BENCHMARKING SMART E-GOVERNMENT DEVELOPMENT: INSIGHTS FROM A NATIONAL PERSPECTIVE

Renáta Máchová, Jitka Komárková, Hana Kopáčková, Martin Lněnička

Abstract: *The concept of smartness has become a priority area for many governments, driven by the effort to enhance their ability to provide more attractive and user-focused public services. This approach has also influence on the set of indicators that are used to evaluate these efforts. In contrast to the previous studies to benchmark e-government development, the society is now more advanced in using ICT and consuming online public services. There is a need to reshape traditional view on e-government development and introduce a new set of indicators that would better capture the full range of smarter e-government. This paper provides insights on this issue from a national perspective. A two-step validation process was applied to evaluate the capabilities of the new set of indicators to assess and benchmark smart e-government development. The results indicate that the newly proposed index provides a robust measure to benchmark smart e-government development.*

Keywords: *E-government development, Smartness, Expert panel, Benchmarking framework, Composite index.*

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

Introduction

The diffusion and use of Information and Communication Technologies (ICT) among citizens and businesses is increasing rapidly and public sector needs to be prepared for these challenges. Therefore, multiple concepts regarding ICT are being introduced and utilized by governments worldwide to address these emerging trends. The term "*e-government*" covers most of them since it establishes the connection between the use of ICT and public services.

According to one of the most recent definitions given by Bogdanoska-Jovanovska (2016), e-government is "*a process of introducing ICT in the public sector for the purpose of creating a flawless, responsive, and citizen-focused government by transforming the process of delivering online public services and by introducing a fundamental re-thinking of the way government departments and agencies work.*" In dealing with the evolution of this term, see United Nations (2016), smartness has recently emerged as a desirable characteristic of governments, cities, communities, infrastructures, and devices (Awoleye et al., 2014; Gil-Garcia et al., 2016). There are many different views and perspectives on smartness and smart governments. As reported by Gil-Garcia et al. (2014), being a smarter government requires having a forward-thinking approach to the use and integration of information, technology, and innovation in the activities of governing. Scholl and Scholl (2014) then claimed that "*actionable and omnipresent information along with its underlying technologies are substantial prerequisites and backbones for developing models of smart (democratic) governance, which foster smart, open, and agile governmental institutions as well as*

stakeholder participation and collaboration on all levels and in all branches of the governing process." As noted by Maheshwari and Janssen (2014), it is crucial to establish smart e-government ecosystems that enable successful delivery of public services and benchmarking of these efforts. The importance of these ecosystems for the identification, development, experimentation and adoption of innovative solutions is also emphasized by other authors, such as Fioroni et al. (2014). Therefore, smart e-government development must focus on the larger ecosystem's environment, including dimensions like legal framework, ICT infrastructure, security and privacy, capabilities of involved stakeholders, and especially related indicators that represent these efforts.

An indicator is a quantitative or a qualitative measure derived from a series of observed facts that can reveal relative positions (e.g. of a country) in a given area (Nardo et al., 2008). Benchmarking is one of the general techniques that can be used for comparing the development of e-government using a set of indicators. Such indicators are used to calculate some kind of index (Berntzen and Olsen, 2009). E-government benchmarks are used to assess the progress made by an individual country over a period of time, and to compare its growth against other nations (Rorissa et al., 2011). As reported by Gil-Garcia et al. (2014), there is no consensus in terms of what the term smart e-government includes and how it is related to emergent technologies and innovation in the public sector. In addition, indicators that are suitable for benchmarking smart e-government have not yet been established (United Nations, 2016), and the existing e-government benchmarks could not be applied. This situation has occurred because there is a difference in the type of data sources used in the previous benchmarks and in the government model (framework) characteristics (Veljković et al., 2014).

In regard of this issue, this paper provides contribution to research in the field of e-government research. It aims to identify the key components and indicators of smart e-government development on the national level. The main assumption is based on accepting the importance of the smartness concept for the public sector. However, in contrast to ongoing research stream that examines this concept on the local level of districts, cities and municipalities, authors of this paper argue that the preparedness of governments as well as citizens should be at first explored from the national perspective. In particular, the ICT infrastructure together with computing resources and their security and legal aspects are defined on this level. This approach provides the insights that can be used to more precisely define (target) the boundaries of smart ecosystems on the local level. In addition, the findings can provide a valuable tool for decision support and targeting and planning of smart policies and investments.

