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MODERNIZING PUBLIC ADMINISTRATION: E-GOVERNMENT AS A TOOL FOR EFFECTIVE GOVERNANCE

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Abstract
Amidst the rapid globalization of digital transformation, e-government represents a strategic and indispensable means for modernizing public administration and deepening the bond between citizens and state institutions. This paper examines the impact of e-government on the effectiveness of the government, specifically how the digitization of public services leads to greater transparency, reduced bureaucratic structures, and enhanced administrative quality. The empirical analysis is based on data from the 27 EU member states, with the Government Effectiveness indicator, provided by the World Bank, as the dependent variable. This research explores the correlations and direct influences between the level of e-government development and institutional performance. The results showed a strong and statistically significant positive correlation between e-government development and the extent of institutional integrity, socio-economic progress, and government effectiveness. This relationship is powerful in countries with a high degree of digital infrastructure and clearly laid public policies in the areas of anti-corruption and ICT. It demonstrates how the strategic use of digital solutions can significantly enhance administrative capacity and governance in the digital era.
Keywords: *Government Effectiveness, Modernizing Public Administration, DESI, Digitalization Policy, e-government.*
JEL Classification: C12; D73; H11; H83; O21; Y10.

1. INTRODUCTION

As the world moves toward digital integration at a rapid pace, reforming public administration has become a key element of government reform. Government effectiveness, transition, and digitalization are crucial aspects in modernizing public administration and enhancing the state's ability to deliver high-quality services to the public. Nonetheless, the consequences of e-Government differ greatly depending on the institutional environment, digital maturity, and technological platforms of each country. The modernization of public administration via e-Government technology is relevant to improving the efficiency, transparency, and participation of society in decision-making. The diffusion of digital technologies not only revolutionizes the delivery of public services but also the way interaction between state institutions and society provides tremendous benefits (higher efficiency, lower costs, transparency, and citizen participation) for the society in which it operates. But also, some intractable challenges (i.e., digital divide, data security, and institutional complexity).

E-government, as an ICT delivery by the public and interactive administration, is now viewed as an important driver of an efficient, transparent, and citizen-oriented agency (Troitiño, Mazur, and Kerikmäe, 2024). That change requires substituting traditional bureaucratic models with system-level embedding systems of integrated digitalization, fostering civic citizen participation and accountability.

Our paper is structured as follows: Section 2 reviews the literature on the proposed topic to identify the main research directions and the existing research gap. In part 3, we presented the research methodology, followed by part 4, which includes the results presentation and discussion section. The final part (Part 5) was reserved for conclusions, including policy recommendations.

This article aims to examine the extent to which e-Government serves its dual purpose in relation to the modernization of public administration, thereby maximizing government effectiveness. It also focuses on emerging trends of Artificial Intelligence (AI), Internet of Things (IoT), blockchain technologies, and the future direction of digital governance.

Based on these premises, our article proposes an empirical analysis of how e-government can facilitate a practical, relevant, and applicable administration in the 21st century.

2. LITERATURE REVIEW

For research purposes, digital transformation in public administration is a matter of great concern. E-government is viewed as a tool to enhance efficiency, facilitate access, increase transparency, and promote citizen participation. In this regard, the current review provides overviews of major themes, pros, challenges, and emerging trends in e-Government. It is also a study of the effects of digitalization on the government’s performance and what makes digital

governance successful. The review consists of six broad parts, each focusing on a specific aspect of e-Government.

2.1. E-government: definitions, evolution, and conceptual models

E-Government: Application of ICT in the Public sector towards efficiency, quality of services, and the democratic system. This concept went from the traditional e-Government of e-Government 1.0, which involved basic digitalization (e-Government 1.0), to the use of social networks and Web 2.0 for interaction and collaboration (e-Government 2.0), to e-Government 3.0 (Kim & Robinson, 2012; Terzi *et al.*, 2019; Vrabie, 2023) and, in the present, including emerging technologies (AI, Blockchain, IoT). An integrated approach is now emerging, combining digitalization with institutional and legislative reforms. It is not enough to offer services; it is also necessary to co-create them in collaboration with citizens, thereby making public administration increasingly integrated with the general public (Alakash *et al.*, 2024). This idea encompasses multiple domains, including citizen orientation, communication channels, and technology (Malodia *et al.*, 2021; Zou *et al.*, 2023).

Next, Table 1 summarizes the evolutionary stages of e-Government models.

