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CURBING CORRUPTION IN THE PUBLIC SECTOR BY UTILIZING ELECTRONIC PUBLIC ADMINISTRATION

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Abstract

Corruption is a highly debated issue that harms both the governments of individual countries as well as citizens themselves. Corruption in the public sector can lead to an increase in public spending and a reduction in the amount of taxes levied, thus increasing fiscal deficits and creating macroeconomic instability. Utilizing electronic administration within the public sector has recently been given much attention a key tool for fighting corruption in public administration. E-administration not only makes it possible to provide more information to the population more simply, efficiently, and quickly, but it also helps to eliminate discretion on the part of officials, i.e., the officials' power to make decisions based on their personal assessment of a situation. This paper focuses on the relationship between a country's corruption level and the degree of e-government being used in the country. Using graphical interpretation of statistical data and regression analysis, it was found that utilizing e-government within public administration has a positive effect on a country's corruption level. However, economic performance demonstrated the greatest influence on the corruption level for the given period and group of countries.

Keywords: corruption, corruption perception index, e-government, e-government development index, public administration

INTRODUCTION

A number of studies show that corruption in public administration impacts a wide range of taxpayers. For example, these taxpayers could possibly feel the consequences of corrupt behavior in the form of tax and price increases or poor service quality. For this reason, corruption in public administration is considered to be a very serious problem, since it affects a large section of society (Leff, 1989; Rose-Ackerman, 1997).

One feasible way to reduce corruption, especially in the public sector, could be to reduce the interactions between officials and the public. This can be achieved by means of electronic administration. Utilizing electronic administration in the public sector has recently been given much attention as a key tool for fighting corruption by allowing greater public access to information. The term indicates digital communication with institutions of public administration, i.e., electronic communication. It improves the delivery of public services to citizens and businesses via information

and communication technology that allows citizens faster, more accessible and less costly service (Halásková and Halásková, 2018). E-administration also limits direct contact between citizens and officials, thereby reducing discretion on the part of officials, which can decrease the risk of corruption (Bhatnagar, 2003; Shim and Eom, 2008; Mistry and Jalal, 2012).

This paper focuses on e-government in terms of its use in reducing corruption in public administration. The paper's goal is to verify whether electronic administration has an influence in reducing corruption levels in public administration for a set of 113 countries during the period of 2003 to 2017.

The Impact of E-Government on Corruption in Public Administration

Corruption is often called "sand in the wheels" of an economy because of its negative economic consequences. The negative effects of corruption on foreign investment have been shown by Shleifer and Vishny (1993). Corruption tends to reduce investment incentives for both local and foreign entrepreneurs. When the latter are frequently forced to pay bribes before they can found a business or are solicited to pay large sums of money to public officials in order to remain in business, corruption hinders and even blocks business creation and development, thus hindering economic growth. In addition, corruption increases transaction costs, impedes the development of a market economy, undermines the free market system by increasing the degree of uncertainty, and reduces a government's revenues while raising its spending (Huntington, 1968; Rose-Ackerman, 2013; Tanzi, 1998). In particular, it compromises the fundamental role of the state in certain areas, such as contract enforcement and the protection of property rights, and makes it difficult for governments to intervene by imposing necessary regulatory controls and inspections to correct for market failures. Corruption also leads to a misallocation of resources, particularly when decisions about investing public funds and approving private investments are made not on the basis of a project's economic or social value but rather on the potential revenue that public officials could expect to receive in the wake of their decisions (Jain, 2001).

According to a number of studies (e.g., Andersen, 2009; Bhatnagar, 2003; Shim and Eom, 2008; United Nations, 2016; Andersen and Rand, 2006; Mistry, and Jalal, 2012; Kimbro, 2002; Kim, 2007; Dzhumashev, 2014), digitizing public administration can positively affect its level of corruption. These studies agree that increased use of e-government can weaken the factors causing corruption, reduce officials' monopoly on power, and ultimately lead to greater transparency in the operation of public administration (Kim, 2007; Mistry and Jalal, 2012). The use of e-administration helps make delivering services and information easier, faster, and more efficient. Citizens are then closer to the public authorities and are better informed about ongoing processes, which also affect their willingness to participate in public affairs.