1 Research Methodology and Methods

The methodology of this research follows systematic online searches in order to derive suitable indicators for benchmarking smart e-government development. For this purpose, it follows the set of steps defined by Zahran et al. (2015). A cross-search among several databases was employed to retrieve related articles. The review spanned the broad spectrum of journals and reports specifically focused on e-government development assessment and benchmarking. As noted by Berntzen and Olsen (2009), the use of widely referenced indicators is recommended to benchmark e-government development. Thus, this research will not address local measures and indicators that are

not published by well-established institutions. Also, it is beyond the scope of this research to consider the effects and impacts of e-government.

Since there are various aspects and data quality assumptions of e-government development benchmarks, Rorissa et al. (2011) and Zahran et al. (2015) argued that the conceptualization of e-government development into stages is doubtful. At similar lines, Yildiz (2007) criticized this approach based on stages and complained that there is no agreement on the number of stages and requirements. These authors suggest that the outcomes of benchmarking frameworks should be presented as components rather than stages. Thus, this paper discusses this issue in the context of smart e-government components. Such a structure improves the stakeholder's understanding of the driving forces behind the concept. Finally, since composite indices are much easier to interpret than trying to find a common trend in many separate indicators (Nardo et al., 2008), this paper presents the results of benchmarking smart e-government development in the form of a composite index. As stated by Hudrliková (2013), this approach is very tempting for all users of statistical information (policymakers, academics, experts, journalists, public, etc.) because they can operate with only one figure.

First, based on the literature review, a list of potential indicators that are widely recognised as having significant impacts on a nation's e-government development was gathered. Then, these indicators were discussed and classified into components, their weights were determined, and mathematical models were established to incorporate them into a single composite index. Following this approach, an expert panel was established, engaging experts on e-government development, to validate the relevance of these components and indicators and then define their weights. The expert panel is one of the participatory methods of weighting (Nardo et al., 2008). For this purpose, a five-point Likert scale (from 1 = extremely unimportant to 5 = extremely important) was utilized to determine the suitability of selected indicators for each component. Each expert was first asked to evaluate them. The following discussion revealed the list of indicators. These were weighted based on their importance for each component.

After that, a benchmarking framework with the most important indicators was developed and the weights for each component and its indicators were selected. In addition, a range of weights for sensitivity analysis was gathered from the expert panel. The validity of the new index scoring and respective ranking was assessed by evaluating how sensitive the country ranks are to the assumptions made on the index structure and weighting of the indicators. In the second step of the validation process, Spearman's and Kendall's rank correlation coefficients were used to compare the new index to the already existing indices to validate the conformity of the rank methods.

2 Literature Review and Theoretical Background

2.1 Importance of Assessment and Benchmarking of E-government Efforts

There is a fundamental shift in benchmarking e-government due to the ability to use a large variety of data sources and virtually anybody can be involved (Maheshwari and Janssen, 2014). The impact of using ICT by governments has been discussed by several authors who reported what are the key benefits, challenges, and limitations of e-government. The literature pointed out that modern ICT enable improvements of

internal operations in public agencies and institutions as well as delivery of public services and engagement among stakeholders.

The assessment and benchmarking of these efforts is crucial to measure the effectiveness of invested resources and get information for strategic planning of future e-government development projects (Kao, 2015; Máchová and Lněnička, 2015; Rorissa et al., 2011; Siskos et al., 2014). In this regard, different benchmark techniques are used for comparing e-government development based on indicators that yield some sort of score (Siskos et al., 2014; Yildiz, 2007; Zahran et al., 2015). Reliable, relevant and valid benchmarking frameworks can offer notices to point policy makers and practitioners in the right direction (Nardo et al., 2008; Saisana and Saltelli, 2011). Some of them are based on measurable characteristics of the entities, other use one or more subjective measures, a few employ a combination of both (Rorissa et al., 2011). Various benchmarking frameworks have been developed and used in practice over the past decades. In general, most of these frameworks tend to measure e-government development a country according to how it is capable to deal with infrastructure and technology, people and human skills, accessibility and connectivity, and transparency (Rorissa et al., 2011; Siskos et al., 2014; Yildiz, 2007). For more information about the field of e-government assessment, see Bogdanoska-Jovanovska (2016).

The measurable outcomes of these frameworks are usually presented in the form of indices and rankings (Máchová and Lněnička, 2015). The basic idea is first to find the criteria that reflect e-government development and then design a scoring system based on the weights for each of these criteria to transform the data collected into numbers (Berntzen and Olsen, 2009; Kao, 2015). The criticism towards the current benchmarks is directed at their rigidity since they did not respect the influence of technological, social and demographic evolution together, where new concepts in e-government began to appear (Bannister, 2007; Máchová and Lněnička, 2015; Rorissa et al., 2011).

