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Computer-Integrated Technologies and Artificial Intelligence in the Digital Transformation of Management Processes

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Abstract

The digital transformation of management processes through computer-integrated technologies and artificial intelligence is a key factor in improving the efficiency of public administration. This study provides a comprehensive empirical assessment of the relationship between digital transformation, artificial intelligence readiness, and Government Effectiveness at the global level. The analysis covers 190 countries and uses the Government Effectiveness Index from the Worldwide Governance Indicators as the dependent variable. The independent variables include the GovTech Maturity Index, E-Government Development Index (EGDI), Online Service Index, E-Participation Index, and Oxford Government AI Readiness Index (Oxford GAIR). The logarithm of GDP per capita at purchasing power parity was included as a control variable. Spearman correlation and linear regression analyses, including simple and multiple models, demonstrate statistically significant positive relationships between all examined digital indicators and government effectiveness. The strongest effects were observed for EGDI ($\beta = 0.820$ in the paired model) and Oxford GAIR ($\beta = 0.759$ in the paired model). After controlling for economic development, the digital factors remained independently significant, with adjusted R^2 values ranging from 0.693 to 0.733. Based on these findings, the DT-CIT-AI (Digital Transformation–Computer-Integrated Technologies–Artificial Intelligence) model is proposed, integrating four interrelated blocks: technological infrastructure, intelligent capabilities, digital citizen participation, and government effectiveness. The model provides a practical framework for developing national digital transformation strategies. The findings confirm that investments in computer-integrated technologies and artificial intelligence can strengthen efficient, transparent, and citizen-oriented public administration, even when differences in countries' levels of economic development are taken into account.

Keywords: digital transformation, public administration, Government Effectiveness, GovTech Maturity Index, E-Government Development Index, artificial intelligence

1. INTRODUCTION

The digital transformation of management processes has become one of the most important challenges and, at the same time, one of the major opportunities facing the modern state. Around the world, citizens have long been accustomed to the speed and convenience of banking applications, delivery services, and online shopping. Accordingly, traditional bureaucracy no longer fully meets their expectations. People increasingly expect to receive high-quality public services quickly, transparently, and without unnecessary paperwork. Therefore, the combination of computer-integrated technologies and artificial intelligence within the public administration system goes far beyond purely technical modernization.

The concept of e-government, which originated at the end of the twentieth century, gradually evolved from the simple digitization of documents to the creation of intelligent, data-driven systems focused on the needs of citizens. Today, attention is increasingly directed toward Government 3.0 – a model in which artificial intelligence, big data, and integrated digital platforms help predict societal needs, optimize resources, and support more informed decisions [1, 2]. However, despite the significant number of existing studies, there is still a lack of comprehensive empirical research that simultaneously considers the impact of computer-integrated technologies and artificial intelligence on the overall efficiency of public administration, especially while accounting for differences in countries' levels of economic development.

The scientific novelty of this study lies in its comprehensive global assessment of the impact of key indicators of digital transformation and readiness to use artificial intelligence on the Government Effectiveness indicator in a sample of 190 countries worldwide, while controlling for the economic factor. Unlike previous studies, which mostly examined individual aspects of digitalization, this study provides a holistic view of the transformation of management processes and proposes a model that can become a practical tool for shaping effective public policy.

2. LITERATURE REVIEW

The digital transformation of public administration is one of the key processes of our time. It combines technological progress with the need to make government more efficient, transparent, responsive, and closer to citizens. For this reason, studying the impact of computer-integrated systems and artificial intelligence on the quality and effectiveness of public administration is of particular contemporary relevance.

The concept of the digital transformation of governance originates in theories of e-government. Since the late 1990s, studies in this area have emphasized the transition from paper-based processes to electronic services. According to Fountain [3], technologies can not only automate administrative procedures but can also transform the institutional structure of the state and change the relationship between government, citizens, and business. This idea was further developed within the concepts of Government 2.0 and Government 3.0. While Government 2.0 emphasized the transition toward openness, transparency, and active citizen participation through web technologies and social networks [4, 5], Government 3.0 shifts the focus toward intelligent, data-driven, and human-centered systems in which artificial intelligence, big data, and platform solutions play a key role [1, 2, 6]. Thus, the emphasis has shifted from simple digitalization toward the creation of open, interactive, and personalized public administration systems [7, 8].

Modern research emphasizes that digital transformation goes far beyond the implementation of information technologies. It encompasses changes in organizational culture, the restructuring of business processes, and the development of human capital [9, 10]. In the public sector, this means moving from a vertical-hierarchical management model toward a more horizontal, networked, and data-driven model [11].

