“Digital drivers of public management of countries’ economic development amid global changes”

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DIGITAL DRIVERS OF PUBLIC MANAGEMENT OF COUNTRIES' ECONOMIC DEVELOPMENT AMID GLOBAL CHANGES

Abstract

This paper examines the digital drivers of public administration amid global transformations. Based on a comparative analysis of Denmark, Estonia, Singapore, South Korea, Poland, and Ukraine, five groups of indicators were assessed: digital government readiness, digital infrastructure, digital economy, digital human capital, and economic development outcomes. The methodology combines Pearson correlation analysis, cross-sectional least squares (OLS), pooled panel least squares (OLS), and two-way fixed-effects models on a balanced panel of 42 country observations for 2018–2024. The results demonstrated strong cross-country links between institutional effectiveness, digital maturity, and economic development. The World Governance Indicator is the strongest correlate of GDP per capita in the pooled specification. The E-Government Development Index exhibits a loss of significance in fixed-effects specifications. The results suggest that the strongest pooled relationships predominantly capture persistent differences across countries rather than persistent within-country effects over time.

The study identifies four digital maturity profiles: mature digital states (Denmark, Singapore), dynamic leaders (Estonia, South Korea), systemic digital transformation (Poland), and transformation in crisis (Ukraine). Despite the war, e-government use increased by 20 percentage points, and the World Governance Indicator improved by 0.20 between 2018 and 2024. Hypothesis testing provides partial or descriptive support for the proposed relationships, while the 60% digital skills threshold is considered a descriptive pattern rather than a formally tested moderating effect. The WAR coefficient remains strongly associated with unemployment, but a causal interpretation is not required. The results support differentiated policy recommendations, emphasizing that digital transformation is embedded in institutional, human, and security settings.

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INTRODUCTION

Global changes at the beginning of the XXI century, namely the acceleration of technological cycles, the COVID-19 pandemic, the energy crisis, and armed conflicts, have confronted public administration with fundamentally new challenges, namely the need to ensure the continuity of public services, effectively allocate resources, and support economic development amid unprecedented uncertainty. In response to these challenges, digitalization has turned from an auxiliary tool into a systemic factor in the transformation of public administration. According to the UN (United Nations, 2024), 193 states consider digital technologies as a priority mechanism for improving the effectiveness of state institutions. At the same time, the issue of how digital drivers really determine the quality of economic development, and not only increase the convenience of individual services, remains open and requires empirical verification using comparative data.

1. LITERATURE REVIEW

In recent years, the digital transformation of public administration has become a key factor in modernizing state institutions, ensuring territorial competitiveness, and stimulating economic development. Amid global changes, accompanied by accelerating technological cycles, pandemic crises, energy shocks, and geopolitical instability, digitalization is increasingly considered not only a technological tool but a systemic mechanism for the transformation of public administration, the economy, and society.

In modern scientific literature, several conceptual approaches to the study of digitalization of public administration and its impact on socio-economic development have been formed. Digitalization is seen as an independent driver of economic growth, increasing productivity, and modernizing public services. Within this approach, the development of the ICT sector, digital infrastructure, e-governance, and cloud technologies is a key prerequisite for the integration of regions into the global digital economy (Abbas et al., 2025; Kryvda et al., 2022). At the same time, the development of the information economy depends directly on the level of digital education and the state's ability to develop modern human capital (Sitnicki et al., 2026).

A significant body of research focuses on developing digital infrastructure and the digital economy. The Internet, 4G/5G mobile networks, cloud technologies, and digital platforms are basic tools for ensuring innovation activity, entrepreneurship development, and economic sustainability of regions. Particular attention is paid to developing IT products, digital services, and institutional support for digital business (Kochubei et al., 2021; Biloskurskyy et al., 2019). Some studies emphasize that the digitalization of administrative accessibility contributes to the development of peripheral and rural areas, ensuring a reduction in spatial inequality and expanding the population's access to public services (Ducman et al., 2025; Cojocaru Bărbieru et al., 2023).

An important area of modern scientific research is related to the digitalization of public administration and increasing the efficiency of state institutions. The scientific literature proves that e-governance increases the transparency of administrative processes, reduces bureaucratic barriers, optimizes interaction between the state and citizens, and forms new mechanisms of data-driven governance. Scholars also pay considerable attention to the role of digitalization in building an effective system of state regulation and modernizing management mechanisms (Shaposhnykov et al., 2025; Grosu et al., 2020). In addition, Traversa and Ivaldi (2025) investigate how political and institutional factors influence the effectiveness of public policy implementation under digital transformation.

The challenges of digital human capital and its role in ensuring the state's economic adaptability have also been extensively studied. Digital skills, ICT competencies, and the share of ICT specialists are critical prerequisites for successful digital transformation. Insufficient digital competencies hinder the development of the digital economy and exacerbate regional disparities, while human capital development accelerates innovation and modernizes the labor market (Burkynskyi et al., 2021; Verstiak et al., 2025).

A separate block of research is devoted to the impact of digitalization on the labor market and employment. Digital technologies are a factor in the transformation of the employment structure, the development of a platform economy, and the formation of new forms of economic activity. At the same time, digitalization not only stimulates economic growth, but also increases structural unemployment and social differentiation amid insufficient adaptability of the labor market. This issue is especially relevant in the context of postwar economic recovery and structural modernization of the state (Guliyev et al., 2024; Duha et al., 2026; Shkarlet et al., 2025).

Currently, more and more scientists are paying attention to the use of artificial intelligence in public administration, education, economic development, and national security. Artificial intelligence is seen as a tool for improving the efficiency of management decisions, optimizing the use of resources, and predicting socio-economic processes (Petsavas & Ioakimidis, 2026;

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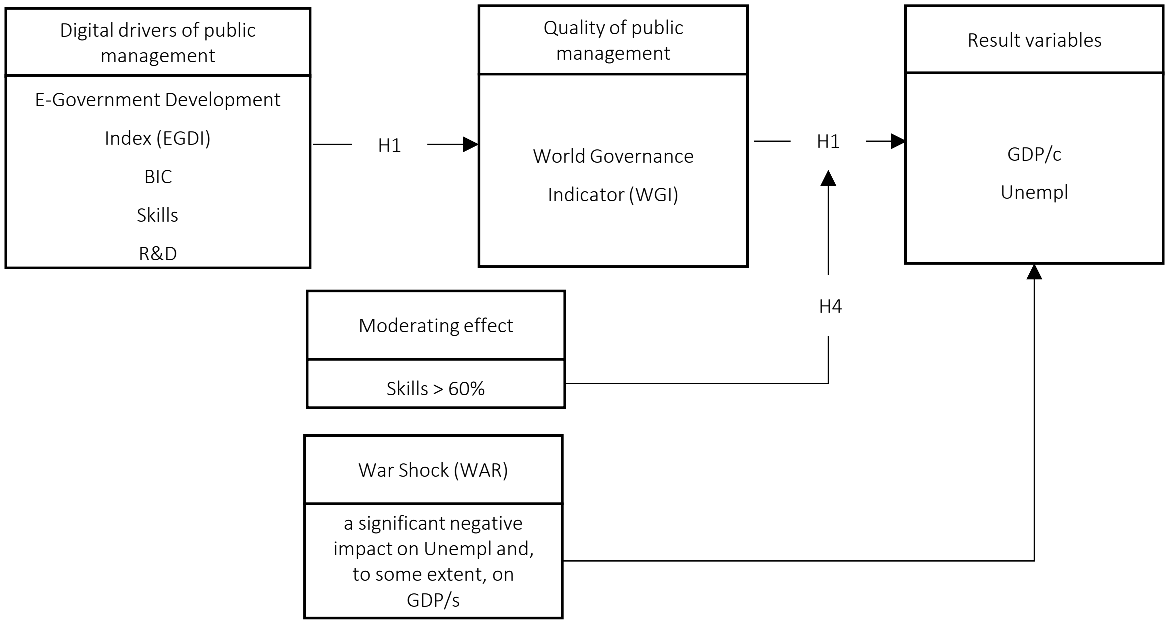

Figure 1. Conceptual framework of the study

Kosach et al., 2024). At the same time, research on the digitalization of territorial communities and mechanisms for forming regions' investment attractiveness in the context of digital modernization of public administration is developing (Kliuchnyk et al., 2025).

