AN ANALYTICAL HIERARCHY PROCESS MODEL FOR THE EVALUATION OF THE E-GOVERNMENT DEVELOPMENT

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Abstract: *With the increasing number, variety and effects of modern technologies, e-government needs to define a new evaluation model that fits their requirements and operations. Therefore, this paper presents an example on solving the e-government development evaluation problem using the Analytical Hierarchy Process method. The proposed model consists of criteria identified through the comparison of the selected e-government indices, including the new approaches such as cloud computing, open data, social media, etc. A case study is presented to demonstrate the usefulness of this model to solve multiple criteria decision making problems.*

Keywords: *AHP, Decision making, E-government evaluation, E-government indices.*

JEL Classification: *C43, C44, H11, H83, L86.*

Introduction

Since the development of e-government is a continuous process of improvement, it requires continuous evaluation and updating its framework using modern computing technologies and platforms. However, e-government also faces several challenges and constraints, primarily budget shrinking, increasing public demand for information and services and continuous advances in technology, resources and standards. In order to overcome these challenges, governments should be willing to adopt innovative ideas for e-government such as cloud computing, big data analytics, open data portals, etc. In such a situation, the traditional e-government model has become difficult to operate.

A large amount of research has been investigated into monitoring, evaluating and benchmarking e-government system. Thus, with the rapid e-government development, it becomes critical to investigate, redefine, restructure and also reweight the related e-government development frameworks and indices.

E-government is closely related to e-readiness, which is defined as the degree to which a community (citizens, businesses and governments) is prepared to participate in using modern information and communications technologies (ICT) [11], [17]. But these terms are nowadays mostly used as synonyms.

1 Problem formulation and research methodology

In [14], there has been introduced a model using an Analytic Hierarchy Process (AHP), but only focused on the regional level in the developing countries. Since this paper is intended to focus on the European level, only a few of the proposed criteria may be used. Yuming and Hongyan [20] used AHP to analyze the relative weight of the influential factors to the success of the e-government development. However, they only focused on the single index in the selected developing countries.

The main aim of this paper is to propose an AHP model for the comparison of the selected European countries based on the new innovative ideas for the e-government evaluation. To meet this aim, some objectives are defined. The first objective of this paper is to determine the variables or criteria in the e-government evaluation using the global e-government development indices and related reports. For this reason, a list of criteria has been elaborated in detail based on the literature review, experiences and the needs of governments to analyze capability of each selected index. The second objective is to propose a case study, which uses the AHP model and help to select the most suitable European country based on the defined criteria.

The first part of this paper is based on literature review of foreign and domestic resources which led to make recommendations on the selection of the most suitable e-government development indices and the related criteria to propose the AHP model. The case study then consists of the AHP method over the set of obtained data. Data were collected mostly from annual e-government reports [3], [17] or [19], international journals, reference books, websites, and related organizations/authorities, etc. The main tools used are the Expert Choice software and Microsoft Excel 2010.

2 Literature review

2.1 E-government development and related indices

Through the last 15 years, several frameworks have been introduced to compare and assess the opportunities and challenges facing various e-government strategies and initiatives. Some of them are based on measurable characteristics of the entities, others then use one or more subjective measures, a few employ a combination of both [11]. The output is then mostly a rank or weighted index. There are a number of indexes. However, the range of tools uses widely varying definitions and different methods for measurement. Some of them have become frequently used as benchmarks, guiding the debate as well as governments' investments in e-government [2], [10]. In the European Union (EU), there is a series of the EU e-Government Benchmarking reports. This annual exercise started in 2001 and the 2014 report [1] is the eleventh measurement. These reports are focused on the best performing countries that have implemented the most mature e-government services. The results are mostly shown in the graph and there is no single ranking, but more rankings based on the measured services. Also the weights or even indicators in the same model may change over the time for different reasons, the most important, emerging new technology or paradigm. The last report is based on the E-government Benchmark Framework 2012–2015 [1].