Table 1. Implementation models and strategies

e-Government	Key technologies	Main characteristics
1.0	Web portals, e-services	Basic digitalization of services
2.0	Social media, Web 2.0	Interaction, Participation, Collaboration
3.0	AI, IoT, blockchain, VR/AR	Automation, service customization, predictive analytics
Integrated approach	Integrating additional tools and technologies	Integrating digitalization and institutional and legislative developments.

Source: authors' own élaboration

2.2. Benefits of e-government

Specialized literature has identified several advantages of e-Government. As stated on the EU portal of the European Commission, the digitalization of public services offers an efficiency advantage, increases citizen participation, and, in turn, reduces the cost to both citizens and businesses. Shaxnoza (2024) notes that ICT enhances organizational processes and reduces bureaucracy. Goloshchapova *et al.* (2023) emphasize the importance of digitalization in improving transparency and combating corruption, both of which contribute to economic progress and also aid in poverty reduction as a complementary effect. Digital technologies encourage citizen involvement, allowing citizens to have some influence on politics (McCarthy *et al.*, 2023; Miselo and Munyenyembe, 2025). E-government enhances the quality and accessibility of public services for citizens and corporations (Avianto *et al.*, 2022). In contrast, the quality of electronic services

has a tangible impact on public satisfaction (Taufiqurokhman *et al.*, 2024). Public governments, as the primary service providers, have invested enormous resources in information and communication technologies over the past decade, but have encountered issues with efficiency. Studies have demonstrated that digitalization needs to be supplemented with institutional reform and a user-centered perspective to have a real impact (Peristeras *et al.*, 2009).

2.3. Challenges and limitations

Structural and situational considerations have influenced the E-Government. One significant obstacle is the digital divide - disparities in access to technology and IT skills, which reduce the benefits of digitalization, especially in developing countries (Brown, 2005). E-governance and the digital divide are two interrelated concepts, as citizens often struggle to access or effectively utilize advanced information technologies. At the same time, excluding the user perspective may result in a limited and insufficient understanding of the administrative reforms that follow the introduction of digitalization (Helbig *et al.*, 2009). The "digital divide," which may impede successful digitalization – particularly in countries with inadequate technological infrastructure or insufficient access to digital capacity – has also been observed (Asgarkhani, 2005; Androniceanu and Georgescu, 2023). User satisfaction and accessibility are significant determinants for e-Government services; thus, without them, adoption and utilization rates are low. Furthermore, a harmonious blend between the technical foundation and user experience is necessary to enhance satisfaction and citizen engagement (Ameen *et al.*, 2024). The adoption of digital technology also requires the restructuring and enhancement of competencies in the public sector (Di Giulio and Vecchi, 2021; Dawes, 2008). Other issues include privacy, data protection, and ethical considerations in artificial intelligence (Hand, 2018; Al-Ansi *et al.*, 2024).

2.4. Key factors in digital governance

Adaptability and digital agility are also essential for supply chain resilience, and good government support is associated with this resilience (Dubey *et al.*, 2023). The evolution from mere digitalization to transformation, engagement, and involvement in contexts and on-the-ground action reflects an increasing complexity that is closer to a sense of alignment with societal needs (Janowski, 2015; Smorgunov, 2021). Governance system performance is dependent on cooperation among the governmental and public sectors, and digitalization facilitates new collaboration and co-governance (Smorgunov, 2021; Kukharenko, 2024).

2.5. Emerging technologies and future directions

Emerging technologies, such as AI, the Internet of Things (IoT), and blockchain, are rapidly transforming the digital governance landscape. Al-Ansi *et al.* (2024) demonstrate that these technologies enhance process effectiveness and empower citizens, while also posing some fairness and privacy risks. Vrabie (2023) discusses the evolution of e-Government 3.0, a transformation where digitalization serves as an enabler, combining smart innovations for automation, citizen participation, personalized public services, and predictive analytics.

2.6. The relationship of eGovernment with governmental effectiveness

The strong linkage between e-government and the effectiveness of government has been explored in the previous works of several authors (Moreno-Enguix *et al.*, 2019; Nam, 2019; Hodžić *et al.*, 2021; Zou *et al.*, 2023; Krasnykov *et al.*, 2024). Digitalization levels heavily affect the efficiency of governments. More recent studies report that nations with high levels of digital maturity tend to perform well in public service delivery, while the impact is modest in underdeveloped economies (Wandaogo, 2022; Androniceanu and Georgescu, 2023). Additionally, to provide them with the best governance standards, public administrations must adapt the new technology accordingly and react quickly to citizens' needs (Mittal, 2020; Dubey *et al.*, 2023; Smorgunov, 2021).