Artificial intelligence occupies a special place in modern digital transformation. AI technologies make it possible to automate complex analytical processes, predict citizens' needs, optimize the allocation of resources, and improve the quality of decision-making [12, 13]. Research indicates that governments actively implementing AI tools can achieve higher levels of operational efficiency and improved adaptability in complex administrative environments [14].

An important area of development is GovTech, an ecosystem of technological solutions focused specifically on the needs of the public sector. Unlike traditional e-government, GovTech places particular emphasis on the internal transformation of state institutions, the integration of systems, and the use of advanced technologies, including artificial intelligence [15].

Empirical studies generally confirm a positive relationship between the level of digitalization in the public sector and the quality of public administration. International studies demonstrate that the development of e-governance is associated with increased efficiency of state institutions [16]. In particular, indices developed within the framework of the United Nations E-Government Survey, such as the E-Government Development Index (EGDI), Online Service Index (OSI), and E-Participation Index (EPI), are used to assess governments' digital capacity, the accessibility of online services, and opportunities for citizens' digital participation [17]. Studies of digital interaction between the state and society also show that the development of e-participation can be associated with increased transparency, greater trust in state institutions, and the creation of additional public value in public administration [18, 19].

In the field of artificial intelligence, the Oxford Government AI Readiness Index (GAIR) has become a widely used international assessment tool. Research drawing on this index examines how countries with higher levels of AI readiness

perform in areas related to public services, institutional capacity, and government effectiveness [20–22].

At the same time, modern research emphasizes the decisive role of contextual factors in shaping the effects of the digitalization of public administration. In particular, the level of economic development, institutional capacity, and the prevalence of corruption can significantly affect the outcomes associated with the introduction of digital technologies. Empirical studies show that the spread of the Internet and digital tools can reduce corruption by increasing transparency and reducing direct contacts between citizens and officials, although these effects are heterogeneous and depend on the quality of the institutional environment [23, 24]. At the same time, in developing countries, digital transformation may be accompanied by increased socio-economic disparities because of unequal access to technology, a phenomenon described by the concept of the "digital divide" [8]. This suggests that the effectiveness of digital governance depends substantially on inclusion policies and broader institutional development.

Despite a substantial body of research, several important gaps remain. First, most studies focus on individual aspects, for example, only e-government or only artificial intelligence. A comprehensive analysis of the combined role of computer-integrated technologies and artificial intelligence in the efficiency of public administration therefore remains limited. Second, many studies are regional in scope or use relatively small samples, which complicates global generalizations. Third, insufficient attention is paid to separating the effect of digital transformation from the country's overall level of economic development.

Thus, the relevance of this study lies in a comprehensive empirical assessment of the impact of key indicators of digital transformation and readiness to use artificial intelligence on the Government Effectiveness indicator in a global sample of countries while controlling for the economic factor. This approach makes it possible not only to confirm general trends but also to determine the relative strength of the influence of various digital components, which is important for the formation and implementation of effective public policy.

3. MATERIALS AND METHODS

The study is quantitative in nature and uses a cross-sectional empirical design. The purpose of the empirical stage was to assess the impact of indicators of the digital transformation of management processes and readiness to use artificial intelligence on the effectiveness of public administration at the global level. For this purpose, a sample was formed that, after data cleaning, included 190 countries worldwide with a complete set of values for all analyzed variables. This sample size provides sufficient statistical power and supports the formulation of reasonable conclusions at the global level.

The main outcome indicator is the Government Effectiveness Index (GE) from the Worldwide Governance Indicators, which reflects the quality of public services, the professionalism of the civil service, the ability of the state to formulate and implement effective policies, and the overall institutional effectiveness of public authorities [25].

The key international indices of digital transformation were used as independent variables:

- GovTech Maturity Index (GTMI) – a comprehensive indicator of the maturity of digital transformation in the public sector, particularly the level of adoption and integration of computer-integrated technologies [26];
- E-Government Development Index (EGDI), Online Service Index (OSI), and E-Participation Index (EPI) – indices that assess the development of e-government, the accessibility of online services, and the level of citizens' digital participation, respectively [17];
- Oxford Government AI Readiness Index (GAIR) – an integral indicator of public-sector readiness for the implementation, governance, and use of artificial intelligence [21, 27].

The control variable was the logarithm of gross domestic product per capita at purchasing power parity (ln GDP per capita, PPP, constant 2021 international $), which made it possible to account for the impact of each country's overall level of economic development [28].

Data for all indicators were collected from official open sources of international organizations. The initial data set underwent a systematic cleaning procedure. Countries with incomplete values for at least one of the variables were excluded. This procedure ensured a balanced sample and reduced the risk of biased results arising from missing data.