In a global perspective, frequently cited indices include the United Nations (UN) E-government rankings, the Economist's E-government readiness and digital economy rankings, Brown university's global e-government report, Waseda E-government ranking, World Economic Forum's (WEF) index and International Telecommunication Union's (ITU) index. The early 2010s has added new indices to the e-government development evaluation research, e.g. the Asia Cloud Computing Association's (ACCA) Cloud Readiness Index (CRI), Business Software Alliance (BSA) Global Cloud Computing Scorecard, the Web Index produced by the World Wide Web Foundation (W3F) or Open Knowledge Foundation's (OKF) index.

In recent years, most of the researchers have focused on the current state of the art of e-government, the evaluation of the e-government services or relationship between businesses, citizens and governments. Špaček [16] outlined emerging coordination practices that can be observed in European countries and stated that governments across Europe work with a mix of instruments aimed at enhancing the centralization of their e-government development through various centrally promoted infrastructures and services that allow for more integrated service delivery, virtual or physical, and through changes in organizational structures. Rorissa et al. [11] then assessed the strengths and limitations of six selected frameworks for computing e-government indices and concluded that benchmarking evaluations should be extended to include other means of access and delivery of e-government services, such as digital television or mobile technologies. Mazengera in [9] then used the correlation analysis to identify factors contributing to successful e-government implementation. This study has revealed that there was the correlation between the Internet use and the number of mobile phones, but a very low correlation with the literacy level. Krishnan et al. in [4] showed that ICT infrastructure, e-participation and human capital had a direct relationship with e-government maturity.

Mohammed and Ibrahim [10] revisited the existing e-government indices to show the main common indicators and proposed a preliminary framework to refine indices' indicators according to the characteristics of the cloud computing. This framework is based on the claim that the benefits of cloud computing for e-government will reduce the need for some requirements, while the challenges impose more attention to others. As a result, some indicators will get low weight in the index and others will get high weight or even new indicators or variables can by introduced. Also Kurdi et al. [5] designed a framework for assessing the readiness of e-government systems, which was focused on the migration to cloud computing. The framework covered four dimensions – technological block (network and security infrastructures and quality of systems and services), organizational block (structure, culture, size and strategy of organization together with strategic planning), people and stakeholders block (citizens, businesses and governments) and the last one is environment and society block (demographic characteristics and social, cultural, political and economic issues of a country).

Among others, also the EU, the UN or the WEF emphasize the importance of cloud computing technologies, social media, open and big data to provide flexibility and enable greater consistency in the public services. These elements are the driving forces behind making use of e-government in increasingly sophisticated ways [1], [17], [19].

2.2 Multiple criteria decision making and AHP in the e-government development

Real-world decision making problems are usually complex and no structures are to be considered through the examination of a single criterion, or point of view that will lead to the optimum decision. Multiple criteria decision making (MCDM) offers a lot of methods that can help in problem structuring and tackling the problem complexity because of the multi-dimensionality of the sustainability goal and the complexity of socio-economic, environment and government systems [21].

AHP is a MCDM tool that has been used in almost all the applications related with decision making [18]. AHP, developed by Saaty [12], [13], is a powerful, flexible and widely used method for complex problems, which consider the numeric scale for the measurement of quantitative and qualitative performances. This is an Eigen value approach to the pairwise comparisons. It is one of the very few MCDM approaches capable of handling many criteria [12], [18]. The most important characteristic of AHP is combining knowledge, experience, individual opinions and foresights in a logical way. Moreover, it can be also user friendly as AHP is well supported by commercially developed software (e.g. Expert Choice), which also provides sensitivity analysis of results [18].

