

DOI: [https://doi.org/10.30970/fp.3\(61\).2026.189204205](https://doi.org/10.30970/fp.3(61).2026.189204205)

JEL Classification: H11, H20, H61, H83, O33

DIGITALIZATION OF PUBLIC SERVICES AND STATE FISCAL CAPACITY: INSTITUTIONAL MECHANISMS AND RESILIENCE IN WARTIME

ZAKHARKINA Liudmyla

PhD in Economics, Associate Professor,

*Associate Professor of the Department of Financial Technologies and Entrepreneurship
Sumy State University*

ORCID ID: <https://orcid.org/0000-0003-1002-130X>

ZAKHARKIN Oleksii

Doctor of Science in Economics, Professor,

*Associate Professor of the Department of Financial Technologies and Entrepreneurship
Sumy State University*

ORCID ID: <https://orcid.org/0000-0001-9317-252X>

BORONOS Volodymyr

PhD in Economics, Professor?

Research Fellow

Sumy State University

ORCID ID: <https://orcid.org/0009-0001-8124-6533>

Abstract. *The study assesses how digital public services support state fiscal capacity under wartime shocks. Evidence from Ukraine and four comparator countries suggests that digitalization indirectly supports administrative continuity and fiscal resilience, while its effects depend on cybersecurity and institutional integration.*

Keywords: *digital public services; fiscal capacity; GovTech; tax revenue; institutional resilience; cybersecurity; wartime economy; post-war reconstruction.*

Problem Statement. The full-scale war against Ukraine has radically changed the requirements for the functioning of the public finance system and has strengthened the importance of the state's fiscal capacity as a basic condition for macroeconomic stability, defense capability, and post-war reconstruction. In a situation of simultaneous growth in defense spending, large-scale social transfers, the need to restore critical infrastructure, and servicing state debt, the issues of revenue mobilization and increasing the efficiency of budget spending are becoming systemic. According to international partners, the volume of Ukraine's recovery needs is measured in hundreds of billions of US dollars, which objectively limits fiscal space and makes urgent the search for internal sources to strengthen the state's financial stability. In this context, the digitalization of key public services ceases to be an exclusively service-modernization and public-administration-transformation tool and becomes a means of fostering institutional and fiscal stability. Electronic administration of taxes and customs payments, digital business registration, electronic procurement, digital social payments, and the integration of state registers and platforms such as Diia form a new

architecture of interaction between the state and citizens and businesses. This architecture potentially affects fiscal capacity by reducing compliance costs, increasing voluntary tax payment, reducing shadow practices, reducing administrative costs, increasing transparency of expenditures, and ensuring the continuity of state functions in conditions of military risks. At the same time, the scientific and applied problem is the lack of an integrated methodology for accurately measuring the impact of the digitalization of public services on fiscal results. Existing international digital governance indices (EGDI, GTMI, Digital Government Index, etc.) provide comparative assessments of digital maturity but do not directly measure fiscal effects. At the same time, tax administration assessment tools (TADAT, ISORA, RA-GAP) focus on the performance of revenue authorities but do not always account for the degree of digital transformation of services as an influencing factor. In addition, in wartime conditions, macroeconomic shocks (migration, infrastructure destruction, changes in the structure of GDP) significantly complicate the identification of causal relationships between digital reforms and fiscal indicators.

Therefore, there is a need to develop a hybrid methodological framework that combines macro indicators of digital development, institutional indicators of administrative capacity, service operational metrics, and tools for causal analysis. Such a framework enables a distinction between intermediate results of digitalization (reduced processing time, a higher share of online interactions, fewer errors, and increased accessibility) and final fiscal effects (growth in tax revenues, a narrower tax gap, and greater expenditure efficiency), while also accounting for external shocks and cyber risks.

Analysis of Recent Research and Publications. The relationship between the digitalization of the public sector and the fiscal capacity of the state is shaped at the intersection of several scientific areas: public finance theory, e-government research, the digital transformation of tax administration, and institutional economics. In modern literature, digitalization is increasingly viewed not as an auxiliary tool for optimizing services but as a structural factor for increasing the efficiency of public administration, transparency of budget processes, and sustainability of financial systems [1; 2].

Within the framework of e-government research, the key emphasis is traditionally placed on the availability of online services, the integration of digital infrastructure, and the quality of interaction between the state and citizens. The conceptual framework proposed by the UN within the E-Government Survey [3] defines the digital state as a combination of online services, telecommunications infrastructure and human capital [4; 5]. In these works, digitalization is interpreted as a tool for increasing the inclusiveness and efficiency of government institutions, but the direct connection to fiscal outcomes is usually indirect.

Further development of the topic is reflected in the World Bank's research on GovTech and the digital maturity of the public sector. Within the GovTech approach, digitalization is viewed as the integration of basic government systems, online service delivery, digital interaction, and technological "enablers" that form the institutional environment for transparency and effectiveness [6; 7]. This approach brings digital transformation closer to the institutional capacity category, which is directly related to revenue mobilization and expenditure efficiency.

In the tax administration literature, digitalization is increasingly interpreted as a factor in reducing compliance costs and increasing voluntary tax payment. The Tax Administration 3.0 concept proposed by the OECD emphasizes transitioning from traditional control to data-driven administration, integrating business processes with tax systems, and automating accounting obligations. In this context, digital technologies are seen as tools for minimizing tax gaps and increasing operational transparency [8].