2.2 Towards using Emerging Technologies for Smart E-government Development

Various inter (national) organizations have taken actions to address the importance of these technologies by preparing guidelines, recommendations or exemplary legislation. For example, according to the United Nations (2016) report, the global trends of e-government development should support the implementation of the sustainable development goals. The Information Society Report of International Telecommunication Union (2016) highlights the importance of big data analytics, mobile broadband, and cybersecurity in the context of sustainable economic and social development. Cross-border data flows, digital innovation, big data and analytics, cloud and mobile computing, open data initiatives and engagement of stakeholders are the new trends of ICT according to World Economic Forum (2016). With the increasing importance of these trends, new indicators and approaches need to be introduced in the measuring of e-government development, and the existing indices should to be updated, redefined and restructured. In this regard, Máchová and Lněnička (2015) proposed a benchmarking framework to evaluate e-government development using the new trends in ICT, but they did not take into account the concept of smartness.

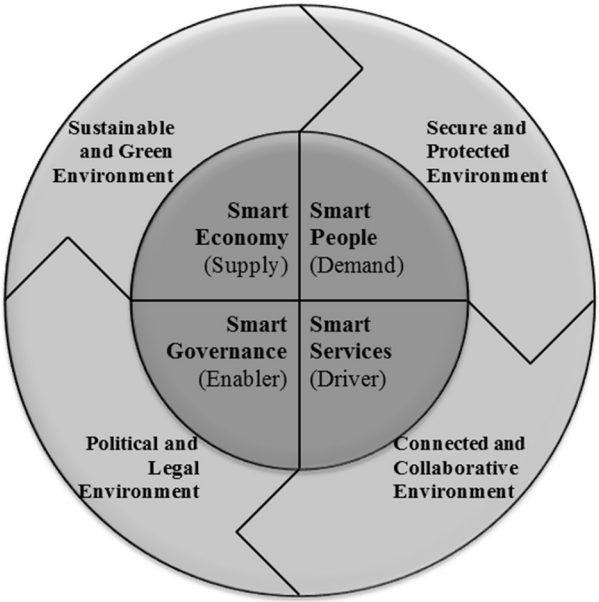
Smart e-government is used to characterize activities that creatively invest in emergent technologies coupled with innovative strategies to achieve more agile and resilient government structures and governance infrastructures (Gil-Garcia et al., 2014).

They see it as the deployment of a creative mix of emerging technologies and innovation in the public sector, which is based on specific contexts and problems. This concept is characterised by putting greater emphasis on external relationships with citizens and other stakeholders through websites, mobile devices, and other digital channels than internal government operations (Gil-Garcia et al., 2016). Another important trend is the accelerated development and transformation of cross-boundary information integration in government efforts. Scholl and Scholl (2014) outlined the smartness of governance in the context of openness and decision-making, information sharing and use, stakeholder participation and collaboration, etc.

3 Defining Benchmarking Framework and Composite Index

The benchmarking framework should clearly define the issue to be measured and its components, selecting individual indicators and weights that reflect their relative importance (Nardo et al., 2008; Saisana and Saltelli, 2011). The eight components established through the expert panel are shown in Fig. 1.

Fig. 1: The components of smart e-government development



Source: Authors

The environment supporting smart e-government development must be sustainable and green, secure and protected, connected and collaborative, and meet political and legal aspects. The intersection of e-government for sustainable development was explored by Estevez and Janowski (2013). Efforts should be made to ensure privacy and security of personal data due to hacking and other malicious activities, which are closely linked with cybersecurity (United Nations, 2016). In this regard, Awoleye et al. (2014) discussed the importance of secure smart e-government for public services, participation and communication. According to Fioroni et al. (2014), the promotion of a strong participation, adoption of open platforms, and engagement of stakeholders in the online service development process are the key prerequisites. Interoperability measurement, benchmarking and improvement in the context of big and open data was reconceptualised by Maheshwari and Janssen (2014). Among others, they emphasized laws and regulations, constitutional restrains, political commitment, jurisdictional regulations, change management, environment and ethics, and financial constraints.

Smart governance holds the promise of a more transparent, efficient, and resilient government for citizens (Gil-Garcia et al., 2014). Transparency and accountability of institutions can be enhanced by opening up government data (United Nations, 2016). In this regard, this component is characterized as an enabler of smart e-government development. Selected areas that have been put into focus and are likely candidates for smart governance initiatives were identified by Scholl and Scholl (2014). Gil-Garcia et al. (2016) identified fourteen components of smartness that can be applied to different branches and levels of government. Smart services are drivers of value generation for all the stakeholders. According to Fioroni et al. (2014), the number of available online services, their effectiveness and usage level and their level of interaction are important indicators of the smartness level of e-government. Gil-Garcia et al. (2014) provided perspectives on the nature of smart governments and illustrate exemplar practices and initiatives on how governments are opening up and transforming service delivery to become smarter. Smart economy provides a platform that facilitates the supply of smart services. Smart people represent a demand for smart services. This component requires taking into account various indicators focused on human capital and skills (Scholl and Scholl, 2014).