Data analysis was carried out in several stages. First, descriptive statistics (means, standard deviations, minimum values, and maximum values) were calculated for all variables. To assess the relationships between the indicators, Spearman's rank correlation coefficient (Spearman's rho) was used because the distributions of most variables did not follow a normal distribution.

The main method of hypothesis testing consisted of paired linear regression models, in which Government Effectiveness was the dependent variable and each digital indicator was entered separately as an independent variable. To control for the impact of the country's level of economic development, multiple linear regression models were estimated with the inclusion of the logarithm of GDP per capita. All models were tested for multicollinearity using the Variance Inflation Factor (VIF) and the Tolerance Index.

The statistical significance of the models was assessed at $p < 0.05$. Standardized coefficients β were used to compare the relative strength of the influence of different factors. All statistical calculations were performed using the IBM SPSS Statistics software package (version 28).

This methodological approach made it possible not only to establish the presence and direction of the observed relationships but also to separate the effect of digital transformation from the country's general level of economic development, which is an important condition for the validity and interpretability of the results obtained.

4. RESULTS

To study the impact of the digital transformation of management processes on the efficiency of public administration, an empirical model was developed in which Government Effectiveness (GE) serves as the outcome indicator. This indicator is a component of the World Bank's Worldwide Governance Indicators (WGI) system and characterizes the quality of public administration by assessing the effectiveness of public services, the professionalism of the civil service, the quality of public policy formulation and implementation, and the institutional capacity of public authorities [25]. In the context of digital transformation, this indicator is considered the final outcome of the modernization of management processes because the introduction of digital technologies is aimed not only at automating administrative procedures but also at increasing the overall effectiveness of state institutions.

The theoretical basis of the study is the assumption that the development of digital technologies in the public sector has a positive impact on the quality of management. The digital transformation of government involves the comprehensive use of information systems, digital platforms, electronic services, data-exchange mechanisms, and artificial intelligence tools to optimize management processes. To test this hypothesis, paired linear regression was used to determine the separate relationship of each digital transformation indicator with the effectiveness of governance.

The general form of the regression model is as follows:

$$GE_i = \beta_0 + \beta_1 X_i + \varepsilon_i,$$

where GE_i is the indicator of public administration efficiency for the i-th country; X_i is a separate indicator of digital transformation; β_0 is the constant of the model; β_1 is a parameter characterizing the strength and direction of the influence of the digital factor; and ε_i is the random error term.

The empirical analysis was carried out using an international sample of countries. The initial data set was formed by matching the Government Effectiveness indicator with data for all digital transformation and AI-readiness indicators used in the study, including the GovTech Maturity Index (GTMI), E-Government Development Index (EGDI), E-Participation Index (EPI), Online Service Index (OSI), and Oxford Government AI Readiness Index (GAIR). These indicators were considered together because they represent complementary dimensions of the broader process of public-sector digital transformation while remaining analytically distinguishable within the empirical framework. Following the data matching and cleaning procedure, the final sample included 190 countries with a complete set of values for all variables in the empirical model. The same completeness criterion was applied consistently to every country included in the analysis. Excluding countries with incomplete data ensured the comparability of observations, maintained a balanced analytical sample, and avoided the potential influence of missing values on the regression estimates.

The GovTech Maturity Index (GTMI) is used as a comprehensive indicator of the digital maturity of the public sector. Unlike traditional e-governance indicators, the GTMI assesses not only the availability of digital services but also the level of internal digital transformation within government bodies. The index includes the following components: digitalization of core government systems, development of digital public services, digital interaction with citizens, and institutional prerequisites for the development of GovTech [26]. Taken together, these components characterize the level of adoption and integration of computer-integrated technologies within the public administration system.

The E-Government Development Index (EGDI) is used as an indicator of the comprehensive development of e-government. It characterizes the ability of the state to use digital technologies to ensure the effective provision of public services and also reflects the organization of interaction between public authorities and society. Methodologically, EGDI is formed on the basis of three components: the Online Service Index, Telecommunications Infrastructure Index, and Human Capital Index [17]. Thus, EGDI reflects the overall capacity of the state to carry out the digital transformation of management processes.

The E-Participation Index (EPI) characterizes the level of citizens' digital participation in public administration. The indicator reflects citizens' ability to receive government information, participate in electronic consultations, and use digital channels to influence management and public decision-making processes [17]. In the context of digital transformation, EPI is considered an indicator of the transition from a traditional vertical management model toward a more open, participatory, and interactive system of interaction between the state and society.

The Online Service Index (OSI) was used to assess a practical outcome of public-sector digitalization. This indicator

reflects the level of development of digital public services, the accessibility of administrative procedures through online platforms, the integration of electronic services, and the orientation of public services toward users' needs [17]. Within the framework of this study, OSI is considered a direct mechanism through which digital technologies can affect the effectiveness and accessibility of public management.

