Digital Interactions with Public Authorities in Romania and other Eastern European Member States: A Predictive Model

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Abstract

E-government plays a vital part in the progress of countries in the European Union, especially in Eastern European Member States. It facilitates citizens, irrespective of their geographic location or socioeconomic status, in accessing government services and information, as well as participating in digital interactions with public authorities. The current paper analyses the evolution of e-government in Eastern European Member States in terms of the general populations' ability to utilize the internet for downloading and submitting government official forms. Also, the current research paper aims to provide a predictive model of the evolution of digital interactions with public authorities in Romania by using time series data, specific statistical tests, and Holt's additive double exponential smoothing model for forecasting. The results suggest that Romania has potential for growth in digital interactions with public authorities and acknowledge the need for investments in digital literacy programs, simplification of administrative procedures, and improvement of regional digital infrastructure.

Keywords: *e-government, digital interactions, public authorities, Eastern European Member States*

JEL Classifications: C53, O38, O57
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1. Introduction

The public sector is facing increasing demands and expectations as a result of the rapid advancements in digital technologies, while governments are confronted with the challenge of harnessing the full potential of these technologies. (European Commission, 2022). As e-commerce has transformed the private sector, electronic government (e-government) emerges as the subsequent wave of progress in the public domain. Numerous governments worldwide are embracing e-government as a strategy to lower expenses, enhance public services, and heighten the effectiveness and

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efficiency of operations at the national, regional, and local levels of the public sector (Alsherhri & Drew, 2010).

Effective implementation of e-government can bring forth numerous benefits, such as improved efficiency and cost savings for both governments and businesses. It can also foster transparency and openness in governance. Over the past decade, the online availability of public services has steadily grown, with the Covid-19 pandemic further accelerating the need for digital interactions in the context of the widespread restrictions (United Nations, 2023).

Services for citizens tend to have lower availability online compared to services for businesses. While the rollout of basic digital public services is progressing steadily, including online forms and appointment booking, the availability of more advanced public services that utilize innovative digital technologies such as AI and big data still necessitates significant investment (European Commission, 2017). Within the European Union, each member state is actively involved in modernizing and digitally transforming public services. However, there are significant variations in the outcomes achieved across different countries, implying that not all states possess the same capacity to attain a comparable level of e-government development (Doran et al., 2023).

E-government plays a crucial role in the development of countries throughout the European Union, particularly in Eastern European Member States, by enabling citizens, regardless of their geographical location or socioeconomic status, to access government services and information and engage in digital interactions with the public authorities (Derindag et al., 2019). Moreover, e-government advancements streamline bureaucratic processes, reduce paperwork and automate procedures, leading to cost savings for governments and faster service delivery for citizens, while providing increased transparency and reducing opportunities for corruption (Sheryazdanova et al., 2020).

2. Literature review

According to The World Bank (2015), e-government encompasses the utilization of information technologies in order to revolutionize interactions between governments, citizens, businesses, and other governmental entities. The application of such technologies serves multiple purposes, such as enhancing the delivery of government services to citizens, facilitating improved interactions with businesses and industries, empowering citizens through access to information, and enabling more efficient government management.

Grönlund and Horan (2005) emphasize that the main definitions of e-government have originated from practical fields, being established by the governments in order to form the foundation for national strategies aimed at achieving excellence through the utilization of Internet technology. According to the same authors, these definitions shared similarities, often explicitly mentioning three main goals: achieving a more efficient government, providing better services to citizens, and enhancing democratic processes. In their work, Archmann and Iglesias

(2010) highlight the advantages of employing digitalization in the public sector, such as heightened efficiency and innovation. The authors argue that this form of governance places greater emphasis on citizen-centricity, reduces bureaucratic processes, and adopts a market-oriented approach. Asogwa (2013) shares the same view on the benefits of the widespread utilization of public e-services but points out that the advantages could be compromised in the presence of inadequate infrastructure.

According to Tomaszewicz (2015), the level of digital literacy skills significantly influences the development and effectiveness of e-government initiatives. This dependence on the human factor is primarily driven by the competence and motivation of both citizens and public administration personnel. Reddick and Anthopoulos (2014) underline that digitally literate citizens are more likely to use new digital media when interacting with the governments. Chohan and Hu (2022) showed that e-government ICT training program increase digital literacy among citizens and create a positive impact by reducing the digital divide and promoting "a more equitable usage of public services in developing societies."