Thanks to utilizing e-administration, contact between officials and citizens is reduced. This may result in greater transparency for activities that restrict a public official's ability to accept or even require a bribe. By implementing e-administration, the possibility of unfair disclosure is also decreased. The retention of transaction data makes it possible to monitor and link people to their unauthorized actions. Fear of consequences is thus a deterrent against corrupt practices. E-administration reduces corruption externally by improving relations with citizens and internally by employing more efficient and accessible controls. Transparency can be ensured, provided that the country's legal framework promotes free access to information. In the past, many countries around the world have had strict laws concerning state secrets, which have been abolished in favor of the Freedom of Information Act, especially in the United States and Europe. There has been no such shift in developing countries. With citizens' increasing access to information, governments must also address the risks associated with citizens' privacy and security (Bhatnagar, 2003).

Mistry and Jalal (2012) investigated the relationship between corruption and introducing e-administration. Their study confirmed that utilizing e-administration has an impact on reducing corruption. This relationship was confirmed using the results of regression analysis. Regression analysis demonstrated that changes in the implementation of computerization led to changes in corruption in both economically developed and underdeveloped countries. Specifically, a 1% increase in IT use leads to reducing corruption by 1.17%.

The results of other studies (Pathak *et al.* 2007) confirm a positive relationship between e-government and corruption. The authors conclude that electronic government can explain a maximum of 8.2% of the difference in limiting corruption in Ethiopia. This shows that implementing

e-administration is important in the fight against corruption, but that it also has its limits. The conclusions of this study also show that more than half of people consider corruption in public administration to be widespread, resulting in public services being perceived negatively.

For example, Elbahnasawy (2014) specifically states that while maintaining other factors at a constant level, an increase in e-administration by one standard deviation (a 0.2 point rise in the e-government index) leads to reducing the perception of corruption by 0.25 points to 0.43 points. The author also mentions other additional factors that influence corruption – economic performance (measured by GDP), for example. Any increase in GDP by one standard deviation ($12,739 per capita) reduces corruption by 0.04 points to 1.01. There is also an impact on the scope and quality of online services, where an increase in standard deviation (0.24 points) reduces corruption by 0.15 points. Corruption also greatly impacts the quality of the legal environment, which includes the level at which law or justice serves the power to promote one's own interests (Katsios, 2015). Increasing the standard deviation of the Rule-of-Law Index (by 1.01 points) reduces corruption by 0.45 points to 0.61 points (Elbahnasawy, 2014).

MATERIALS AND METHODS

The aim of this paper is to analyze the impact of electronic administration on reducing corruption in a selected set of countries. A group of 113 of the world's countries were used for the analysis, regardless of their geographical jurisdiction or political establishment. The time period of 2003 to 2017 was selected.

The Corruption Perception Index (CPI) was chosen for analyzing the country's rate of corruption. In 2012, the CPI's rating scale was revised (it was previously from 0 to 10, now it is from 0 to 100). Due to the need for longer-term comparisons, the actual rating on the previous scale of 0 to 10 – where 0 represented a very corrupt country and 10 indicated a country without corruption – has been converted for data analysis using the post-2012 corruption rating. The E-Government Development Index (EGDI) was selected to be the indicator for evaluating the countries' level of e-administration. The EGDI was originally established in 2003 and utilizes an interval of < 0; 1 >, where a value of one represents a high level of e-government, and a zero index value indicates a low degree of application for these methods in public administration.

In these analyses, the relationship between EGDI and CPI was initially examined for two time periods (i.e., 2003 and 2017). The next step examined whether there was a relationship between the change in EGDI over this period and the change in CPI over the same time period. In order to fulfill the paper's goal, a graphical interpretation employing bag plots and linear regression analysis was used to assess the impact of selected variables on the corruption level. All testing was performed at a 5% level of significance. Parameter estimates were derived using the least squares method.

Bag plots are generalized two-dimensional graphs that are used to graphically interpret statistical data. They are employed to describe a phenomenon using two explanatory variables. A bag plot is a generalization of a box graph, which is used to visualize one-dimensional data. In the case of bag plots, the data are two-dimensional. Combinations of the individual countries' dependent and independent variables make up the points in the graph. The inner dark part includes 50% of the observations (between the first and third quartile) and the median of the observations, which is indicated by a dark square. The outer region of the bag is the light section, which contains other countries that have values with a wider range than those in the dark area without being outlying values. Outside these two areas, there are remote values, which are marked with an asterisk. The chart also shows other characteristics, such as the country's rank in comparison to the rated countries. The orientation of the bag shows the relationship between the variables. A positive relationship between the variables can be assumed if the bag is expanding, with a falling bag showing the opposite, negative relationship.

