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THE ROLE OF DIGITAL LITERACY IN STRENGTHENING CIVIL SERVANTS' COMPETENCIES AND PUBLIC GOVERNANCE OUTCOMES

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ABSTRACT

Digital transformation calls for the enhancement and cultivation of public servants' competencies, thereby enabling them to more fully realize their intellectual potential and contributing to the overall improvement of the public administration's efficacy. The aim of this study was to assess the influence of the E-Government Development Index and the E-Participation Index on public government's effectiveness at a global scale. The research applied the methods of regression and correlation analyses, as well as ANOVA testing. Utilizing panel data from 190 countries during 2014-2024, the study examined the E-Government Development Index, E-Participation Index, and Government Effectiveness. The findings suggest that in nations exhibiting a high degree of e-government advancement and active e-participation, the digital literacy among public servants and citizens is correspondingly elevated. This observation substantiates the rationale for employing the E-Government Development and E-Participation indices as indicators that indirectly reflect the level of digital literacy within both civil servants and the general public. The study revealed a close positive correlation among all indicators of e-governance, e-participation, and governance efficacy. The strongest correlations were observed between the E-Participation Index and the Online Service Index (correlation coefficient 0.95), followed by the E-Government Development Index and the E-Participation Index (0.84), and the E-Government Development Index and the Government Effectiveness Index (0.81). A regression model elucidating the influence of e-governance sub-indices, with an explanatory power of 66.04%, demonstrated that all three independent variables exert a direct and statistically significant impact on governance efficacy. An analysis concerning the influence of e-participation indicated that the E-Participation Index also possesses a statistically significant and direct effect on governance effectiveness, albeit its impact is partially overlapped by other components of e-governance. The insights derived from this study may support the formulation of strategies aimed at the countries' digital advancement, integrating initiatives to reinforce the digital literacy of both the population and civil servants.

Keywords: *E-governance, E-participation, Online Services, Human Capital, Telecommunication Infrastructure, Government Effectiveness*

1. INTRODUCTION

The evolution of e-government has meant a transforming change for governments, shifting teering them away from analog and paper-based practices. These changes steered to elevated expectations for the digital competencies of civil servants and the broader society. Further profress depends on the efficacy of the skills development initiatives for both public officials and the citizens, alongside the context in which these skills are

employed [1, 2]. Consequently, the public sector needs to implement comprehensive strategies aimed at transforming organizational culture, improving the work environment, and fostering flexibility and adaptability. Moreover, such strategies should empower and cultivate employee proactivity, instill a positive attitude toward change, while also identify, comprehend, and develop the requisite skills for the a digital state [3, 4].

The European Digital Competence Framework encompasses five fundamental spheres: information literacy, communication and collaboration, digital content creation, security, and problem-solving [3]. Dingelstad et al. [5] have further elaborated on the list of essential competencies to include data literacy, critical thinking, teamwork, subject area expertise, data analysis proficiency, stakeholder engagement, innovation, and political insight. Within the scope of these expanded frameworks, the varying notions of the composition and content regarding requisite digital skills complicate their evaluation. That being said, individual scholars propose specific methodologies [6, 7]. For instance, current scholarly research aims to assess the public servants' digital literacy levels through survey methodologies [8, 9]. This has enabled Hoan [10] to substantiate the low levels of digital literacy among a sample of Vietnamese civil servants. Conversely, a study by Astrialita and Nafi'ah [11] revealed higher levels of digital literacy among public officials in East Java. This discrepancy may indicate a significant gap in civil servants' digital competencies across various nations. However, the differences in evaluative approaches do not allow making direct comparisons.

Due to the differences in requirements for digital competencies and the specific conditions for their cultivation across various nations, there is no single indicator that objectively specifies their level. Nevertheless, indicators that may indirectly signify the digital literacy levels of public servants and the general public on a global scale could include the E-Government Development Index and E-Participation [12, 13]. The consideration of these metrics as indicators for digital literacy is justifiable, for they reflect the extent of digital transformation within the public sector and the degree of citizen engagement in digital governance [14, 15]. The advancement of digital competencies directly influences employees' capacity to effectively adopt e-government tools, thereby refining the transparency, accountability, and efficacy of management processes [16, 17]. Furthermore, a sufficient level of digital skills among the population is imperative for the public services' effective utilization, which is partially represented by E-Participation [18, 19]. Thus, it is expedient to examine these indicators in their entirety, which will facilitate a comparative analysis of digital literacy levels among countries and accordingly facilitate the assessment of its consequences on other phenomena.

Despite the growing attention to digital literacy, e-government, and e-participation, there is still no clear empirical understanding of how these internationally comparable indicators are reflected in the actual effectiveness of public governance at the global level. In addition, the close relationship between e-government development and e-participation makes their empirical assessment methodologically challenging. Therefore, this study addresses the following research questions: 1) how e-government development and e-participation are related to government effectiveness; 2) how e-government indicators influence governance effectiveness; 3) whether e-participation has an independent impact on governance effectiveness.

