

E-governance and Corruption Perception: Global Insights and Ukraine's Context During War and Displacement

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Abstract

This study explores the intricate relationship between e-governance and corruption perception using the E-Government Development Index (EGDI) and Corruption Perceptions Index (CPI) data. Ukraine's legal landscape is examined, highlighting efforts to enhance public administration transparency. This study underscores the role of citizens in fostering e-governance and reducing corruption and crime. Comparative analyses challenge assumptions about income and e-governance, while “smart grids” and digitalization emerge as solutions to energy challenges in Ukraine. Ultimately, this study illuminates the transformative potential of e-governance and its significance in modern governance paradigms during wartime and in situations involving a large number of displaced people.

Keywords: Public Administration, Transparency, E-Government Development Index, Corruption Perceptions Index, Anti-Corruption, Cybersecurity, Legislative Reforms, Smart Grids.

Introduction

The integration of digital technologies into governance, energy systems, and economic activities has become a transformative force in an increasingly interconnected world. With its emphasis on transparency, efficiency, and citizen engagement, e-governance has gained prominence as a catalyst for reform. Simultaneously, the digitalization of the energy sector holds promise for enhanced efficiency, sustainability, and resilience. Amid these advancements, corruption's shadow looms, emphasizing the need to explore its intersection with digital endeavours.

This study investigates the intricate relationship between e-governance, energy digitalization, and corruption crimes, using Ukraine as a case study. By leveraging the E-Government Development Index (EGDI) as a measure of e-governance implementation and the Corruption Perceptions Index (CPI) to gauge

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corruption levels, authors delve into the impact of digitalization on transparency, efficiency, and anti-corruption efforts. Furthermore, authors examined Ukraine's legislative landscape, wartime role, and postwar recovery strategies in the context of e-governance and energy digitalization. This study highlights the potential of digital justice to drive efficiency, transparency, and progress in Ukraine's public administration and energy sectors.

The implementation of electronic governance has been extensively discussed in both academic and political circles. However, the digitalization of public administration and services continues to be a relevant issue that requires constant improvement (Radzikhovskiy, 2022). The definition of e-government remains controversial, with some researchers I. Lindgren et al. (2021) arguing that it is essential to define what the term covers before implementing it at the state level. However, others believe that the goal this type of public administration should achieve is primary and not its definition.

Based on an analysis of examples from Switzerland and the Netherlands, B. Klievink et al. (2017) concluded that the implementation, direction, and emphasis of e-government could have different vectors in countries with different government systems. In countries with a federal system, the development of the national data infrastructure is implemented separately by the subjects of the federation, in parallel with the state's efforts. By contrast, in countries with a unitary system, priority tasks are set by the state. Nevertheless, positive practices should be thoroughly studied and implemented regardless of the state system.

Cooperation among institutions is crucial for the successful implementation of e-government, as demonstrated in Switzerland (Neuroni et al., 2011). In federal countries, involving public organizations, the scientific community, and other subjects capable of contributing to the achievement of the goal is essential. The exchange of ideas, information, and achievements between cantons is crucial to accelerate the process and reduce federal budget costs. The influence of non-governmental organizations is also critical, and this area requires more research attention. Switzerland, as a federal country, faces fundamental problems with the introduction of electronic governance due to the lack of coordination between cantons, as proposed in a study (Fraefel et al., 2013). This study highlights the need to introduce state coordination along with a definition of the main priorities of electronic governance. This study is fundamentally important for further research on coordination in developing countries.

The interests of citizens and their basic needs should be prioritized when introducing electronic services, although the underlying issues are complex (Patergiannaki & Pollalis, 2021). S. Malodia et al. (2021) are exploring all aspects of successful e-government, including how the political and economic situation in

a country affects the digitalization of society. They also raise questions about whether the different attitudes of society members toward violating their privacy restrain implementation.

Privacy concerns have been raised by some scientists, as violations of privacy can lead to manipulation, fraud and crime (Agozie & Tugberk, 2021; Bayaga, 2021; Mavriki & Karyda, 2022). Possible decreases in confidentiality are subject to criticism, which may threaten democracy. Access to electronic services for migrants, internally displaced persons, and persons with low-income levels is extremely important, as emphasized in a study relevant to Ukraine during the war (Brantly & Brantly, 2023; Martin-Shields et al., 2021). This study prompts further research into the functioning of e-governance during military operations.