The Oxford Government AI Readiness Index (GAIR) is used as an indicator of the readiness of the public sector to implement, govern, and use artificial intelligence technologies. The index was developed by Oxford Insights and assesses the ability of governments to harness AI in ways that can benefit the public [27]. The 2025 index framework covers six key pillars: Policy Capacity, Governance, AI Infrastructure, Public Sector Adoption, Development and Diffusion, and Resilience. As part of the study, the Oxford GAIR Pillar Mean was used as a package-derived arithmetic mean of the six published pillar scores, aggregating the results for these components for modeling purposes. This indicator therefore characterizes the overall level of readiness of state institutions to integrate artificial intelligence into management processes while recognizing that the pillar mean is not an official Oxford Insights aggregate score. The inclusion of this indicator in the empirical model makes it possible to assess the extent to which the development of public-sector AI capabilities is associated with increased efficiency of public administration. Data for this derived indicator were obtained from Park et al. [21].

Before conducting the regression analysis, the main statistical characteristics of the variables used in the study were evaluated. Table 1 presents the mean values, standard deviations, minimum values, and maximum values of the indicators included in the empirical model.

Table 1. *Descriptive statistics of variables included in the empirical model*

	GE	GTMI	EGDI	EPI	OSI	Oxford GAIR
Mean	51,58	0,59	0,64	0,49	0,58	43,60
Std. Deviation	18,80	0,27	0,23	0,28	0,26	20,76
Minimum	9,09	0,01	0,10	0,00	0,00	10,28
Maximum	95,67	1,00	0,99	1,00	1,00	87,68

Source: calculated by the authors

The descriptive statistics demonstrate significant cross-country differentiation in both the efficiency of public administration and the level of digital transformation in the public sector. The average value of Government Effectiveness is 51.58 points, with a standard deviation of 18.80, indicating substantial differences in the quality of public administration among the sampled countries. The indicator ranges from 9.09 to 95.67 points, confirming the existence of a considerable gap between countries with different levels of institutional capacity.

Digital transformation indicators also show substantial variability. The average value of the GovTech Maturity Index is 0.59, with index values ranging from 0.01 to 1.00, reflecting different levels of digital maturity across public sectors. A similar pattern is observed for the E-Government Development Index, for which the average value is 0.64 and the range of variation extends from 0.10 to 0.99.

The lowest average value among the digital indicators is observed for the E-Participation Index (0.49). This may indicate that mechanisms for citizens' digital participation are less evenly developed than electronic public services. At the same time, the Online Service Index has an average value of 0.58. This finding confirms that the development of digital public services is one of the more common areas of digital transformation within contemporary government systems.

The Oxford Government AI Readiness Index is also characterized by substantial cross-country variability. The average value of the index is 43.60 points, with a standard deviation of 20.76. This indicates considerable differences among countries in the readiness of the public sector to implement and use artificial intelligence technologies. The indicator values range from 10.28 to 87.68 points, reflecting the uneven development of AI capabilities in state institutions at the global level. The width of this observed range also confirms that the sample includes countries located at markedly different stages of AI-related institutional and technological readiness. The results show substantial gaps among countries in institutional readiness to integrate artificial intelligence into management processes, in the development of appropriate infrastructure, and in the practical use of AI-based solutions in the public sector.

To ensure comparability, the Oxford Government AI Readiness Index was converted to a scale from 0 to 1 by dividing the original values by 100. As shown in Figure 1, the E-Government Development Index (0.64) has the highest average value, indicating the highest level of development among the examined areas of digital transformation. The GovTech Maturity Index (0.59) and Online Service Index (0.58) have similar average values, confirming the active development of digital public services and institutional digital capacity.

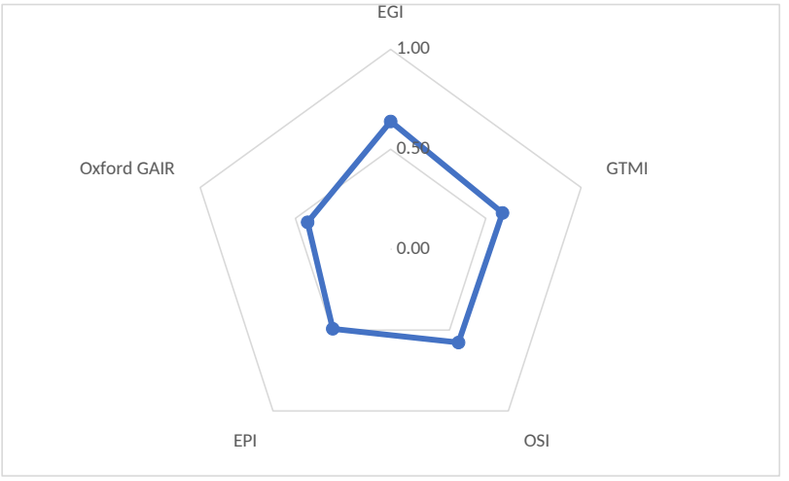

Figure 1. *Average values of indicators of digital transformation of the public sector and readiness for the use of artificial intelligence (scale 0–1)*

Source: built by the authors.