Evaluating the impact of e-governance and e-participation on governance efficacy presents an important research objective, because these indicators most fully reflect the tangible outcomes resulting from improving digital literacy skills among civil servants as well as citizens. They illustrate the extent to which acquired digital competencies underly the concrete management outcomes – namely, transparency, accountability, and government effectiveness [20]. This study proposes a novel approach to assessing digitalization effects within the public sector, enabling the tracing of how acquired digital skills manifest as concrete results in management activities. The research hypothesis posits that e-governance and e-participation produce direct positive influences on governance efficacy. The objective of this work is to evaluate the impact of the E-Government Development Index and the E-Participation Index on the effectiveness of public governance on the global scale. The tasks delineated for this study include:

- assessing the correlation between e-governance, e-participation, and management efficacy through correlation analysis;
- evaluating the influence of e-governance on management efficacy employing a regression model;
- analyzing the impact of e-participation on management efficacy utilizing a regression model;
- formulating conclusions and recommendations based on the analytical findings.

This study provides a novel empirical assessment of the relationship between e-government

development, e-participation, and governance effectiveness at the global level. Unlike prior research, which is largely theoretical or locally focused, this work quantifies how digital literacy of public servants and citizens influences public administration performance across 190 countries. The findings offer actionable insights for policymakers and contribute to the literature on digital transformation in public governance.

2. LITERARY REVIEW

Against the backdrop of the ongoing e-government's evolution, the need to enhance digital literacy among both the citizens and public officials has gained heightened significance. Matvejciuk and Polovyi [21] maintain that currently, within the framework of digital transformations (particularly, the advancement of e-government), the enhancement of citizens' digital competence constitutes an important requiurement. For example, Mukhiddinovna [22] observed that the fact of the nations' lagging behind in adopting novel technologies, specifically artificial intelligence, can lead to economic isolation and stagnation. From this standpoint, investment in research and development, alongside the improvement of public servants' digital skills, is imperative to ensure that governmental digital development strategies are effectively executed. Further, Nică et al. [23] consider the enhancement of public servants' digital skills to be of paramount priority, requiring civil officials to obtain appropriate training to ensure that digitalization initiatives in public service are successfully realized. Next, Cardoso and Gomes [24] accentuate the need for a holistic strategy aimed at cultivating digital competencies to tackle the complexities of digital governance and guarantee that sustainable transformation within public services is successfully attained. However, the conclusions drawn from these studies are mostly based on theoretical implications, which constrains their practical applicability.

Bilan et al. [25] conducted an empirical study, which demonstrated that in nations where the cultivation of civil servants' digital skills is given due attention, a corresponding increase in macroeconomic performance and competitiveness is observed. Furthermore, it is important to assess to what extent the digital skills development and digital governance impact the quality of public services, as well as the formulation and implementation of public policy. Thus, the e-Government Development Index and the E-Participation Index are frequently mentioned in scholarly works on public servants' and citizens' digital literacy [26, 27]. Nevertheless, the extant studies do not delve into exhaustive analysis of their correlation with governance effectiveness.

Quantitative analysis conducted by Inakefe et al. [28] showed that e-governance will yield high results provided that civil servants are forced to implement reforms. What is more, their professional development should suffice to ensure a high digital literacy level. Nonetheless, these findings call for a thorough empirical validation across a broader sample, including nations with higher e-government implementation metrics.

In light of the above, the researchers are nor unanimous in evaluating the effectiveness of enhancing public servants' digital competencies. the impact of developing digital skills among public servants is shown in several studies to be geographically dependent, influenced by the institutional and socio-economic context of a specific nation. To this end, Putra and Syahrul [29] demonstrated that digital literacy and transformational leadership do not notably affect workers' productivity in Padang City. Further, Silitonga [30] examined the extent to which public servants' digital literacy in Jakarta, West Java, and Yogyakarta provinces contributes to public sector's digital transformation. The researchers included various factors of the concept of knowledge exchange, specifically the readiness to learn as well as the willingness to share. The paper illustrated that neither readiness to learn nor willingness to share exerted a significant influence on digital transformation. Rather, the paramount factor for this process to be successful was its regulation. Instead, Hoan [10] noted that despite the differences in political, economic, cultural, and social conditions that encourage nations to take their own digital transformation paths, the human factor remains invariably influential. The researchers claim that the human factor, that is digital literacy, proved to be fundamental in attaining the digital transformation objectives and fulfilling governmental commitments in the digital environment. Studies demonstrate the importance of taking into account each country's unique conditions; however, due to territorial limitations, their conclusions cannot be fully extrapolated to other states.