Empirical studies at the cross-country level demonstrate a positive relationship between e-government development and tax revenues, but highlight the difficulty of establishing causality [9]. In particular, the World Bank's work indicates that digitalization can reduce tax compliance costs and stimulate revenue growth, but the effect depends on the quality of institutions and the overall level of development [10]. Other studies analyzing the implementation of electronic invoicing show an increase in declared sales and tax liabilities after the transition to digital administration formats, suggesting a reduction in evasion [11]. A separate line of literature links digitalization with anti-corruption effects and increased transparency of public finances. Studies of e-procurement and open data show that digital platforms can increase competition and reduce budget losses, thereby indirectly affecting the state's fiscal capacity. In this context, digitalization is seen as a tool for institutional strengthening that combines fiscal discipline with accountability [12].

At the same time, recent literature highlights new risks associated with digital transformation, particularly cyber threats and the vulnerability of digital systems. The growing role of online transactions in tax administration and social payments increases the potential for losses in the event of cyberattacks, underscoring the need to integrate cyber resilience measures into fiscal capacity research [13].

Thus, a review of the literature indicates a significant body of research that separately analyzes the digitalization of public administration, tax administration, or fiscal resilience. However, comprehensive approaches that integrate these dimensions into a single methodological framework for assessing the impact of digitalization of key public services on fiscal capacity remain limited, especially in the context of wartime shocks and post-war reconstruction. This research gap determines the logic of further analysis within the framework of this article.

Purpose of the Article. The aim of this article is to develop and empirically apply an integrated analytical framework for assessing the relationship between the digitalization of key public services and the state's fiscal capacity, with particular attention to the institutional mechanisms operating during wartime shocks and post-war recovery.

The study is guided by the hypothesis that digital public services strengthen state fiscal capacity indirectly through administrative efficiency, institutional continuity, and transparency rather than through an immediate mechanical increase in tax revenues.

To achieve this aim, the study sets the following objectives:

- to conceptualize the relationship between the digitalization of public services and fiscal capacity by integrating insights from public finance theory, e-government research, and institutional economics;
- to systematize and justify the selection of international composite indicators (EGDI, GTMI) as measures of digital maturity and to assess their relevance for analyzing fiscal implications;
- to evaluate the dynamics of Ukraine's digital transformation during 2018–2024 from a comparative perspective involving Estonia, Lithuania, Poland, and Georgia, and to identify the structural features of digitalization;
- to analyze changes in tax revenue as a share of GDP as an aggregate indicator of fiscal capacity and to interpret its dynamics in relation to digital development and war-induced macroeconomic shocks;
- to formulate evidence-based conclusions regarding the role of digital public services in strengthening fiscal sustainability in wartime and post-war recovery contexts.

By addressing these objectives, the study seeks to move beyond descriptive assessments of digital governance and contribute to the development of a hybrid

methodological approach capable of linking digital transformation with measurable dimensions of fiscal capacity.

Scientific Novelty of the Study. The scientific novelty lies in developing a risk-adjusted analytical framework that integrates digital maturity indices, a macro-fiscal indicator, and a cybersecurity indicator, enabling a distinction between direct fiscal outcomes and the indirect institutional, behavioral, and resilience-related channels through which digital public services strengthen state fiscal capacity under wartime shocks and during post-war recovery.

The research methodology is aimed at developing an integrated analytical framework to assess the relationship between the digitalization of key public services and the state's fiscal capacity in the context of wartime shocks and post-war reconstruction. Given the complexity of the research object, the methodological approach is built as a multi-level system that combines macro indicators of digital maturity, indicators of institutional capacity, fiscal aggregates, and risk-oriented indicators of cyber resilience. The choice of these instruments is driven by the need to simultaneously ensure international comparability, statistical reliability, and relevance to the Ukrainian context.

To measure the level of digitalization in the public sector, two internationally recognized composite indices were used: the E-Government Development Index (EGDI) and the GovTech Maturity Index (GTMI). Their simultaneous application stems from the fact that each reflects different, yet complementary, aspects of digital transformation.

The EGDI, developed by the UN Department of Economic and Social Affairs, is one of the oldest and most widely cited global e-government indicators. Its methodology is based on three components [3]: online services, telecommunications infrastructure, and human capital. The EGDI enables the assessment of the systemic maturity of the digital state in a broad institutional context and the tracking of long-term dynamics over the 2018–2024 period. This index was selected to capture the background trajectory of Ukraine's digital transformation and compare it with countries that have broadly similar institutional conditions. Its advantages include regular publication, a standardized methodology, and cross-country comparability. However, the EGDI also has limitations: it measures the overall development of e-government but does not provide detailed information on the quality of government-system integration, analytical capabilities, or digital enablers. The World Bank's GovTech Maturity Index was therefore selected as the second baseline instrument.

The GTMI [14] assesses the digital maturity of the public sector across four structural dimensions: core government systems, online service delivery, digital citizen engagement, and GovTech enablers. This index moves from a general description of digitalization to an analysis of its institutional architecture, which is critical for assessing the impact on fiscal capacity. For example, a high level of online service delivery (PSDI) may not be accompanied by sufficient data integration or risk analytics, limiting the fiscal impact.