3. METHODOLOGY

In this study, we employed a combination of research methods: a review and systematization of the relevant literature, as well as a quantitative approach involving the collection, processing, and analysis of statistical data, along with comparative evaluations of the results obtained through empirical validation.

To test the dependency hypothesis (H1): "government effectiveness is positively determined by institutional integrity, the level of e-government, the degree of digitalization, and various socio-economic indicators", we propose an econometric model expressed through the following multiple regression equation:

$$Gov\_Efi = \beta0 + \beta1(E\_gov\_web)i + \beta2(DESI)i + \beta3(Transparency)i + \beta4(us\_int)i + \beta5(Control\_corrup)i + \beta6(Competitivity)i + \beta7(ed\_tertiary)i + \mathcal{E}i$$

Where:

- The dependent variable (Y) is Government Effectiveness (*Gov_Ef*).
- The independent variables (X1÷X7) included in the analysis are: E-government activities of individuals via websites (*E_gov_web*), Digital Economy and Society Index (*DESI*), Transparency (*Transparency*), Individuals using the Internet (*us_int*), Control of Corruption

(*Control_corrup*), World Competitiveness Ranking (*Competitivity*), and Educational Attainment, at least completed short-cycle tertiary (*ed_tertiary*).

- **β1**–**β7** are the regression coefficients.
- **β0** is the intercept (constant)
- $\mathcal{E}i$ is the random error term.

The following table defines the variables under investigation (Table 2).

Table 2. Variables selected in the analysis

Dependent variable (Y)	**What measures?**	**Relevance:**	**Source of data:**
Government Effectiveness - Percentile Rank, [0;100], *(Gov_Ef)*	It measures perceptions of the quality of public services, the degree of independence of public services from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.	It is a synthetic indicator that captures government performance in a broad sense, being suitable for international comparisons (cross-sectional analyses between states).	World Bank – Worldwide Governance Indicators (WGI)

Independent variable (X)	**What measures?**	**Relevance:**	**Source of data:**
(**X1**): DESI composite index = Digital Economy and Society Index, Aggregate score, weighted score of the DESI dimension [0;100], *(DESI)*	It measures the level of digitisation of the economy and society in the EU member states.	A digitized society indirectly supports the efficiency of public administration.	European Commission, Digital Decade (DESI visualization tool).
(**X2**): E-government activities of individuals via websites, % of people *(E_gov_web)*	Internet use: obtaining information from the websites of public authorities (last 12 months), % of individuals, out of the total. The indicator measures, in the context presented, a specific behavior of citizens.	Reflects the level of digital interaction between citizens and public administration, having a direct impact on citizens' perception of the reality of government efficiency.	EUROSTAT
(**X3**): Transparency, all life events, score: [0;100], *(Transparency)*	Assess the extent to which governments are transparent about: the process of providing public services, their responsibilities and performance, and the personal data involved in providing services and citizens' access to them.	Transparency is an essential institutional factor for effective administration, as it reduces information asymmetries between the state and citizens, increases accountability and institutional control, and contributes to increased public trust in institutions.	E-Gov. Benchmark, European Commission

Independent variable (X)	What measures?	Relevance:	Source of data:
(X4): Individuals using the Internet, % of population, who have used the Internet (from any location) in the last 3 months *(us_int)*	It measures the percentage of the total population using the internet, providing useful information about the degree of digital literacy.	It is a fundamental indicator of digital access and the level of digital inclusion in a society, being an indirect but facilitating factor of administrative efficiency.	EUROSTAT
(**X5**): Control of Corruption: Percentile Rank, [0;100], *(Control_corrup)*	It measures the perception of how control over corruption is exercised in a country.	It is one of the most important predictors of government effectiveness, as corruption reduces the efficiency of resource allocation, affects the quality of public services, and decreases the trust and participation of citizens.	World Bank – Worldwide Governance Indicators (WGI)
(**X6**): IMD Competitiveness Index, general score [0;100], *(Competitivity)*	Measure national competitiveness by combining statistical data from the IMD World Competitiveness Yearbook, IMD World Talent Ranking, and IMD World Digital Competitiveness (2/3) reports with survey results and opinions from executive managers (1/3).	National economic competitiveness is closely linked to the quality and performance of public institutions. Greater competitiveness reflects a more efficient public administration capable of creating conditions conducive to economic and social development.	IMD World Competitiveness
(**X7**): Educational attainment, at least completed short-cycle tertiary, population 25+, total, % *(ed_tertiary)*	Percentage of persons aged +25 years or older who have completed at least the form of short-cycle tertiary education.	A well-educated workforce is essential for the effective adoption and use of digital technology and adaptability. It is a control variable that has an indirect influence on government effectiveness.	World Bank

Source: authors' own élaboration

Data collection: The data corresponding to these variables were collected for the EU27 member states over 6 years (2017–2022). Number of observations: 28 (27 EU member states and average).