Despite prior studies highlighting the importance of digital literacy for public servants and citizens [21–24, 28–30], there is limited empirical evidence on how these competencies, measured by global indices such as the E-Government Development Index and E-Participation Index [26, 27], impact governance effectiveness. Most research remains

theoretical or focused on local contexts, leaving a clear gap for comparative, cross-country analysis of digital skills' role in enhancing public administration.

3. METHODOLOGY

3.1 Research procedure

The study was conducted in three stages. The first stage, preparatory in nature, encompassed the analysis of the extant literature, the formulation of the hypothesis and objectives of the research, the formation of the sample, as well as the collection and refinement of the data. The second stage dealt directly with the analysis, which included correlation analysis and regression analysis of e-governance influence on the governance effectiveness, alongside regression analysis evaluating the impact of e-participation on governance effectiveness. In the final stage, the findings of the analysis were summarized, leading to the formulation of conclusions and recommendations.

3.2 Sampling

In this paper, e-governance is examined along with e-participation, both of which are interpreted as the results of digital literacy development of public servants and the population respectively. This correlation can be explained by the fact that the level of e-government largely reflects the public servants' digital competencies. Evidence of this assertion is found in the initiatives of UNESCO, which developed the Digital Competences Framework Program tailored for civil servants. The programme aims to develop the skills necessary for the effective use of digital technologies in the public sector [31]. Similarly, the OECD has proposed the Digital Talent and Skills Framework Programme in the Public Sector, which identifies key skills for governments to attain digital maturity [3]. Thus, the level of e-governance reflects the public servants' ability to use digital technologies effectively.

Key indicators in the work were respectively e-Government Development Index, e-Participation Index and Government Effectiveness Index, which characterize the level of development of e-governance, e-participation and governance effectiveness. The e-Government Development Index encompasses 190 UN countries and evaluates how e-government policies and strategies are applied in general and in specific sectors to deliver essential services. The index ranges from 0 to 1 (1 is a high level of development), thereby providing an assessment of countries relative to each other, rather than an absolute value. Mathematically, the e-Government Development Index is computed as the weighted average value of scores for key e-government measures, namely: the volume and quality of online services (Online Service Index), the state of development of the telecommunication infrastructure (Telecommunication Infrastructure Index) and the Human Capital Index. Each of these indices is a complex indicator that can be isolated and scrutinized independently [32]. The Government Effectiveness Index measures the quality of public services, public service, policy development and implementation, and confidence in government commitments to improve or maintain these aspects. The score shows the country's score on an aggregated index in units of the standard normal distribution, typically ranging from approximately -2.5 to 2.5 [33].

Therefore, the effective operation of digital public services is impossible without the ability of public servants to use them, ensuring the proper quality of digital services. Particularly indicative in this context are the Online Service Index and the Human Capital Index subindices, while the Telecommunication Infrastructure Index deals mainly with technological aspects. Accordingly, the level of e-participation is an indicator of citizens' digital skills. The capacity to enagge with the state in an online format implies the ability of users to use digital tools to obtain information, advice or access to participate in decision-making. Thus, e-governance and e-participation are not only indicators of the management's digital transformation, but also reflect the results of digital skills development among public servants and the population.

The sample of countries comprised of 190 countries, thereby ensuring a high representativeness of the results and the possibility of generalizing conclusions on global trends in the development of e-governance, digital literacy as well as public administration's effectiveness. Data from almost all UN countries (excluding those for which data were unavailable) were sourced into the work, which ensured high representativeness and accessibility of the data. Data were collected for the period from 2014 to 2024 [32, 22]. The latest available data for 2023 was employed for the Government Effectiveness index, while the E-Government Development and E-Participation indices were submitted for 2024. Given that E-Government Development and E-Participation are published biennially and were not calculated in 2023, this approach ensures comparability of the most current available data.

3.3 Methods

The study employed a correlation analysis method to estimate the linear relationship between the variables under study. This made facilitated obtaining a general idea of the nature and strength of interdependence between them, which became the foundation for further regressive assessment of the influence of individual factors. Correlation analysis was implemented using Pearson's correlation formula (1).

$$r_{XY} = \frac{\sum(X_i-\bar{X})(Y_i-\overline{Y})}{\sqrt{\sum(X_i-\bar{X})^2 \sum(Y_i-\bar{X})^2}} \quad (1)$$

where X_i, Y_i are the observed values of the variables X and Y;

$\bar{X}, \bar{Y}$ — mean values of variables;

N— number of observations.