Tab. 1 lists the indicators of the benchmarking framework, their data sources and year, and particularly their local and global weights identified by the expert panel. The table contains 30 indicators, which were selected from 46 indicators identified through the literature review. All of them were gathered from publicly available data sources and international reports published by International Telecommunication Union (ITU), Transparency International (TI), United Nations (UN), World Economic Forum (WEF), or World Wide Web Foundation (W3F).

Tab. 1: Components and indicators of the benchmarking framework

Component and its indicators	Data source / Year	Weights	
		Local	Global
1. Sustainable and Green Environment		**0.100**	
Energy architecture performance index	WEF / 2016	0.300	0.030
Environmental performance index	Yale University / 2016	0.350	0.035
Use of ICT to increase environmental awareness and behavioural change	W3F / 2014	0.350	0.035
2. Secure and Protected Environment		**0.125**	
Global cybersecurity index	ITU / 2014	0.300	0.038
Effective legal protection from cybercrime	W3F / 2014	0.325	0.041
Personal data protection laws/regulations	W3F / 2014	0.375	0.047
3. Connected and Collaborative Environment		**0.100**	
Accessibility of digital content	WEF / 2014	0.275	0.028
Wireless broadband subscriptions per 100 inhabitants	ITU / 2015	0.200	0.020
International Internet bandwidth (bit/s) per Internet user	ITU / 2015	0.225	0.023
E-participation index	UN / 2015	0.300	0.030
4. Political and Legal Environment		**0.100**	
Effectiveness of law-making bodies	WEF / 2016	0.300	0.030
Laws relating to the ICTs	WEF / 2016	0.350	0.035
Government success in ICT promotion	WEF / 2016	0.350	0.035

5. Smart Economy (Supply)		**0.125**	
Global competitiveness index	WEF / 2016	0.225	0.028
Time required to start a business (days)	World Bank / 2016	0.225	0.028
Capacity for innovation	WEF / 2016	0.275	0.034
Gross domestic expenditure on R&D (total, % of GDP)	UNESCO / 2014	0.275	0.034
6. Smart People (Demand)		**0.150**	
Tertiary education gross enrollment rate	UNESCO / 2014	0.275	0.041
Mean years of schooling (of adults) (years)	UNESCO / 2014	0.250	0.038
Quality of education system	WEF / 2016	0.275	0.041
Use of web-powered ICT to improve education outcomes	W3F / 2014	0.200	0.030
7. Smart Governance (Enabler)		**0.125**	
Importance of ICTs to government vision of the future	WEF / 2016	0.275	0.034
Corruption perceptions index	TI / 2016	0.225	0.028
Open data barometer	W3F / 2015	0.275	0.034
Impact of open data on transparency and accountability	W3F / 2014	0.225	0.028
8. Smart Services (Driver)		**0.175**	
Online service index	UN / 2015	0.225	0.039
Impact of ICTs on access to basic services	WEF / 2016	0.175	0.031
Availability of latest technologies	WEF / 2016	0.200	0.035
Impact of ICTs on new services and products	WEF / 2015	0.200	0.035
Cost of mobile broadband (prepaid 500 MB) (USD)	ITU / 2015	0.200	0.035

Source: Authors

According to Nardo et al. (2008), the most widespread linear aggregation is the summation of weighted and normalised individual indicators. The following formula was proposed in computing a composite index for a given country:

$$\text{SmartEgov}_i = \sum_{j=1}^{n} w_{ij} * v_{ij} \quad (1)$$

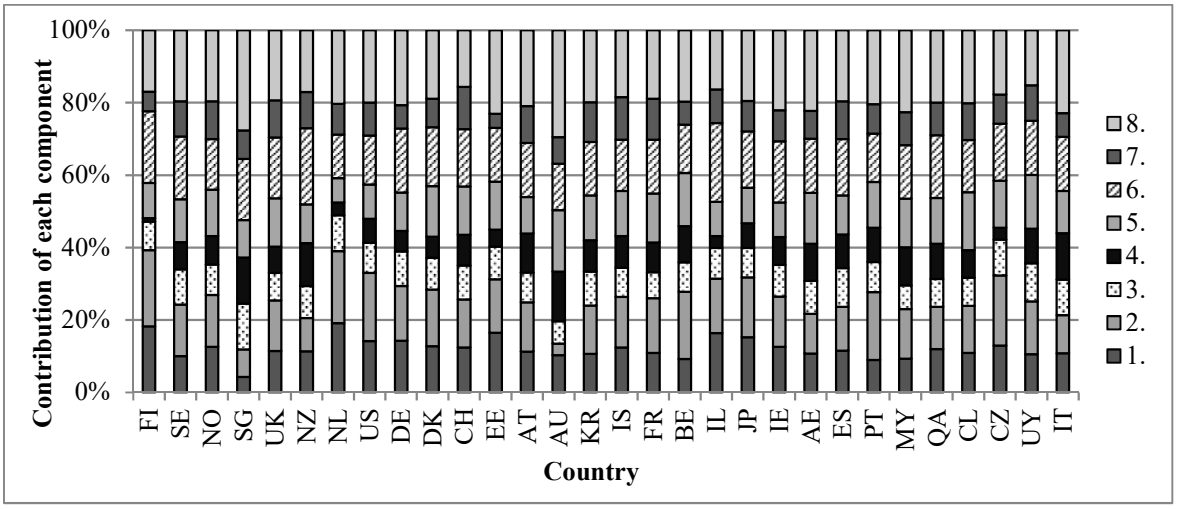
where *SmartEgov* is the overall value for a country (*i*), *j* is each of the indicators, *n* is total number of indicators, w_{ij} is a global weight assigned to the each indicator (*j*), v_{ij} is an individual value for each indicator on a normalized scale of 0 to 1. The sum of all weights equals 1.

4 Computing and Validating the Composite Index

The number of countries for which data are available varies across indicators. Nardo et al. (2008) suggested different imputation methods based on case deletion, single imputation or multiple imputations. Since the benchmarking framework was approved by the expert panel, and hence cannot be changed, countries with at least one value missing were deleted. The next step was the finding of outliers. For univariate data, Hudrliková (2013) recommended to apply the rules about simultaneous values of skewness and kurtosis, i.e. the skewness greater than 1 and the kurtosis greater than 3.5 are problematic. In accordance with this rule, no indicator for any of the compared countries showed these problems. In this regard, the final number of countries included in the study was 63.

The indicators are not measured in the same units and some of them also do not have the same direction. These indicators were transformed prior to the next analysis. First, the scale for selected indicators was reversed so that higher values always reflect better performance. Second, the Z-score standardization procedure was applied for each indicator to ensure that the overall index is equally decided by its components. After that, the normalisation converted data in order to have the same range. Then, weights gained from experts were applied to calculate the index using the formula (1). The results are in Tab. 2 as a set of values on a scale from zero to one. The index was calculated at the two level of aggregation, i.e. also for each component, see Fig. 2.

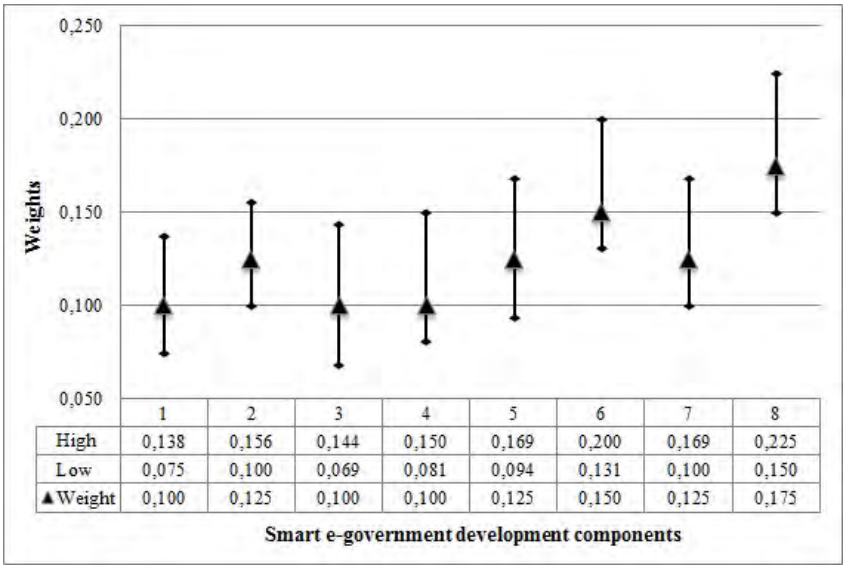
Fig. 2: Contribution of each component to overall index



Source: Authors

Sensitivity analysis aims to analyse the robustness of composite indices. It assesses the contribution of the individual source of uncertainty to the output variance. The results of the analysis are generally reported as country rankings with their related uncertainty bounds (Nardo et al., 2008). The experts were asked to define a sensitivity range of weights for each component. Fig. 3 provides a graphical presentation of the average low and high weights for components. It is a conservative weighting scheme.

