are contained in the interval [0,1], the closer its value to unity, the higher the level of ICT use and information society development in the region is. Detailed information on the identified critical success factors, indicators and values of synthetic development measure for people, enterprises and public administration in the Silesian Voivodeship is presented later in this paper.

3. Calculation of regional information society index (RISI) for Silesian Voivodeship

The ranking of 10 critical success factors for ICT adoption by people in the Silesian Voivodeship based on the value of arithmetic mean is presented in *Table 1*. A complete list includes 41 factors in four dimensions (economic, socio-cultural, technological and organisational) and at three development stages (ICT access, ICT competences and ICT use). Technological availability of ICT was assessed as the highest by 499 respondents from this voivodeship (the mean equals to 4.45). Apart from it two other factors from the technological dimension were indicated, i.e. people's ICT competences and open source software licences. Four factors were assigned to economic dimension (financial situation of people, ICT costs, economic benefits for people arising from ICT adoption, competition in ICT market). Two

factors are organisational factors, i.e. need to make people's lives easier and people's satisfaction with e-products and e-services delivered by enterprises and public administration. One factor – people's awareness of ICT is of socio-cultural nature. The coefficient of variation stays in the range between 16% and 21%. All factors have enough variability to be useful (above 10%). Cronbach's alpha coefficient for each construct is above 0.90, and for all 41 factors it equals to 0.905. This means strong internal consistency and good reliability of scale.

Table 1. 10 CSFs for ICT adoption by people in Silesian Voivodeship

No.	Critical success factor	n	mean	min	max	standard deviation	coefficient of variation
1	Technological availability of ICT	499	4.45	1	5	0.71	16%
2	Need to make people's lives easier	497	4.43	1	5	0.81	18%
3	Financial situation of people	499	4.38	1	5	0.78	18%
4	People's satisfaction with e-products and e-services delivered by enterprises and public administration	498	4.36	1	5	0.81	18%
5	ICT costs	499	4.34	1	5	0.82	19%
6	Economic benefits for people arising from ICT adoption	498	4.22	1	5	0.75	18%
7	People's awareness of ICT	498	4.22	1	5	0.79	19%
8	Competition in ICT market	497	4.20	1	5	0.82	20%
9	People's ICT competences	493	4.20	1	5	0.79	19%
10	Open source software licences	498	4.18	1	5	0.86	21%

Source: own calculation.

As noted in the previous section, each of the 10 critical success factors was described by specific indicators. The indicators must meet the following criteria – suitability, availability of data and convergence with international measurement standards (Żelazny, 2015b). The list of indicators along with the results of the calculation of sub-index of ICT adoption by people (pICT) in the Silesian Voivodeship is presented in *Table 2*.

pICT value at the level of 0.31 means that in order to reach the hypothetical reference pattern in terms of ICT use by the inhabitants of the Silesian Voivodeship, the distance of 0.69 would have to be made up for, thus more than double the distance compared to the one currently achieved.

Table 3 presents a ranking of 10 critical success factors for ICT adoption by business in the Silesian Voivodeship based on the arithmetic mean. A complete list includes 52 factors in four dimensions (economic, socio-cultural, technological and organisational) and at three development stages (ICT access, ICT competences and ICT use). Economic benefits for enterprises arising from ICT adoption were assessed as the highest by 259 respondents from this voivodeships (the mean equals to 4,37). Apart from it two other economic factors were indicated among 10 CSFs, i.e. financial situation of enterprises and competition in ICT market. The broadest set is made up of technological factors, namely: information security in enterprises, ICT competences of enterprises' employees, quality of front- and back-office information systems in enterprises and integration of front- and back-office information systems in enterprises. The organisational dimension is composed of – customers' satisfaction with e-services and e-products delivered by enterprises and top management support. One factor – management personnel awareness of ICT, was classified in the socio-cultural dimension.