Linear regression analysis is a method for estimating the value of a dependent variable based on knowledge of independent variables. In the case of one independent variable, this is simple regression, which describes the relation between a dependent variable and one independent variable (the so-called regressor). In contrast, multiple regression is used in the case of multiple independent variables, i.e., when a dependent variable depends on two or more regressions. The linear regression formula can be expressed as follows:

$$y = \alpha + \beta_1 \times x_1 + \beta_2 \times x_2 + \cdots + \beta_n \times x_n + \varepsilon \quad (1)$$

Parameter y is the dependent variable, and the x parameters are independent of the variable. Alpha

(a) determines the distance of the intersection of the regression line with the y-axis from the origin of the coordinate (the value of the regression function for x = 0). Beta (b) indicates regression coefficients that express how much the dependent variable changes when the value increases independently of the unit variable. The index n indicates the number of independent variables. The symbol ε signifies residual scattering. This is a graphical representation of the distance of the points from the line (Baltagi, 2013).

The estimation of the corruption rating in relation to the e-government rating using simple linear regression takes the form:

$$CPI = \alpha + \beta \times EGDI + \varepsilon, \quad (2)$$

where CPI is the rating for the country's level of corruption, and the EGDI is the country's e-government rating.

The estimation of the change in the degree of corruption caused by a change in e-government can be written as the following model:

$$\Delta CPI = \alpha + \beta \times \Delta EGDI + \varepsilon, \quad (3)$$

where DCPI is the change in the level of corruption and DEGDI is the change in the e-government rating.

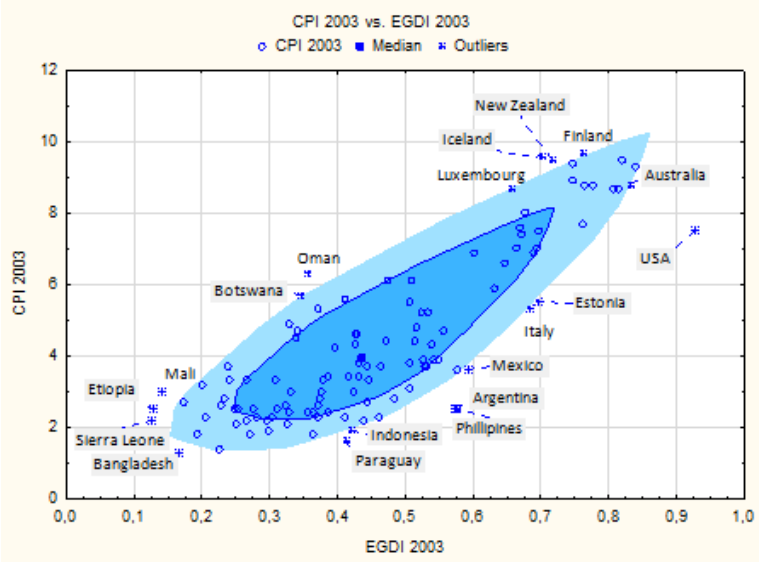
RESULTS

Fig. 1 shows the bag plot for the selected set of countries. Data from 2003 was used. The 2003 EGDI rating of the country's e-government level is applied on the x-axis; the y-axis is the corridor index of the CPI for 2003.

Greater capacity for using information technology in public administration is expressed by higher EGDI values. In contrast, a lower corruption rate in the country is characterized by higher CPI ratings. At first glance, the bag fence's visible positive slope confirms a positive correlation between the level of corruption and the level of e-administration for these countries in 2003. There are several outlying countries in the bag fence, whether from the point of view of the extent of corruption or the use of e-government. The country lagging most in the area of corruption is Bangladesh, which scored a corruption rating of just 1.3 out of 10 points in 2003. Other lagging countries include Sierra Leone, Ethiopia, and Mali. The United States has overtaken other countries in its rating for utilizing e-administration in the public sector. For the year 2003, the e-government rating in this country reached 0.927 by a large margin; the second best country was Sweden at 0.840. Finland's corruption rating surpassed the others with the highest value, a 9.7 out of 10.