Fig. 3: Sensitivity range of weights from the experts



	1	2	3	4	5	6	7	8
High	0,138	0,156	0,144	0,150	0,169	0,200	0,169	0,225
Low	0,075	0,100	0,069	0,081	0,094	0,131	0,100	0,150
▲Weight	0,100	0,125	0,100	0,100	0,125	0,150	0,125	0,175

Source: Authors

Then, three alternative weighting schemes were defined as the most representative in the literature of composite indicators and worth being tested in the sensitivity analysis (Saisana and Saltelli, 2011). These scenarios were taken into account: expert weighting vs. factor analysis derived weights at the component level (S1), where each component is weighted according to its contribution to the overall variance in the data; expert weighting vs. equal weighting at the component level (S2); and then expert weighting vs. equal weighting at the indicator level (S3). The sensitivity analysis of the new index ranking to the different weighting schemes implied a reasonably high degree of robustness of the index for those countries, see Tab. 2.

Tab. 2: Ranking based on the expert weights and the sensitivity analysis

Country	Expert weights		S1		S2		S3	
	Value	Rank	Value	Rank	Value	Rank	Value	Rank
Finland	0.829	1	0.831	1	0.821	1	0.823	1
Sweden	0.817	2	0.820	2	0.813	3	0.817	3
Norway	0.813	3	0.809	5	0.808	4	0.806	5
Singapore	0.812	4	0.818	3	0.814	2	0.818	2
United Kingdom	0.808	5	0.817	4	0.803	5	0.810	4
New Zealand	0.778	6	0.769	9	0.772	6	0.767	8
Netherlands	0.776	7	0.777	7	0.766	7	0.769	7
United States	0.774	8	0.787	6	0.762	9	0.769	6
Germany	0.763	9	0.754	11	0.753	10	0.748	10
Denmark	0.760	10	0.769	8	0.764	8	0.760	9
Switzerland	0.751	11	0.754	10	0.748	11	0.744	11
Estonia	0.743	12	0.733	12	0.736	12	0.731	12
Austria	0.733	13	0.726	15	0.728	13	0.722	15
Australia	0.733	14	0.729	13	0.720	15	0.724	14
South Korea	0.727	15	0.716	16	0.714	17	0.716	16
Iceland	0.725	16	0.726	14	0.723	14	0.727	13
France	0.719	17	0.712	17	0.716	16	0.710	17
Belgium	0.704	18	0.695	19	0.691	19	0.693	18
Israel	0.698	19	0.692	20	0.687	20	0.687	20
Japan	0.694	20	0.711	18	0.700	18	0.690	19
Average change to the expert weights			1.2 rank		0.7 rank		0.8 rank	

Source: Authors

Finally, Spearman rank order correlations and Kendall tau correlations between the new index and the already existing e-government development indices revealed that the SmartEgov index has very high correlation with the Networked Readiness Index (NRI) by WEF as well as the E-government Development Index (EGDI) by UN and the ICT Development Index (IDI) by ITU on the significance level 0.05. These results, shown in Tab. 3, indicate that the existing e-government development indices can be considered as smart in the context delimited by the benchmarking framework. Thus, this implies that most of the countries are prepared for providing smart services.

Tab. 3: Degree of correspondence between the new index and other indices

	Rank correlation coefficient	EGDI	IDI	NRI
SmartGov index	Spearman	0.926	0.926	0.964
	Kendall	0.772	0.761	0.847

Source: Authors

5 Discussion and Limitations

Benchmarking of e-government services is an important mechanism for helping in setting policy priorities and a source for identifying best practices (Berntzen and Olsen, 2009). Thus, among the best performing countries, North European countries, namely Finland, Sweden, and Norway, may provide useful insights on how to make e-government development smarter. In this regard, the recommendations should be linked to improvements in the delivery of smart services. These services should be designed in the context of the sustainable and green environment. On the other hand, benchmarking frameworks may send misleading policy messages if poorly constructed or misinterpreted (Nardo et al., 2008). Furthermore, the outcomes of benchmarks need to be interpreted sensibly and it is always necessary to be aware of the risks of their politicization (Bannister, 2007). According to Siskos et al. (2014), rankings should be based on transparent computational procedures to maximize their acceptability by both governments and the scientific community, leading to frameworks and indices that achieve wide consensus. Therefore, the expert panel established for the purpose of this study provided the initial insights into the discussion on indicators that can be used to measure the impact of the smartness concept in the public sector.