The regression analysis made it possible to assess the joint impact of independent variables (e-governance and e-participation sub-indices) on governance effectiveness. This approach made it possible to determine both the strength and direction of this influence and showed the extent to which changes in the dependent indicator can be elucidated by independent ones. Regression analysis was conducted using formula (2):

$$Y_t = \beta_0 + \beta_1 X_{1t} + \beta_2 X_{2t} + \cdots + \beta_k X_{kt} + \varepsilon_t \quad (2)$$

where Y_t is the dependent variable;

$X_{1t}, X_{2t}, \ldots X_{kt}$ — independent variables;

β_0 is a constant;

β_k — regression coefficients;

ε_t is a random error.

To evaluate the correctness of the constructed regression model, a test of the normality and homoscedasticity of the residuals was conducted. This analysis verifies the data adherence to the fundamental assumptions of linear regression, thereby ensuring the obtained estimates reliability. The overall significance of the constructed regression models was tested by applying the ANOVA. The Fisher criterion (F) is determined using formula (3).

$$F = \frac{MSR}{MSE} = \frac{SSR/k}{SSE/(n-k-1)}, \quad (3)$$

where is SSR the regression sum of squares;

SSE — the sum of the squares of the balances;

k — the number of independent variables;

n — the volume of the sample.

3.4 Instruments

Data was processed in MS Excel with automated regression and correlation functions using built-in statistical add-ins.

4. RESULTS

A study of the relationship between e-governance, e-participation, and governance effectiveness revealed the presence of remarkable correlations between the indicators. The conducted analysis provided us with an initial understanding of the interdependencies within a selected sample of nations. The correlation analysis matrix is presented in Table 1.

Table 1: Results of correlation analysis between indicators of e-governance, e-participation and management effectiveness

R	E-Government Development Index	E-Participation Index	Online Service Index	Human Capital Index	Telecommunication Infrastructure Index	Government Effectiveness
E-Government Development Index	1.0000					
p-value (2-tailed)						
E-Participation Index	0.8411	1.0000				
p-value (2-tailed)	0.0000					
Online Service Index	0.9038	0.9532	1.0000			
p-value (2-tailed)	0.0000	0.0000				
Human Capital Index	0.8841	0.6313	0.6727	1.0000		
p-value (2-tailed)	0.0000	0.0000	0.0000			
Telecommunication Infrastructure Index	0.9382	0.6772	0.7567	0.7937	1.0000	
p-value (2-tailed)	0.0000	0.0000	0.0000	0.0000		
Government effectiveness	0.8093	0.6474	0.6969	0.7395	0.7763	1.0000
p-value (2-tailed)	0.0000	0.0000	0.0000	0.0000	0.0000	

Source: calculated by the author [32, 33]

In Table 1, it can be seen that there exists a distinctly noticeable (0.5-0.7), strong (0.7-0.9), or very strong (>0.9) correlation among all the examined indicators. It should be mentioned that the relationship among the Online Service Index, Human Capital Index, Telecommunication Infrastructure Index, and E-Government Development Index is expected to be close, as the first three indicators are sub-indices of the latter. At the same time, a strong correlation characterizes various other pairs of indicators. The most noticeable correlation (0.95) is observed between the E-Participation Index and the Online Service Index, which indicates that citizens' engagement is directly dependent on online services' quality and accessibility. What is more, the E-Government Development Index demonstrates a significant correlation with the E-Participation Index (0.84), accentuating the interdependence between the e-government's refinement and citizens' engagement in digital interactions with governmental authorities. Government Effectiveness exhibits a strong correlation with both the E-Government Development Index (0.81) and its sub-indices (ranging from 0.7), in addition to the E-Participation Index (0.65). This emphasizes the connections among the quality of the administration, the public policy's efficacy, as well as the extent of implementing digital tools for service provision and citizen participation in governance processes.

To ascertain the influence of e-government indicators on governance effectiveness across 190 countries, the next stage of the work involved a regression analysis. The analysis does not include the e-participation indicator in view of its pronounced multicollinearity with e-governance. Hence, the impact of this specific indicator will be explored in detail below. The findings regarding the influence of e-governance indicators on governance effectiveness are presented in Table 2.

Table 2: Results of the analysis of the impact of e-government indicators on the effectiveness of governance

Indicator	Coeff.	Std Err	LCL	UCL	t State	p-value	H0 (5%)	VIF	Beta
The Intercept	-2.1050	0.0728	-2.2478	-1.9622	-28.9293	0.0000	*Rejected*		
Online Service Index	0.7650	0.1090	0.5512	0.9788	7.0207	4.2154E-12	*Rejected*	2.4190	0.2068
Human Capital Index	1.4648	0.1583	1.1542	1.7754	9.2554	0.0000	*Rejected*	2.7942	0.2930
Telecommunication Infrastructure Index	1.4582	0.1349	1.1935	1.7228	10.8114	0.0000	*Rejected*	3.5787	0.3873
T (5%)	1.9625								
LCL – Lower limit of 95% confidence interval									
UCL – Upper limit of 95% confidence interval									