At the same time, the lower average values of the E-Participation Index (0.49) and Oxford GAIR (0.44) indicate that citizens' digital participation and public-sector readiness to use artificial intelligence remain less developed areas when compared with more established e-government tools.

The descriptive statistics confirm the suitability of the selected variables for further regression analysis because all indicators are characterized by sufficient cross-country variability and provide meaningful variation for subsequent statistical estimation.

For a preliminary assessment of the nature of the relationship between public administration efficiency and the indicators of digital transformation, a correlation analysis was conducted. Because the indicators were formed from an international sample of countries and most variables did not satisfy the assumptions of a normal distribution, Spearman's rank correlation coefficient (Spearman's rho) was used. The results of the correlation analysis are presented in Table 2.

Table 2. *Correlation matrix of variables of the empirical model*

	GE	GTMI	EGDI	EPI	OSI	Oxford GAIR
GE	1,000	0,624**	0,828**	0,691**	0,733**	0,755**
GTMI	0,624**	1,000	0,809**	0,840**	0,881**	0,873**
EGDI	0,828**	0,809**	1,000	0,881**	0,927**	0,879**
EPI	0,691**	0,840**	0,881**	1,000	0,957**	0,846**
OSI	0,733**	0,881**	0,927**	0,957**	1,000	0,891**
Oxford GAIR	0,755**	0,873**	0,879**	0,846**	0,891**	1,000

Source: calculated by the authors
Note: **. Correlation is significant at the 0.01 level (2-tailed).

The correlation analysis confirms the existence of statistically significant positive relationships between all indicators of digital transformation and the effectiveness of public administration. All correlation coefficients are statistically significant at the level of $p<0.01$, indicating stable positive associations between the level of digital development in the public sector and the quality of governance.

The strongest correlation with the Government Effectiveness indicator is observed for the E-Government Development Index (ρ=0.828; $p<0.01$). This indicates that comprehensive e-government development is most strongly associated with higher efficiency of public administration. High correlation values are also observed for the Oxford Government AI Readiness Index (ρ=0.755; $p<0.01$) and the Online Service Index (ρ=0.733; $p<0.01$), confirming the important role of public-sector readiness for artificial intelligence and the development of digital public services in effective governance.

Positive and statistically significant associations were also found for the E-Participation Index (ρ=0.691; $p<0.01$) and the GovTech Maturity Index (ρ=0.624; $p<0.01$). These results indicate that both digital interaction between the state and citizens and the broader digital maturity of state institutions are important factors associated with increased efficiency in the functioning of government bodies.

Particular attention should be paid to the high level of interconnection among individual indicators of digital transformation. The highest correlation coefficients are observed between the E-Participation Index and the Online Service Index (ρ=0.957), between the E-Government Development Index and the Online Service Index (ρ=0.927), and between the Online Service Index and the Oxford Government AI Readiness Index (ρ=0.891). In addition, significant correlations

were recorded between the Oxford Government AI Readiness Index and the E-Government Development Index (ρ=0.879), as well as between the Oxford Government AI Readiness Index and the GovTech Maturity Index (ρ=0.873). These results indicate that countries with highly developed e-governance and digital public services are simultaneously characterized by greater readiness to implement artificial intelligence technologies in the public sector.

At the same time, the high mutual correlations among digital indicators indicate not only potential statistical limitations related to their simultaneous inclusion in a multivariable model but also their conceptual proximity. These indicators reflect interrelated aspects of the state's digital development and can therefore be interpreted as different manifestations of a broader latent characteristic – the digital capacity of the public sector.

In view of this consideration, separate paired regression models were used at the next stage of the study. This approach makes it possible to isolate the relationship of each indicator with governance effectiveness and to provide additional verification of the consistency and robustness of the observed statistical results.

Table 3 presents the results of the paired linear regression models. In each model, the dependent variable is the Government Effectiveness indicator.

Table 3. *Results of the evaluation of paired regressions*

Model	Independent variable	β (Standardized Beta)	t	p-value	R^2	F
M1	GTMI	0,634	11,231	0,000	0,402	126,136
M2	E-Government Development Index	0,820	19,673	0,000	0,673	387,013
M3	E-Participation Index	0,701	13,461	0,000	0,491	181,202
M4	Online Service Index	0,740	15,063	0,000	0,547	226,905
M5	Oxford GAIR	0,759	15,993	0,000	0,576	255,788

Source: built by the authors

All constructed models are statistically significant at the level of p < 0.001, indicating stable positive associations between indicators of digital transformation, readiness for the use of artificial intelligence, and the efficiency of public administration. The results are consistent across all examined indicators, which may indicate that these indicators belong to a common conceptual field of digital development in the public sector.