3. The digital interactions with public authorities in Romania compared to other Eastern European Member States

In the context of the increasing importance of digital interactions with public authorities in the development of countries, the general populations' ability to utilize the internet for downloading and submitting government official forms represents an important indicator of e-government adoption among the Member States.

The shift towards digital channels for government interactions improved convenience and accessibility for individuals (OECD, 2020), as citizens can download necessary documents from home and submit them electronically at any time, reducing the need for physical interactions with the public officials and saving time and additional effort (Money et al., 2011). Moreover, with online submissions, government agencies can receive and review forms more efficiently, leading to quicker turnaround times for approvals, notifications, or other necessary actions, therefore reducing bureaucratic delays. Additionally, digital interactions enhance accuracy and reduce errors, as online forms often incorporate validation mechanisms and automated checks to ensure that all required information is provided and in the correct format, minimizing the need for follow-ups or resubmissions.

Another important aspect of the utilization of the internet for government forms is that it increases transparency and accountability (Mensah et al., 2020), creating a digital trail that allows both citizens and authorities to track the progress of their interactions. The utilization of online forms reduces paper usage, printing, and physical storage requirements and contribute to environmental sustainability by moving towards paperless processes (European Commission, 2020). This shift aligns with the EU's global efforts to promote sustainability and reduce waste.

For the purpose of this study, the digital interactions with the public authorities throughout the EU was determined as a composite index of two

dimensions: the use of internet by individuals for downloading official forms and the use of internet by individuals to submit completed official forms to public authorities:

$$\text{DI\_IDX} = \gamma_1 \times \text{FORM\_DWN} + \gamma_2 \times \text{FORM\_SBM} \quad (1)$$

Where $\gamma_{[1,2]}$ represents the coefficients corresponding to each of the two dimensions studied, determined by the author in accordance with their estimated contribution to the overall digital interactions index score:

$$\gamma \begin{pmatrix} 1 \\ 2 \end{pmatrix} = \begin{pmatrix} 0{,}35 \\ 0{,}65 \end{pmatrix} \quad (2)$$

Table 1. Variables

Variable ID	Description	Source
FORM_DWN	E-government activities of individuals via websites - Internet use: downloading official forms (% of individuals)	Eurostat
FORM_SMB	E-government activities of individuals via websites - Internet use: submitting completed forms (% of individuals)	Eurostat
DI_IDX	E-government activities of individuals via websites – Individuals' Digital Interactions with Public Authorities Composite Index (% of individuals)	Own

Source: own research

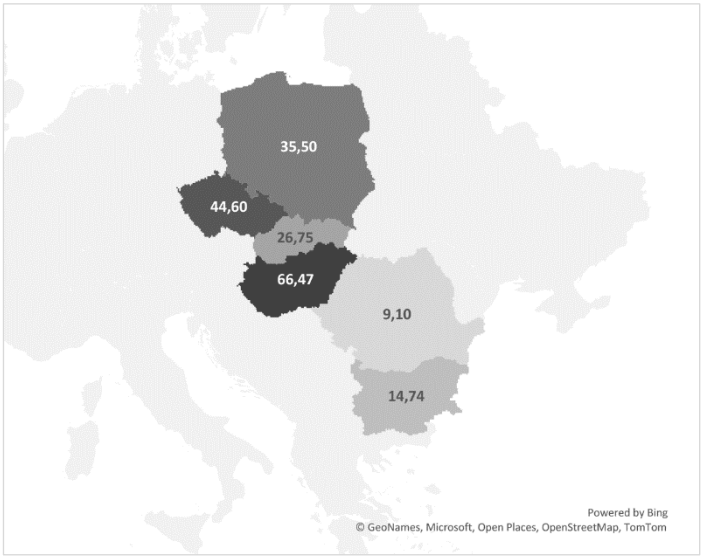
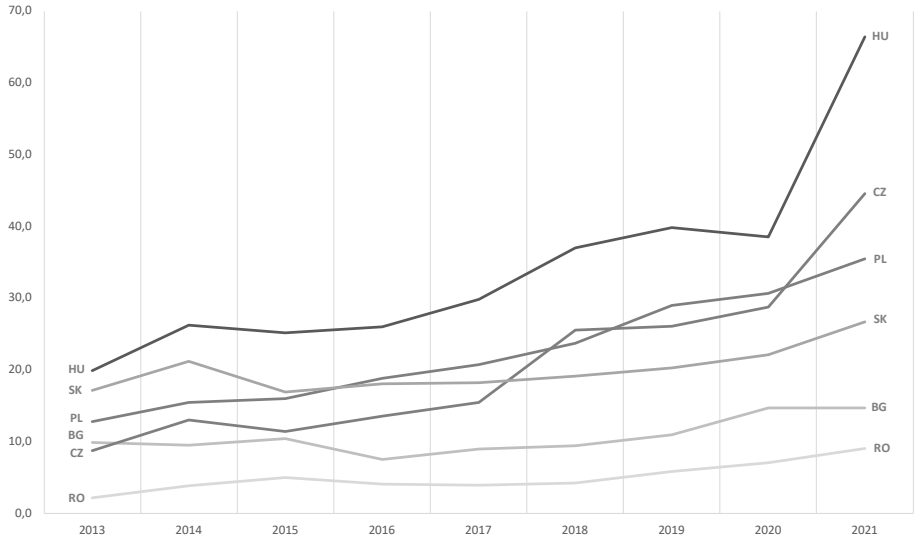