Source: calculated by the author [32, 33]

The general view of the resulting model is as follows: Government Effectiveness = –2.1050 + 0.7650 * Online Service Index + 1.4648 * Human Capital Index + 1.4582 * Telecommunication Infrastructure Index. By the coefficient of determination, the model explains about 66.04% of the variation in the dependent measure, and the correlation coefficient between the variables is 0.81. All of the independent variables included in the model, namely the E-Government Development Index sub-indices, have a direct statistically significant impact on governance effectiveness. The impact of the Human Capital Index and Telecommunication Infrastructure Index is about the same (1.47 and 1.46, respectively), and the impact of the Online Service Index is slightly lower (0.77). This means that when the Human Capital Index increases by one unit, Government Effectiveness increases by an average of 1.47 units, other things being equal. Similarly, increasing the Telecommunication Infrastructure Index by one unit contributes to an increase in Government Effectiveness by 1.46 units. Likewise, an increase in the Online Service Index by one unit increases this indicator by 0.77 units. The reliability of the model was substantiated using the ANOVA test, the results of which are presented in Table 3.

Table 3. Results of ANOVA test for the model of the influence of e-government indicators on governance performance

Source of Variation	d.f.	S.S.	M.S.	F	p-value
Regression	3.	609.9661	203.3220	614.8107	0.0000
Residual	944.	312.1871	0.3307		
Totals	947.	922.1532			

Source: calculated by the author [32, 33]

The ANOVA table shows that the regression model possesses statistical significance ($F = 614.81$, $p < 0.001$). Accordingly, the independent variables together significantly explain the variation of the dependent variable. Graphical representations for assessing the normality and homoscedasticity of the residuals are presented below (Figures 1-3).

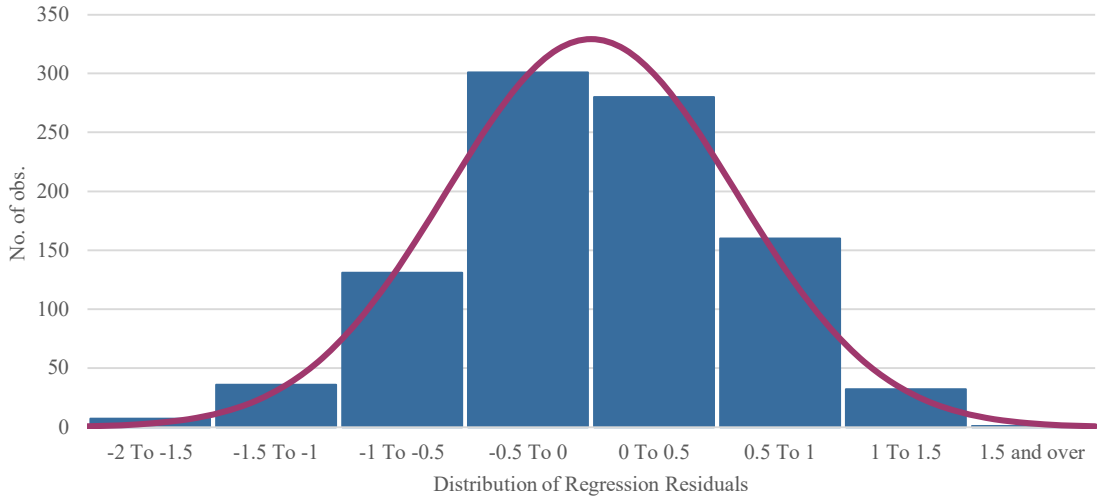

Figure 1: Histogram of the residues distribution in the regression model

Source: calculated and constructed by the author from data [32, 33]

The histogram of the residuals exhibits a symmetrical distribution centered around zero, signifying that the residuals are approximating a normal distribution. The absence of significant distortions or "heavy tails" proves the model's adequacy. This means that the assumption of normality of the residues is fulfilled.