Fig. 2 shows the bag plot for these countries for data from 2017. The x-axis shows the EGDI's e-government rating for 2017 and the y-axis shows the 2017 CPI corruption rating.

A positive relationship was also found between the corruption level and e-government in public administration for the 2017 variables, which is evident from the positive slope. The bag fence again shows several outlying values. The most remote countries in terms of the use of electronic methods in public administration are Bahrain

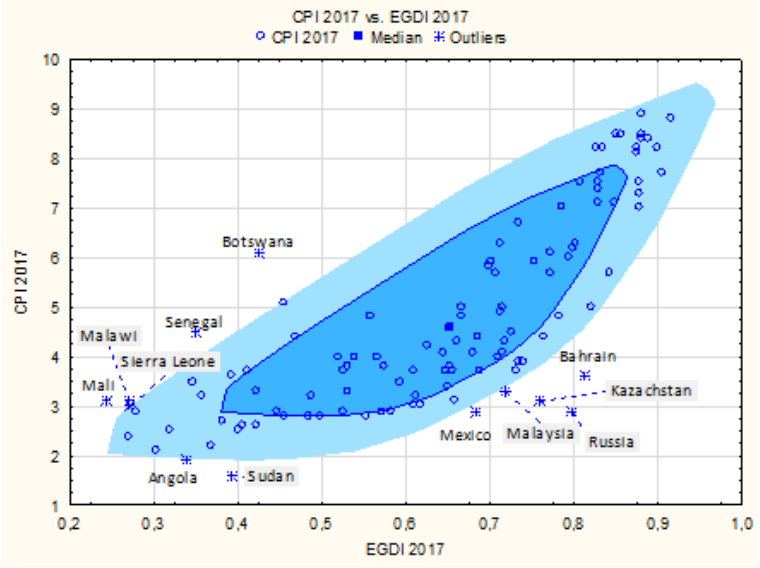


1: *Bag plot CPI 2003 vs. EGDI 2003*

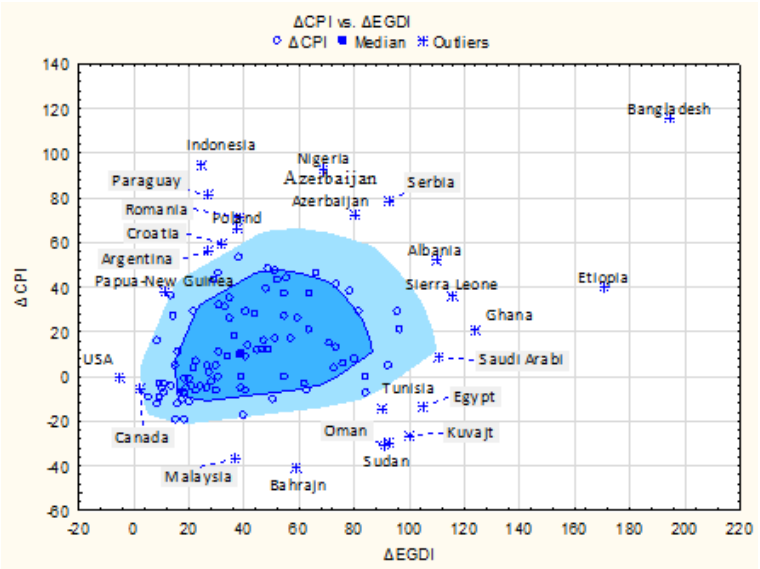
and Mali. Despite a low rating of just 3.6 points, Bahrain's rating for improvement in public sector e-administration was 0.812. On the other hand, Mali is a remote point because of its very low use of e-administration in the public sector, and, at 0.242, it has the lowest value of all countries surveyed. According to corruption level rating, Sudan is the most remote country, with a Corruption Perception Index rating of only 1.6.

The bag plot in Fig. 3 depicts the CPI and EGDI changes between 2003 and 2017 for the selected set of countries. This Fig.3 indicates the development of CPI and EGDI during the sampling period. The x-axis denotes change in the e-government rating, ΔEGDI, and the y-axis indicates change in the corruption rating, the value of ΔCPI.