Thus, modern scientific literature forms a fairly broad theoretical basis for the study of the digital transformation of public administration, covering digital infrastructure, e-governance, human capital, digital economy, and economic development. However, available studies mainly analyze individual components of digitalization, which necessitates a comprehensive study of the relationship between digital drivers of public administration and effective indicators of economic development.

The purpose of this paper is to assess the associations between digital drivers of public administration and economic development outcomes based on data from six countries for 2018–2024, identify profiles of digital maturity of public administration, and formulate practical recommendations.

To empirically examine the hypothesized relationships between the state's digital maturity, public administration efficiency, and economic development, a system of hypotheses has been formulated concerning the expected relationships between digital maturity and key indicators – GDP per capita and unemployment rate:

H1: *a higher level of a country's digital readiness has a positive impact on GDP per capita and helps reduce unemployment rates in the regions;*

H2: *a higher level of digital infrastructure development has a positive impact on GDP per capita and a negative impact on the unemployment rate;*

H3: *the growth of the digital economy has a positive impact on the structural transformation of the economy;*

H4: *a higher level of digital workforce and innovative capacity has a positive impact on GDP per capita and reduces unemployment rate;*

H5: *a country's digital maturity (H1–H4) has a statistically significant positive impact on indicators of public administration effectiveness and the level of economic development.*

The conceptual model of the study (Figure 1) reflects relationships between digital drivers of public administration, effectiveness of public administration as an intermediate link, and indicators of economic development. The model also accounts for the moderating effect of digital skills and the exogenous impact of the war shock on the labor market and economic growth.

2. METHOD

The study applies system analysis to conceptualize digital drivers as elements of a single public administration system; a comparative method to compare the experience of six countries; correlation analysis (Pearson coefficient) and OLS regression modeling to quantify associations between variables; panel regression with country and year fixed effects to distinguish between cross-country and within-country variation; and a case study method for in-depth analysis of digital resilience in Ukraine.

For the analysis, countries with different levels of development were selected for contrast (leaders, emerging economies, and countries relevant to Ukraine). This selection aims to provide analytical diversity rather than statistical representativeness.

The choice of countries is due to the need to cover different models of digital transformation of the state. The sample comprises small countries with high digital maturity (Denmark, Estonia), Asian technology leaders with different institutional systems (Singapore, South Korea), and countries with a similar initial transformation context (Poland). Finally, Ukraine is a country that carries out digital modernization of public administration in the context of active war and double pressure – external (Russian war aggression) and internal (reforming institutions). Combining data from heterogeneous international databases risks methodological incompatibility, which is a limitation of this study.

The indicators cover 2018–2024. For the regression analysis of the relationship between digital maturity (blocks 1–4) and the effects of public governance and economic development (block 5), we constructed a balanced panel: 6 countries × 7 years = 42 observations (Table 1).

The selection of indicators was carried out according to the following criteria:

(1) the availability of verified data in recognized international databases for the entire study period 2018–2024;

(2) methodological compatibility between the sample countries;

(3) drivers of public governance and effects of economic development;

(4) coverage of both input (institutional and infrastructure) and performance (economic and social) characteristics.

From the initial list of indicators, those for which the data are fragmented or methodologically incompatible between countries were removed; in particular, data on venture financing of regions, the number of startups, and the IMD Regional Competitiveness Index, which are formed according to different methodologies in different countries and do not allow direct comparison.

The structure of Table 1 is built on the logic of "drivers → effects". Blocks 1 to 4 record independent research variables: the state of digitalization of state institutions, infrastructure, economy, and human capital, while block 5 reflects the resulting (dependent) variables: the dynamics of employment and GDP per capita as integral indicators of the effectiveness of public administration and the level of economic development of the country.

The hypotheses are tested sequentially: first, descriptive statistics and correlation analysis, then pooled panel regression analysis for 6 countries for 2018–2024 ($n = 42$ observations).

Correlation analysis helps to identify the structure and density of linear relationships between indicators, assess variable pairs that are candidates for regression modeling, and measure anomalous observations (outliers) that require separate interpretation. The Pearson pairwise correlation coefficient r was used for the assessment, which measures the density of the linear relationship between two variables in the range from –1 to +1. The correlation matrix is built on cross-sectional analysis

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Table 1. Research indicator system

Indicator	Description	Features	Source
Block 1. Digital readiness of the state			
EGDI	Assesses online services, ICT infrastructure and human capital	Calculation frequency – every 2 years, odd years – linear interpolation	United Nations Department of Economic and Social Affairs (n.d.)
The use of e-governance by citizens	Share of Internet users (16–74 years old) who interacted with the authorities online for 12 months, %	–	Eurostat (n.d.b.), World Bank (n.d.e.), State Statistics Service of Ukraine of Ukraine (n.d.)
WGI	Covers the quality of public services, civil service, policy formation	Unit: –2.5 (weak) ... +2.5 (strong)	World Bank (n.d.e)
Block 2. Digital infrastructure			
Broadband Internet coverage (BIC)	Share of households with access to fixed broadband Internet	≥30 Mbps, %	Eurostat (n.d.c.) broadband coverage / Statbase (2025), State Statistics Service of Ukraine of Ukraine (n.d.)
Mobile Internet coverage	Share of the population covered by 4G/5G networks, %	Ukraine is characterized by network degradation as a result of shelling of base stations; Recovery partially via Starlink	GSMA Intelligence (n.d.), State Statistics Service of Ukraine of Ukraine (n.d.)
Block 3. Digital economy			
Share of the ICT sector in GDP	Share of the gross value added of the ICT sector in the country's GDP, %	Singapore and South Korea – estimates based on Statista data	Statista (n.d.), Eurostat (n.d.d.), State Statistics Service of Ukraine (n.d.)
Cloud Technologies in Business (Cloud)	Share of enterprises (≥10 people) using cloud computing, %	EU 2030 target: 75% of enterprises	Eurostat (n.d.a.), Fortune business Insights (n.d.), State Statistics Service of Ukraine of Ukraine (n.d.)
Block 4. Digital Human Capital and Innovation			
The population's basic digital skills (Skills)	Proportion of individuals with basic/ advanced digital skills	EU 2030 target: 80% of the population. % of people 16–74 years old	Eurostat (n.d.f.), European Commission (2023), World Bank (n.d.a.), State Statistics Service of Ukraine of Ukraine (n.d.)
ICT specialists, % employed	Share of ICT professionals among total employment, %	EU 2030 target: 20 million professionals (≈8% employed).	Eurostat (n.d.e.), Organisation for Economic Co-operation and Development (2026), State Statistics Service of Ukraine of Ukraine (n.d.)
R&D, % OF GDP	Gross domestic expenditure on research and development in % of GDP	–	Eurostat (n.d.d.), Lowy institute (n.d.), State Statistics Service of Ukraine of Ukraine (n.d.)
Block 5. Effects of the Country's Economic Development			
Unemployment rate (Unempl)	Unemployment rate, annual average, %	The methodology does not fully cover the labor market due to martial law in Ukraine	World Bank (n.d.d.), State Statistics Service of Ukraine of Ukraine (n.d.)
GDP per capita (GDP/c), $ (PPP), thousand	GDP per capita in current international dollars	PPP, current prices	World Bank (n.d.b.), State Statistics Service of Ukraine of Ukraine (n.d.)