Table 2. Sub-index of ICT adoption by people (pICT) in Silesian Voivodeship

CSFs for ICT adoption by people	Symbol	Inidicators	$\overline{d_0}$	S_d	d_0	$\overline{d_i}$	pICT
Technological availability of ICT	p.1.1.	Speed of Internet connection	**2.2**	**0.47**	**3.1**	**0.31**	**0.31**
	p.1.2.	Technological constraints of ICT adoption					
Need to make people's lives easier	p.2.1.	Facilitation of everyday professional and personal life arising from ICT adoption					
	p.2.2.	Changes in people's daily lives arising from ICT adoption					
Financial situation of people	p.3.1.	Financial capabilities of people for adopting ICT					
	p.3.2.	People's wealth					
People's satisfaction with e-products and e-services delivered by enterprises and public administration	p.4.1.	People's satisfaction with e-services or e-products delivered by enterprises					
	p.4.2.	People's satisfaction with e-government services					
ICT costs	p.5.1.	Expenditure incurred by people for adopting ICT					
Economic benefits for people arising from ICT adoption	p.6.1.	Economic benefits for people arising from ICT adoption					
People's awareness of ICT	p.7.1.	Awareness of the need to adopt ICT to make everyday personal and professional life easier					
Competition in ICT market	p.8.1.	Intensity of competition in ICT market					
People's ICT competences	p.9.1.	ICT competences of people					
	p.9.2.	Mentors of ICT					
Open source software licences	p.10.1.	Usage of open source software					

Source: own calculation.

The coefficient of variation stays in the range between 16% and 21%. All factors have enough variability to be useful (above 10%). Cronbach's alpha coefficient for each construct is above 0.95, and for all 52 factors it equals to 0.953. This means strong internal consistency and good reliability of scale.

Table 3. 10 CSFs for ICT adoption by business in Silesian Voivodeship

No.	Critical success factor	n	mean	min	max	standard deviation	coefficient of variation
1	2	3	4	5	6	7	8
1.	Economic benefits for enterprises arising from ICT adoption	259	4.37	2	5	0.70	16%
2.	Financial situation of enterprises	260	4.28	2	5	0.80	19%
3.	Information security in enterprises	260	4.25	1	5	0.90	21%
4.	ICT competences of enterprises' employees	258	4.24	2	5	0.74	17%

1	2	3	4	5	6	7	8
5.	Customers' satisfaction with e-services and e-products delivered by enterprises	259	4.24	1	5	0.80	19%
6.	Quality of front- and back-office information systems in enterprises	259	4.22	1	5	0.78	18%
7.	Competition in ICT market	258	4.21	1	5	0.81	19%
8.	Top management support	261	4.18	2	5	0.75	18%
9.	Management personnel awareness of ICT	261	4.17	2	5	0.77	18%
10.	Integration of front- and back-office information systems in enterprises	256	4.16	1	5	0.77	19%

Source: own calculation.

Based on the list of 10 CSFs for ICT adoption by business in the Silesian Voivodeship, indicators were assigned and the calculation of bICT sub-index was made. The relevant data is contained in *Table 4*.

bICT value at 0.37 means that in order to reach a hypothetical reference pattern in the use of ICT by enterprises from the Silesian Voivodeship, the distance of 0.63 would have to be made up for.

Table 5 presents the ranking of 10 critical success factors for ICT adoption by public administration in the Silesian Voivodeship based on the arithmetic mean. A complete list includes 55 factors in four dimensions (economic, socio-cultural, technological and organizational) and at three development stages (ICT access, ICT competences and ICT use). Two factors from the technological dimension received the highest ranking, i.e. integration of front- and back-office information systems and quality of e-government services (4.58). The set of technological factors is complemented by – information security in government units and ICT competences of government employees. Three factors are of economic nature, i.e. financial situation of government units, public outlay on hardware, networks, and telecommunications and public outlay on front- and back-office information systems. Electronic communication between government units, state standardization of solutions for e-government and top management support are standardisation success factors for e-government adoption. In the group of 10 CSFs for ICT adoption by public administration in the Silesian Voivodeship there was no single socio-cultural factor (the first from this area, i.e. ICT awareness of management personnel in government units was classified at 11 place with the arithmetic mean equal to 4.33).

Table 4. Sub-index of ICT adoption by business (bICT) in Silesian Voivodeship

CSFs for ICT adoption by busienss	Symbol	Indicators	$\overline{d_0}$	S_d	d_0	$\overline{d_i}$	bICT
Economic benefits for enterprises arising from ICT adoption	b.1.1.	Improvement of enterprise's financial situation arising from ICT adoption					
	b.1.2.	Improvement of management in enterprise arising from ICT adoption					
Financial situation of enterprises	b.2.1.	Financial capabilities of enterprises for adopting ICT					
	b.2.2.	Profit of enterprises					
Information security in enterprises	b.3.1.	Legal regulations concerning information security and personal data protection					
	b.3.2.	Technological security of front- and back-office information systems					
ICT competences of enterprises' employees	b.4.1.	ICT competences of enterprises' employees					
	b.4.2.	Training of employees in ICT					
Customers' satisfaction with e-services and e-products delivered by enterprises	b.5.1.	Customers' satisfaction with e-services and e-products delivered by enterprises					
Quality of front- and back-office information systems in enterprises	b.6.1.	Quality of front- and back-office information systems	**1.93**	**0.57**	**3.09**	**0.37**	**0.37**
Competition in ICT market	b.7.1.	Conducting competitiveness analyses of ICT product prices and quality on the ICT market					
	b.7.2.	Intensity of competition in ICT market					
Top management support	b.8.1.	Coordination of ICT projects in enterprise					
	b.8.2.	Alignment between business and ICT					
Management personnel awareness of ICT	b.9.1.	Management personnel awareness of the need to adopt ICT to improve enterprise performance					
	b.9.2.	ICT competences of management personnel					
	b.9.3.	Training of management personnel in ICT					
Integration of front- and back-office information systems in enterprises	b.10.1.	Implementation of ERP system					
	b.10.2.	Implementation of Business Intelligence system					