The main aim of calculation technique is to make a reciprocal matrix comparison expressing the relative values of a set of attributes. The comparisons are used to structure a matrix of pairwise comparisons called the judgment matrix or square matrix *M*. To calculate relative weights of elements in each pairwise comparison matrix, the Eigen value method can be employed. The Eigen value (λ_{max}) can be then obtained by summing of products between each element of Eigen vector multiplied by the total of columns of the reciprocal matrix. Inconsistency may occur when λ_{max} moved away from n this is because of the inconsistency responses in pairwise comparisons. Saaty [12], [13] proved that the biggest Eigen value is equal to the number of comparisons (λ_{max} = n). Therefore, the matrix *M* should be examined for consistency by using consistency index (CI) as illustrated in the equation (1):

$$CI = \frac{\lambda max - \mathrm{n}}{n-1} \tag{1}$$

While CI depends on n, then should calculate consistency ratio (CR) as shown in the equation (2):

$$CR = \frac{CI}{RI} \tag{2}$$

where RI is the Random consistency index. The CR of less than 0.1 or (CR ≤ 0.1) indicates a satisfactory degree of consistency, otherwise, subjective judgments have to be revised [12], [13].

Shareef et al. [14] applied the SWOT analysis method to identify the priority factors (strengths and opportunities) and to concentrate on the most important factors of e-government. Then, the AHP method was used to provide a quantitative measure of significance of each factor on the decision making process to implement selected e-government development strategies. E-government project is a core of each national strategy for its benefits now and in the future. The problem of e-government projects failure is complicated due to its compound multi-attribute nature. Therefore, Sultan el al. [15] proposed a multiple criteria decision model to implement the most important and efficient actions for successful e-government projects. They concluded that human skills have the highest importance for the success of the e-government transformation.

Liangkui et al. [6] used AHP to establish the evaluation model of the e-government services outsourcing, which can determine the influence degree of different factors on e-government services outsourcing. Liu and Wang [7] proposed a hierarchical model and calculation method of e-government objectives according to the principles of AHP. Their aim was to ensure that e-government policy makers can select a higher score to consider the object as a key according to the specific scores of various options and give priority to decision making through preferences. Yuming and Hongyan [20] then used AHP to optimize the E-Government Development Index (EGDI) by the UN. Their results showed that online services are less important than telecommunication infrastructure or human capital.

3 An AHP model proposal and description

3.1 Criteria definition and selection

Firstly, the most suitable e-government indices have to be chosen. Although there are a lot of indices, most of them cannot be used. Mostly because there is a big time gap between the individual reports (the progress in time cannot be clearly compared) or they only cover selected countries. Consequently, the EGDI by the UN [17], the ITU's ICT

Development Index (IDI) [3] and the Networked Readiness Index (NRI) by the WEF [19] were chosen and compared. A brief description of them is presented in the Tab. 1, including the weight of each component (if available). The next step is the criteria selection.

Tab. 1: Comparison of the selected e-government development indices

Index	Period covered	Countries covered	Number of reports	Structure and components of the index
EGDI	2003–2014	193	7	1/3 Online Service Index (4 components), 1/3 Telecommunication Infrastructure Index (5 components with the same weight), 1/3 Human Capital Index (4 components with 1/3, 2/9, 2/9 and 2/9 weight).
IDI	2008–2014	166	6	2/5 Access sub-index (5 components with the same weight), 2/5 Use sub-index (3 components, same weight), 1/5 Skills sub-index (3 components with the same weight).
NRI	2002–2014	148	13	1/4 Environment sub-index (consists of the political and regulatory environment, business and innovation environment = 2 pillars), 1/4 Readiness sub-index (infrastructure and digital content, affordability, and skills = 3 pillars), 1/4 Usage sub-index (individual, business, and government usage = 3 pillars), 1/4 Impact sub-index (economic impacts and social impacts = 2 pillars).

Source: Author

Therefore, these three indices were decomposed and improved to encompass the new trends with a focus on the increasing emphasis on service usage, open data, cloud computing, social media and multichannel service delivery, the expansion of mobile government and e-participation. The hierarchy of criteria can be seen from the Tab. 2 As an indicator of the state of open data, the Open Data Index by the OKF and own criterion evaluating the existence of the open data portal, were added to the model together with the e-Participation Index by the UN, the International Property Rights Index by the Property Rights Alliance (PRA) and the existence of the cloud computing national framework or strategy as an own criterion.