Thus, the combination of the EGDI and the GTMI provides a balance between a macro-level measurement of digital maturity and an analysis of the structural institutional components that directly affect tax administration, customs procedures, and social benefits.

To assess fiscal capacity, the tax revenue (% of GDP) indicator from the World Development Indicators database was used as a basic macro indicator [15]. The choice of this indicator is due to several factors.

First, it is a standardized international indicator based on the IMF's Government Finance Statistics data, which ensures comparability between countries. Second, the share of tax revenues in GDP allows us to assess not only the absolute volume of revenues, but also

the level of resource mobilization relative to the size of the economy. Third, the indicator is sensitive to changes in administration, reductions in tax gaps, and increases in voluntary compliance behavior.

However, this indicator does not permit direct identification of the effect of digitalization on revenues because it is also influenced by macroeconomic conditions, wartime shocks, and changes in tax policy. It is therefore used as an aggregate outcome indicator that must be supplemented with institutional and process indicators.

The study additionally uses the Global Cybersecurity Index (GCI) based on the official ITU editions for 2020 and 2024 [16; 17]. The GCI measures national cybersecurity commitments across five pillars: legal, technical, organizational, capacity-development, and cooperation measures. The fifth edition retains the 0–100 scale, but revises the questionnaire, weighting, verification procedures, and presentation of country performance through a tier-based model. Therefore, changes between the 2020 and 2024 scores are interpreted as directional evidence of strengthened or weakened reported cybersecurity commitments rather than as a perfectly homogeneous time series.

Five countries were selected for empirical analysis: Ukraine, Estonia, Lithuania, Poland, and Georgia. The selection was based on four methodological criteria.

First, institutional and historical comparability. All countries belong to post-socialist or transitional economies that formed their models of public administration after the 1990s and underwent digital modernization in similar starting conditions.

Second, regional relevance and economic integration. Poland and Lithuania are EU member states with which Ukraine is integrating within the European integration process. Estonia is an internationally recognized leader in digital governance, which makes it a “reference” model. Georgia was chosen as an example of a country undergoing an active digital transformation amid external challenges and limited resources.

Third, variability in levels of digital maturity. Estonia and Lithuania demonstrate high values across the selected digital indicators, whereas Poland and Georgia recorded lower GTMI values and were classified in Group B. This allows Ukraine’s trajectory to be assessed not only against recognized digital leaders but also against countries with more comparable institutional and development conditions.

Fourth, the availability of complete and comparable statistical data on EGDI, GTMI, GCI, and tax indicators.

In general, the methodology is built as a hybrid analysis model that combines macroeconomic indicators (tax revenues/GDP), composite digital maturity indices (EGDI, GTMI), and a cyber resilience indicator (GCI). This approach allows us to trace the long-term dynamics of digital transformation, assess the structural quality of digital infrastructure, compare digital outcomes with fiscal mobilization, and account for the risk-oriented dimension of cybersecurity. The choice of these indices and countries ensures a balance between international comparability, institutional relevance, and analytical depth. This creates a basis for further causal analysis of the impact of digitalization of key public services on Ukraine's fiscal capacity in the context of war and post-war reconstruction.

Presentation of the Main Research Results. Empirical analysis shows that during 2018–2024, Ukraine recorded the largest EGDI increase among the countries in the comparative sample. The dynamics of the UN E-Government Development Index (EGDI) indicate not merely a gradual expansion of digital services but a sustained improvement in Ukraine’s position in the international digital-government landscape (Table 1). The starting value was 0.6165 in 2018, when electronic services and digital infrastructure had developed but had not yet formed a fully integrated, large-scale service-delivery model. The index rose

to 0.7119 in 2020, 0.8029 in 2022, and 0.8841 in 2024. The total increase over six years was 0.2676 points, compared with 0.1241 in Estonia, 0.1576 in Lithuania, 0.0722 in Poland, and 0.0899 in Georgia.

Table 1

E-Government Development Index (EGDI)

Country	2018	2020	2022	2024	Δ 2018→2024
Estonia	0.8486	0.9473	0.9393	0.9727	0.1241
Georgia	0.6893	0.7174	0.7501	0.7792	0.0899
Lithuania	0.7534	0.8665	0.8745	0.9110	0.1576
Poland	0.7926	0.8531	0.8437	0.8648	0.0722
Ukraine	0.6165	0.7119	0.8029	0.8841	0.2676

Source: compiled by the authors based on [3].