Figure 1. Individuals' Digital Interactions with Public Authorities Composite Index among the Eastern European Member States (% of individuals), 2021
Source: own research, using Microsoft Excel®

Among the Eastern European Member States, in 2021, the Individuals' Digital Interactions with Public Authorities Composite Index was highest in Hungary (66,47%) and Czech Republic (44,6%). Poland (35,5%) and Slovakia (26,75%) ranked in the middle, while the smallest shares were registered in Bulgaria (14,74%) and Romania (9,1%).

Figure 2 summarizes the data tracks and progress made by each Eastern European Member State in terms of digital interactions with public authorities since 2013, measured as the number of individuals who downloaded and submitted official forms to public authorities as a percentage of total individuals. Hungary is the top performing country, registering an increase with almost 47 percentage points since 2013, followed by the Czech Republic, with 36 percentage points. The slowest growth rates were registered by Romania, with 7 percentage points and Bulgaria, with almost 5 percentage points. During the Covid-19 pandemic, only Hungary (+28 percentage points) and Czech Republic (+16 percentage points) made significant advances in terms of digital interactions with public authorities.



	2013	2014	2015	2016	2017	2018	2019	2020	2021
Bulgaria	9,96	9,55	10,43	7,55	9,05	9,44	10,99	14,77	14,74
Czechia	8,81	13,03	11,46	13,60	15,48	25,61	26,09	28,81	44,60
Hungary	19,90	26,24	25,17	26,05	29,85	37,03	39,88	38,55	66,47
Poland	12,87	15,48	16,07	18,89	20,75	23,73	29,01	30,68	35,50
Romania	2,19	3,89	5,05	4,13	4,01	4,27	5,89	7,10	9,10
Slovakia	17,17	21,22	16,99	18,13	18,26	19,14	20,34	22,13	26,75

Figure 2. Evolution of Individuals' Digital Interactions with Public Authorities Composite Index in the Eastern European Member States (% of individuals), 2013-2021

Source: own research, using Microsoft Excel®

4. Research methodology

The number of individuals who download and submit official forms is primarily driven by the legal and regulatory framework in a country and the their accessibility and availability. Although government policies may mandate specific forms to be filled out for various purposes, barriers such as limited distribution channels, lack of digital literacy or other technological constraints, may deter individuals from accessing and submitting the forms. Moreover, excessive bureaucracy, in terms of overly complicated official forms and submission procedures, and insufficient public awareness may create a perception of inefficiency, leading to fewer digital interactions with the public authorities.

According to Eurostat (2023) data, Romania ranks the lowest among the Eastern European Member States in terms of digital interactions with public authorities, with a gap of more than 5,6 percentage points from the next ranking country. The present research aims to provide a predictive model for the evolution of the digital interactions with public authorities in Romania, measured as the number of individuals who downloaded and submitted official forms to public authorities as a percentage of total individuals. Therefore, we can formulate the following hypothesis (H1): *The Individuals' Digital Interactions with Public Authorities Composite Index for Romania is expected to increase with at least 80% (corresponding to 7,3 percentage points) by 2025*.