The transparency of public bodies has a significant positive effect on the level of perception of corruption in a country, as shown in several studies (Blikhar et al., 2022a; Cifuentes-Faura, 2022; Elbahnasawy, 2021). The problem of the shadow economy is very painful for Ukraine (Blikhar et al., 2022b). Therefore, it is relevant to analyse the positive impact of data transparency on the reduction of unaccounted taxes, illegal employment, and illegal businesses. The introduction of e-governance in developing countries is hindered by the lack of political will of the authorities, low digital literacy of the population, and limited financial resources (Alhassan, 2022; Garad & Qamari, 2021; Karma et al., 2022). Papers by O. Skydan et al. (2022; 2023), M. Abubakr and K. Tugberk (2021), and O. Obolenskyi and V. Ohorodnyk (2021) compare the e-governance of developing countries with that of economically successful and stable countries, enabling the authors to find suggestions for applying successful experiences. Unfortunately, there is a lack of research on the impact of public attitudes toward corruption on e-governance performance.

To perform the analysis, the R programming language was employed for sequential data processing and statistical analyses of both EGDI and CPI data. A question has been raised as to whether it is worth implementing electronic services in Ukraine during times of war. There is an opinion that budgetary funds should not be allocated for purposes other than the military. To address this, the impact of the EGDI on the CPI was investigated.

The methodology included visual data analysis, normality tests (Shapiro-Wilk, Anderson-Darling), and the application of the Kendall coefficient to investigate the relationships between the variables. The subsequent sections explore various aspects of e-governance in Ukraine. Recent legislative developments related to e-governance reflecting the government's commitment to transparency, efficiency, and accessibility to public administration were examined.

Furthermore, this study delves into the role of e-governance as a catalyst for reforms, highlighting the pivotal role of electronic services and collaborative efforts among government entities and international partners.

Empirical and comparative analysis of international data

The EGDI is an important integrated indicator that has been calculated by the United Nations Department of Economic and Social Affairs since 2001, with the first rating appearing in 2003. It is evaluated once every two years and assesses the main achievements of countries worldwide in implementing electronic governance. This report is unique in that it assesses the state of e-government development in all UN member states and serves as a tool for decision-makers to identify their e-government strengths and challenges, guide e-government policies and strategies, and highlight new e-government trends, challenges, and innovative practices, as well as opportunities for e-government development. The EGDI comprises three generalized indices: the online services, telecommunications infrastructure, and human capital indices, with all components having equal weights. The Online Services Index (OSI) measures the government's ability and willingness to provide services and communicate with its citizens electronically, whereas the communication infrastructure index measures the existing infrastructure that citizens require to participate in e-government. Finally, the Human Capital Index (HCI) measures citizens' ability to use e-government services.

Having analysed the results of the research conducted to determine the value of EGDI in 2020, authors note that European countries are the leaders in the digitalization of public services and e-government (Table 1). So, out of the 25 first places in the ranking of countries with the highest EGDI value in 2020, 16 are European countries. Among the countries with the best EGDI rating, authors note Denmark, Estonia, Finland, Sweden, Great Britain, and others (United Nations, 2023).

Table 1. EGDI analysis countries in Europe with the highest rating and Ukraine

Country/Indicator	EGDI Rank, 2020	OSI, 2020	HCI, 2020	TII, 2020	EGDI, 2022	EGDI, 2020	EGDI, 2018
Denmark	1	0.9706	0.9588	0.9979	0.9717	0.9758	0.915
Estonia	3	0.9941	0.9266	0.9212	0.9393	0.9473	0.8486
Finland	4	0.9706	0.9549	0.9101	0.9533	0.9452	0.8815
Sweden	6	0.9000	0.9471	0.9625	0.9410	0.9365	0.8882
UK	7	0.9588	0.9292	0.9195	0.9138	0.9358	0.8999

Iceland	12	0.7941	0.9525	0.9838	0.9410	0.9101	0.8757
Norway	13	0.8765	0.9392	0.9034	0.8879	0.9064	0.8557
Austria	15	0.9471	0.9032	0.8240	0.8801	0.8914	0.8301
Switzerland	16	0.8294	0.8946	0.9482	0.8752	0.8907	0.852
Spain	17	0.8882	0.8989	0.8531	0.8842	0.8801	0.8415
France	19	0.8824	0.8612	0.8719	0.8832	0.8718	0.879
Lithuania	20	0.8529	0.9218	0.8249	0.8745	0.8665	0.7534
Malta	22	0.8118	0.8290	0.9232	0.8943	0.8547	0.8011
Slovenia	23	0.8529	0.9256	0.7853	0.8781	0.8546	0.7714
Poland	24	0.8588	0.9001	0.8005	0.8437	0.8531	0.7926
Germany	25	0.7353	0.9362	0.8856	0.8770	0.8524	0.8765
Ukraine	69	0.6824	0.8591	0.5942	0.8029	0.7119	0.6165

Note: TII – Telecommunications Infrastructure Index.