Data preparation: Missing data were addressed using Python-based predictive models. Linear regression was applied to estimate the 2022 values for the E-government indicator, while EU-level figures were calculated as population-weighted averages where applicable.

Statistical software used in analyses: IBM SPSS Statistics, version 30.

Methods and techniques used in data analysis:

• The Pearson correlation coefficients were used to evaluate the strength of relationships between variables (theoretical range: 0 – 1, preferred range: 0.50 – 0.95).

• Statistical significance testing determines whether observed results reflect true effects or are likely due to chance. In theory, a *p*-value (Sig.) below 0.05 typically indicates significance at the 95% confidence level. In practice, *p*-values (Sig.) below 0.1 are sometimes accepted as marginally significant.

't-test' for coefficients: Tests whether individual predictors significantly affect the dependent variable.

H_0: $\beta_i = 0$ (no effect); H_1: $\beta_i \neq 0$ (significant effect)

'F-test' for model significance:

Assesses whether the regression model as a whole is significant.

H_0: All coefficients = 0; H_1: At least one $\neq 0$

In ANOVA (Analysis of Variance), the F statistic compares the variance between groups to the variance within groups. Significance is accepted when Sig. (p-value) < 0.05.

• Factorial analysis: The Kaiser-Meyer-Olkin statistical test (KMO) is applied to assess the internal coherence of selected variables. The KMO should range from 0.5 to 1, indicating adequate sampling.

• Multiple regression analysis. Method: Multiple Linear Least Squares (OLS) linear regression. In regression analysis, the coefficient of determination (R^2) is crucial as it shows the percentage of variation in the dependent variable explained by the independent variables.

Residue analysis:

• Durbin-Watson (DW) Test for Residual Autocorrelation: Interpretation of the Test Results: If $1.5 \leq DW \leq 2.5$, there is no significant autocorrelation (i.e., autocorrelation is not problematic); If $DW \approx 2$, it indicates no autocorrelation of errors (the ideal scenario).

• PRESS (Predicted Residual Sum of Squares) is a validation measure in linear regression that assesses prediction accuracy using leave-one-out cross-validation. Unlike R^2, which evaluates model fit on the dataset, PRESS measures out-of-sample predictive accuracy, providing a robust alternative for model validation. A low PRESS score – particularly when the PRESS/SST ratio is below 50% (ideal situation) – indicates moderate to strong predictive performance. Conversely, a ratio between 51% and 100% suggests a poor model fit, with prediction accuracy decreasing as the ratio approaches 1.

• '-3 / +3 rule' for standardised residuals. The residual is a measure of the error of the model relative to the actual data. The '-3 / +3 rule' is based on the standard normal distribution (mean = 0, standard deviation = 1). Interpretatıon: If Standardized Residual = [-2 to +2] → (normal situation), If Standardized

Residual [-2.0 to -3.0 / +2.0 to +3.0] → (potential outlier), and If Standardized Residual = [< -3.0 or > +3.0] → (significant outlier).

Relevant Graphical Representations:

• Histogram of Residuals shows the distribution of standardized residuals (differences between observed and predicted values). A bell-shaped, symmetrical histogram suggests normally distributed residuals, supporting model validity. Skewed, flat, or multimodal shapes may indicate model misspecification, outliers, or nonlinearity.

• Normal P-P Plot compares the distribution of standardized residuals to a normal distribution. Residuals closely following the diagonal suggest normality. Deviations may point to poor model fit or non-normal errors.

Both graphs (Histogram and P-P Plot) verify the normality of the residual distribution, but through different diagrams.

• Scatterplots show how EU countries align with the regression trendline (R^2). Those near the top are leading performers relative to the model.