The highest level of association is demonstrated by the model using the E-Government Development Index. The coefficient of determination is R^2=0.673, meaning that 67.3% of the variation in the Government Effectiveness indicator is explained by differences in the level of e-governance development among countries within this paired model. A standardized coefficient of β=0.820 indicates the strongest positive relationship among the factors examined.

A slightly lower but still comparable level of explanatory capacity is demonstrated by the model using the Oxford Government AI Readiness Index (GAIR). The coefficient of determination is R^2=0.576, and the standardized coefficient is β=0.759. These results indicate that public-sector readiness to implement and use artificial intelligence technologies is one of the most significant factors associated with improved efficiency of public administration. The high statistical significance of the model (F=255.788; p<0.001) confirms the importance of institutional, technological, and managerial prerequisites for the use of artificial intelligence in the activities of public authorities.

The model using the Online Service Index also demonstrates a high level of explanatory capacity (R^2=0.547; β=0.740), confirming the important role of digital public-service development in improving the effectiveness of state institutions. The high coefficient values indicate that the availability and integration of online services constitute an important mechanism for the continuing modernization of the public sector.

A positive and statistically significant relationship was also found for the E-Participation Index (R^2=0.491; β=0.701). This finding confirms that citizens' digital involvement in public administration processes is associated with increased governance efficiency and with the development of more open forms of interaction between the state and society.

The model using the GovTech Maturity Index also shows a statistically significant positive relationship with Government Effectiveness (R^2=0.402; β=0.634). These results indicate that public-sector digital maturity and the introduction of computer-integrated technologies create important institutional and technological prerequisites for improving the quality and efficiency of public administration.

Thus, the empirical results support the research hypothesis that the digital transformation of management processes and states' readiness to use artificial intelligence technologies are important factors associated with improved efficiency of public administration. This overall conclusion is supported by the consistent direction and statistical significance of the relationships observed across all five paired regression specifications. The strongest relationships are demonstrated by comprehensive e-governance development and the level of readiness for artificial intelligence implementation, indicating the growing role of AI technologies in modernizing state institutions and improving the quality of public administration.

To determine whether the statistical relationship between the digital transformation of management processes and the efficiency of public administration remains after accounting for countries' levels of economic development, an additional stage of regression analysis was carried out with gross domestic product per capita included as a control variable.

The inclusion of the economic factor is necessary because the level of development of state institutions, the quality of public services, and the government's digital capacity depend substantially on the country's overall socio-economic development. Higher-income countries typically have greater financial capacity to develop digital infrastructure, strengthen human capital, modernize the civil service, and adopt innovative technologies. Therefore, without controlling for the economic level, the positive relationship between digital indicators and Government Effectiveness may partially reflect broader differences in countries' overall levels of development.

To control for this factor, the logarithm of GDP per capita (PPP, constant 2021 international $) [28] was used. The logarithmic transformation reduces asymmetry in the distribution of the economic indicator and helps account for the potentially nonlinear relationship between a country's income level and the quality of public administration.

For each indicator of digital transformation and readiness to use artificial intelligence, a separate multiple linear regression model was estimated:

$$GE_i = \beta_0 + \beta_1 X_i + \beta_2 \ln(GDP)_i + \varepsilon_i$$

where GE_i is the Government Effectiveness indicator for the i-th country; X_i is the relevant digital transformation indicator (GTMI, EGDI, EPI, OSI, or Oxford GAIR); $\ln(GDP)_i$ is the logarithm of GDP per capita; β_1 is the standardized coefficient characterizing the independent relationship of the digital factor with public administration efficiency after controlling for economic development; and ε_i is the random error term.

The results of the assessment are presented in Table 4.

Table 4. *Regression results of digital transformation indicators and AI readiness on Government Effectiveness controlling for economic development*

Model	Digital transformation indicator	Standardized β (Digital factor)	Standardized β (ln GDP per capita)	t (Digital factor)	p-value	Adjusted R^2	F-statistic
M1	GTMI	0.209	0.694	4.106	< 0.001	0.693	204.067
M2	EGDI	0.403	0.465	4.854	< 0.001	0.703	214.136
M3	EPI	0.286	0.637	5.584	< 0.001	0.714	225.594
M4	OSI	0.310	0.605	5.680	< 0.001	0.715	227.223
M5	Oxford GAIR	0.362	0.567	6.809	< 0.001	0.733	248.441

Source: built by the authors

The results of the multiple regression analysis confirm that the indicators of digital transformation and states' readiness to use artificial intelligence retain statistically significant positive relationships with Government Effectiveness even after the level of economic development is taken into account.