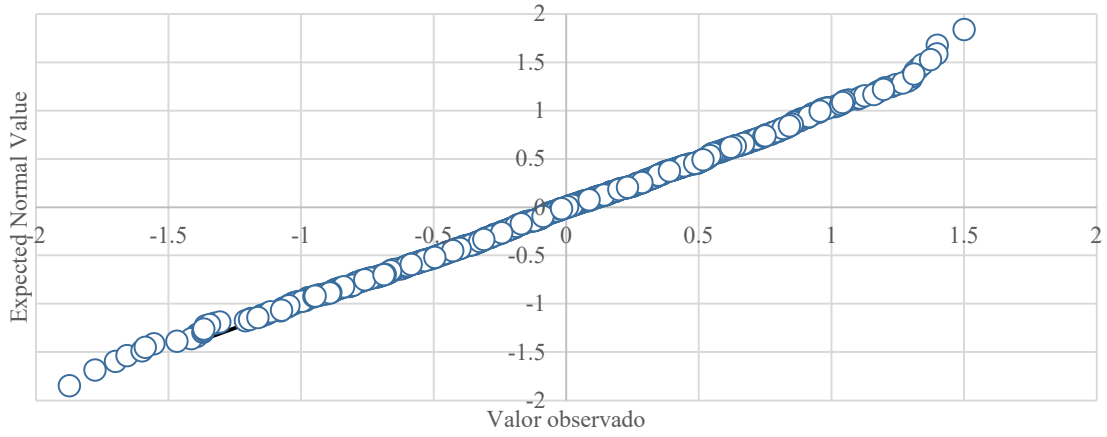

Figure 2: Graph of comparing the empirical and theoretical quantiles (Q—Q plot)

Source: calculated and constructed by the author from data [32, 33]

On the Q-Q graph, the points are located along a diagonal line, indicating that the actual distribution of the residuals is close to theoretically normal. Small deviations at the edges are not statistically significant. So, the model conforms to the assumption of normality.

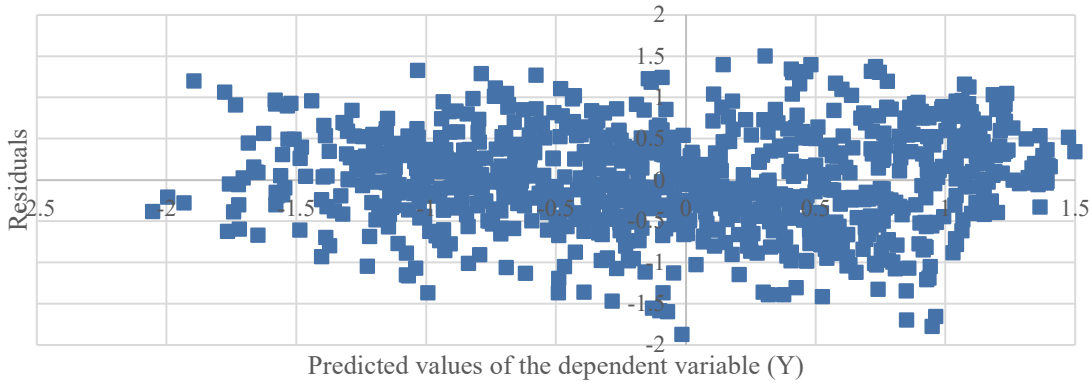

Figure 3: Graph of residuals dispersion from predicted values

Source: calculated and constructed by the author from data [32, 33]

The graph of the residuals from the predicted values shows a uniform distribution of points without any visible trends. This suggests homoscedasticity – the constancy of the residuals variance across the range of predictions. Further, the absence of structural patterns confirms that the model is constructed correctly.

In the following stage of the research, the impact of e-participation on the effectiveness of governance was tested. This analysis facilitated a deeper understanding of the complex effect between increasing digital literacy and the governance effectiveness, thereby complementing the technical aspects of e-governance with a social-communication dimension. The results of the regression analysis are presented in Table 4.

Table 4: Results of the analyzing the impact of e-participation on the governance effectiveness

Indicadores	Coeff.	Std Err	LCL	UCL	t State	p-value	H0 (5%)	VIF	Beta
The Intercept	-1,2167	0,0506	-1,3160	-1,1173	-24,0300	0,0000	*Rejected*		
E-Participation Index	2,3487	0,0899	2,1723	2,5251	26,1273	0,0000	*Rejected*	1,0000	0,6474
T (5%)	1,9625								
LCL – Lower limit of 95% confidence interval									
UCL – Upper limit of 95% confidence interval									

Source: calculated by the author [32, 33]

The model can be presented as follows: Government Effectiveness = –1.2167 + 2.3487 * E-Participation Index. This model exhibits a slightly lower explanatory capacity compared to its predecessor - 41.85%, with a correlation coefficient of 0.65 between the variables. The E-Participation Index demonstrates a direct and statistically significant influence on governance efficacy, evidenced by a regression coefficient of 2.35. The model's reliability was assessed through the ANOVA test, the findings of which are presented in Table 5.

Table 5: Results of ANOVA test for the model of e-participation's influence on governance performance

Source of Variation	d.f.	S.S.	M.S.	F	p-value
Regression	1,	386,5162	386,5162	682,6346	0,0000
Residual	946,	535,6370	0,5662		
Total	947,	922,1532			

Source: calculated by the author [32, 33]

The ANOVA table shows that the regression model is statistically significant ($F = 614.81$, $p < 0.001$). Thus, the variation of the dependent variable is substantially elucidated by the independent variables. Figure 4 shows the dispersion diagram for this model.