4. FINDINGS AND DISCUSSION

Below, we present the results of the quantitative analysis for the first and last years in the dataset (2017 and 2022). In the bivariate correlation matrix for 2017, we observe medium to strong intensity links between the dependent variable, Government Effectiveness (Gov_Ef), and the other predictors, statistically validated (Table 3).

Table 3. Correlation matrix_2017

2017		**(X1)**	**(X2)**	**(X3)**	**(X4)**	**(X5)**	**(X6)**	**(X7)**
Gov_Ef **(Y)**	**Pearson Correlation**	0.869	0.800	0.501	0.859	0.929	0.831	0.612
	Sig.	<0.001	<0.001	0.007	<0.001	<0.001	<0.001	<0.001
	N.	28	28	28	28	28	28	28
Where: **(Y)** is the dependent variable and (**X1÷X7**) are the predictors								

Source: authors' own élaboration

The KMO test indicates good internal consistency of the analyzed factors (86.7% in 2017), suggesting that the factors were chosen correctly, and consequently, the solution obtained is very good (Table 4).

Table 4. KMO & Bartlett's test_2017

KAISER-MEYER-OLKIN Measure of Sampling Adequacy		0.867
Bartlett's Test of Sphericity 2017	Approx. Chi Square	228.779
	Df.	28
	Sig.	< 0.001

Source: authors' own élaboration

Regarding the regression results, we note that $R^2 = 0.925$, which means that the model explains 92.5% of the variation in the Gov_Ef dependent variable. On the other hand, DW ≈ 2.2 → There is no significant autocorrelation. Also, PRESS < SST (583 < 3935) → condition fulfilled; PRESS / SST = 14,8% (< 50%) → good predictive model (Table 5).

Table 5. Model Summary_2017

2017 Model summary	R	R Square (R^2)	Adj. R Square	Std. Error of the Estimate	PRESS	Durbin-Watson
1	0.962	0.925	0.899	3.83860	583.324	2.243

Source: authors' own élaboration

Multifactorial ANOVA certifies the statistical significance of the model as a whole, with a significance level below 0.05. In our case, Sig. < 0.001, the condition is met, indicating that the model is statistically significant and that at least one independent variable contributes significantly to explaining the dependent variable (Table 6).

Table 6. ANOVA_2017

2017 Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3640.116	7	520.017	35.292	< 0.001
	Residual	294.698	20	14.735		
	Total	3934.814	27			

Source: authors' own élaboration

The strongest predictor of government effectiveness is X5, control of corruption. High positive effect (β = 0.758) and excellent statistical significance (Sig. < 0.001). Interpretation: Governments that better control corruption are perceived as more effective. The remaining variables are not statistically significant (Sig. > 0.05). Possible causes could be multicollinearity problems; however, since the model as a whole has been validated, we do not intend to conduct further investigations into multicollinearity (Table 7).

Table 7. Regression coefficients_2017 (method: 'enter')

2017 Model	Unstandardized B	Coefficients std. error	Standardized coefficients Beta (β)	t	Sig.
(Constant)	29.163	9.765		2.987	0.007
X1	0.423	0.248	0.269	1.708	0.103
X2	0.110	0.080	0.173	1.377	0.184
X3	-0.006	0.062	-0.008	-0.102	0.920
X4	0.049	0.206	0.038	0.236	0.816
X5	0.577	0.126	0.758	4.563	<0.001
X6	-0.142	0.161	-0.138	-0.882	0.388
X7	-0.185	0.157	-0.105	-1.179	0.252
Where: (**X1÷X7**) are the predictors					

Source: authors' own élaboration

Taking into account the above results of the general model (SPSS, method: 'enter'), several models have been examined by eliminating non-significant variables stepwise (SPSS, method: 'backward'). Thus, it was noted that the effectiveness of the government in 2017 depended mainly on the control of corruption and, to a lesser extent, on digitisation (DESI). Corruption control is the most significant factor, underscoring the importance of institutional integrity for effective administrative performance. In simpler models, digitalization has a moderate but clear effect. This effect is more visible when less important factors are excluded. E-government web services, competitiveness, tertiary education, internet use, and transparency are not statistically significant. Their weak impact may result from overlap with stronger factors, measurement issues, or the indirect effect of government effectiveness on overall governance. Modernizing technology alone is not enough. Strong control of corruption is crucial because robust institutions support digital reforms, which improve governance.