At the same time, in addition to European countries, some of the best results are also shown by individual representatives of the Asian region, America, and Oceania. South Korea ranks second in the ranking with an EGDI value of 0.96 (which is only 0.02 lower than Denmark), Australia in 4th place (EGDI 0.94), New Zealand and the USA in 5th place (EGDI 0.93), Singapore in 6th place (EGDI 0.92), and Japan in 8th place (EGDI 0.9).

The analysis of the individual components of the integrated EGDI showed that some countries are characterized by the highest Online Service Index values (in particular, Estonia, Finland, Great Britain, Austria, and France). The value of the HCI is crucial for Norway, Spain, Lithuania, Slovenia, Poland, and Germany. The highest values of the TII were typical for Denmark, Sweden, Iceland, Switzerland, and Malta.

As for Ukraine's place in the ranking, according to the results of the 2020 EGDI study, it ranks 69th in the ranking with an EGDI value of 0.7119. At the same time, compared with 2018, the EGDI value increased by 0.0954 (which corresponded to the 82nd place in the 2018 ranking) (Figure 1).

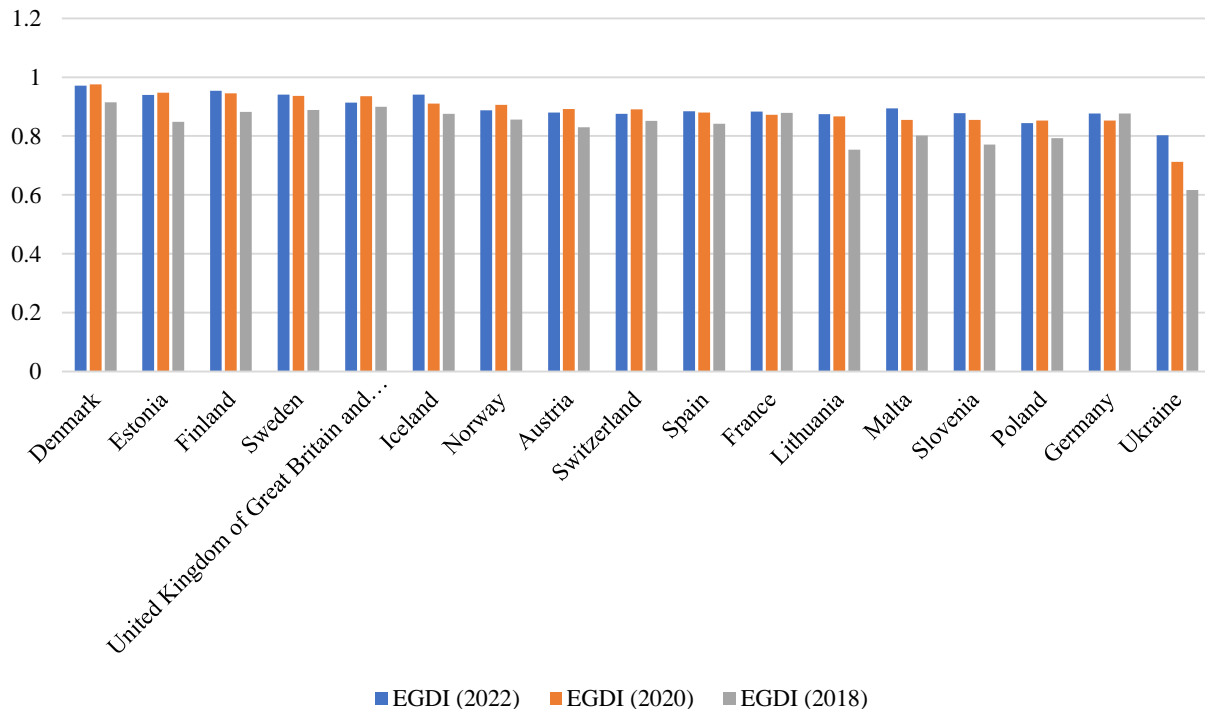


Figure 1. Comparison of EGDI index in European countries in 2022, 2020, 2018

Simultaneously, the value of the integrated EGDI in 2020 for all leading European countries had positive dynamics (except for France and Germany, which saw a drop in the EGDI value). Therefore, authors can witness the significant attention of developed countries in Europe, which are among the 25 countries with the highest EGDI ratings, to improving the quality of electronic public services.