The increase occurred consistently across three consecutive two-year intervals: 0.0954 in 2018–2020, 0.0910 in 2020–2022, and 0.0812 in 2022–2024. Thus, even after the onset of full-scale war, the upward trajectory continued, although at a somewhat slower pace in the final interval. This pattern is important for two reasons. First, the EGDI captures not only the availability of online services but also the broader foundations of the digital state through its online-services, telecommunications-infrastructure, and human-capital components. Second, continued growth under wartime conditions indicates that the public-administration system retained the capacity to scale services, maintain infrastructure, and support user and staff capabilities despite migration, infrastructure damage, and other shocks. In 2024, Ukraine's EGDI value of 0.8841 exceeded Poland's value of 0.8648 and approached Lithuania's value of 0.9110, while remaining below Estonia's value of 0.9727. This places Ukraine among the higher-performing digital-government systems in the selected sample. The trajectories nevertheless differ: Estonia recorded a slight decline from 0.9473 in 2020 to 0.9393 in 2022 before rising to 0.9727 in 2024, whereas Ukraine showed an increase at every observation point. This consistency suggests that digitalization developed as a systemic process rather than as a set of isolated initiatives. The available evidence also indicates that high digital-maturity values coexist with widespread service use: in 2025, 59% of Ukrainians used government e-services [18], while the use of Diia had also become widespread. For fiscal-capacity analysis, the scale and frequency of digital transactions matter because they create conditions for measurable changes in intermediate mechanisms, including shorter compliance times, fewer errors, more timely filing and payment, and better targeting of social benefits. The EGDI dynamics therefore provide evidence that Ukraine's digital transformation moved from the development of individual services toward a scalable system capable of operating under wartime constraints. At the same time, the EGDI is not a fiscal indicator and does not demonstrate automatic revenue growth; rather, it captures the state's capacity to provide services through digital channels and provides a basis for examining how this capacity may translate into fiscal outcomes through taxation, customs administration, business registration, social payments, and administrative-performance indicators.

The GovTech Maturity Index (GTMI) provides a structural complement to the EGDI by shifting the analysis from general e-government development to the institutional capabilities of the public sector. According to the World Bank's 2022 edition [14],

Ukraine's overall GTMI score was 0.77, placing it in Group A, which includes countries with substantial GovTech maturity. Estonia recorded 0.96 and Lithuania 0.92, while Poland and Georgia recorded 0.68 and 0.61, respectively, and were classified in Group B. These results position Ukraine among the stronger performers in the selected sample, particularly in online public service delivery.

The component scores provide additional insight. Ukraine's Public Service Delivery Index (PSDI) was 0.97, close to Estonia's value of 1.00. This indicates a high degree of end-to-end digitalization in key public services, including the submission of applications, processing, and receipt of results through electronic channels with limited offline intervention. From the perspective of fiscal capacity, end-to-end digitalization can reduce transaction costs and increase transparency. At the same time, Ukraine's overall GTMI score of 0.77 remained below the values for Lithuania and Estonia, indicating uneven development across components. The component scores point to comparatively weaker performance in the integration of core government systems and in GovTech enablers. Consequently, challenges remain in inter-agency integration, data governance, user feedback, and the resilience of digital infrastructure. These back-office elements are especially important for risk-based controls, automated analytics, and tax-gap management.

Within the selected sample, Estonia and Lithuania combined high digital-maturity indicators with comparatively stable tax-revenue ratios, particularly in 2021–2023. Ukraine, despite its high PSDI value, experienced substantial macro-fiscal volatility in 2022. This comparison indicates that the availability of digital services alone does not ensure revenue stability unless it is complemented by data integration, risk analytics, and cyber resilience.

According to the 2025 GTMI update, Ukraine also belonged to Group A and demonstrated a high level of maturity in online public service delivery [15]. This creates a relevant setting for further causal analysis using more granular indicators, including compliance rates, reporting timeliness, administrative costs, and the targeting of social benefits. Overall, the GTMI evidence indicates that Ukraine has achieved a high level of digital maturity in public service delivery, while further strengthening of fiscal capacity requires deeper institutional integration and continued development of digital enablers. The combination of high-quality online delivery with advanced analytics, data governance, and cybersecurity is essential for translating digital maturity into long-term fiscal sustainability.

However, the analysis of the dynamics of tax revenues as a share of GDP shows a more complex picture (Table 2). The analysis of the tax revenues indicator as a share of gross domestic product allows us to assess the fiscal mobilization of the state in an aggregated dimension and trace its relationship with the processes of digital transformation. The study uses the World Bank indicator Tax revenue (% of GDP), which is based on the IMF Government Finance Statistics data and reflects mandatory unpaid tax payments to the state (excluding most social contributions), which is important for correct international comparison.

Table 2

Tax revenue (% of GDP)

Year	Estonia	Georgia	Lithuania	Poland	Ukraine
2016	21.7	23.0	17.1	16.2	19.6
2017	20.9	23.0	16.8	16.7	20.1
2018	20.8	22.0	16.8	17.2	20.1
2019	21.1	22.9	20.1	17.1	19.2

Year	Estonia	Georgia	Lithuania	Poland	Ukraine
2020	20.7	21.2	20.5	17.3	19.2
2021	21.7	21.5	21.3	19.0	19.1
2022	21.1	22.9	21.3	17.1	16.7
2023	21.3	23.6	21.4	18.0	17.5
2024	n.d.	24.3	n.d.	n.d.	21.0

Source: compiled by the authors based on [16].

In 2016–2021, Ukraine’s tax revenue share fluctuated around 19–20% of GDP: 19.6% in 2016, 20.1% in 2017–2018, 19.2% in 2019–2020, and 19.1% in 2021. This relative stability indicates a well-established revenue mobilization model with moderate elasticity to cyclical fluctuations. Compared to the sample countries, Ukraine’s pre-war level was lower than Estonia’s (over 21% of GDP) and Georgia’s (around 21–23% of GDP), but comparable to Poland’s and lower than Lithuania’s in the years after 2019. Thus, until 2022, Ukraine was in the “middle range” of fiscal mobilization among Central and Eastern European countries.