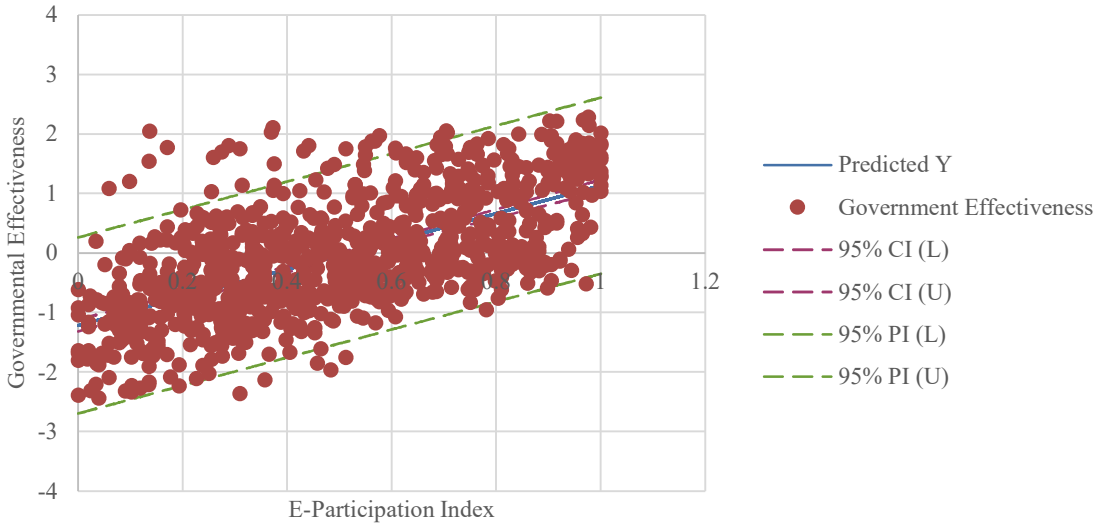

Figure 4: Dispersion diagram of "Governance Effectiveness" vs "E-Participation Index"

Source: calculated and constructed by the author [32, 33]

The dispersion diagram illustrates a positive correlation between the governance effectiveness and the degree of e-participation. In particular, nations exhibiting elevated e-participation rates usually demonstrate higher effectiveness of governmental institutions. Nonetheless, the heightened regression coefficient for the E-Participation Index does not signify its dominant influence, as this metric was examined independently from other components of e-governance. Its impact would evidently decrease because of the partial overlapping the influence among the variables, if integrated into a common model. However, despite the partial overlap of their influence, the construction of individual models has shown that e-governance indicators, as well as the level of e-participation of citizens, are important factors in improving the governance effectiveness. This overlap is explained by the fact that effective e-government cannot fully realize its potential without engaging citizens in digital services. On the other hand, active e-participation depends upon the availability of appropriate electronic tools. According to the results of the study, general recommendations were devised to strengthen the management effectiveness through enhancing the population's and civil servants' digital literacy in the context of digital transformation:

– ensure balance in the implementation of e-government and the development of digital skills of public servants;
– implement proper training of public servants in accordance with the requirements of digital transformation individually for each position;
– coordinate the development of e-government with programs and initiatives to improve the digital skills of the population;
– use e-governance performance monitoring and evaluation systems to timely identify problems in the provision of digital services and adjust the digital skills development programs for the public servants;
– ensure the integration of citizen feedback into the digitalization process in order to adapt the services to the users' real needs and increase the e-participation level of the population.

5. DISCUSSION

The analysis revealed a profound interconnection between e-governance and e-participation. Moreover, both metrics have a substantial impact on the quality of public administration. The validity of the author's hypothesis, which posits that the digital proficiency of civil servants partially reflects the maturity of e-governance, is corroborated by other scholarly works. Inakefe et al. [28] emphasized that enhancing the public officials' digital literacy is a critical prerequisite for the successful implementation of e-government initiatives. Accordingly, the e-government indicators analyzed are largely a consequence of the effective use of digital competencies by civil servants and public service providers. A similar conclusion is drawn by Hoan [10], who asserts that the public servants'

digital literacy empowers them to execute professional responsibilities within the framework of digital governance and to modernize public administration. Cardoso and Gomes [24] noted that the complexities of digital governance can only be overcome by implementing a comprehensive strategy for developing the digital competencies of public servants. Regarding e-participation, the above scholars' findings are consistent with those of Anzar et al. [26]. Researchers hold that when the level of competence of users in the field of digital technologies improves, the trust, use and effectiveness of e-government increases. Ibrahim [27] also states that the development of digital literacy, encompassing trust, digital skills and digital transformation, contributes to increasing the e-government's effectiveness.