Source: own calculation.

The coefficient of variation stays in the range between 13% and 19%. All factors have enough variability to be useful (above 10%). Cronbach's alpha coefficient for each construct is above 0.93, and it equals to 0.934 for all 55 factors. This means strong internal consistency and good reliability of scale.

Table 5. 10 CSFs for ICT adoption by public administration in Silesian Voivodeship

No.	Critical success factor	n	mean	min	max	standard deviation	coefficient of variation
1.	Integration of front- and back-office information systems	66	4.58	3	5	0.66	14%
2.	Quality of e-government services	66	4.58	3	5	0.61	13%
3.	Electronic communication between government units	67	4.55	3	5	0.63	14%
4.	State standardization of solutions for e-government	67	4.51	1	5	0.75	17%
5.	Information security in government units	66	4.48	2	5	0.71	16%
6.	Top management support	67	4.48	3	5	0.68	15%
7.	Financial situation of government units	67	4.43	2	5	0.84	19%
8.	ICT competences of government employees	66	4.42	3	5	0.61	14%
9.	Public outlay on hardware, networks, and telecommunications	67	4.42	2	5	0.68	15%
10.	Public outlay on front- and back-office information systems	67	4.34	2	5	0.79	18%

Source: own calculation.

Based on the list of 10 CSFs for ICT adoption by government in the Silesian Voivodeship, indicators were assigned and gICT sub-index was worked out. The relevant data is included in *Table 6*.

Table 6. Sub-index of ICT adoption by government (gICT) in Silesian Voivodeship

CSFs for ICT adoption by public administration	Symbol	Indicators	$\overline{d_0}$	S_d	d_0	$\overline{d_i}$	gICT
Integration of front- and back-office information systems	g.1.1.	Integration of functional area information systems (ERP modules)	**2.09**	**0.47**	**3.02**	**0.31**	**0.31**
	g.1.2.	Integration of functional area information systems (ERP modules) and front-office information systems					
	g.1.3.	Implementation of electronic document management system					
Quality of e-government services	g.2.1.	Quality of e-government services					
	g.2.2.	Maturity of e-government services					
Electronic communication between government units	g.3.1.	Interoperability of information systems					
	g.3.2.	Implementation of electronic inbox for supporting G2G relations					
State standardization of solutions for e-government	g.4.1.	State standardization of e-government services					
Information security in government units	g.5.1.	Legal regulations concerning information security and personal data protection					
Top management support	g.6.1.	Management personnel's awareness of the need to adopt ICT for improving government unit performance					

CSFs for ICT adoption by public administration	Symbol	Indicators	$\overline{d_0}$	S_d	d_0	$\overline{d_i}$	gICT
	g.6.2.	Management personnel support for ICT projects					
	g.6.3.	Coordination of ICT projects					
	g.6.4.	Formalised information society strategy					
	g.6.5.	Training of management personnel in ICT					
	g.6.6.	ICT competences of management personnel					
Financial situation of government units	g.7.1.	Financial capabilities of government unit for adopting ICT					
ICT competences of government employees	g.8.1.	ICT competences of government employees					
	g.8.2.	Training of employees in ICT					
	g.8.3.	Employees' awareness of the need to adopt ICT for improving government unit performance					
Public outlay on hardware, networks, and telecommunications	g.9.1.	Public outlay on hardware, networks and telecommunications					
	g.9.2.	Public outlay on hardware, networks and telecommunications per full-time employees					
Public outlay on front- and back-office information systems	g.10.1.	Public outlay on front- and back-office information systems					
	g.10.2.	Public outlay on front- and back-office information systems per full-time employees					

Source: own calculation.

gICT value at the level of 0.31 means that in order to reach the hypothetical reference pattern in terms of ICT use by public administration units from the Silesian Voivodeship, the distance of 0.69 would have to be made up for, thus more than double the distance compared to the one currently achieved.