All five models are statistically significant (p<0.001), and the coefficients of determination demonstrate high explanatory power: the Adjusted R^2 values range from 0.693 to 0.733. This means that including the digital characteristics of the public sector together with the economic factor makes it possible to explain approximately 69–73% of the cross-country variation in the level of public administration efficiency. The consistently high values across the five model specifications further indicate that the combined consideration of digital and economic characteristics provides substantial explanatory information for the differences observed among countries.

The highest explanatory power is demonstrated by the model that includes the Oxford Government AI Readiness Index (Adjusted R^2=0.733). The coefficient of the digital factor remains statistically significant (β=0.362; p<0.001), indicating an independent relationship between public-sector readiness to use artificial intelligence technologies and the effectiveness of public administration after economic development is controlled.

A high level of statistical significance was also observed for the E-Government Development Index (β=0.403; p<0.001), Online Service Index (β=0.310; p<0.001), E-Participation Index (β=0.286; p<0.001), and GovTech Maturity Index (β=0.209; p<0.001). These results show that various components of digital transformation – from the development of electronic services to institutional digital maturity – are associated with higher quality and effectiveness of public administration.

At the same time, the logarithm of GDP per capita remains one of the strongest predictors of Government Effectiveness in all models. This finding confirms the importance of economic development as a fundamental factor in the institutional capacity of the state. Nevertheless, the continued statistical significance of digital factors after GDP is included indicates that digital transformation is not merely a reflection of the economic advantage of developed countries but has its own independent relationship with the effectiveness of public administration.

Given the high correlations among individual indicators of digital transformation, an additional check for possible multicollinearity was conducted in the regression models that included the control variable – GDP per capita. The Variance Inflation Factor (VIF) and Tolerance indicator were used for this assessment. A commonly used criterion for the absence of serious multicollinearity is VIF<5 together with Tolerance>0.2.

The test results showed that, across all constructed models, VIF values range from 1.314 to 1.935 and Tolerance values range from 0.517 to 0.761, as shown in Table 5. These values indicate the absence of a critical level of interdependence between the predictors. Thus, including individual digital transformation indicators together with the economic-development indicator does not lead to serious distortion of the estimated regression coefficients.

Table 5. *Results of multicollinearity testing in regression models*

Model	Digital indicator	Tolerance	VIF
M1	Oxford Government AI Readiness Index	0,591	1,693
M2	GovTech Maturity Index	0,761	1,314
M3	E-Government Development Index	0,517	1,935
M4	E-Participation Index	0,693	1,443
M5	Online Service Index	0,655	1,526

Source: built by the authors

Thus, the extended regression models support the research hypothesis that the development of digital management technologies and the formation of public-sector AI capabilities are associated with a higher level of public administration efficiency, even after differences in countries' levels of economic development are taken into account.

Summarizing the regression results, all digital transformation indicators used in the study demonstrate stable positive relationships with public administration efficiency. This consistency across the separate model specifications strengthens the overall empirical pattern identified in the analysis. At the same time, the high correlations among these indicators reveal substantial conceptual overlap and allow them to be interpreted as different dimensions of a single latent phenomenon – the digital capacity of the state. In other words, the indicators describe closely connected but not identical aspects of the same broader process of public-sector digital development. In this context, the results should not be interpreted simply as the influence of fully independent factors but rather as coherent evidence of the broader importance of public-sector digital development for improving governance effectiveness.

5. DISCUSSION

The empirical analysis shows that the digital transformation of management processes based on computer-integrated technologies and artificial intelligence is a significant factor associated with improved efficiency of public administration. The strongest positive relationship is demonstrated by the E-Government Development Index ($\beta = 0.820$ in paired regression and $\beta = 0.403$ after GDP control), confirming the key role of comprehensive digital infrastructure in the modernization of administrative processes [16]. Readiness to use artificial intelligence (Oxford GAIR) also retains an independent relationship ($\beta = 0.362$; $p < 0.001$), even after the country's level of economic development is taken into account. This indicates that AI not only automates routine operations but can also change the logic of managerial decision-making from reactive approaches toward more predictive and adaptive approaches [12, 13].

The findings also emphasize the human-centered potential of such a transformation. When management processes become more integrated, transparent, and intelligent, the state can become more responsive to citizens: services can be delivered faster and in more personalized forms, while decisions can become better informed and more transparent. This transformation can contribute not only to increased operational efficiency but also to strengthening public trust in government institutions [19].