The findings support the conclusions drawn by Bilan et al. [25] and Mukhiddinovna [22], proving the necessity to improve the public servants' digital competencies through quantitative analysis. The direct impact of e-government development stemming from digital competence and civil servants' professional development can be traced in increasing the public administration effectiveness, decisions transparency, and citizens' trust in the authorities. The importance of assessing the digital skills of the population along with the assessment of the digital skills of public servants is noted in the work of Matvejciuk and Polovyi [21]. This research expands the scientists' conclusions, empirically confirming that citizens' e-participation is imperative for public servants' effective work in the conditions of digital transformations. Accordingly, such participation is ensured by citizens' ability to use digital interaction tools with the authorities.

The author's findings have certain discrepancies with those of other researchers, which is attributable to differences in sampling and analysis approaches. For instance, Silitonga [30], Putra and Syahrul [29] found no significant correlation of civil servants' digital literacy indicators with indicators of digital transformation effectiveness and labor productivity. This underscores that territorial specificity significantly influences the relationship between indicators of public servants' digital skills and management effectiveness. In turn, the author's research shows that at the global level, digital skills improvement and, as a result, effective e-governance, have a positive and significant impact on the effectiveness of the board. Nevertheless, some important consequences of the increase in civil servants' and citizens' digital literacy remained outside the scope of this article. Therefore, future inquiries should assess the role of increasing digital literacy in the fight against misinformation and fakes following the example of Müller-Török et al. [34] and Soßdorf et al. [35], as well as addressing corruption, as in Merhi [36] and Umeanwe [37].

The comparative analysis of the author's findings with those of other works not only corroborate the author's approach but also reinforces the hypothesis about the impact of digital literacy on management effectiveness. The differences regarding other works allow us to deepen the understanding of the digital literacy's impact on management effectiveness at the local level. The practical implications lie in explaining the impact of e-governance and e-participation indicators on management effectiveness. Moreover, the study showed that these indicators are closely related to each other. The practical use of these results provides for their integration into the process of digital strategies development for nations. In particular, such strategies should specifically comprise provisions to improve the digital literacy of both civil servants and the general public, ensuring a high level in public services' provision and use.

6. LIMITATIONS

An overarching limitation of this study lies in the lack of adequate consideration of the local context (specifically, the cultural, institutional, and other disparities among nations), since the data covered by the research relates to the macro level. Additionally, another constraint of the paper is the absence of the recent data for the Government Effectiveness Index for 2024.

7. CONCLUSIONS

Digital literacy, as a key aspect of public servants' intellectual potential, not only enhances professional competencies but also positively influences the overall performance of public administration. This study demonstrates that in countries with high e-government development and active e-participation, the digital literacy of both public servants and citizens tends to be proportionally high. This pattern likely reflects elevated requirements for skills needed both to provide public services and to effectively use them.

The correlation analysis revealed strong positive relationships among all indicators of e-governance, e-participation, and governance effectiveness. The strongest correlation was observed between the E-Participation Index and the Online Service Index (0.95), highlighting the dependence of citizen digital engagement on the quality and accessibility of online

services. A notable correlation also exists between the E-Government Development Index and the E-Participation Index (0.84), as well as between the E-Government Development Index and Government Effectiveness (0.81), emphasizing the interconnection between digital infrastructure and administrative performance.

Regression analysis confirmed that all three e-governance sub-indices have a direct, statistically significant impact on governance effectiveness. The model explains 66.04% of the variation in the Government Effectiveness Index, with the Human Capital Index (1.46) and the Telecommunication Infrastructure Index (1.47) being the most influential factors, while the Online Service Index also shows a meaningful, albeit smaller, effect (0.77). The separate analysis of e-participation indicated that the E-Participation Index explains 41.85% of the variation in governance effectiveness (correlation coefficient 0.65), though examining it in isolation may overestimate its influence due to potential overlaps with other e-governance components.

Overall, the findings confirm that effective digital governance requires both robust e-government structures and active citizen participation. This underlines the importance of policies that simultaneously enhance public servants' digital competencies and encourage citizens' engagement with online services. A critical observation is that the current models, while informative, may not fully capture complex interactions between different e-governance components or contextual factors such as institutional and socio-economic differences.

This study provides practical guidance for policymakers and public administrators to prioritize digital skills development among civil servants, ensuring effective e-government implementation. It highlights the link between high-quality online services and citizen engagement, supporting the design of user-centered digital platforms. Overall, the findings help improve public administration performance and inform professional training and digital transformation strategies. The study confirmed the significant impact of digital literacy, e-government, and e-participation on governance effectiveness, providing empirical evidence across 190 countries. Open issues remain regarding the interaction of these factors with initiatives addressing disinformation, regional socio-economic disparities, and sector-specific public services. Further research could explore these areas and examine how integrating multiple e-governance components simultaneously affects overall public administration performance.

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