Tab. 2: The hierarchy of the selected criteria and their data sources

Hierarchy of criteria		Data source	Range of the values
1. political environment and intellectual property rights			
	1.1 ICT use and government efficiency	WEF	1–7 (best)
	1.2 Accessibility of digital content	WEF	1–7 (best)
	1.3 Availability of latest technologies	WEF	1–7 (best)
	1.4 Cloud computing framework or strategy	own	Y/N
	1.5 International Property Rights Index	PRA	1–10 (best)
2. ICT readiness, businesses and citizens environment			
	2.1 Quality of educational system	WEF	1–7 (best)
	2.2 Global competitiveness index	WEF	1–7 (best)
	2.3 Mobile cellular telephone subscriptions per 100 inhabitants	ITU	0–304 (in 2014)
	2.4 Percentage of individuals using the Internet	ITU	0–100
	2.5 Use of virtual social networks	WEF	1–7 (best)
	2.6 e-Participation Index	UN	0–1
3. open data and e-service delivery			
	3.1 Open Data Index – percentage of openness	OKF	0–100
	3.2 National open data portal	own	Y/N
	3.3 E-service delivery – transactional presence	UN	0–100
	3.4 E-service delivery – networked (connected) presence	UN	0–100

Source: Author

3.2 Selection of alternatives and a decision table

These European countries were chosen as an example of alternatives for the case study: Czech Republic, Hungary, Poland and Slovakia. The following Tab. 3 shows the values of selected indices between 2008 and 2014. The IDI and the NRI values have to be normalized to fit the data within unity (1), so all data values will take on a value of 0 to 1. The highest value in each line is then bold. The main purpose is to demonstrate the development of e-government in these countries. This information may also influence the decision making process and the distribution of preferences. As an example, only Poland has all the best values in 2014, i.e. there can be identified a continuous improvement.

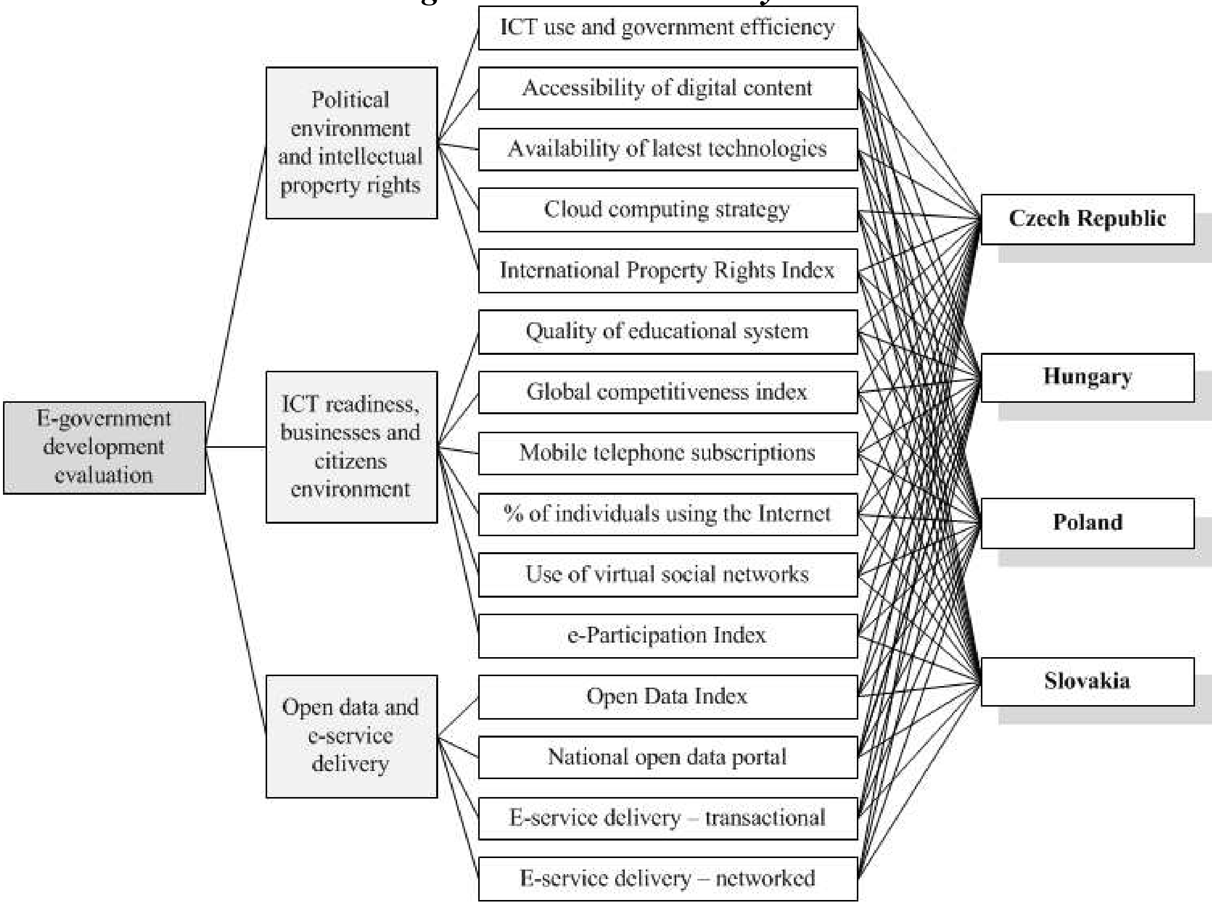
Tab. 3: The development of the selected indices between 2008 and 2014