data for 2024 ($n = 6$), which allows us to identify the structure of relationships between digital drivers and indicators of economic development and public administration efficiency in the current state across countries. Given the size of the cross-sectional sample ($n = 6$), the critical value for the significance level $p \leq 0.05$ is $|r| \geq 0.811$, and for $p \leq 0.01$, $|r| \geq 0.917$. Only correlations exceeding the first threshold are considered statistically significant in the cross-sectional dimension. Correlation analysis and initial least squares models, built on a cross-sectional sample of six countries using 2024 data, are not a tool for definitive statistical evidence of causality. They are a tool for determining the directions and strengths of the relationships between digital drivers of public administration and economic development indicators, as well as for preliminary selection of variables for further econometric modeling. A small sample size increases the sensitivity of estimates to influential observations, particularly in countries such as Singapore and Ukraine, which differ significantly in their levels of digital development and socio-economic conditions. The cross-sectional results are interpreted as exploratory rather than definitive evidence of causality. The study's conclusions are based on cross-correlation coefficients and complementary analysis methods, which ensure greater reliability and stability of the results.

Regression modeling was conducted in two stages. In the first stage, eight cross-sectional specifications were estimated using 2024 data (n = 6). In the second stage, pooled specifications were estimated on a balanced panel of 42 observations across countries and years (6 countries × 7 years). Given that observations are repeated within countries, pooled least squares is considered a descriptive guideline. The main panel specifications include country fixed effects and year fixed effects. To assess uncertainty, standard errors are clustered across countries. The resulting conclusion is treated as a sensitivity analysis, and p-values are estimated with five degrees of freedom. The WAR indicator is 1 for Ukraine in 2022–2024 and 0 otherwise. Its definition is conditioned by the time of the full-scale war, but this in itself does not establish causal identification. The EGDI is published every two years, so the observations for 2019, 2021, and 2023 for each country are linearly interpolated. Therefore, 18 of the 42 annual EGDI observations (42.9%) are interpolated and should not be interpreted as independently observed annual measurements.

3. RESULTS AND DISCUSSION

For a systematic comparative analysis of the level of digitalization of public administration and assessment of its impact on the efficiency of public administration and the economic development of the country, the study formed a data panel for six countries, broken down into five thematic blocks of indicators (Table 2). For each indicator, the value for 2024 as the current state and the change Δ 2018→2024 as an indicator of the pace and direction of digital transformation are given. The dynamic dimension is fundamental to distinguish between countries with a high level achieved through long-term institutional accumulation (Denmark and Singapore) and countries with accelerated catch-up growth (Poland, Estonia, and Ukraine).

Table 2 reveals four conceptually distinct profiles of digital maturity of public administration among the countries studied, which are essential both for testing the hypotheses and forming practical recommendations.

The first profile ("mature digital states") is represented by Denmark and Singapore. Both countries show the highest values in most dimensions consistently. Denmark ranks first in the world for EGDI (0.999), while Singapore leads for WGI (2.28) and GDP per capita (PPP 116 thousand USD), and has also achieved 100% mobile internet coverage. At the same time, both countries show relatively modest changes in EGDI for 2018–2024 (+0.08 and +0.11, respectively), not because they have slowed down their development, but because they are approaching the saturation limit of the index. In contrast, Singapore demonstrates the highest absolute GDP per capita growth among all six countries (+18.0 thousand USD), which is descriptively consistent with H3 about the multiplier effect of a mature digital economy.

The second profile ("dynamic catching up leaders") is represented by Estonia and South Korea. Estonia is a unique case of a small state, demonstrating both one of the highest levels of digitalization and the highest share of the ICT sector in GDP among EU countries (8.0% in 2024, +2.8 p.p. in 6 years). Especially indicative is the record share of ICT specialists among the employed – 6.1%, which confirms the systemic bet on digital human capital as the main factor of development. South Korea, in turn, has an unprecedented level of investment in R&D – 5.0% of GDP, which is the second highest in the world after Israel (Organization for Economic Co-operation and Development, 2026), and reflects a model in which innovation activity is the main driver of competitiveness, despite the relatively lower EGDI (0.969) compared to Denmark and Estonia.

The third profile ("the country of catching up with digital transformation") is represented by Poland. Although the absolute values of Poland's indicators are significantly inferior to the leaders (EGDI 0.856; broadband coverage 88%; digital skills 59%), the dynamics of change are among the highest in the sample. E-governance increased by 17 percentage points, broadband Internet coverage by 16 percentage points, and the use of cloud technologies

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Table 2. Comparative characteristics of digital drivers of public administration and their impact on economic development: Experience of Denmark, Estonia, Singapore, South Korea, Poland, and Ukraine (2018–2024)

Source: United Nations Department of Economic and Social Affairs (n.d.); World Bank (n.d.a. – n.d.e.); Eurostat (n.d.a. – n.d.f.); GSMA Intelligence (n.d.); Organization for Economic Co-operation and Development (2026).

Indicator	Denmark	Estonia	Singapore	South Korea	Poland	Ukraine
Block 1. Digital readiness of the state						
EGDI, 2024	0.999	0.981	0.976	0.969	0.856	0.774
D 2018→2024	+0.08	+0.1	+0.11	+0.07	+0.04	+0.05
The use of e-governance by citizens, 2024	99	88	93	86	55	50
D 2018→2024	+9.0	+15.0	+6.0	+8.0	+17.0	+20.0
WGI, 2024	1.91	1.3	2.28	1.22	0.75	–0.18
D 2018→2024	+0.02	+0.12	+0.07	+0.01	–0.04	+0.2
Block 2. Digital infrastructure						
Broadband Internet coverage (BIC), 2024	98	95	99	99	88	62
D 2018→2024	+10.0	+13.0	0	+1.0	+16.0	–3.0
4G/5G mobile internet coverage, 2024	99	98	100	99	95	71
D 2018→2024	+2.0	+4.0	+1.0	0	+9.0	–11.0
Block 3. Digital economy						
Share of ICT sector in GDP, 2024	6.7	8.0	17	12	3.9	5.2
D 2018→2024	+0.9	+2.8	+4.0	+2.0	+0.5	+1.2
Share of enterprises using cloud technologies (Cloud), 2024	76	78	81	68	49	28
D 2018→2024	+20.0	+19.0	+26.0	+24.0	+22.0	+13.0
Block 4. Digital Human Capital and Innovation						
Percentage of the population with digital skills (Skills), 2024	82	74	82	83	59	52
D 2018→2024	+4.0	+3.0	+8.0	+6.0	+10.0	+2.0
ICT professionals as % of total employment, 2024	5.0	6.1	5.5	4.7	4.2	3.5
D 2018→2024	+0.8	+0.5	+0.7	+0.7	+0.7	+0.7
R&D, % OF GDP	3.01	2.17	1.9	5.0	1.67	0.44
D 2018→2024	–0.02	+0.58	–0.04	+0.47	+0.46	–0.03
Block 5. Effects of Economic Development						
Unemployment rate (Unempl), 2024	5.2	7.6	1.9	2.8	3.0	19.5
D 2018→2024	+0.2	+2.2	–0.2	–1.0	–0.9	+10.7
GDP per capita (GDP/c), $ (PPP), thousand, 2024	66.1	41.0	116	50	41.2	8.8
D 2018→2024	+10.3	+8.0	+18.0	+7.9	+11.2	–0.6