The current analyses refers to a time series data set from 2013 to 2021 (latest available values) and was performed using Microsoft Excel® and XLSTAT®. The first step of the analysis was a visual inspection of the time series data, followed by the Dickey-Fuller test, in order to determine the stationarity of the analysed data (Harris, 1992) and Mann-Kendall test, in order to determine whether there is a trend in the data series (Kamal & Pachauri, 2018).

Variable	Obs.	Min.	Max.	Mean	Std. deviation
DI_IDX	9	2,190	9,100	5,070	2,042

Dickey-Fuller test:	
Tau (Observed value)	-1,660
Tau (Critical value)	-14,216
p-value (one-tailed)	0,473
alpha	0,05

Mann-Kendall trend test:	
Kendall's tau	0,778
S	28
Var(S)	92,000
p-value* (Two-tailed)	**0,005**
alpha	0,05

**An approximation has been used to compute the p-value.*

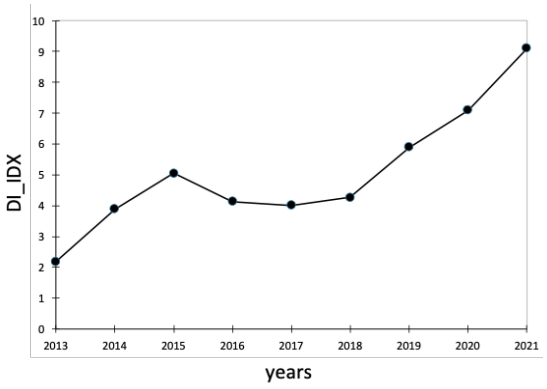


Figure 3. Dickey-Fuller and Mann-Kendall tests for DI_IDX variable
Source: own research, using XLSTAT®

Regarding the Dickey-Fuller test, we formulate the null hypothesis *H0: There is a unit root for the time series*. As the computed Dickey-Fuller p-value from Figure 3 is greater than the significance level alpha ($0{,}473 > \alpha = 0{,}05$), one cannot reject the null hypothesis *H0*, therefore the series is not stationary.

The null hypothesis for the Mann-Kendall test is: *(H0) There is no trend in the series*. As the Mann-Kendall computed p-value is lower than the significance level alpha ($0{,}005 < \alpha = 0{,}05$), one should reject the null hypothesis *H0*, and accept the alternative hypothesis *(Ha): There is a trend in the series*.

In conclusion, for this purpose of the current predictive analysis, the Holt's Exponential Smoothing method was used (additive double exponential smoothing), as the time series is non stationary and has a positive trend with no observed seasonality (Gardner, 1985).

The level update recursive equation of the model is given by the formula:

$$L_t = \alpha \times Y_t + (1 - \alpha)(L_{t-1} + T_{t-1}) \quad (3)$$

Where, L_t is the level estimate for period t, Y_t is the value at current time step t, L_{t-1} is the previous level estimate, T_{t-1} is the previous trend estimate and α is a smoothing constant ($0 \leq \alpha \leq 1$).

The trend estimate for a time t is computed as:

$$T_t = \beta(L_t - L_{t-1}) + (1 - \beta)T_{t-1} \quad (4)$$

Where, T_t is the trend estimate for the period t, L_t and L_{t-1} are the level estimates for the current and previous period, T_{t-1} is the previous trend estimate and β is the smoothing constant for the trend equation ($0 \leq \beta \leq 1$).

The forecasting equation is defined as:

$$F_{t+k} = L_t + k \times T_t \quad (5)$$

Where F_{t+k} is the forecasted value for $(t + k)$ period, L_t is the level estimate for time t, k is the number of future forecasts and T_t is the trend at time t.

5. Result

Holt's additive double exponential smoothing model was used to compute the level (L_t) and trend (T_t) estimates for the analysed periods needed for the forecasting equation. The model residuals represent the difference between the forecasted and actual values for the time series. The smoothing constants: α for the level estimate (L_t) and β for the trend estimate (T_t) were computed using Microsoft Excel® Solver, so that the Root Mean Square Error (RMSE) value is minimum (Ostertagova & Ostertag, 2012).