Country	Index	Year				Average value
		2008	2010	2012	2014	
Czech Republic	EGDI	**0.670**	0.606	0.649	0.607	*0.633*
	IDI	0.492	0.597	0.630	**0.672**	*0.598*
	NRI	0.555	0.558	0.555	**0.583**	*0.563*
Hungary	EGDI	0.649	0.632	**0.720**	0.664	*0.666*
	IDI	0.518	0.604	0.591	**0.652**	*0.591*
	NRI	0.547	0.497	**0.550**	**0.550**	*0.536*
Poland	EGDI	0.613	0.558	0.644	**0.648**	*0.616*
	IDI	0.495	0.595	0.622	**0.660**	*0.593*
	NRI	0.468	0.457	0.527	**0.533**	*0.496*
Slovakia	EGDI	0.589	0.564	**0.629**	0.615	*0.599*
	IDI	0.486	0.594	0.585	**0.658**	*0.581*
	NRI	**0.528**	0.477	0.490	0.517	*0.503*

Source: Author

The first step in the AHP method is to decompose the complex decision problem into the hierarchical structure with the goal at the top of the structure. The hierarchy then descended from the more general criteria in the second level to sub-criteria. The four considered decision alternatives are located at the bottom level of the hierarchy as depicted in the Fig. 1.

Fig. 1: The AHP hierarchy model



Source: Author

It has to be noted, that the usage of the AHP method is not a new discovery in the measurement of the e-government development. However, the main contribution of this paper lies in providing a new measurement framework, which reflects the actual trends in the e-government development. These trends are then based on the in-depth analysis of global e-government reports by the ITU [3], the UN [17], the WEF [19] and also the EU [1].

A decision table with the values for the selected alternatives can be seen from the Tab. 4. The data used are from 2014.