in business by 22 percentage points in six years. Thus, systemic investments and targeted digital policies can significantly accelerate transformation even under initial conditions inferior to leaders. At the same time, the decrease in WGI by 0.04 p.p. in 2018–2022 (due to the conflict around judicial reform) demonstrates that digital readiness is a necessary but not sufficient condition for the effectiveness of public administration – institutional quality remains an independent factor.

The fourth profile ("digital transformation in the context of an existential crisis") is an exclusively Ukrainian case that has no direct analogs in world practice. Table 2 records a deep contradiction: Ukraine demonstrates one of the highest growth rates in the use of e-governance (+20 p.p.) and one of the largest absolute improvements in WGI (+0.20 p.p.) – despite the lowest level of GDP per capita (8.8 thousand USD) and the only reduction in this indicator in the sample (–0.6 thousand USD for 2018–2024). A sharp deterioration in infrastructure indicators – the coverage of BIC fell to 62% (–3 p.p.), mobile Internet – to 71% (–11 p.p.), which is a direct consequence of systemic strikes on critical infrastructure. The catastrophic increase in unemployment to 19.5% reflects the scale of the demographic and economic shock. However, the preservation and even acceleration of the digitalization of public services (the Diia platform) under conditions of active hostilities is an independent scientific phenomenon that deserves a separate analysis as a model of "digital resistance" of the state.

A comparative analysis of the dynamics in Block 3 (digital economy) confirms the systemic nature of the spread of cloud technologies in the business environment. All six countries showed an increase of 13 to 26 p.p. over six years, with the highest rate recorded in Singapore (+26 p.p.) and South Korea (+24 p.p.) – countries with conscious state support for cloud infrastructure. This is consistent with H3 about the multiplicative role of the digital economy, although the causal mechanism needs verification based on regression analysis with a time lag.

In general, Table 2 allows us to formulate a preliminary conclusion: there is a pronounced positive correlation between the digitalization level of public administration (blocks 1–4) and the effective indicators of economic development (block 5) under normal conditions (Denmark, Estonia, Singapore, Korea, and Poland). However, this can be significantly deformed or even reversed in the context of an armed conflict (Ukraine). This conclusion is of fundamental importance for the formulation of recommendations on digital policy: the effectiveness of digital drivers of public administration depends both on the level of technological development and the general security, institutional, and macroeconomic context.

The correlation analysis was performed according to the values of thirteen indicators in six countries. Eight key variables representing all five blocks of the study were selected from the full matrix: EGDI (Block 1), WGI (Block 1), Broadband Internet Coverage (Block 2), Share of Enterprises with Cloud Technologies (Block 3), Share of the Population with Digital Skills (Block 4), R&D Spending in % of GDP (Block 4), Unemployment Rate and GDP Per Capita (Block 5). The matrix of coefficients is given in Table 3.

The matrix analysis reveals a dense positive cluster between the digital drivers of blocks 1–4. EGDI is statistically significantly correlated with WGI (r = 0.90*), BIC (r = 0.94**), Cloud (r = 0.98**), and Skills (r = 0.95**). This confirms the systemic, rather than fragmentary, nature of digital transformation – the digital readiness of the state, infrastructure, economy, and human capital develop synchronously. The cluster structure of relationships confirms H1 about the mutually reinforcing nature of digital drivers and justifies the feasibility of their comprehensive, rather than fragmentary, study.

WGI is the only variable that has a statistically significant correlation with GDP. The strongest relationship with GDP per capita is demonstrated by WGI (r = 0.92; $p \leq 0.05$) – the only statistically significant pair in the "driver → GDP" group. Other GDP predictors – EGDI, BIC, Cloud, Skills – do not reach the threshold of 0.81 (r = 0.67–0.76). The results indicate that the impact of digitalization on economic development can be realized through institutional efficiency. This result may represent an institutional channel, which is consistent with

Table 3. Matrix of Pearson's pairwise correlation coefficients between digital drivers of public administration and economic development indicators (n = 6, 2024 data)

Source: Our calculations based on data from United Nations Department of Economic and Social Affairs (n.d.); World Bank (n.d.a. – n.d.e.); Eurostat (n.d.a. – n.d.f.); Organisation for Economic Co-operation and Development (2026)

Indicator	EGDI	WGI	BIC	Cloud	Skills	R&D	Unempl	GDP/c
EGDI	1.00	0.90*	0.94**	0.98**	0.95**	0.68	–0.72	0.67
WGI	0.90*	1.00	0.89*	0.94**	0.89*	0.44	–0.77	0.92*
BIC	0.94**	0.89*	1.00	0.93**	0.90*	0.71	–0.92*	0.72
Cloud	0.98**	0.94**	0.93**	1.00	0.92**	0.55	–0.74	0.76
Skills	0.95**	0.89*	0.90*	0.92**	1.00	0.76	–0.70	0.73
R&D	0.68	0.44	0.71	0.55	0.76	1.00	–0.61	0.24
Unempl	–0.72	–0.77	–0.92*	–0.74	–0.70	–0.61	1.00	–0.71
GDP/c	0.67	0.92*	0.72	0.76	0.73	0.24	–0.71	1.00

Legend:

r ≥ 0.92 (** p ≤ 0.01)	0.81 ≤ r < 0.92 (* p ≤ 0.05)	0.60 ≤ r < 0.81 (moderate, insignificant)	|r| < 0.60 (weak)	r ≤ -0.81 (* or **)	r ≤ -0.92 (**)

Note: two-tailed test, df = 4, n = 6. Critical values: ** p ≤ 0.01 (|r| ≥ 0.92; t ≥ 4.60); *p ≤ 0.05 (|r| ≥ 0.81; t ≥ 2.78).

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H1 and with the concept of the "digital dividend" formulated in the World Bank reports (World Bank, 2016).