A slight positive slope can be observed for the bag fence for the changes in values, so it is possible to assume a positive relationship between the variables, i.e., e-government and the corruption level in the public administration. The graph contains a relatively large amount of outlying values. The most remote value belongs to Bangladesh. This country shows the biggest changes in both variables. The change in the corruption level in the public administration between 2003 and 2017 was 115%; the change in the e-government rating reached almost 195%.



2: *Bag plot CPI 2017 vs. EGDI 2017*



3: *Bag plot ΔCPI vs. ΔEGDI*

Ethiopia is another distinctly remote country. In the period under review, the second largest change in e-government rating was for Ethiopia at 170%. Examples of outlying values include Malaysia, Bahrain, Sudan, and Kuwait, mainly due to a negative change in the corruption rating for the period under review.

Simple linear regression is used to estimate the change in the countries' degree of corruption based on knowledge of change in the use of electronic public administration. It describes the dependence of the dependent variable (the corruption rate) on independent variables (the use of e-administration). The estimation of the percentage change in the corruption rating (ΔCPI) caused by the percentage change in e-administration (ΔEGDI) between 2003 and 2017 can be written as the following model:

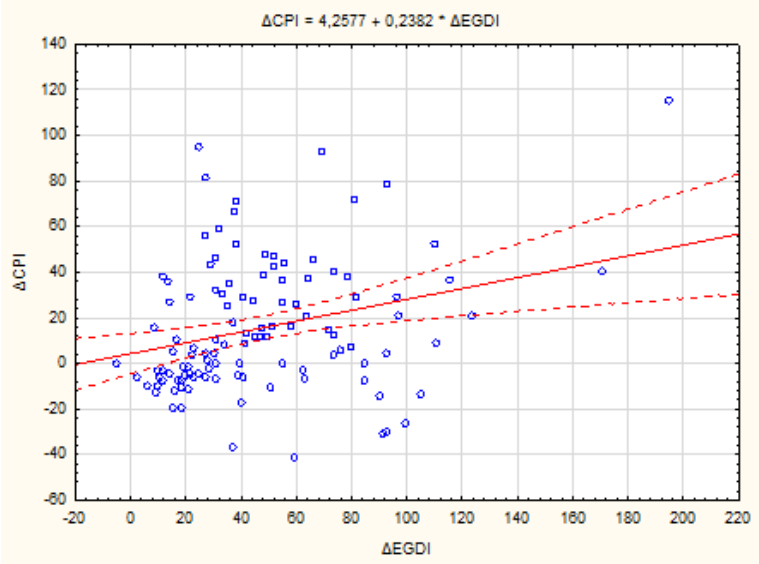
$$\Delta CPI = \alpha + \beta \times \Delta EGDI + \varepsilon, \quad (4)$$

where DCPI is the change in the corruption rating from 2003 to 2017, and DEGDI is the change in the e-government rating for the same years.

Fig. 4 shows a linear regression model depicting the changes in the levels of corruption and computerization for the selected set of countries between 2003 and 2017. The percentage change in EGDI between 2003 and 2017 is shown on the horizontal axis, and the vertical axis shows the change in CPI for the same years. A linear regression line, which is supplemented by a confidence band, threads through the data. Again, the confidence interval is 0.95.

The linear regression line's positive slope confirms that using e-administration has a positive effect in reducing corruption in this set of countries. Under unchanging conditions, a one-percent change in the e-government rating shows a rise in the corruption rating of more than 0.2% over the monitored period. The values for this linear regression model are shown in Tab. I.

The regression model indicates a low value for the determination coefficient, $R^2 = 0.079787$. On this basis, it can be argued that only approximately 8% of the variability of the explained variable (ΔCPI) can be explained by the model.



4: *Linear regression model of ΔCPI vs. ΔEGDI*

I: *Results of linear regression for ΔCPI vs. ΔEGDI*

N = 113	**R = 0,282466603 R2 = 0,0797873818 p < 0,002435**					
	b*	**Std. error of b***	**b**	**Std. error of b**	**t (111)**	**p-value**
constant term			4,257743	4,483326	0,949684	0,344336
% change of EGDI	0,282467	0,091051	0,238241	0,076795	3,102305	0,002435

The estimated model for explaining the relationship between corruption level and e-government in public administration takes the following form:

$$\Delta CPI = 4{,}2577 + 0{,}238 \times \Delta EGDI + \varepsilon \quad (5)$$

Simple linear regression has shown that to a certain degree, change in corruption level depends on change in the use of e-government in public administration, with a 1% increase in the EGDI e-government rating CPI rate increase of 0.238 %. The low proportion of explained variability suggests that other unpredictable factors also affect the change in CPI.