Tab. 4: A decision table for the evaluation of selected countries using AHP

Criteria	Alternatives			
	Czech Republic	Hungary	Poland	Slovakia
1.1	3.6	3.9	3.4	3.4
1.2	6.1	6.1	5.1	5.8
1.3	5.2	5.2	4.4	5
1.4	Y	N	N	N
1.5	6.5	6.3	6.2	6.3
2.1	3.7	3.4	3.4	2.7
2.2	4.43	4.25	4.46	4.1
2.3	131.3	116.4	150.0	113.9
2.4	74.1	72.6	62.8	77.9
2.5	6	5.6	5.1	5.9
2.6	0.2549	0.451	0.4902	0.6275
3.1	66	48	42	35
3.2	Y	N	N	Y
3.3	23	37	42	16
3.4	21	9	26	38

Source: Author

4 Results and discussion

After the AHP model had been completed, a pairwise comparison of all the criteria belonging to a certain level was performed. Pairwise comparisons were performed systematically to include all the combinations of criteria and sub-criteria relationships. A matrix was formed in each group on the hierarchy. According to the data collected in the decision table, the criteria and sub-criteria were compared according to their relative importance with respect to the parent element in the adjacent upper level by using a nine-point scale. This scale ranges from 1/9 (least valued than), to 1 (equal), and to 9 (absolutely more important than).

Next, alternatives were compared by assigning corresponding numerical values based on the relative importance of alternatives under each of the sub-criterion in the decision hierarchy. In each level of the hierarchical structure, after comparing data in couples, the weight of each element was computed. The last step is to use the Eigen value approach to estimate the relative weight of decision elements and aggregate the relative weights of decision elements to arrive at a set of rating for the alternatives. For the accuracy of this application, an additional test reflecting AHP consistency (CR) was performed. Finally, a series of sensitivity analyses were conducted to investigate the impact of changing the priority of the criteria on the alternatives' ranking.

To show the importance of preferences, two use cases were designed. The first one is focused on the "old" concept of e-government, which emphasized the role of the political environment and users' readiness such as percentage of individuals using the Internet and global competitiveness index. The second use case is then focused on the "new" concept of e-government using new trends and technologies such as open data, cloud computing or social network. In the Tab. 5, each sub-criterion weights in the "local column" is relative to the criterion of superior and in the "global column" is combining weights related to the goal.

Tab. 5: Criteria and their weights for the defined use cases

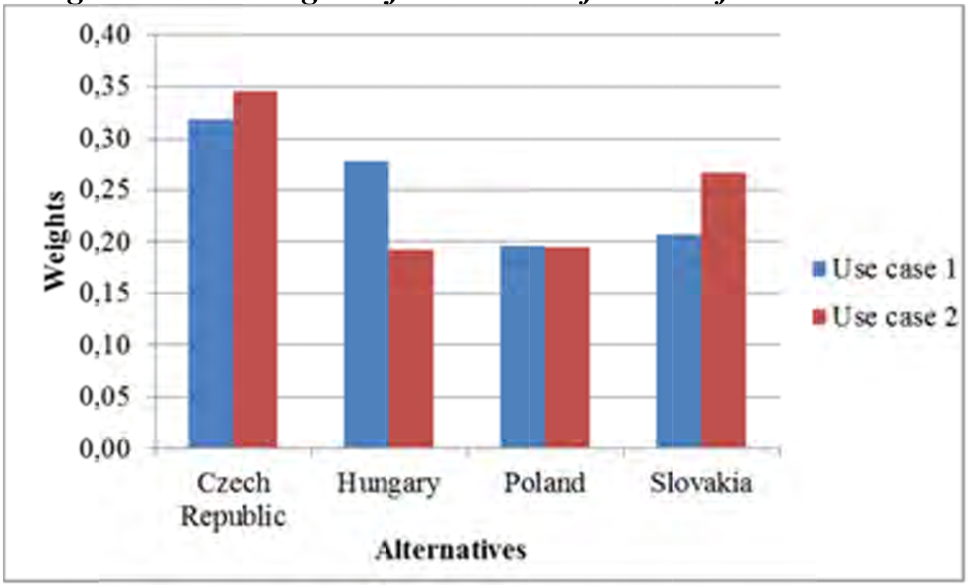
Hierarchy of criteria		Weights			
		Use case 1		Use case 2	
		Local	Global	Local	Global
1. criterion		**0.540**	-	**0.196**	-
	1.1 sub-criterion	0.384	0.207	0.068	0.013
	1.2 sub-criterion	0.209	0.113	0.169	0.033
	1.3 sub-criterion	0.212	0.114	0.187	0.037
	1.4 sub-criterion	0.080	0.043	0.464	0.091
	1.5 sub-criterion	0.115	0.062	0.112	0.022
2. criterion		**0.297**	-	**0.311**	-
	2.1 sub-criterion	0.217	0.064	0.095	0.030
	2.2 sub-criterion	0.159	0.047	0.071	0.022
	2.3 sub-criterion	0.244	0.072	0.157	0.049
	2.4 sub-criterion	0.210	0.062	0.127	0.039
	2.5 sub-criterion	0.094	0.028	0.328	0.102
	2.6 sub-criterion	0.076	0.023	0.222	0.069
3. criterion		**0.163**	-	**0.493**	-
	3.1 sub-criterion	0.195	0.032	0.391	0.193
	3.2 sub-criterion	0.138	0.022	0.276	0.136
	3.3 sub-criterion	0.276	0.045	0.138	0.068
	3.4 sub-criterion	0.391	0.064	0.195	0.096