BIC demonstrates a significant negative correlation with the Unempl (r = –0.92): higher digital coverage – lower unemployment, which confirms H2 in the cross-country dimension. The relationship BIC ↔ GDP/c (r = 0.72) does not reach the threshold of significance; i.e., infrastructure affects GDP indirectly, through WGI and cloud technologies as intermediate links. At the same time, Ukraine, whose Internet coverage has decreased to 62% due to infrastructure destruction (versus 88% in Poland), is an outlier that weakens the overall correlation. This confirms *H2*, as the digital divide acts as a barrier to balanced development.

The highest correlation in the entire matrix outside the main diagonal is shown by the pair "Cloud – Skills" (r = 0.92**; $p \leq 0.01$). This result is critical for public administration: it shows that deploying cloud solutions in the business environment and improving the population's digital competence are inextricably linked processes characterized by a very high level of joint variation. Countries where both indicators are low (Poland, Ukraine) form a vicious circle, with low skills holding back cloudization and limited access to cloud tools slowing down skill acquisition. The observed pattern is descriptively consistent with *H4*, but does not constitute a formal test of moderation.

R&D spending does not show any statistically significant correlation in the two-tailed test ($|r| \leq 0.76$). The main reason is the heterogeneity of economic models, as Singapore (R&D = 1.9% at GDP = 116 thousand USD) differs significantly from other observations. The trade-finance and logistics model of the Singaporean economy generates wealth mainly through global positioning, rather than domestic R&D. In contrast, South Korea (R&D = 5.0%, GDP/c = 50 thousand USD) supports the trend. The absence of statistically significant R&D correlations suggests that its relationship with economic development may be context-dependent and requires verification on a larger and more homogeneous sample.

Based on correlation analyses, these intermediate results can be formulated.

First, ten out of twelve significant pairs are formed exclusively between variables of blocks 1–4 and do not include performance indicators (GDP/c, Unempl). This is a fundamental structural observation: EGDI, WGI, BIC, Cloud, and Skills develop systematically and demonstrate synchronous development, and do not function as independent factors. The densest pair is formed by EGDI and Cloud (r = 0.98; $p \leq 0.01$), that is, progress in the digitalization of public services and the cloudization of business occurs almost synchronously in all six countries studied. The pairs "EGDI–Skills" (r = 0.92**), "EGDI–BIC" (r = 0.94**), "WGI–Cloud" (r = 0.94**), and "BIC–Cloud" (r = 0.93**) are close in density. Thus, digital transformation is an interdependent process; none of the four driver blocks develops in isolation. This result is consistent with the interconnectedness component of H1 and is a justification for comprehensive, rather than fragmented, digital public administration strategies.

Second, WGI is the only variable that demonstrates a statistically significant correlation with GDP per capita. Among all the pairs studied, only one demonstrates a statistically significant relationship between the digital driver and GDP/c: WGI – GDP/c (r = 0.92; $p \leq 0.05$). No other variable, neither EGDI (r = 0.67), nor BIC (r = 0.72), nor Cloud (r = 0.76), nor Skills (r = 0.73), reaches the significance threshold of 0.81. This means that, under strict statistical standards, the effect of digital drivers on economic well-being is realized mainly through improving the quality of public institutions, and not directly through technological equipment. WGI may represent a potential institutional channel through which digital transformation is associated with economic outcomes: infrastructure, egovernance, and skills are highly correlated with WGI (r = 0.89–0.94*), and WGI, in turn, is significantly associated with GDP. This chain is consistent with *H1* and is consistent with the concept of the "digital dividend" of the World Bank (2016): digitalization brings economic results only when accompanied by appropriate analog complements: quality institutions, the rule of law, and effective public administration.

Third, the pair "BIC– Unempl" (r = –0.92) is the only significant relationship between the digital driver and the employment outcome. The negative sign provides partial support for *H2* in the cross-sectional dimension, i.e., a higher level of broadband Internet coverage is statistically associated with lower unemployment in the studied sample. This relationship is also the most practically significant for Ukraine, namely the reduction in BIC coverage from 74% (2022) to 62% (2024) due to the destruction of infrastructure coincides with a sharp increase in unemployment to 19.5%, although the causal relationship requires verification using panel data. The relationship "WGI–Unempl" (r = –0.77) does not reach the threshold of significance, i.e., it is more strongly associated with employment outcomes than the quality of institutions.

Fourth, digital skills (Skills) participate in four of the twelve significant pairs ("EGDI– Skills", "WGI– Skills", "BIC–Skills", "Cloud–Skills"), which is one of the most related variables in the matrix. Particularly important is the pair "Cloud–Skills" (r = 0.92**) – cloudization of business and digital competence of the population form demonstrate a very close statistical relationship, providing descriptive support for *H4* – digital infrastructure and technologies in business reveal their potential only with an appropriate level of human capital. Countries with skills below 60% (Poland – 59%, Ukraine – 52%) also have significantly lower cloudization of business (49% and 28% respectively), while countries with skills above 74% (Denmark, Estonia, Singapore, and Korea) demonstrate cloudization of 74–81%.

Fifth, none of the pairs involving R&D (% of GDP) reaches the threshold of statistical significance (|r| ≤ 0.76). This does not refute the theoretical role of research and development, but indicates the specificity of the sample. Singapore, with spending of 1.9% of GDP and GDP of 116 thousand USD, is a clear outlier, which can significantly weaken the estimate of linear dependence. The present results do not provide statistically significant evidence of an R&D–development relationship.

The structure of significant correlations reflects the two-level architecture of connections in the system of digital drivers. At the first level, a dense, mutually reinforcing cluster emerges among the drivers (10 out of 12 pairs, r = 0.89–0.98); at the second level, two-point outputs link to performance indicators (WGI→ GDP/c and BIC→Unempl). These correlations indicate that digital drivers can form an interconnected system, while their connection with economic results is most associated with the quality of public administration. This is consistent with the assumption of a potential institutional channel through which public administration efficiency transforms digital advantages into economic outcomes, but requires further verification through regression and panel analysis.

Eight regression models were constructed: four simple (M1 to M4, dependent variable – GDP/c), one simple for the labor market (M5, dependent variable – unemployment rate), and three multiple (M6 to M8), combining two predictors. The choice of specifications was determined by the results of correlation analysis, i.e., the regressions included pairs of variables that demonstrated statistically significant or close-to-significant correlations in Table 3. The summary results of modeling are given in Table 4.

Among all single-predictor models, the M2 model demonstrates the highest explanatory power,

Table 4. Results of regression analysis of the impact of digital drivers of public administration on economic development indicators (n = 6, OLS estimation)

M	Dependent variable	Predictor(s)	Equation	r	R^2	R^2adj	p–value	Meaning / Note
M1	GDP/c	EGDI	GDP = –193+267*EGDI	0.674	0.454	–	p ≈ 0.142	p > 0.05
M2	GDP/c	WGI	GDP = 8,2 + 37.6*WGI	0.915	0.838	–	p ≈ 0.010	p ≈ 0.01
M3	GDP/c	BIC	GDP = –106 + 1.8*BIC	0.717	0.514	–	p ≈ 0.109	p > 0.05
M4	GDP/c	Cloud	GDP = –28.7+1.3*Cloud	0.759	0.576	–	p ≈ 0.080	p > 0.05
M5	Unempl	EGDI	Unempl=55.7–52.9*EGDI	–0.722	0.521	–	p ≈ 0.105	p > 0.05
M6	GDP/c	WGI + BIC	GDP = 87.9 + 53.8*WGI – 1.1*BIC	–	0.880	0.801	p ≈ 0.041	p ≤ 0.05 – the best
M7	GDP/c	EGDI + Cloud	GDP = 409 – 667*EGDI + 4.1*Cloud	–	0.692	0.487	p ≈ 0.171	p > 0.05 (multicol.)
M8	Unempl	WGI + EGDI	Unempl = 22.1 – 4.9*WGI – 10.2*EGDI	–	0.600	0.334	p ≈ 0.253	p > 0.05

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where the predictor is WGI ($R^2 = 0.838$, $t = 4.550$, $p \leq 0.05$). The regression equation shows that an increase in the government efficiency index by one unit is associated with an increase in GDP per capita by 37.6 thousand USD. (PPP) under the same other conditions. The model explains 83.8% of the variance in GDP – a fairly high proportion for cross-country data. This result is the strongest formal criterion across all system models and partially supports H1 – institutional efficiency of public administration is the leading mechanism that translates a state's digital maturity into real economic growth. However, at n = 6, even this finding should be interpreted with caution.