As stated by Hudrliková (2013), there is not only one correct method how to develop a composite index. Saisana and Saltelli (2011) reviewed some good and bad practices from the literature and argued in favour of a multi-modelling approach to represent different scenarios in the construction of an aggregate measure. Rorissa et al. (2011) argued that the methods become more problematic when include calculated indices and subjective indicators. On the other hand, several authors are opposed to the use of quantitative approaches to calculate rankings since these are concentrated only on the aspects that are measurable and do not take into account the perspective of various stakeholders (Bannister, 2007; Veljković et al., 2014). Another weakness of this type of benchmark is that the indicators do not show the target value that each indicator needs to reach. To solve this issue, Kao (2015) applied the idea of non-dominance to find Pareto-optimal, or efficient, countries on e-government, and calculate the target value of each indicator for the dominated, or inefficient, countries.

Another problem is that, in practice, many services are the responsibility of lower levels of government (Berntzen and Olsen, 2009). A further limitation of this study comes from the use of secondary data. In addition, a longitudinal benchmarking, rather than a one-time look, should provide a better sense of the progress being made by countries (Rorissa et al., 2011). Finally, in contrast to similar research conducted by Hudrliková (2013) who dealt with the comparison of performance of the European Union Member States using the composite indicator principles, this paper provided a larger sample of indicators as well as countries that were assessed and benchmarked. In addition, the results presented in this paper are based on the consensus of the expert panel. It is, however, questionable if it is desired to have tens of indicators for measuring all the details about this issue.

Conclusions and Further Research Directions

This research attempted to contribute to the e-government development body of knowledge by identifying and validating the components and indicators characterizing the concept of smartness in e-government development. The national perspective was

chosen for this aim since the governments must at first fully understand the ICT infrastructure together with computing resources and their security and legal aspects as well as capabilities of involved stakeholders they face in order to more precisely define the boundaries of smart ecosystems on the local level. The methodology presented in this paper provided the approach for including or excluding specific indicators into components and also to create the composite index based on the relative weights of these indicators towards the constitution of this index. For this purpose, the expert panel was established in order to take into account multiple viewpoints and to increase the robustness of the benchmarking framework. The utilization of this panel proved to be a useful part of the process, as this provided the opportunity to gain in-depth insights with limited resources. In addition, the limitations of this approach were discussed to overcome the shortcomings of benchmarking and dispute over the outcomes. The new index was validated using three weighting schemes to gauge the robustness of the results, to increase its transparency, and to identify the countries whose rank improves or deteriorates under certain assumptions.

The benchmarking framework represented by the smart e-government development index summarized the multi-component view on smart e-government, and hence, provides a support tool for decision-makers as well as facilitates communication with general public. The number of indicators that were used can be also easily extended or reduced and more experts or other stakeholders can be involved in their identification and validation. The future research should be directed towards discovering, proposing, and validating frameworks for benchmarking smart cities on the local level.

Acknowledgement

This research is supported by University of Pardubice, SGS_2017_17 project.

References

Awoleye, O. M., Ojuloge, B., & Ilori, M. O. (2014). Web application vulnerability assessment and policy direction towards a secure smart government. *Government Information Quarterly*, 31, pp. S118-S125. DOI: 10.1016/j.giq.2014.01.012

Bannister, F. (2007). The curse of the benchmark: an assessment of the validity and value of e-government comparisons. *International Review of Administrative Sciences*, 73(2), pp. 171-188. DOI: 10.1177/0020852307077959

Berntzen, L., & Olsen, M. G. (2009). Benchmarking e-government A comparative review of three international benchmarking studies. In: *2009 Third International Conference on Digital Society*. IEEE, pages 77-82.

Bogdanoska-Jovanovska, M. (2016). Demarcation of the Field of E-Government Assessment, *Transylvanian Review of Administrative Sciences*, 12(48), pp. 19-36.

Estevez, E., & Janowski, T. (2013). Electronic Governance for Sustainable Development – Conceptual framework and state of research. *Government Information Quarterly*, 30, pp. S94-S109. DOI: 10.1016/j.giq.2012.11.001

Fioroni, G., et al. (2014). Smart Government - Toward an Innovative Concept of a "One-Stop Shop" for Interactive Online Services. In: *IEEE Smart Cities Inaugural Workshop, December 2014 in Trento, Italy*. IEEE, pages 1-10.