A structural break occurs in 2022, when the indicator drops to 16.7% of GDP. This drop is the largest for the entire analyzed period and is directly related to the wartime shock: production cuts, business relocation, infrastructure destruction, wartime tax benefits, and the general transformation of the economic structure. It is important to emphasize that this decline occurred despite digital services continuing to function and even expand. This means that in the short term, the macroeconomic shock prevails over the institutional effects of digitalization.

In 2023, the indicator recovered to 17.5% of GDP and increased to 21.0% in 2024. Two years after the lowest value in the analyzed period, the tax-revenue ratio therefore returned to and exceeded its pre-war level. The increase of 4.3 percentage points from the 2022 minimum is consistent with the restoration of the tax base and improved revenue mobilization, although the aggregate indicator does not allow the contribution of tax administration to be isolated. In the 2023 comparison, Ukraine remained below Estonia (21.3%) and Georgia (23.6%), but the gap narrowed further in 2024. The increase should not be interpreted as a direct effect of digital reforms. Tax revenue as a share of GDP is influenced by the structure of the economy, tax-policy changes, economic recovery, and other macroeconomic factors. Digital transformation nevertheless provides institutional infrastructure that can facilitate revenue mobilization after a shock. Electronic reporting, online communication with taxpayers, registry integration, procedural automation, and risk analytics can reduce administrative costs and revenue losses associated with the shadow economy when conventional control mechanisms are constrained by wartime conditions.

Comparison with other countries shows that states with a high level of digital maturity exhibit a more stable trajectory of the indicator, even during periods of global crisis. For example, in Estonia, the value remained within a narrow corridor of 20.7–21.7% of GDP during 2016–2023, reflecting the structural stability of the tax system. In the Ukrainian case, volatility in 2022–2024 is significantly higher, but the speed of recovery can be considered an indicator of institutional adaptability. Thus, the dynamics of the tax revenue-to-GDP ratio in 2016–2024 demonstrate three key phases: pre-war stability, wartime decline, and post-shock recovery exceeding the previous level. In the context of the study, this allows us to draw a cautious but well-founded conclusion: the digitalization of

public services does not eliminate macroeconomic risks, but it enhances the state's institutional capacity to more quickly restore fiscal mobilization after deep shocks. It is this ability to restore, rather than the absolute level of the indicator, that is a key element of fiscal sustainability in war and post-war reconstruction.

An important result is also the assessment of cyber resilience. In the context of the digitalization of key public services, cybersecurity ceases to be a purely technical issue and becomes a component of fiscal sustainability. The growth of online transactions across tax administration, customs procedures, social payments, and registration services means that cyber incidents can directly affect budget revenues, the timeliness of payments, and the cost of infrastructure restoration. Therefore, the analysis of the dynamics of the Global Cybersecurity Index (GCI) (Table 3) should be considered not as an auxiliary, but as an integrated element of assessing fiscal risks.

Table 3

Global Cybersecurity Index (GCI)

Country	2020	2024	Δ 2020-2024
Estonia	99.48	95.04	-4.44
Georgia	81.07	91.92	10.85
Lithuania	97.93	92.88	-5.05
Poland	93.86	93.54	-0.32
Ukraine	65.93	83.93	18.00

Source: compiled by the authors based on [17; 18].

Note: The 2024 overall score was calculated as the sum of the five pillar scores. The 2020 and 2024 scores are not fully comparable because the fifth edition of the GCI introduced methodological refinements.

Based on the official ITU editions, Ukraine's GCI score increased from 65.93 in 2020 to 83.93 in 2024, a rise of 18.00 points. Georgia also increased from 81.07 to 91.92 (+10.85). Estonia, Lithuania, and Poland recorded 2024 scores of 95.04, 92.88, and 93.54, respectively. These differences should not be interpreted as pure year-to-year deterioration or improvement because the fifth edition revised the questionnaire, weighting, verification, and presentation of country performance. They nevertheless provide directional evidence of changes in national cybersecurity commitments across editions.

From a fiscal capacity perspective, cyber risk has several dimensions. First, cyber attacks can temporarily disrupt the functioning of tax or customs systems, directly affecting the timeliness of revenue collection. Second, compromising registers or interfering with data can create the risk of erroneous assessments, fraud, or information leakage, undermining payers' trust and potentially stimulating tax evasion. Third, restoring infrastructure after incidents requires additional budgetary expenditures, which in wartime conditions have an opportunity cost.

It is also important to consider that Ukraine is experiencing a simultaneous growth of two processes: a sharp increase in the volume of digital transactions (due to the scaling of electronic services) and an increase in cyber capabilities. This creates the effect of "expanding the risk surface": the more operations are carried out online, the greater the system's potential vulnerability, even with improved protection. Therefore, the increase in GCI by 18 points should be interpreted not as the completion of the process of strengthening security, but as a necessary condition for maintaining the functioning of the digital state in

extreme conditions.

Comparative analysis shows that countries with high GCI values combine developed digital infrastructure with established incident-response mechanisms, a regulatory framework, and inter-agency coordination. In Ukraine, the increase in the reported score, together with its placement in Tier 3 in the 2024 edition, reflects the mobilization of regulatory and organizational resources; however, given the scale of wartime cyberattacks, maintaining the pace of cybersecurity development remains critically important.