Comparing the values of the EGDI in different regions of the world, authors can conclude that e-governance and digitization were the most widely implemented in European countries (the average value of the EGDI for 2020 was 0.82). E-government is also widespread in some Asian countries (the average value of EGDI for 2020 is 0.64) and the United States (the average value of EGDI for 2020 is 0.63). The worst situation is with the digitization and implementation of electronic services in the public administration of African countries (the average value of the EGDI for 2020 is 0.39). The African continent has the greatest prospects for the active introduction of digital technologies and services. At the same time, the average value of EGDI for 2020 for all analysed countries is 0.6, which is 0.05 more than the average value of EGDI for 2018.

In general, the states pay more attention to the annual provision of digital services. A positive achievement in the digitalization of public authority can be considered an introduction to many countries of the world at the state, regional, and local levels of a wide list of electronic services for various categories of citizens (elderly people, young people, women, persons with disabilities, and migrants), which are united on an online platform (Meduna, 2023). Another positive development (especially typical of Ukraine) was the use of an online platform for public procurement (the Prozorro system) and the open publication of public service recruitment announcements. This approach allows to avoid corruption (because all data are open for analysis and bring guilt to justice) and ensures the implementation of equal conditions for all participants in market relations. Figure 2 shows Ukraine's EGDI for 2012-2022.

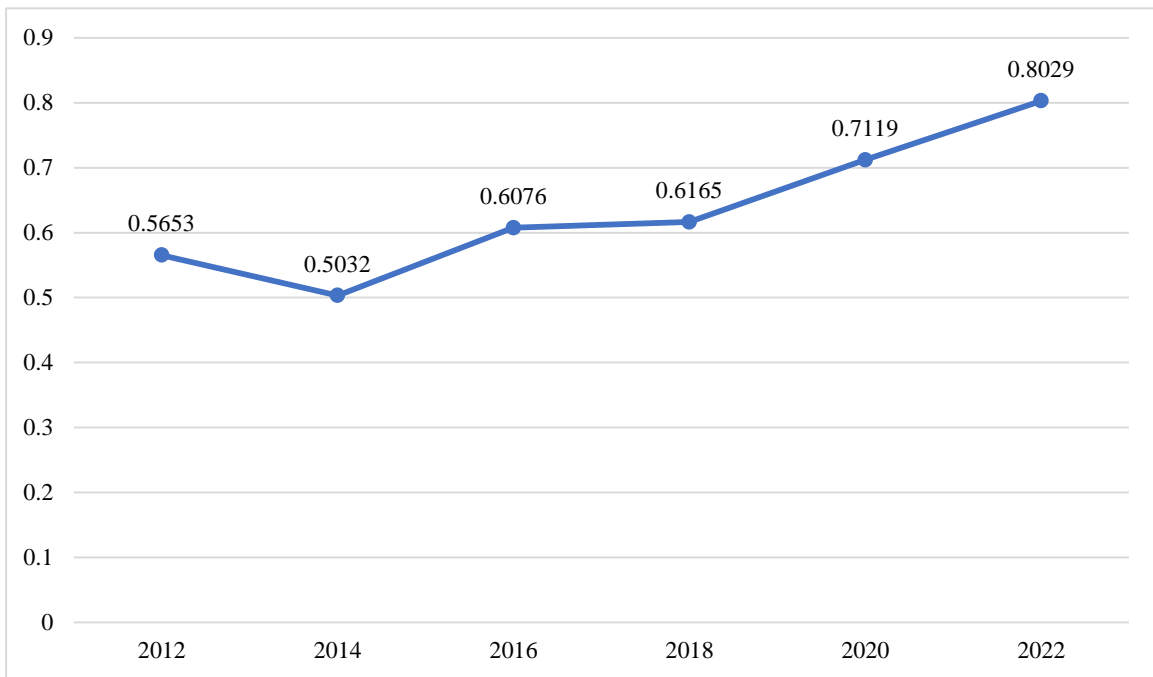


Figure 2. EGDI index of Ukraine for 2012-2022

The CPI was developed annually by Transparency International (2023) to demonstrate the level of corruption in countries worldwide. The evaluation was based on the assessments of businessmen and analysts. An index of 100 indicates no corruption. Level 0 indicates extreme corruption.