The M1 model "GDP/c – EGDI" demonstrates a moderate level of explanatory capacity ($R^2 = 0.454$, $t = 1.824$, $p > 0.05$) – the coefficient at EGDI is statistically insignificant. The equation formally assumes that every +0.1 units of EGDI corresponds to a GDP growth of 26.7 thousand USD, but the low reliability of the estimate does not allow us to draw such conclusions. The deviation of Singapore (EGDI = 0.976, GDP = 116 thousand USD) significantly affects the slope of the regression line, overestimating it. Without Singapore, the correlation between EGDI and GDP among the remaining five countries would be significantly weaker, meaning that EGDI is a composite indicator of digital readiness, but not a direct generator of well-being.

The M3 model "GDP/c – BIC" ($R^2 = 0.514$, $t = 2.055$, $p > 0.05$) and M4 "GDP/c – Cloud" ($R^2 = 0.576$, $t = 2.331$, $p > 0.05$) do not reach the threshold of statistical significance. The M4 equation may indicate that an increase in the share of enterprises with cloud technologies by 10 pp is associated with GDP growth by 13 thousand USD. Poland is an illustrative example – an increase in the share of cloud technology use by businesses by 22 pp in 2018–2024 was accompanied by an increase in GDP by 11.2 thousand USD, which is close to the model's forecast. However, due to the lack of statistical significance, these results cannot be considered reliable confirmation of *H3* regarding the multiplier effect of the digital economy.

Model M5 "Unempl – EGDI" shows $R^2 = 0.521$ and is not statistically significant ($t = –2.086$, $p > 0.05$). The negative coefficient of the equation is consistent with H2, i.e., a higher level of e-governance is associated with a lower level of unemployment, but due to the non-significance of the coefficient, this relationship cannot be considered statistically significant.

At the same time, the model explains only 52.1% of the unemployment variance, and Ukraine is an outlier – with EGDI = 0.774, the model predicts unemployment of about 14.8%, while the actual unemployment rate is 19.5%. The difference of 4.7 pp can be considered a measure of the "digitally independent" impact of the armed conflict on the labor market – the share of unemployment that is not explained by the digitalization level.

The M6 multiple model "GDP/c – (WGI + BIC)" is the best specification in the system of constructed models ($R^2 = 0.880$, R^2adj = 0.801, $F = 11.034$ ($p \leq 0.05$)). The model explains 88.0% of the variance in GDP per capita – a very high proportion for such a small cross-sectional sample. The positive and strong WGI coefficient (53.8) indicates the leading role of the quality of public governance. The negative coefficient at BIC (–1.1) is not a meaningful effect, but a consequence of multicollinearity. Thus, WGI and BIC are closely correlated with each other ($r = 0.78$), so in the multiple model, WGI absorbs a significant proportion of the variation previously attributed to BIC. With a fixed level of WGI, BIC does not have an independent positive contribution to GDP, but this does not mean that there is no real impact of it. This influence is implemented through WGI as an intermediate variable.

The M7 model "GDP/c – (EGDI + Cloud)" (R^2adj = 0.487, $F = 3.377$) does not reach the threshold of statistical significance, despite a moderately high $R^2 = 0.692$. The reason is the high multicollinearity between the predictors (r(EGDI, Cloud) = 0.902), which leads to the instability of the coefficient estimates. The negative coefficient at EGDI (–667) is a distinct artifact of multicollinearity and does not allow meaningful interpretation. This result serves as a methodological caveat, i.e., at $n = 6$, multiple models with highly correlated predictors are unstable and require either the selection of one of the predictors or the use of alternative estimation methods.

The M8 model "Unempl – (WGI + EGDI)" (R^2adj = 0.334, $F = 2.252$) is not statistically significant, although the trend of the negative impact of both predictors on unemployment is theoretically consistent. The main reason is the dominant influence of Ukraine's outlier (unemployment of 19.5% with a relatively average EGDI = 0.774), which does not allow the model to identify a stable linear relationship. If Ukraine were excluded, the significance of the model would increase significantly.

In the second stage, pooled OLS specifications were estimated on the balanced panel of 42 country-year observations (6 countries × 7 years). Because these observations are repeated within countries, pooled OLS is treated as a descriptive benchmark, while the main panel specifications control for country and year fixed effects. The transition from $n = 6$ to $n = 42$ fundamentally changes the conditions of statistical inference: at df ≥ 39, the critical value |t| decreases to 2.021 ($p \leq 0.05$) and 2.704 ($p \leq 0.01$) compared to 2.776 in cross-sectional specifications. All eight specifications use the same dependent variables (GDP/s, Uempl) and predictors from blocks 1–4. Two additional methodological variables were introduced: (1) a military dummy variable WAR (WAR = 1 for Ukraine 2022–2024, WAR = 0 for all other observations) to isolate the impact of the armed conflict; (2) country dummy variables (country fixed effects, base – Ukraine) to control for time-invariant heterogeneity. The results are presented in Table 5.

Model P1 (GDP/c~WGI) is a useful pooled benchmark and demonstrates a strong positive association between WGI and GDP per capita ($R^2 = 0.812$, R^2adj = 0.808, $F = 173.2$, $p < 0.001$; $b = 32.65$, SE = 2.48, $p < 0.001$). However, this pooled estimate should not be interpreted as a robust within-country effect because the 42 observations represent repeated observations from only six countries. The result is therefore primarily informative about the strong cross-country association between institutional effectiveness and economic development.

Model P2 (GDP/c~EGDI) also shows a significant pooled association ($R^2 = 0.378$, R^2adj = 0.362, $F = 24.3$, $p < 0.001$; $b = 229.57$, SE = 46.60, $p < 0.001$). An increase in EGDI by 0.1 units is associated with approximately USD 22.96 thousand higher GDP per capita in the pooled sample. This estimate, however, is not robust to the inclusion of country and year fixed effects.