Source: Author

Fig. 2 shows the final weights for the selected alternatives for each use case. Based on these results, the main findings are discussed as follows. In terms of the selected alternatives, the Czech Republic is regarded as the highest priority by decision maker compare to Hungary, Poland and Slovakia for both use case. It is found that Hungary is more focused on the "old" concept of e-government and Slovakia is more focused on the "new" concept of e-government.

The results have important implications for governments, especially in Hungary, that they should place more emphasis on the criteria of cloud computing, social media, open and big data, because the importance of these technologies is still increasing in the society. Also the other European countries may be compared using the proposed AHP model. For future studies, more alternatives which encompass both domestic and international aspects may be added to the current research.

Fig. 2: Overall weights of alternatives for the defined use cases



Source: Author

Conclusion and future research directions

The aim and partial objectives were completed successfully. E-government aims at increasing the convenience and accessibility of government services and information to citizens, businesses and also governments. Therefore, the purpose of this paper was to develop a decision support model by using AHP. The proposed model addresses the most relevant issues in selecting the country with the best e-government system based on the defined hierarchy of the criteria. This paper also analyzed the structure of the selected e-government development frameworks and indices to introduce the issue of redefining and reweighting of these indices and their attributes.

The future research will be directed to the extension of this model to cover the other EU Member States or countries in the world, while the selected attributes may be omitted or reweighted to measure the impact of new technologies on the e-government development, e.g. using the framework presented in [8]. The proposed model can be also used to calculate a new index using the hierarchy of criteria defined in the Table 2, where all these attributes will get weight according to their importance for the e-government development, e.g. as it was proposed in [10].

References

[1] EUROPEAN COMMISSION. *Delivering the European Advantage?: The 11th eGovernment Benchmark report*. Luxembourg: Publications Office of the European Union, 2014. 120 p. ISBN 978-92-79-38052-5.

[2] GRÖNLUND, Å. Connecting eGovernment to Real Government – The Failure of the UN eParticipation Index. In: *Electronic government.* Berlin Heidelberg: Springer, 2011, pp. 26–37.

[3] INTERNATIONAL TELECOMMUNICATION UNION. *Measuring the Information Society Report 2014*. Geneva: Telecommunication Development Bureau, 2014. 250 p. ISBN 978-92-61-15291-8.

[4] KRISHNAN, S.; TEO, T.; LIM, J. E-Participation and E-Government Maturity: A Global Perspective. In: *Grand Successes and Failures in IT: Public and Private Sectors*. Berlin Heidelberg: Springer, 2013, pp. 420–435.

[5] KURDI, R.; TALEB-BENDIAB, A.; RANDLES, M.; TAYLOR, M. E-Government Information Systems and Cloud Computing (Readiness and Analysis), In: *Developments in E-systems Engineering (DeSE)*. IEEE, 2011, pp. 404–409.