In the proposed methodology for assessing the relationship between digitalization and fiscal capacity, cybersecurity acts as a modifier of the effects of digital reforms. High digital maturity, as measured by the EGDI or GTMI, can support revenue mobilization and efficiency gains only when accompanied by sufficient cyber resilience. Otherwise, digitalization may generate additional fiscal risks through incidents, service outages, or data loss.

Thus, the GCI comparison indicates that Ukraine substantially strengthened its reported cybersecurity commitments between the two editions. Given the methodological refinements and the continuing gap with Tier 1 countries, cybersecurity should be integrated into fiscal-capacity assessment as a permanent risk factor and a key area of public investment.

An analysis of the scale of electronic government service use indicates a high penetration of digital channels. In 2025, 59% of Ukrainian citizens used government e-services [19]. By March 2026, the Diia ecosystem had reached 24 million users and provided more than 77 services in the application [20]. This scale creates a basis for reducing transaction costs, shortening the time required to obtain administrative decisions, and improving voluntary compliance. Even small reductions in per-transaction costs can translate into substantial aggregate savings. Overall, the digitalization of public services in Ukraine progressed rapidly and reached a high level of international comparability, while its fiscal contribution remains primarily indirect, through administrative continuity, transparency, cost reduction, and institutional resilience.

Thus, the empirical results are consistent with the hypothesis that the digitalization of key public services contributes to state fiscal capacity during wartime and post-war reconstruction through a set of institutional, behavioral, and resilience mechanisms rather than through a direct and immediate fiscal effect.

The findings of this study contribute to the ongoing academic debate on whether digital transformation of public administration translates into measurable fiscal outcomes. While previous literature has generally identified a positive association between e-government development and tax revenues, it has also emphasized the difficulty of isolating causal effects [9; 10]. The results obtained in this article both confirm and nuance these conclusions.

First, the empirical dynamics for Ukraine demonstrate that rapid growth in digital maturity (as reflected in EGDI and GTMI indicators) does not automatically lead to an immediate increase in tax revenues as a share of GDP. In 2022, despite continued progress in digitalization, tax revenues fell sharply due to war-related macroeconomic shocks. This confirms the thesis that digitalization is not a substitute for macroeconomic stability, nor does it immunize the fiscal system against exogenous shocks. In other words, digital maturity is a necessary but not sufficient condition for fiscal sustainability.

However, the post-shock recovery observed in 2023–2024 provides evidence consistent with the institutional-channel hypothesis. The restoration and subsequent exceeding of the pre-war tax revenue-to-GDP ratio suggest that digitalized administrative

infrastructure may enhance the fiscal system's adaptive capacity. Electronic reporting, automated risk analytics, digital customs procedures, and integrated registries reduce transaction costs and support continuity of revenue mobilization under territorial disruption and population displacement. Digitalization therefore appears to function as a resilience multiplier rather than as a direct revenue generator.

Second, the structural decomposition using the GovTech Maturity Index offers additional insight. Ukraine's exceptionally high Public Service Delivery Index (PSDI) indicates strong front-office digitalization, yet the comparatively lower scores in core government systems and GovTech enablers suggest that back-office integration remains a limiting factor. This distinction is crucial for fiscal interpretation. While user-facing digital services improve accessibility and compliance convenience, sustainable fiscal gains depend on deep data integration, interoperability of registers, and advanced analytics. Without these institutional components, digitalization risks remaining service-oriented rather than fiscally transformative.

Third, the inclusion of the Global Cybersecurity Index introduces a risk-adjusted perspective that is often absent in conventional e-government studies. Ukraine's higher 2024 score and its placement in Tier 3 indicate stronger reported cybersecurity commitments than in the 2020 edition. However, because the fifth edition changed the questionnaire, weights, verification procedures, and tier presentation, the score difference should be interpreted cautiously. The substantive conclusion remains that digital maturity can contribute to fiscal capacity only when supported by adequate cyber protection; otherwise, digitalization may increase systemic vulnerability and fiscal exposure.

From a comparative perspective, the trajectories of Estonia, Lithuania, and Poland illustrate a different pattern. In these countries, high and stable digital maturity coexists with relatively stable tax revenue shares. In contrast, Ukraine exhibits higher volatility but also stronger post-shock recovery dynamics. This suggests that in transitional or crisis-affected economies, digitalization plays a more visible role in facilitating fiscal rebound, whereas in mature systems its effect is embedded in long-term structural stability.

The results also highlight important methodological implications. Aggregate fiscal indicators such as tax revenue (% of GDP) are influenced by multiple macroeconomic variables, including GDP contraction, tax policy changes, and external financial assistance. Therefore, attributing fiscal improvements solely to digital reforms would be analytically incorrect. A more precise evaluation requires micro-level administrative data (tax gap measures, compliance rates, processing times, administrative cost ratios) and quasi-experimental approaches capable of isolating reform effects. The hybrid framework proposed in this study – combining digital maturity indices, fiscal aggregates, and cybersecurity indicators – should therefore be viewed as an intermediate analytical step rather than a definitive causal model.

In the context of war and post-war reconstruction, the discussion acquires an additional strategic dimension. Digitalization reduces physical dependency on administrative infrastructure, enables remote service delivery, and supports continuity of fiscal operations during territorial disruptions. At the same time, it requires sustained investment in cybersecurity, data governance, and institutional integration. The Ukrainian case demonstrates that digital public services can remain operational under extreme conditions, but long-term fiscal dividends will depend on synchronizing service expansion with analytical capacity and cyber resilience.