Table 5. Panel regression results: Pooled OLS benchmarks and two-way fixed-effects specifications (n = 42, 2018–2024)

Model	Dependent	Predictors	R²	R²adj	F	Coefficients and Significance
P1	GDP/c	WGI	0.812	0.808	F=173.2; p<0.001	WGI: 32.65 (2.48; <0.001; [27.64; 37.66])
P2	GDP/c	EGDI	0.378	0.362	F=24.3; p<0.001	EGDI: 229.57 (46.60; <0.001; [135.48; 323.67])
P3	GDP/c	WGI + EGDI	0.868	0.862	F=128.6; p<0.001	WGI: 45.35 (3.76; <0.001; [37.75; 52.95]); EGDI: –157.92 (38.82; <0.001; [–236.38; –79.47])
P4	GDP/c	WGI + WAR	0.816	0.807	F=86.7; p<0.001	WGI: 33.91 (2.84; <0.001; [28.17; 39.66]); WAR: 8.28 (9.00; 0.362; [–9.92; 26.49])
P5	Unempl	EGDI	0.314	0.297	F=18.3; p<0.001	EGDI: –34.30 (8.02; <0.001; [–50.52; –18.09])
P6	Unempl	EGDI + WAR	0.839	0.831	F=101.7; p<0.001	EGDI: –11.77 (4.41; 0.011; [–20.68; –2.86]); WAR: 15.32 (1.36; <0.001; [12.57; 18.08])
P7	GDP/c	WGI + Country FE + Year FE	0.994	0.991	Joint model significance not used as evidence for predictor significance	WGI: –18.98 (18.97; p=0.363; 95% CI [–67.74; 29.79])
P8	Unempl	EGDI + WAR + Country FE + Year FE	0.981	0.972	Joint model significance not used as evidence for predictor significance	EGDI: 19.49 (18.66; p=0.344; [–28.49; 67.47]); WAR: 12.88 (0.16; p<0.001; [12.48; 13.28])

Note: P1–P6 are pooled OLS benchmarks. P7–P8 are two-way fixed-effects models with country and year effects and country-clustered standard errors. Because only six country clusters are available, p-values for the clustered coefficients use t(5) as a small-cluster sensitivity assessment. 95% confidence intervals are reported for the focal coefficients. WAR = 1 for Ukraine in 2022–2024 and 0 otherwise.

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Model P3 (GDP/c~WGI+EGDI, R^2adj = 0.862, $F = 128.6$, $p < 0.001$) reveals strong multicollinearity between WGI and EGDI ($r = 0.90$). The negative EGDI coefficient in the multiple specification should therefore not be interpreted as a causal or independent negative effect. The model primarily demonstrates the high degree of shared variation among institutional and digital-readiness indicators.

Model P4 (GDP/c~WGI+WAR) provides a pooled control for the conflict-period relationship. WAR is statistically insignificant in this specification ($b = 8.28$, $t = 0.92$, $p \approx 0.36$). This indicates that after accounting for WGI, Ukraine's performance over 2022–2024 does not add a statistically significant pooled contribution to GDP per capita.

Model P5 (Unemployment~EGDI) shows a statistically significant negative pooled relationship ($b = -34.30$, SE = 8.02, $t = -4.28$, $p < 0.001$; $R^2 = 0.314$). The estimate is sensitive to the significantly different dynamics of unemployment in Ukraine over 2022–2024 and should not be interpreted as a causal effect within the country.

Model P6 (Unemployment~EGDI+WAR) separates the pooled associations of EGDI and the war period. EGDI is negatively associated with unemployment ($b = -11.77$, $t = -2.67$, $p \approx 0.011$), while WAR is strongly positively associated with unemployment ($b = 15.32$, $t = 11.28$, $p < 0.001$). The WAR coefficient represents a conditional war-period differential rather than a causal estimate, because the indicator equals one only for Ukraine in 2022–2024 and no independent counterfactual treatment group is available.

Fixed effects analysis significantly changes the interpretation of the combined results. Model P7 includes fixed effects for both country and year. With standard errors clustered by country and five degrees of freedom to estimate the sensitivity of small clusters, the WGI coefficient is –18.98 (SE = 18.97; $t = -1.00$; $p = 0.363$; 95% CI [–67.74, 29.79]). The strong pooled WGI association is not robust to controlling for persistent differences across countries and common year shocks.

Model P8 also includes country and year fixed effects. The coefficient of EGDI is 19.49 (SE = 18.66; $t = 1.04$; $p = 0.344$; 95% CI [–28.49; 67.47]), while WAR remains strongly associated with higher unemployment ($b = 12.88$, SE = 0.16; $t = 82.76$; $p < 0.001$; 95% CI [12.48; 13.28]). The very large t-statistic should not be interpreted as evidence of causal identification, given the highly concentrated WAR indicator and the small number of country clusters. Given the cluster structure of six countries, the WAR estimate should be interpreted as a conditional relationship rather than a causal effect of the war.

Taken together, the combined models reveal strong cross-country relationships, while the two-way fixed effects specifications provide little evidence of persistent within-country effects for WGI or EGDI over the period 2018–2024. This distinction is central to the interpretation of the study. Digital and institutional maturity are closely related to levels of development across countries. However, the six-country panel does not establish that annual changes in these indicators independently generate corresponding changes in GDP per capita or unemployment.

The results of the correlation and regression analyses should be interpreted as evidence of association. WGI may represent an important institutional channel through which digital transformation translates into economic outcomes, but no formal mediation analysis has been conducted.

In the cross-sectional analysis, WGI is the only indicator with a statistically significant relationship with GDP per capita ($r = 0.92$; $p \approx 0.01$). In the pooled panel, WGI also has the strongest statistical relationship ($t = 13.16$, $p < 0.001$), but this relationship disappears after controlling for country and year fixed effects. Accordingly, WGI should not be considered the most reliable or powerful predictor in a causal or within-country sense.

The impact of digital infrastructure (BIC) remains largely descriptive in this study. Its strong cross-correlation with unemployment ($r = -0.92$) does not establish an independent causal effect, and the small number of countries limits the reliability of the cross-correlation inference.

R&D is not a statistically significant predictor in this sample. This result is reasonable to interpret due to structural heterogeneity and the small number of countries. The effect of R&D may be nonlinear and context-dependent, and needs to be tested in a larger and more homogeneous panel.

The analysis of unemployment shows that the war period is strongly associated with higher unemployment in the pooled specification. This association remains after controlling for EGDI, but the WAR coefficient should not be interpreted as a causal treatment effect. However, since WAR is equal to unity only for Ukraine in 2022–2024, this coefficient cannot be interpreted as a pure treatment effect. The result documents the conditional difference associated with the Ukraine conflict period relative to the remaining country-year observations.

The significance of the overall F-statistic of a panel model should be distinguished from the significance of its individual numerical predictors. In the fixed-effects specification, the high R^2 and overall significance of the model are largely driven by country and time effects, while the focal coefficients of WGI and EGDI are statistically insignificant in the two-way fixed-effects specification. This finding significantly clarifies the interpretation of the pooled estimates.

The results of correlation and regression analyses, cross-sectional ($n = 6$, 2024) and panel Pooled OLS ($n = 42$, 2018–2024) allow for the sequential verification of five hypotheses of the study. Based on the cross-sectional, pooled OLS, and two-way fixed-effects results, the proposed hypotheses receive varying levels of empirical support.

Hypothesis H1 is partially supported. The EGDI and WGI are highly correlated, and WGI is significantly associated with GDP per capita in the cross-sectional and pooled analyses. However, the coefficient on WGI becomes statistically insignificant in the two-way FE model ($b = -18.98$, $p = 0.363$). The data are consistent with an institutional channel, but a formal mediation mechanism was not tested, and within-country effects were not established.