The high correlations among the digital transformation indicators demonstrate their systemic interdependence. Computer-integrated technologies provide the technological foundation, artificial intelligence adds analytical capacity, and electronic citizen participation provides necessary feedback from society. Without an integrated and coordinated approach, the potential effect of individual digital tools can be substantially reduced.

Proposed model: Model of Digital Transformation of Management Processes Based on Computer-Integrated Technologies and Artificial Intelligence (DT-CIT-AI Model)

The proposed model contains four interrelated blocks that reproduce the underlying logic of the transformation of management processes:

1. Computer-Integrated Technologies Integration Unit. This unit covers the GovTech Maturity Index and Online Service Index. At this level, disparate information systems are combined within a single computer-integrated public-administration platform. This integration, in turn, ensures continuous data exchange and supports the automation of routine administrative operations.

2. Artificial Intelligence Layer. This layer corresponds to the Oxford Government AI Readiness Index. At this level, artificial intelligence is integrated into management processes to analyze large volumes of data, predict the consequences of decisions, optimize resource allocation, and automate complex analytical and decision-support tasks.

3. Digital Participation and Feedback (E-Participation) block. This block represents the E-Participation Index. Citizens receive practical tools for influencing management processes through electronic consultations, co-creation platforms, and structured feedback mechanisms. This participation, in turn, can increase the legitimacy, responsiveness, and overall quality of public decisions.

4. Block of Effectiveness and Institutional Effectiveness (Outcome). This block is measured by the Government Effectiveness Index and serves as the target outcome block of the model. It integrates and reflects the cumulative results generated by the preceding technological, analytical, and participatory levels.

The model also incorporates feedback mechanisms. Improvements in management effectiveness can increase motivation for further digital transformation, while high-quality citizen participation can help adjust AI algorithms, service priorities, and development priorities. Empirical support for the model is provided by the high Adjusted R^2 values (0.693–0.733) observed in regression models that control for economic development.

The DT-CIT-AI Model can function as a diagnostic tool for assessing the maturity of digital transformation within individual public authorities. It can also serve as a basis for developing national digital-transformation strategies and as a structured framework for future international comparative research.

In summary, the study shows that investment in computer-integrated technologies and artificial intelligence in public administration represents more than a technical modernization initiative. It constitutes a strategic path toward creating a more effective, transparent, and human-centered management system. For Ukraine, implementing the principles of the DT-CIT-AI Model creates an opportunity to improve the quality of public services substantially and to strengthen the country's competitiveness in the digital age.

6. CONCLUSIONS

The study confirms that the digital transformation of management processes based on computer-integrated technologies and artificial intelligence is a significant and independent factor associated with improved efficiency of public administration. Empirical results obtained from a large international sample indicate statistically significant positive relationships for all examined indicators even after controlling for countries' levels of economic development. The strongest relationships are demonstrated by comprehensive e-governance development and readiness to implement artificial intelligence, emphasizing the transition from simple automation toward smarter, more predictive, and more adaptive forms of management.

The scientific novelty of the study lies in the comprehensive analysis of the interaction between computer-integrated technologies and AI in the context of real management processes, the separation of their statistical relationships from the economic factor, and the proposed integrative model. This model combines the technological framework, intelligent capabilities, citizen participation, and performance outcomes. It therefore creates a holistic framework for understanding, assessing, and planning digital transformation in public administration.

The findings have substantial practical importance. For Ukraine, as for many other countries, they indicate the need for systematic rather than fragmented implementation of digital solutions. Investments in system integration, the development of artificial intelligence, and mechanisms for citizens' electronic participation can not only increase the efficiency of state institutions but can also make those institutions more accessible, responsive, and understandable to ordinary people.

At the same time, the study has several limitations. The cross-sectional design does not allow the dynamics of changes over time to be fully traced. In addition, the high correlations among digital indicators demonstrate their systemic and interrelated nature. Promising directions for further research include panel-data analysis, examination of sector-specific features of digital transformation, and qualitative case studies of successful implementation practices.

AUTHORSHIP AND CONTRIBUTIONS

Henrikh Kazarian: Conceptualization, Methodology, Project administration, Formal analysis, Writing – original draft. Serhiy Gryvko: Conceptualization, Methodology, Data curation, Writing – original draft. Dmytro Voronets: Investigation, Data curation, Formal analysis, Writing – original draft. Serhiy Sokyrko: Validation, Visualization, Writing – review and editing. Mykhailo Dyachenko: Supervision, Writing – review and editing.

All authors contributed substantially to the conception and design of the study. All authors reviewed and approved the final version of the manuscript and agreed to be accountable for all aspects of the work.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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DATA AVAILABILITY

Data are available from the corresponding author upon reasonable request.

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