We analysed Ukraine's CPI for 2012-2020 to determine its impact on EGDI. Figure 3 presents the CPI for the same period. The analysis of Figures 2

and 3 demonstrates that there are similar trends in the CPI and EGDI in Ukraine, which generally indicates that reducing corruption, decoupling society from the bureaucracy, and implementing e-government are highly connected.

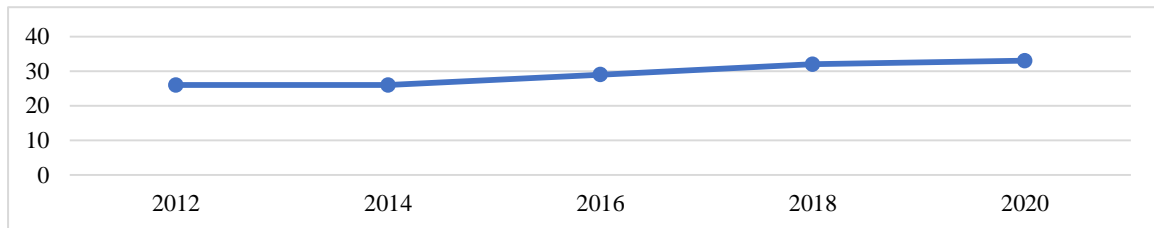


Figure 3. CPI of Ukraine for 2012-2020

According to Transparency International (2023), among the neighbours, Ukraine is still higher only than Russia; the aggressor neighbour also lost 1 point and now ranks 136th in the list with 29 points. In addition, the scores for Hungary decreased by 43 points (-1 point, 73rd place). Moreover, this year Belarus lost as much as 6 points and, with 41 points, ranks 82nd. Poland has not changed its performance and has remained the leader among its neighbours – 56 points and 42nd place, respectively. However, Slovakia managed to improve its scores over the year: 52 points (+3, 56th place), Romania: 45 points (+1, 66th place), and Moldova: 36 points (+2, 105th place).

Ukraine’s loss of one point was a decrease within the error margin. However, given the 10-year retrospective, this indicator indicates a “stagnation” in the fight against corruption over the past three years. This is despite several positive changes that strengthened the anti-corruption ecosystem. The main reason for the sagging scores is that many important anti-corruption tasks are on hold or even regressing. Last year, there were repeated attempts to reverse negative practices, which may continue until 2022 (UN E-Government Knowledgebase, n.d.).

It is important to highlight those additional confirmatory tests were conducted to validate the objectivity of the visual analysis. Specifically, analytical tests for the normality of data distribution, such as the Shapiro-Wilk test and Anderson-Darling tests, were conducted. These tests confirmed the absence of a normal distribution. The results of these tests are listed in Table 2.

Table 2. The results of the normality analysis of the CPI data for the period from 2014 to 2022

Year	Shapiro-Wilk	Anderson-	Histogram
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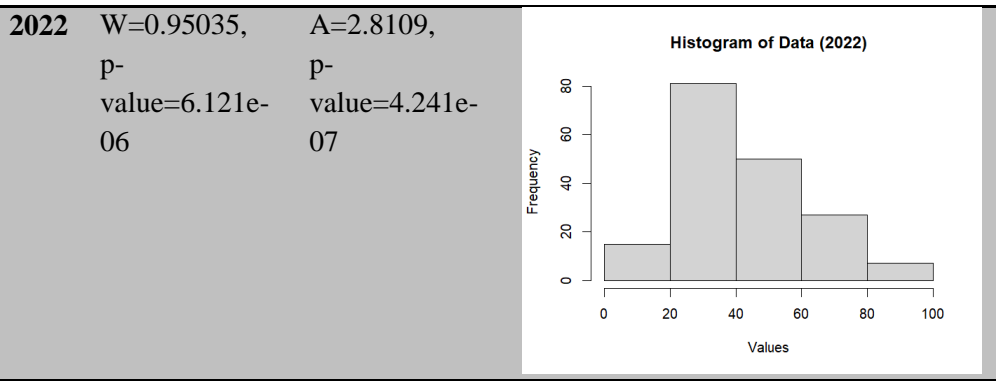
normality test Darling normality test

2014	W=0.94331, p-value=2.095e-06	A=3.4692, p-value=1.049e-08	
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2016	W=0.94537, p-value=2.782e-06	A=3.2001, p-value=4.748e-08	
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2018	W=0.94709, p-value=3.111e-06	A=3.0983, p-value=8.424e-08	
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2020	W=0.95174, p-value=8.225e-06	A=2.5841, p-value=1.521e-06	
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A normality analysis revealed that the distribution was not normal. This prevents the application of the Pearson coefficient to assess the correlation between these indicators and necessitates the use of nonparametric approaches. This led to the conclusion that the Kendall coefficient should be employed to further investigate the relationships between the variables.