Gil-Garcia, J. R., Helbig, N., & Ojo, A. (2014). Being smart: Emerging technologies and innovation in the public sector. *Government Information Quarterly*, 31, pp. I1-I8. DOI: 10.1016/j.giq.2014.09.001

Gil-Garcia, J. R., Zhang, J., & Puron-Cid, G. (2016). Conceptualizing smartness in government: An integrative and multi-dimensional view. *Government Information Quarterly*, 33(3), pp. 524-534. DOI: 10.1016/j.giq.2016.03.002

Hudrliková, L. (2013). Composite indicators as a useful tool for international comparison: The Europe 2020 example. *Prague Economic Papers*, 22(4), pp. 459-473. DOI: 10.18267/j.pep.462

International Telecommunication Union. (2016). *Measuring the Information Society Report 2016*. Geneva: Telecommunication Development Bureau.

Kao, C. (2015). Evaluation and improvement of e-government: The case of European countries. In: *2015 Second International Conference on eDemocracy & eGovernment (ICEDEG)*. IEEE, pages 104-107.

Máchová, R., & Lněnička, M. (2015). Reframing E-Government Development Indices with Respect to New Trends in ICT. *Review of economic perspectives*, 15(4), pp. 383-411. DOI: 10.1515/revecp-2015-0027

Maheshwari, D., & Janssen, M. (2014). Reconceptualizing measuring, benchmarking for improving interoperability in smart ecosystems: The effect of ubiquitous data and crowdsourcing. *Government Information Quarterly*, 31, pp. S84-S92. DOI: 10.1016/j.giq.2014.01.009

Nardo, M. et al. (2008). *Handbook on Constructing Composite Indicators: Methodology and user Guide*. Paris: OECD Publishing.

Rorissa, A., Demissie, D., & Pardo, T. (2011). Benchmarking e-government: A comparison of frameworks for computing e-government index and ranking. *Government Information Quarterly*, 28(3), pp. 354-362. DOI: 10.1016/j.giq.2010.09.006

Saisana, M., & Saltelli, A. (2011). Rankings and Ratings: Instructions for Use. *Hague Journal on the Rule of Law*, 3(2), pp. 247-268. DOI: 10.1017/S1876404511200058

Scholl, H. J., & Scholl, M. C. (2014). Smart Governance: A Roadmap for Research and Practice. In: *iConference 2014 Proceedings.* Humboldt University, pages 163-176.

Siskos, E., Askounis, D., & Psarras, J. (2014). Multicriteria decision support for global e-government evaluation. *Omega*, 46, pp. 51-63. DOI: 10.1016/j.omega.2014.02.001

United Nations. (2016). *United Nations e-Government Survey 2016: E-Government in Support of Sustainable Development*. New York: UN Publishing Section.

Veljković, N., Bogdanović-Dinić, S., & Stoimenov, L. (2014). Benchmarking open government: An open data perspective. *Government Information Quarterly*, 31(2), pp. 278-290. DOI: 10.1016/j.giq.2013.10.011

World Economic Forum. (2016). *The Global Information Technology Report 2016: Innovating in the Digital Economy*. Geneva: SRO-Kundig.

Yildiz, M. (2007). E-government research: Reviewing the literature, limitations, and ways forward. *Government Information Quarterly*, 24(3), pp. 646-665. DOI: 10.1016/j.giq.2007.01.002

Zahran, D. I., Al-Nuaim, H. A., Rutter, M. J., et al. (2015). A Critical Analysis of E-Government Evaluation Models at National and Local Municipal Levels. *The Electronic Journal of e-Government*, 13(1), pp. 28-42.

Contact Address

Ing. Renáta Máchová, Ph.D.
University of Pardubice, Faculty of Economics and Administration
Studentská 84, 53210 Pardubice, Czech Republic
Email: Renata.Machova@upce.cz
Phone number: +420 466 036 074

doc. Ing. Jitka Komárková, Ph.D.
University of Pardubice, Faculty of Economics and Administration
Studentská 84, 53210 Pardubice, Czech Republic
Email: Jitka.Komarkova@upce.cz
Phone number: +420 466 036 070

Ing. Hana Kopáčková, Ph.D.
University of Pardubice, Faculty of Economics and Administration
Studentská 84, 53210 Pardubice, Czech Republic
Email: Hana.Kopackova@upce.cz
Phone number: +420 466 036 245

Ing. et Ing. Martin Lněnička, Ph.D.
Email: martin.lnenicka@gmail.com

Received: 27. 03. 2017, reviewed: 31.07.2017
Approved for publication: 04. 01. 2018