[6] LIANGKUI, Y.; DONGSHAN, M.; QING, J. Analysis Based on AHP about the Factors of E-Government Services Outsourcing. In: *Proceedings of the International Conference on Management and Service Science (MASS'09)*. IEEE, 2009, pp. 1–4.

[7] LIU, J.; WANG, S. A Study on Multi-objective Optimization of E-Government Based on AHP. In: *Proceedings of the 2010 International Conference on Electrical and Control Engineering*. IEEE, 2010, p. 2643–2646.

[8] LNĚNIČKA, M.; MÁCHOVÁ, R.; KOMÁRKOVÁ, J. Cloud E-Government Index as a New Benchmarking Framework for the Public Sector. In: *Proceedings of the 19th International Conference Current Trends in Public Sector Research.* Brno: Masaryk University, 2015, pp. 29–37.

[9] MAZENGERA, B. Factors Contributing To Successful E-Government Implementation in Southern African Development Community (SADC) Countries. In: *Proceedings of the 16th IBIMA Conference on Innovation and Knowledge Management: A Global Competitive Advantage*. IBIMA, 2011, pp. 1050–1057.

[10] MOHAMMED, F.; IBRAHIM, O. Refining E-government Readiness Index by Cloud Computing. *Jurnal Teknologi*, 2013, Vol. 65, No. 1, pp. 23–34.

[11] RORISSA, A.; DEMISSIE, D.; PARDO, T. Benchmarking e-Government: A comparison of frameworks for computing e-Government index and ranking, *Government Information Quarterly*, 2011, Vol. 28, No. 3, pp. 354–362.

[12] SAATY, T. L. Decision making with the analytic hierarchy process. *International journal of Services Sciences*, 2008, Vol. 1, No. 1, pp. 83–98.

[13] SAATY, T. L. How to make a decision: The Analytic Hierarchy Process. *European Journal of Operational Research*, 1990, Vol. 48, No. 1, pp. 9–26.

[14] SHAREEF, M. S.; JAHANKHANI, H.; PIMENIDIS, E. Analysis of the e-Government stage model evaluation using SWOT-AHP method, *University of East London: ROAR,* 2011, pp. 1–30. Available at WWW: <http://roar.uel.ac.uk/1314/1/E-government%20model%20evaluation.pdf>

[15] SULTAN, A.; ALARFAJ, K. A.; ALKUTBI, G. A. Analytic Hierarchy Process for the Success of E-government. *Business Strategy Series*, 2012, Vol. 13, Iss. 6, pp. 295–306.

[16] ŠPAČEK, D. Coordination of and through E-Government: The Case of the Czech Republic. *The NISPAcee Journal of Public Administration and Policy*, 2014, Vol. 7, No. 1, pp. 83–106.

[17] UNITED NATIONS. *United Nations e-Government Survey 2014: E-Government for the Future We Want*. New York: UN Publishing Section, 2014. 263 p. ISBN 978-92-1-123198-4.

[18] VAIDYA, O. S.; KUMAR, S. Analytic hierarchy process: An overview of applications. *European Journal of Operational Research*, 2006, Vol. 169, No. 1, pp. 1–29.

[19] WORLD ECONOMIC FORUM. *The Global Information Technology Report 2014: Rewards and Risks of Big Data*. Geneva: SRO-Kundig, 2014. 343 p. ISBN 978-92-95044-63-0.

[20] YUMING, W.; HONGYAN, L. Optimization for Weight Design of the E-Government Development. In: *Proceedings of the 7th International Conference on Wireless Communications, Networking and Mobile Computing (WiCOM)*. IEEE, 2011, p. 1–4.

[21] ZAVADSKAS, E. K.; TURSKIS, Z. Multiple criteria decision making (MCDM) methods in economics: an overview. *Technological and Economic Development of Economy*, 2011, Vol. 17, Iss. 2, pp. 397–427.

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