The mean CPI indicator values for all the participating countries were calculated for 2012, 2014, 2016, 2018, 2020, and 2022. The correlation between CPI and EGDI for the same periods showed a value of -0.2, indicating the absence of a correlation. Subsequently, a hypothesis was formulated that the implementation of e-governance influences the CPI indicator during the first year, which was used for the analysis. The impact of e-document circulation implementation on the CPI was examined with a lag of one period, in this case – one year. The Spearman’s correlation supported this hypothesis, showing a positive relationship with a coefficient of 0.8 (Figure 4).

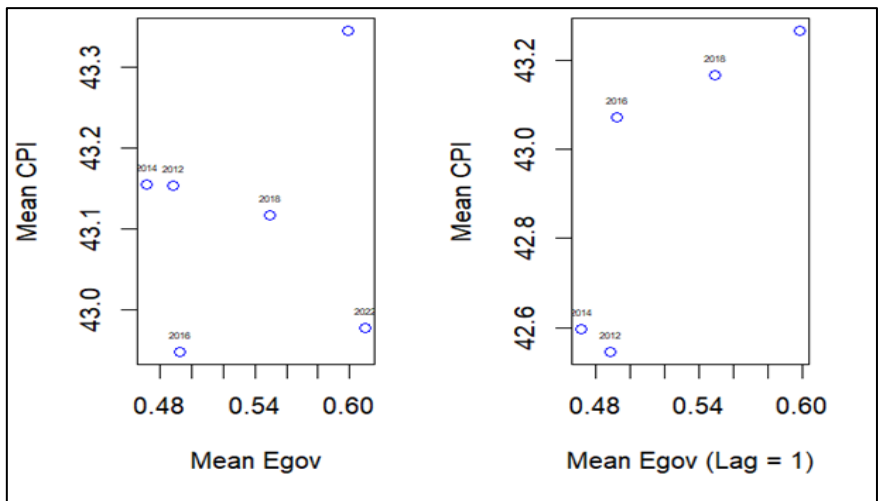


Figure 4. The impact of the EGDI on the CPI

This result suggests that the implementation of e-document circulation systems can contribute to the reduction of corruption within a year after their introduction. However, it should be noted that correlation does not imply causation, and there may be other factors influencing the level of corruption. Nevertheless, the findings are encouraging and point to the potential benefits of e-governance in combating corruption (Cherniei et al., 2022).

E-governance in Ukraine in the context of modern challenges

The development of e-governance is a top priority in Ukraine's public administration system reform. This is crucial for increasing the country's competitiveness and investment attractiveness and for effective public administration in modern conditions. It also helps to reduce corruption. Along with the digitization of the public sector, it is also essential for local authorities to implement digital technologies.

The Law of Ukraine No. 2614-IX "On the National Register of Emissions and Transfers of Pollutants" (2022), defines the legal and organizational principles for the creation and operation of the National Register of Emissions and Transfers of Pollutants. This is to ensure public access to complete, consistent, and reliable data on emissions, transfers of pollutants, and waste. A single, unified electronic system was created to provide information about the state of the environment to the authorities and to provide every citizen with access to such information. The aim is to increase the effectiveness of electronic governance in the field of environmental protection (Ladychenko et al., 2020).

According to the Law of Ukraine No. 1444-IX "On Amendments to Certain Legislative Acts of Ukraine Regarding the Sale of Land Plots and Acquisition of the Right to Use Them Through Electronic Auctions" (2023), the introduction of land auctions is expected to lead to increased competition and significantly increase revenue for the state and local budgets. The creation, operation, and information interaction of the state, community, and other registers and information systems are essential in Ukraine today. A single transparent public information environment simplifies and debureaucratizes the processes of public administration, protects the rights of individuals and legal entities, and satisfies the informational needs of civil society.

The adoption of the Law of Ukraine No. 1907-IX "On Public Electronic Registers" (2023) is positive. This law regulates the legal, organizational, and financial basis for the creation and functioning of public electronic registers. This protects the rights and interests of individuals and legal entities during the creation, storage, processing, and use of information in public electronic registers.