As mentioned above, utilizing e-administration in the public sector is, of course, not the only factor influencing a country's level of corruption. For this reason, it is advisable to extend this model to include other explanatory variables. The estimation of the correlation coefficient for change in the corruption rating to change in the use of e-government is statistically significant (non-zero); therefore, the DEGDI variable has its justification in the model. Studies (Elbahnasawy, 2014; Katsios, 2015) have identified two other factors for further analysis that have been shown to influence countries' corruption levels. These factors are the country's economic performance and the quality of its legal environment, i.e., GDP and the Rule-of-Law Index.

All three independent variables have been used in the following multidimensional regression analysis. The estimation of the change in corruption level (ΔCPI) caused by changes in e-government (ΔEGDI), changes in economic performance (ΔHDP), and changes in the legal system (Δrule-of-law index) between 2003 and 2017 can be written as the following model:

$$\Delta CPI = \alpha + \beta_1 \times \Delta EGDI + \beta_2 \times \Delta HDP + \beta_3 \times \Delta ruleoflaw + \varepsilon \quad (6)$$

Tab. II below uses the resulting multiple regression values for the years 2003 to 2017 and shows how the percentage change in the corruption rating is dependent on the percentage change in the above-mentioned explanatory variables.

The results from the Tab. II show that during the monitored period, the level of corruption was mainly influenced by the degree of e-government in the public sector and the efficiency of the economy. Changing the quality of the regulatory environment did not have a significant impact on the level of corruption for this set of countries over this period.

The multiple regression model takes the following form:

$$\Delta CPI = -11{,}051 + 0{,}1263 \times \Delta EGDI + 0{,}2164 \times \Delta HDP + \\ + 0 \times \Delta ruleoflaw + \varepsilon \quad (7)$$

Of the factors under consideration, economic performance had the greatest influence on the level of corruption for this group of countries during this period. With a 1% change in economic performance, there was a 0.21% increase in the corruption rating. A one percent change in the rating for e-government in public administration led to a 0.12% improvement in corruption ratings.

DISCUSSION

The results of this analysis focusing on how e-government in public administration influences the level of public sector corruption agree with the conclusions of a number of empirical studies dealing with this issue (e.g., Andersen, 2009; Bhatnagar, 2003; Shim and Eom , 2008; United Nations, 2016; Andersen and Rand, 2006; Mistry and Jalal, 2012; Kimbro, 2002; Kim, 2007). The analyses carried out here confirm this claim for a set of 113 elected countries over the period of 2003 to 2017. However, utilizing e-government is not the only factor that affects the state of

II: *Results of multiple regression*

N = 113	**R = 0,476809102 R2 = 0,227346919 p < 0,000003**					
	b*	**Std. error of b***	**b**	**Std. error of b**	**t (109)**	**p-value**
constant term			–11,0513	5,360245	–2,06172	0,041613
% change of EGDI	0,149709	0,089753	0,1263	0,075700	1,66802	0,098183
% change of HDP	0,404249	0,089785	0,2164	0,048068	4,50240	0,000017
% change of rule-of-law	0,021126	0,084910	0,0000	0,000064	0,24880	0,803980

corruption in a country's public administration, as evidenced by the low value of the R^2 coefficient.

The average increase in the values of both variables was determined for the years monitored. Bangladesh showed the greatest improvement in the Corruption Perception Index between 2003 and 2017. Bahrain's results were the worst at 41%, the largest decline in the corruption rating. Concerning the e-government rating, the country of Bangladesh showed the best results, leading by nearly 200%. Negative change occurred in only one country, the United States of America, by almost 6%. Nevertheless, in 2017, the United States still had a high e-government ranking of 0.877; it came in 10th place together with Germany. During this time period, the average EGDI variable increasedhim by more than 47%. However, the average CPI variable improvement was only 15.5%. It is also clear from the charts that countries with higher EGDI values also have higher CPIs, with lower corruption levels being observed in countries with higher degrees of e-administration.