Given the sub-index values of ICT level of use by people, businesses and public administration from the Silesian Voivodeship, the regional information society index was calculated according to the following formula:

$$\text{RISI} = \frac{1}{3}\text{x } 0.31 + \frac{1}{3}\text{x } 0.37 + \frac{1}{3}\text{x } 0.31 = 0.33 \qquad (7)$$

The level of ICT use of by people, businesses and public administration as well as the development of the information society in the Silesian Voivodeship reached a value which represents one-third – i.e. 33% – of the hypothetical development pattern (1). Development activities should take into account the identified critical success factors for an effective and efficient ICT use by the three main actors of the information society.

Conclusions

Research on measuring the role of information and knowledge in socio-economic development has been conducted for over 50 years. Conceptual controversies concerning the original term – information and its derivative – knowledge and interactions between them

result in difficulties in precise defining the categories of information society and knowledge-based economy. Lack of clear concepts makes it impossible to measure accurately the level of IS development.

This study contributes to measuring of information society in two ways. Firstly, the model of IS measurement based on CSFs and method of the taxonomical measure of development was proposed. They are theoretical implications of research. Secondly, it showed practical application of proposed model and calculated the level of IS development in Silesian Voivodeship.

It is assumed that the information society is one in which the realisation of the objectives by people, enterprises and public administration is more rational through the use of information and ICT in economic, cultural and political dimensions. ICT radically change the way of creation, acquisition, gathering, processing and transmission of information. Therefore, the identification of factors that determine the efficient and effective adoption of ICT and information by people, enterprises and public administration should be the first step in the process of measuring information society development as well national as regional level.

The following 10 critical success factors for ICT adoption were diagnosed in the Silesian Voivodeship:

- by people: technological availability of ICT, need to make people's lives easier, financial situation of people, people's satisfaction with e-products and e-services delivered by enterprises and public administration, ICT costs, economic benefits for people arising from ICT adoption, people's awareness of ICT, competition in ICT market, people's ICT competences and open source software licences;
- by enterprises: economic benefits for enterprises arising from ICT adoption, financial situation of enterprises, information security in enterprises, ICT competences of enterprises' employees, customers' satisfaction with e-services and e-products delivered by enterprises, quality of front- and back-office information systems in enterprises, competition in ICT market, top management support, management personnel awareness of ICT and integration of front- and back-office information systems in enterprises;
- by public administration: integration of front- and back-office information systems, quality of e-government services, electronic communication between government units, state standardization of solutions for e-government, information security in government units, top management support, financial situation of government units, ICT competences of government employees, public outlay on hardware, networks, and telecommunications and public outlay on front- and back-office information systems.

Comparing research outcomes of critical success factors sets for efficient and effective adoption of ICT and information by people, enterprises and public administration for Poland and for the Silesian Voivodeship were similar, however order of first ten CSFs was different (Żelazny, 2015c; Ziemba, 2015). It would be worth to examine CSFs in large representative samples as well in Poland and Polish regions as in other countries and regions, i.e. Central and Eastern European Countries. It might be a subject of further research.

The calculated IS development level of a country or region using the presented method shows the distance of this country or region from the theoretical, ideal pattern. It turned out that the Silesian Voivodeship has to make up for two times greater distance in relation to the one achieved nowadays (0.33 versus hypothetical 1). The business sector reached a slightly higher level of ICT adoption in comparison to the public administration and households.

The use of an approach based on the identification of critical success factors that determine the ICT adoption and IS development will help to reduce and remove many measuring restrictions. Generality i.e. the assumption of the possibility of applying measurement methods in a universal way will be replaced by specificity resulting from

different CSFs for countries and regions with different conditions for the IS development and different levels of IS development. It is worth noting that the set of CSFs is the result of multistep research methodology. Arbitrariness in the selection of indicators will be replaced by a description of each CSF by means of such indicators that are correlated with the CSFs and adequately characterise them. Subjectivism of teams of experts in determining weights for the various dimensions will be replaced by a calculation of weights including an evaluation of the validity of each CSF made by a representative sample of respondents.

Of course, identifying different sets of CSFs and various indicators characterising the CSFs will prevent a simple benchmarking. However, this is not a significant limitation of this measurement method. Doubts concerning the type of questions that must be used for various indicators are a bigger limitation. For, the type of a question determines the type of measurement scale (nominal, ordinal, interval and ratio) and mathematical operations. It is recommended that diagnostic questions are formulated in a manner allowing the use of metric scales (interval and/or ratio). A limitation in the application of the presented measurement method may be the fact that it is cost-intensive which is associated with conducting primary research on large representative samples.

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