Additive double exponential smooting table

t (year)	Actual DI_IDX values (%)	L - Level	T - Trend	Forecasted DI_IDX values (%)	Residuals (y-ŷ)
2013	2,19	-	-	-	-
2014	3,89	3,89	1,70	-	-
2015	5,05	5,07	1,18	5,59	-0,54
2016	4,13	4,20	-0,87	6,24	-2,11
2017	4,01	3,99	-0,21	3,32	0,69
2018	4,27	4,25	0,27	3,78	0,49
2019	5,89	5,85	1,59	4,52	1,37
2020	7,10	7,11	1,26	7,44	-0,34
2021	9,10	9,08	1,97	8,37	0,73
2022*	-	-	-	11,04	-
2023*	-	-	-	13,01	-

** forecasting periods*

Model parameters	
α	0,96899
β	1,00000
Std Dev.	2,04232
RMSE	1,06801

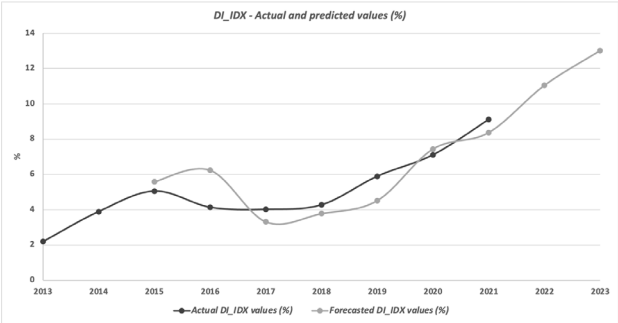


Figure 4. Holt's additive double exponential smoothing model for variable DI_IDX
Source: own research, using Microsoft Excel®

Figure 4 presents the results of the model, including two forecasted periods. The forecasting equation for the next *k* periods become:

$$\text{Forecasted DI\_IDX}(\%)_{2021+k} = 9{,}08 + k \times 1{,}97 \qquad (6)$$

Therefore, the forecasted DI_IDX (%) value for the year 2025 is 16,96%.

6. Conclusions

According to the current research model, the predicted value of the Individuals' Digital Interactions with Public Authorities Composite Index for Romania in 2025 is higher than the 2021 registered value with more than 86% (+7,86 percentage points). This conclusion validates the hypothesis while illustrating a significant potential for Romania to catch up with the other Eastern European Member States by investing in digital literacy programs, simplifying administrative procedures and enhancing digital infrastructure.

The Romanian authorities can increase the level of digital interactions with the citizens by implementing comprehensive digital literacy programs in partnerships with educational institutions and collaborating with the private sector to develop innovative solutions, share best practices and support the implementation of digital initiatives (Misuraca et al., 2020). Moreover, by revising regulations, removing redundant steps and introducing user-friendly online platforms (Ernst & Young, 2018) for accessing and submitting official forms, the government can simplify the administrative procedures and eliminate unnecessary bureaucratic measures. Investments in the improvement of digital infrastructure and software solutions, particularly in rural and underserved areas are fundamental for facilitating digital interactions nationwide.

Although the present research paper aims to provide a reliable predictive model of the evolution of digital interactions with public authorities in Romania, there are some potential limitations regarding the data inputs. The time series used for developing the forecasting model is limited to annual values and does not encompass any seasonality possibly visible in a more detailed set of values. Moreover, future estimates are based on the trend provided by the past values and do not consider possible legislative changes or new initiatives designed to accelerate the e-government implementation and adoption rate in Romania.

Therefore, continuous evaluation and progress monitoring can help determine the effectiveness of implemented measures and identify areas for improvement. The authorities can learn form successful initiatives implemented in other countries and adapt them to the Romanian context and regulations. Future research might identify and address areas for e-government improvement and benchmark Romania's progress against other Member States.

It is important for developing countries to invest in e-government infrastructure, capacity building, and digital literacy programs. By elaborating and implementing an effective e-government strategy, Romania can make significant steps in improving digital interactions with public authorities, narrowing the gap with other EU Member States, and fostering a more efficient and citizen-centric administrative system.

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