Communal services in local municipalities are often low-quality. The implementation of a smart city consortium is designed to solve complex city problems, such as managing social, economic, transport, environmental, and other spheres. Plans for the development and approval of the smart city concept project by the government, which will become a signpost for communities, are being discussed at the joint request of public organizations, businesses, and state and municipal bodies. However, there is currently no definition of a Smart City, what steps need to be taken, or what documents need to be adopted to make a territorial community truly smart. It is essential to consider that many market solutions do not always provide a comprehensive approach and management based on data.

In light of the global trend towards open data, Ukraine has demonstrated significant achievements in exchanging over 5,000 electronic documents between government structures daily. E-governance projects are implemented through the collaboration of all state authorities, local self-governments, and international partners. E-governance is considered a key factor in Ukraine's reforms, as high rates of transformation in various spheres are impossible without the application of digital technology.

One of the priority tasks in recent years has been the introduction of over 100 electronic services that meet the needs of businesses and citizens and minimize corruption risks. As a result, the government portal, which serves as a "single window" for access to all online services, already provides 118 electronic services, including socially important services such as childbirth assistance registration, business registration, land registration, and construction services.

In Ukraine, the first fully automated service was introduced, decisions on which were made without the participation of officials, namely, the start of construction work for class CC1. In the future, the range of such services should be expanded. It should be noted that the philosophy of electronic service development is also being transformed. The State Agency for E-Governance of Ukraine (2019) will not only create new electronic services but also optimize them, considering life and business situations. The result of the first project, which has already been actively worked on by many departments, will be the "e-baby" electronic service, which will combine nine administrative services.

Ensuring more widespread use of electronic services will contribute to the dissemination of accessible and reliable means of electronic identification, in particular the mobile identification service for Ukrainians. Hence, all electronic services introduced by default allow logging using MobileID. The adaptation of Ukrainian legislation to digitalization processes is of great importance for accelerating the pace of e-governance implementation. An important step in this direction was the adoption of a resolution by the Cabinet of Ministers (n.d.) that

provided for the implementation of the digital-by-default principle. According to this principle, in all government acts, the default method for implementing the process described in the document is electronic. To achieve this goal, the government's regulatory acts require digital expertise.

Another significant activity in the field of e-government is the implementation of electronic documents by government bodies. Currently, approximately 5,400 electronic documents are exchanged daily in the system. Future plans include connecting at least 300 new subscribers to the system, primarily at the expense of local self-government bodies, particularly newly established, united territorial communities. Ukraine is actively implementing e-government projects and developing e-services to meet the needs of its citizens and businesses. The implementation of digital technologies and cooperation with international partners have contributed to achieving high transformation rates in various spheres of public administration, which is positively reflected in Ukraine's progress in crime detection and reforms (Cherniavskyi et al., 2021).

During this year, the state authorities gradually transitioned to the European standard for electronic documents, which was approved at the end of the previous year. This will help ensure international compatibility and uniformity of the requirements for electronic documents in public administration. A system for approving draft regulations in electronic form has been developed and tested. The system tracks the progress of acts and builds relevant analytics for employees of the Cabinet of the Ministers' Secretariat. Implementing such a system will optimize the decision-making process and improve the efficiency of state-body activities.

The Trembita electronic interaction system for state electronic information resources has received an expert conclusion from the State Special Communications Service, which indicates that the system components comply with information security requirements (State Agency for E-Governance of Ukraine, 2019). The implementation of Trembita has already begun, and the integration of state authorities' information resources into the system is currently underway. The top priority of the State Agency for Electronic Governance is to connect priority registers to Trembita, including the registers of the Ministry of Justice, Ministry of Social Policy, Pension Fund, State Fiscal Service, and Ministry of Internal Affairs.

Considering all the aforementioned directions, it can be concluded that Ukraine is actively developing and implementing e-government at various levels of public administration. This includes the implementation of the Digital by Default principle, adaptation of the legal and regulatory framework, transition to the European standard for electronic documents, and the introduction of electronic

document circulation. All of these measures will contribute to improving the quality of public services and increasing citizens' trust in government authorities.

Wartime conditions are complex for any country as they involve the establishment of a special regime that differs from the usual regime. In these circumstances, e-government plays an important role, as it enables rapid and efficient communication between authorities and the population, as well as the coordination of actions by government structures.