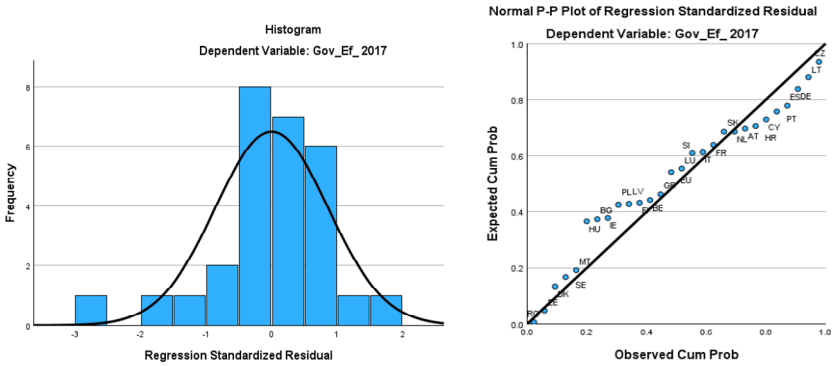
Regarding residues, the model is generally acceptable: errors are distributed symmetrically (average residue ≈ 0) and standardised predicted values are within reasonable limits. A potential negative outlier could exist (gross residual of -9.67 and standardized residual of -2.519), but it is not necessarily a concern if it is only one (Table 8). That is why it would be useful to also check the graphs of the residue (*Histogram,* and *P-P Plot*), to confirm the normality of the residues.

Table 8. Residual Statistics_2017

2017 Residuals Statistics	MIN.	MAX.	MEAN	Std. Deviation (SD)	N
Predicted Value	58.3823	99.9856	80.6174	11.61116	28
Residual	-9.66986	5.80313	0.00000	3.30374	28
Std. Predicted Value	-1.915	1.668	0.000	1.000	28
Std. Residual	-2.519	1.512	0.000	0.861	28

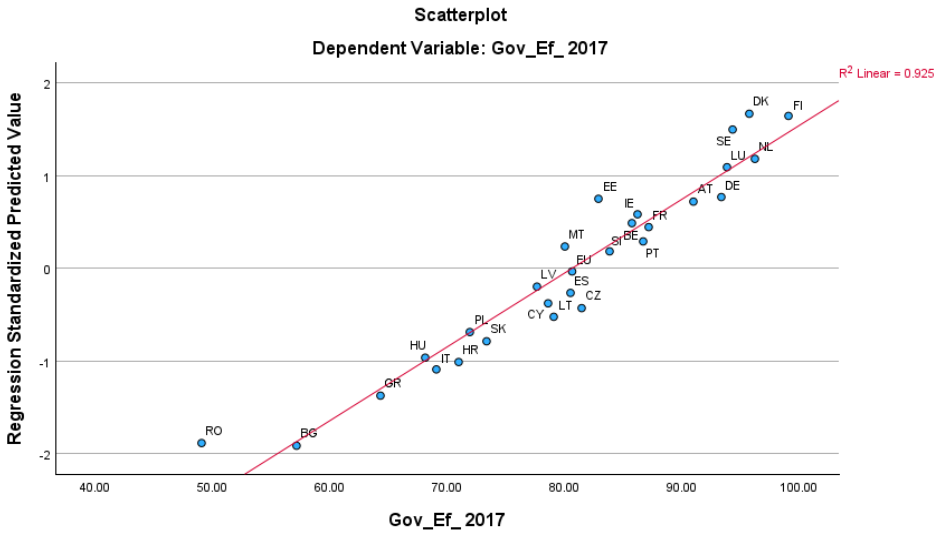
Source: authors' own élaboration

We notice on the graph on the left that the *histogram* has a symmetrical 'bell curve', which means that the residue is distributed approximately normally, a good sign for the chosen model. At the same time, on the right, we note that the *P-P Plot* does not show significant deviations from the diagonal line; we say that the residues are normally distributed (Figure 1).



Source: authors' own élaboration

Figure 1. Residue analysis_Histogram & P-P Plot_2017



Source: authors' own élaboration

Figure 2. Scatterplot_Dependent variable *vs.* Regression Std Predicted Value_2017

The next figure illustrates the 2017 scatterplot, highlighting a top cluster of countries - Nordic states, the Netherlands, Luxembourg, Germany, and Austria - with outstanding performance on the analyzed dimension. In contrast, at the bottom of the ranking are Romania, Bulgaria, Greece, and Hungary. It should be noted that the data obtained refers strictly to the set of variables taken in the analysis (Figure 2).