Hypothesis H2 is partially supported. Broadband coverage is strongly and negatively correlated with unemployment in the cross-sectional analysis, and EGDI is negatively correlated with unemployment in the pooled least squares method. However, after introducing country and year fixed effects, the EGDI coefficient becomes statistically insignificant ($p = 0.344$). The findings support a link between digitalization and labor market outcomes, but not a consistent effect within countries.

Hypothesis H3 is partially supported at the descriptive level only. Cloud adoption is positively associated with several indicators of digital maturity, but the study does not find a statistically significant direct relationship between cloud and GDP. The result should be viewed as an empirical pattern that needs to be tested on a larger panel.

Hypothesis H4 is supported by descriptive rather than formal econometric support. The correlation between cloud and skills is very strong ($r = 0.92$), and the data suggest a possible threshold of around 60% digital skills. However, no threshold or nonlinear moderation model was estimated. The value of 60% should not be presented as a statistically validated threshold.

The general hypothesis H5 is partially supported at the association level. Countries with higher digital and institutional maturity exhibit higher development outcomes, but the strongest pooled relationships are not robust to country and year fixed effects. The two-way FE does not support the strong claim that annual changes in digital maturity independently generate corresponding changes in GDP per capita or unemployment within the six-country sample.

The relationship between digitalization and labor-market outcomes remains controversial. Some scientists consider digital technologies as a factor in creating new jobs, developing digital entrepreneurship, and forming an innovative economy. Others focus on the risks of automation, structural unemployment, and deepening socio-economic inequalities between regions with different levels of digital readiness. As a result, digitalization is dual in nature: on the one hand, it stimulates economic modernization, while on the other, it can give rise to new structural imbalances in the absence of a proper state policy to support human capital.

A separate subject of scientific discussion is the problem of regional asymmetry of digital develop-

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ment. Modern research increasingly emphasizes that digitalization is uneven: large urbanized areas receive much greater benefits from the development of the digital economy compared to peripheral regions. This creates a so-called "digital divide", which can exacerbate territorial disparities even as the state's overall digital maturity increases. In this context, ensuring digital inclusion and equal access of regions to digital infrastructure and public services is of particular importance.

The issue of the state's digital resilience in the context of crisis transformations also remains debatable. The COVID-19 pandemic has demonstrated the importance of digital institutions in ensuring the continuity of public administration and the functioning of the economy. At the same time, modern military conflicts have shown that digitalization can perform not only the function of increasing efficiency, but also the function of ensuring the resilience of the state to systemic security threats. In this context, the concept of "digital resilience" is being formed, which characterizes the ability of digital institutions to support the functioning of the state even in the face of the destruction of physical infrastructure and large-scale economic shocks.

At the same time, another group of researchers emphasizes that digitalization does not have an automatic positive effect without proper institutional capacity of the state, effective governance, and a stable regulatory environment. A high development level of digital services or the ICT sector does not guarantee a long-term economic effect in the absence of high-quality state institutions capable of ensuring effective management of digital transformation. In this study, institutional quality is therefore considered an important potential channel through which digital transformation may be associated with economic outcomes. However, because formal mediation analysis was not conducted, the empirical results do not establish a statistically tested mediation mechanism (Evsyukova et al., 2026; Zhytar et al., 2022).

Despite the significant development of scientific thought, a number of conceptual and methodological gaps remain in modern literature (Kubatko et al., 2022; Tulchynska et al., 2026; Shkolnyk et al., 2022). First, most studies analyze individual components of digitalization without forming an integrated model of interaction of digital drivers. Second, the issue of the relationship between the digital maturity of the state, institutional efficiency, and economic development remains insufficiently studied. Third, there is a shortage of comparative cross-country studies covering states with different models of digital transformation and different operating conditions.

The scientific base on the digital transformation of public administration in the context of a military conflict is especially limited. Most of the modern models of digital development are formed in the context of macroeconomic and security stability, which significantly narrows the possibilities of their application to countries operating in an existential crisis. In this context, Ukraine forms a separate scientific case, as it combines large-scale digitalization of public services with deep security, demographic and economic shocks.

Thus, the modern scientific discussion is gradually changing its perspective from a simplified interpretation of digitalization as a purely technological process to a comprehensive vision of digital transformation as a multi-level system of interaction of digital technologies, institutional quality, human capital and economic development. At the same time, the problem of quantifying the relationships between digital drivers of public administration and performance indicators of development remains insufficiently developed, especially for countries with transformative economies and crisis environments. This is what forms the scientific logic, relevance and research necessity of this article.

The results require careful interpretation because of several methodological limitations. First, the cross-sectional component is based on only six countries, which substantially limits statistical power and makes the estimates sensitive to influential observations. Second, the panel contains 42 country-year observations from the same six countries and therefore cannot be treated as 42 independent observational units. Third, the panel provides only six country clusters, making cluster-robust inference a sensitivity analysis rather than a definitive solution to the small-cluster problem. Fourth, 18 of the 42 annual EGDI observations (42.9%) are linearly interpolated because the source is published biennially; these values should therefore not be interpreted as independently observed annual measurements. Fifth, the WAR indicator equals one only for Ukraine in 2022–2024 and does not provide a conventional treatment-control design or a valid counterfactual, so its coefficient cannot be interpreted as a causal estimate of the effect of the war. Finally, the strong correlations among several digital indicators generate multicollinearity in multiple-predictor specifications and may reduce the stability and interpretability of individual coefficients. These limitations define the scope of the empirical conclusions and motivate replication using larger cross-country panels, more independently observed annual data, and broader country coverage.

CONCLUSION

The study shows that digital maturity, institutional quality, digital infrastructure, and human capital are closely interrelated and linked to economic development in the six countries analyzed. The Governance Index (WGI) is the strongest cross-country correlate of GDP per capita in the cross-sectional analysis ($r = 0.92$; $p \approx 0.01$) and in the pooled panel model P1 ($t = 13.16$; $p < 0.001$; R^2adj = 0.808). However, its coefficient becomes statistically insignificant after controlling for country and year fixed effects ($b = -18.98$; $p = 0.363$). The Governance Index (EGDI) shows a similar pattern, indicating that the strongest pooled relationships mostly reflect persistent cross-country differences rather than persistent within-country effects.

The results offer partial support for the proposed hypotheses. Digitalization is negatively associated with unemployment in cross-sectional and pooled analyses, while this relationship is not robust to two-way fixed effects. The WGI may represent an important institutional channel linking digital transformation to economic outcomes. The proposed threshold of 60% digital skills represents a descriptive pattern rather than a statistically tested moderating effect.

The WAR indicator remains strongly associated with higher unemployment, but its coefficient should be interpreted as a conditional conflict-period association rather than a causal war effect, since the indicator equals one only for Ukraine in 2022–2024 and does not provide a conventional treatment-control design.

Overall, the results suggest that digitalization alone may not be sufficient to generate economic growth. Rather, digital transformation operates within a broader institutional, human-capital, and security environment. Digital resilience can support public-service capacity during crises, while institutional quality, human capital, security, and macroeconomic stability remain important conditions for translating digital capabilities into sustainable development outcomes.

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