Overall, the discussion is consistent with the central hypothesis of the article: digital public services support state fiscal capacity primarily through institutional, behavioral, and

resilience channels rather than through immediate mechanical increases in revenue. The relationship is indirect, cumulative, and conditional on complementary institutional factors. In crisis contexts, digitalization can strengthen adaptive recovery capacity; in stable contexts, it can support structural fiscal discipline. Future research should therefore identify measurable intermediate mechanisms linking digital-service use to compliance behavior and revenue efficiency, particularly through panel econometric models and administrative microdata.

Thus, digital transformation should be conceptualized not as a fiscal end in itself, but as an institutional infrastructure that enables the state to mobilize resources more effectively, transparently, and resiliently in both wartime and post-war reconstruction periods.

Conclusions. This study set out to assess whether and through which mechanisms the digitalization of key public services contributes to the fiscal capacity of the state under wartime shocks and during post-war reconstruction. The empirical analysis, based on a hybrid methodological framework combining digital maturity indices (EGDI, GTMI), a macro-fiscal indicator (tax revenue as a share of GDP), and a cybersecurity indicator (GCI), allows several grounded conclusions to be drawn.

First, Ukraine has demonstrated one of the highest rates of digital transformation among the selected comparative countries during 2018–2024. The steady increase in EGDI values and the high GTMI score, particularly the near-maximum level of digital public service delivery, indicate that digitalization in Ukraine has evolved from isolated initiatives to a systemic, scalable architecture of public service provision. Importantly, this trajectory was maintained even under conditions of full-scale war, indicating institutional continuity and adaptability.

Second, the relationship between digitalization and fiscal capacity is indirect and mediated by institutional and behavioral channels. The decline in tax revenues as a share of GDP in 2022 demonstrates that digital maturity does not neutralize macroeconomic shocks. However, the relatively rapid recovery of the indicator in 2023–2024, culminating in a return to and exceeding the pre-war level, suggests that digitalized administrative infrastructure enhances the fiscal system's resilience and adaptive capacity. Electronic reporting, integrated registries, automated procedures, and online interaction with taxpayers reduce transaction costs, improve compliance conditions, and facilitate faster restoration of revenue mobilization after systemic shocks.

Third, structural analysis using the GovTech Maturity Index shows that front-office digitalization (public service delivery) in Ukraine is highly developed, while deeper integration of core government systems and digital enablers remains an area for further strengthening. For fiscal sustainability, the latter components are crucial, as they underpin risk-based analytics, tax gap management, interagency data exchange, and evidence-based decision-making. Therefore, the long-term fiscal effect of digitalization depends not only on service availability but on the depth of institutional integration.

Fourth, cybersecurity emerges as a critical modifier of the digitalization–fiscal capacity relationship. Ukraine's 2024 GCI profile indicates stronger cybersecurity commitments and institutional resilience in the face of hybrid threats, although direct comparison with the 2020 score requires caution because of methodological changes between editions. Investments in cybersecurity, data protection, and incident response should therefore be treated as integral components of fiscal policy in a digital state.

Overall, the findings are consistent with the central hypothesis of the article: digital public services support state fiscal capacity not through automatic revenue growth but by

strengthening institutional resilience, administrative efficiency, transparency, and continuity of operations. Under wartime conditions, digitalization functions as stabilizing infrastructure that helps the state maintain and restore fiscal mobilization despite physical and economic disruption. During post-war reconstruction, it can provide an institutional foundation for sustainable revenue mobilization, efficient expenditure management, and trust-based interaction among the state, citizens, and businesses.

At the same time, several limitations should be acknowledged. The use of aggregated macro indicators does not allow for precise causal identification of digital reform effects. Future research should incorporate micro-level administrative data, tax gap estimates, compliance behavior metrics, and econometric modeling techniques capable of isolating reform impacts from macroeconomic and policy shocks.

In conclusion, digital transformation should be conceptualized as a strategic component of fiscal capacity building. For Ukraine, the continued synchronization of digital service expansion with institutional integration, analytical capability, and cybersecurity development will be decisive for converting digital maturity into long-term fiscal sustainability in both wartime and post-war contexts.

Reference:

1. Ivashova, L. M., & Parubchak, I. O. (2023). Formuvannia fiskalnoi kultury v umovakh tsyfrovizatsii ta yii rol v detinizatsii ekonomiky [Formation of fiscal culture in the conditions of digitalization and its role in detinization of the economy]. *Publichne upravlinnia ta mytne administruvannia*, 4(39), 33–42. <https://doi.org/10.32782/2310-9653-2023-4.6>
2. Demchyshak, N. B., & Tykhonka, U. T. (2021). Vplyv fiskalnoi detsentralizatsii na napovniuvannist mistsevykh biudzhativ v Ukraini v umovakh rozvytku terytorialnykh hromad ta tsyfrovizatsii derzhavnykh posluh [The impact of fiscal decentralization on the filling of local budgets in Ukraine in the context of the development of territorial communities and the digitalization of public services]. *Ekonomika ta derzhava*, 6, 52–57. <https://doi.org/10.32702/2306-6806.2021.6.52>
3. United Nations Department of Economic and Social Affairs. (n.d.). *UN E-Government Knowledgebase*. Retrieved March 6, 2026, from <https://publicadministration.un.org/egovkb>
4. Balaji, K. (2025). E-government and E-governance: Driving Digital Transformation in Public Administration. In K. Wongmahesak, J. Ahmad, & A. Mustanir (Eds.), *Public governance practices in the age of AI* (pp. 23–44). IGI Global Scientific Publishing. <https://doi.org/10.4018/979-8-3693-9286-7.ch002>
5. Kawabata, M. K., & Camargo, A. S., Jr. (2023). E-Government Innovation initiatives in Public Administration: A systematic Literature Review and a Research Agenda. *Administration & Society*, 55(9), 1758–1790. <https://doi.org/10.1177/00953997231185847>
6. Onyango, G., & Karuri-Sebina, G. (2024). CivicTechs and GovTechs: Policy Digitalisation in Perspective. In G. Onyango & G. Karuri-Sebina (Eds.), *Digitalisation and public policy in Africa: GovTech and CivicTech innovations* (pp. 3–20). Palgrave Macmillan. https://doi.org/10.1007/978-3-031-75079-3_1
7. AlMurtadha, Y. (2024). AI prediction model to investigate the GovTech Maturity Index (GTMI) indicators for assessing governments' readiness for digital transformation. *Journal of Applied Data Sciences*, 5(4), 1838–1849. <https://doi.org/10.47738/jads.v5i4.373>
8. Belahouaoui, R., & Attak, E. H. (2024). Digital taxation, artificial intelligence and

Tax Administration 3.0: Improving tax compliance behavior—A systematic literature review using textometry (2016–2023). *Accounting Research Journal*, 37(2), 172–191. <https://doi.org/10.1108/ARJ-12-2023-0372>

9. Zídková, H., Arltová, M., & Josková, K. (2024). Does the level of e-government affect value-added tax collection? A study conducted among the European Union Member States. *Policy & Internet*, 16(3), 567–587. <https://doi.org/10.1002/poi3.389>

10. Novik, N., Popova, O., Matiashvili, T., Garces, A. D., & Nam, S. H. (2025, March 19). Data insights on tax digitalization: Why direct e-payments matter. *World Bank Blogs*. <https://blogs.worldbank.org/en/opendata/data-insights-on-tax-digitalization--why-direct-e-payments-matte>

11. Bassey, E., Mulligan, E., & Ojo, A. (2022). A conceptual framework for digital tax administration: A systematic review. *Government Information Quarterly*, 39(4), Article 101754. <https://doi.org/10.1016/j.giq.2022.101754>

12. Shah, M. A., Ujan, M. H., & Solangi, M. R. (2025). Impact of Digital Technologies Enhancing Transparency and Reducing Corruption in Government Institutions. *Advance Social Science Archive Journal*, 4(2), 231–239. <https://assajournal.com/index.php/36/article/view/946>

13. Sanni, O. (2025). Digital Taxation and Cybersecurity: Opportunities and Threats. *World Journal of Advanced Research and Reviews*, 28(2), 1096–1106. <https://doi.org/10.30574/wjarr.2025.28.2.3832>

14. World Bank. (2022). *GovTech dataset (October 2022)* [Data set]. World Bank Data Catalog. <https://datacatalog.worldbank.org/search/dataset/0037889/govtech-dataset>

15. World Bank. (2025). *GovTech dataset (December 2025)* [Data set]. World Bank Data Catalog. <https://datacatalog.worldbank.org/search/dataset/0037889/govtech-dataset>

16. World Bank. (n.d.). *Tax revenue (% of GDP)* [Data file]. World Development Indicators. Retrieved March 1, 2026, from <https://databank.worldbank.org/reports.aspx?country=UKR&series=GC.TAX.TOTL.GD.ZS&source=2>

17. International Telecommunication Union. (2021). *Global Cybersecurity Index 2020*. <https://www.itu.int/epublications/publication/D-STR-GCI.01-2021-HTML-E>

18. International Telecommunication Union. (2024). *Global Cybersecurity Index 2024* (5th ed.). <https://www.itu.int/epublications/publication/global-cybersecurity-index-2024>

19. United Nations Development Programme. (2026, January 23). *59% ukrayintsiv korystuiutsia derzhavnymy e-posluhamy – doslidzhennia PROON [59% of Ukrainians use government e-services – UNDP study]*. <https://www.undp.org/uk/ukraine/press-releases/59-ukrayintsiv-korystuyutsya-derzhavnymy-e-posluhamy-doslidzhennya-proon>

20. Ministry of Digital Transformation of Ukraine. (2026, March 16). *Vzhe 24 miliony ukrayintsiv obraly Diiu: Derzhavni posluhy v kilka klikiv [Twenty-four million Ukrainians have chosen Diia: Government services in a few clicks]*. Diia. <https://diia.gov.ua/news/vzhe-24-miliony-ukrayintsiv-obraly-diiu-derzhavni-posluhy-v-kilka-klikiv>

Acknowledgment: The study was conducted within the framework of the project No. 0126U000544 "GovTech for Ukraine: A Digital, Secure, Transparent, and Equitable State in Times of War and Post-War Reconstruction", funded by the Ministry of Education and Science of Ukraine.

Дата надходження статті: 06.08.2026

Дата прийняття статті: 27.08.2026

Дата публікації статті: 30.09.2026