In the bivariate correlation matrix, for 2022, we observe medium and strong intensity links between the dependent variable, Government Effectiveness (*Gov_Ef),* and the rest of the predictors, statistically validated (Table 9).

Table 9. Correlation matrix_2022

2022		**(X1)**	**(X2)**	**(X3)**	**(X4)**	**(X5)**	**(X6)**	**(X7)**
Gov_Ef (Y)	Pearson Correlation	0.770	0.877	0.601	0.780	0.915	0.917	0.624
	Sig.	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	N.	28	28	28	28	28	28	28
Where: **(Y)** is the dependent variable and (**X1÷X7**) are the predictors								

Source: authors' own élaboration

KMO = 88.3% → This shows that the solution obtained is very good (Table 10).

Table 10. KMO & Bartlett's test_2022

KAISER-MEYER-OLKIN Measure of Sampling Adequacy		**0.883**
Bartlett's Test of Sphericity	Approx. Chi Square	211.932
	Df.	28
2022	Sig.	< 0.001

Source: authors' own élaboration

Regarding the regression results, we note that $R^2 = 0.923$, which means that the model explains 92.3% of the variation in the Gov_Ef dependent variable. On the other hand, DW ≈ 2 → There is no autocorrelation of errors. Also, PRESS < SST (911 < 5187) → condition fulfilled; PRESS / SST = 17,6% (< 50%) → good predictive model (Table 11).

Table 11. Model Summary_2022

2022 Model summary	**R**	**R Square (R^2)**	**Adj. R Square**	**Std. Error of the Estimate**	**PRESS**	**Durbin-Watson**
1	0.961	0.923	0.896	4.46868	911.477	2.032

Source: authors' own élaboration

Multifactorial ANOVA certifies the statistical significance of the model, Sig. < 0.001 (Table 12).

Table 12. ANOVA_2022

2022 Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4787.939	7	683.991	34.252	< 0.001
	Residual	399.382	20	19.969		
	Total	5187.321	27			

Source: authors' own élaboration

The strongest predictors of government effectiveness are X5, *Control of corruption* and X2, *E-government activities of individuals via websites (E_gov_web)*. In 2022, the Controlling Corruption predictor had a highly positive standardized effect (β = 0.519) on the dependent variable, Government Effectiveness, which was statistically significant (Sig.). = 0.002 < 0.05. On the other hand, the predictor E_gov_web_2022 has a moderately positive effect (β = 0.220) and is close to the theoretical threshold of statistical significance (Sig. = 0.057), which suggests the link between the development of *E_gov_web* and *Government Effectiveness*. All other variables do not show a significant impact in the tested model, a possible explanation being multicollinearity - a point we do not intend to elaborate on, as the overall model has been validated and editorial space is also limited (Table 13).

Table 13. Regression coefficients_2022 (method: 'enter')

2022 Model	Unstandardized B	Coefficients std. error	Standardized coefficients Beta (β)	t	Sig.
(Constant)	-0.200	21.868		-0.009	0.993
X1	0.114	0.231	0.080	0.495	0.626
X2	0.158	0.078	0.220	2.020	0.057
X3	0.064	0.080	0.070	0.802	0.432
X4	0.180	0.306	0.063	0.588	0.563
X5	0.457	0.131	0.519	3.501	0.002
X6	0.158	0.176	0.163	0.894	0.382
X7	-0.081	0.143	-0.051	-0.566	0.578
Where: (**X1**÷**X7**) are the predictors					

Source: authors' own élaboration

In light of the above results, we conducted an additional investigation. Thus, several models were examined by phasing out insignificant variables (SPSS, method: 'backward'). Interpretation of results: The implementation of strong anti-corruption mechanisms and the development of e-government platforms primarily lead to increased government effectiveness in EU member

states. While economic competitiveness plays a supportive role, its impact is less decisive (marginally significant), and other factors, such as DESI, internet usage, transparency, and tertiary education, do not show a direct significant effect.