The model for estimating change in the levels of corruption and e-government between 2003 and 2017 also confirmed possible positive influence. As in previous cases, the effect is evident from the graph, where the linear regression line has a positive slope. According to the values presented in the final table, some positive dependence was demonstrated, with a one percent change in e-government leading to an increase of 0.238% in the corruption rating. Simple regression analysis has confirmed the findings of other studies that e-government is not the only factor influencing corruption levels (e.g., Elbahnasawy, 2014; Katsios, 2015).

For this reason, three factors that could potentially influence a country's level of corruption were included in the multiple linear regression: e-government level, economic performance, and the quality of the legal system. The results of multiple regression for the complete set of surveyed countries demonstrate the positive impact of e-government and economic performance on countries' corruption levels. Concerning any correlation between change in corruption levels and change in the quality of the legal environment, the results indicate that there is no relationship between these variables, and the quality of the legal environment does not significantly influence the state of corruption in these countries. Therefore, Elbahnasawy's conclusions (2014) about reducing corruption via the quality of the legal system were not upheld.

CONCLUSION

Although corruption has plagued governments since time immemorial, most of them are still not very aware of how to combat this phenomenon. In particular, due to the severity of its consequences and the potential extent of injured parties, corruption in public administration has been the subject of controversial discussions and activities in the area of anti-corruption policy. The introduction of information and communication technology into public administration processes is a relatively modern tool, one which a number of authors believe can help curb corruption in public administration by regulating officials' discretion, allowing for transparent provision and retention of information, and making ongoing processes more efficient (Kim, 2007; Shim and Eom, 2008; Mistry and Jalal, 2012).

This paper has verified the statement concerning e-administration's positive influence on reducing corruption. This analysis was conducted on a set of 113 of the world's countries for the period between 2003 and 2017. Bag plots were used to provide graphical interpretation of the selected data. Linear regression was used to verify the impact of information and communication technology's use on corruption levels in public administration. The regression analysis showed that improvement in e-government ratings led to a decrease in the corruption level for the selected set of countries during period under review. However, this model displayed low variability, indicating other factors were possibly effecting corruption level. A multidimensional regression model – taking into account not only the degree of e-government but also economic efficiency and the quality of the legal environment – also confirmed the positive influence of e-government. However, for the selected set of countries, the most significant effect on a country's corruption level was its economic performance during the period under review.

This analysis of how electronic public administration influences countries' corruption environments builds on existing studies (e.g. Andersen, 2009; Bhatnagar, 2008; Shim and Eom, 2008; United Nations, 2016) and confirms that it is possible to reduce a country's corruption by using e-government methods.

In view of these findings, this paper indicates the need for further research on e-government's impact on corruption. Future research in this area could explore this relationship in order to provide a framework for effectively implementing e-government as part of an anti-corruption strategy that would lead to an actual, noticeable reduction in corruption.

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The list of analyzed countries

Albania	Honduras	Madagascar	Saudi Arabia
Algeria	Chile	Hungary	Senegal
Angola	Croatia	Malaysia	Sierra Leone
Argentina	India	Malawi	Singapur
Armenia	Indonesia	Mali	Slovakia
Australia	Íran	Morroco	Slovenia
Azerbaijan	Ireland	Mauritius	United Arab Emirates
Bahrajn	Iceland	Mexico	United Kingdom of Great Britain and Northern Ireland
Bangladesh	Italy	Moldova	USA
Belgium	Israel	Mosambique	Serbia
Belarus	Jamajca	Namibia	Sri Lanca
Bolivia	Japan	Germany	Sudan
Bosnia and Herzegovina	South African Republic	Nigeria	Spain
Botswana	Jordan	Nicaragua	Sweden
Brasil	Cameroon	Netherlands	Switzerland
Bulgaria	Canada	Norway	Tanzania
Czech republic	Quatar	New Zealand	Thailand
China	Kazakhstan	Oman	Trinidad and Tobago
Denmark	Kenya	Pakistan	Tunisia
Dominican rep.	Colombia	Panama	Turkey
Egypt	Kongo	Papua-New Guinea	Uganda
Ekvádor	Costa Rica	Paraguay	Ukrain
Estonsko	Kuvait	Peru	Uruguay
Etiopie	Cyprus	Poland	Vietnam
Filipíny	Kyrgyzstan	Portugal	Zambia
Finsko	Lebanon	Austria	Zimbabwe
Francie	Latvia	Romania	
Ghana	Lithuania	Russia	
Guatemala	Luxembourg	Greece	

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