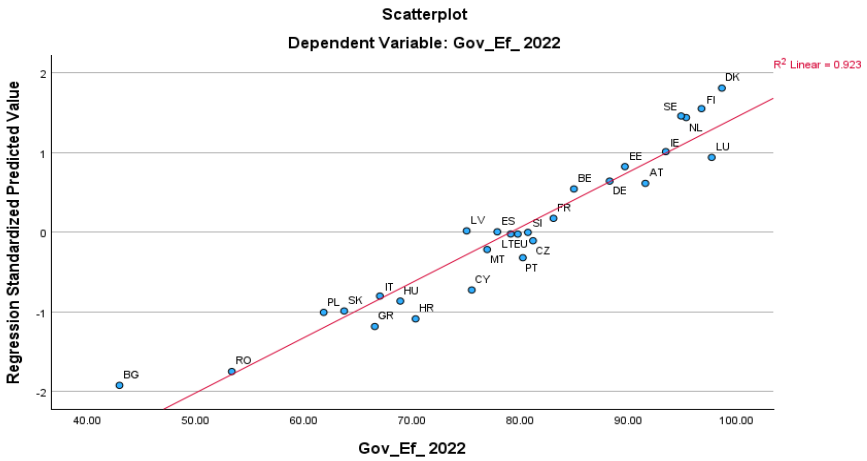
Regarding residues, the model is generally acceptable: errors are distributed symmetrically (average residue ≈ 0, which indicates that the model does not have a systematic error) and standardised predicted values are within reasonable limits [1.923, +1.809], in the range +/-2, so there are no extreme values. A residual standard deviation of 3.85 suggests a moderate dispersion of errors. Additionally, the standardized residues fall within the range of [-2.359, +1.358], which is acceptable according to the theory (a potential negative outlier may exist, but it is not a serious issue). SD = 0.861 < 1, indicating that most of the errors are relatively small compared to the standard deviation of the data (Table 14).

Table 14. Residual Statistics_2022

2022 Residuals Statistics	MIN.	MAX.	MEAN	Std. Deviation (SD)	N
Predicted Value	53.4598	103.1636	79.0704	13.31657	28
Residual	-10.53983	6.06753	0.00000	3.84603	28
Std. Predicted Value	-1.923	1.809	0.000	1.000	28
Std. Residual	-2.359	1.358	0.000	0.861	28

Source: authors' own élaboration

The next figure illustrates the 2022 scatterplot, highlighting a top cluster of countries - Nordic states, the Netherlands, Luxembourg, Ireland, and Austria - with outstanding performance on the analyzed dimension. In contrast, at the bottom of the ranking are Romania and Bulgaria (Figure 3).



Source: authors' own elaboration

Figure 3. Scatterplot_Dependent variable vs. Regression Std Predicted Value_2022

As a general observation, corruption has the most significant impact on government effectiveness in both 2017 and 2022. Throughout the period analysed, the top countries maintain the gap with the countries at the bottom of the ranking.

5. CONCLUSIONS

Empirical evidence supports the statistical predictions (H1) that institutional integrity, e-government, digitalization, and socio-economic aspects collectively have a positive effect on government effectiveness. The results of the study indicate that these features must be enhanced to improve the performance of government, increase public trust, and accomplish multiple functions that encompass social well-being and sustainable development. The bivariate correlation results indicate medium to strong statistical significance for the two variables under investigation. Government effectiveness has also been found to be positively influenced when digitalization measures are supported by coherent public policies, long-term investments in digital infrastructure and human capital, and a commitment from all stakeholders who gain or contribute to this process. Nevertheless, the benefits of digitalization are not universal and vary by region, but are determined by the level of digitalization in a country and its institutional system. At scale, success depends on an interlinked, accountable, citizen-focused solution. The extent to which e-government can achieve its full potential depends on addressing emerging concerns associated with new technologies, including access, ethics, privacy, cybersecurity, and acceptance, as well as reducing regional and contextual disparities. A correlation of more than 90% was observed between Government Effectiveness and Control of Corruption, as supported by multiple regression analysis. This illustrates the clear, positive, and statistically significant role that corruption control plays in governance effectiveness. Seizing this opportunity, public sector reforms should be connected to efforts to reduce corruption.

However, as highlighted in the literature, digitalization may attenuate the risks of corruption. However, the effectiveness of government remains highly variable among EU Member States. The rankings are primarily dominated by Nordic countries, with Luxembourg and the Netherlands, among others, trailing behind. Romania and Bulgaria are significantly lower than all others, with serious administrative gaps.

At the same time, for the sustainable development of public sector governance, the necessary aspects for soundness in institutions must be emphasized, including transparency and effectiveness of digital technologies, and governments should maintain control at all levels.

Limitations and implications for future work

This study has several limitations.

Future developments may investigate potential issues of multicollinearity, conduct panel analysis, expand the range of indicators or countries included, and further examine the risks associated with digitalization, as well as strategies to mitigate them. New hypotheses and research questions may be formulated to advance progress in this area.

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