One of the main advantages of e-government is that it provides rapid and efficient communication between authorities and citizens. During wartime, this is especially important, as citizens must be able to receive information about the current situation and the necessary measures taken by the authorities. E-government allows the posting of information on the current situation, the order of actions for citizens, and contact information for assistance on the official websites of government structures. In addition, e-government provides an opportunity to coordinate actions between government structures. Wartime conditions require a rapid response from governments to ongoing events. The electronic system allows interaction between different departments, services, and other government structures, enabling quick decision-making and timely responses to events (E-governance is the..., 2023).

Thus, e-government during wartime played an important role in ensuring rapid and effective communication between authorities and the population, as well as the coordination of actions between different government structures. At the same time, e-government enables remote access to information and resources, reducing the risks to national security. However, during wartime, e-governments could also become targets for cyberattacks and other cyber threats. Therefore, government structures must ensure the reliable protection of information and data from such threats using modern technologies and developments in the field of cybersecurity. Moreover, e-government can ensure the availability of electronic services for citizens in war zones or those who have limited access to the traditional methods of obtaining necessary information and services. Government structures should ensure the availability of electronic services and resources for all citizens, regardless of their geographical location.

For the effective use of e-government during wartime, proper infrastructure and well-trained personnel are necessary. Government structures must provide an adequate level of technical support, ensure uninterrupted operation of the system, and prepare personnel responsible for the operation of the electronic system. E-government will play a crucial role in Ukraine's post-war reconstruction process, contributing to the country's recovery at multiple levels. The implementation of e-government ensures greater transparency and efficiency in government activities

and facilitates control over the use of state resources and budget funds, particularly in infrastructure reconstruction and social services. E-government allows residents of a country to access various government services without the need to visit institutions personally, which is especially relevant for the population living in post-war reconstruction zones, where access to branches of government services may be limited. E-government can facilitate cooperation between Ukraine and other countries in the field of post-war reconstruction, providing for the exchange of experience, resources, and technologies as well as the joint implementation of projects within the framework of international assistance.

The implementation of e-government contributed to the creation of new jobs and the development of information and communication technologies, which became important factors in Ukraine's economic growth after the war. This stimulates the development of the local IT industry and innovation, which can contribute to a faster recovery of the national economy. Considering the above-mentioned aspects, e-government is one of the key factors in the successful post-war reconstruction of Ukraine. In 2023, as part of e-government development, the digitization of priority sectors of the economy and social life is planned. The focus is on urban planning, customs, social protection, judicial systems, tax systems, healthcare, state registration, notary services, and land relations (Buil et al., 2015; Kasianenko et al., 2020). The digitization of these sectors is an important prerequisite for the successful postwar recovery of the country and the rational use of international financial assistance, as it contributes to increasing the efficiency and transparency of public administration, ensuring citizens' prompt access to necessary services, and stimulating innovative development and international cooperation.

Development of “smart grids” and digitalization of the energy sector in Ukraine

Full-scale military aggression by Russia has revealed that the centralization and imbalance of the Ukrainian energy system are among the objectives of military aggression. Energy infrastructure facilities are consistently targeted by aggressors' cyber forces. Military aggression in Ukraine triggered a global and European energy crisis, compelling European countries to accelerate the implementation of energy independence through the use of unstable renewable energy sources and decentralization. This necessitates maximum automation in energy sector management, forecasting peaks, and demand management, as well as protecting consumer information, as they will be integrated into Europe's unified energy system (Nurtazina et al., 2015).

In March 2022, Ukraine joined the ENTSO-E, requiring the country to implement advanced systems to protect cross-border flows and flexibly balance generation and demand. The lack of a real energy system balance was recognized as a threat to national security in November 2021 (The NSDC of Ukraine..., 2021). The Energy Strategy of Ukraine for the period up to 2035: Security, Energy Efficiency, Competitiveness' defines that the development of digital and intelligent technologies and their penetration into all aspects of human life will enhance energy stability and improve service quality for the population (Order of the Cabinet..., 2022)

Digital tools play a leading role in the development of collective self-consumption schemes and energy communities encompassing communities, villages, or towns. They enable consumers to unite and collectively scale their potential interactions with the electric power systems. For instance, these schemes could allow communities to better track their internal energy consumption and participate in shared energy usage or energy trading within investment projects, potentially making them less dependent on the high electricity prices set in the wholesale market (Doronina & Kryshtof, 2020).

Digital inclusion must ensure that the most vulnerable citizens, the underprivileged, and those living in remote regions have access to new digital technologies and tools as well as the benefits of energy system digitalization. To protect consumer rights and monitor consumption, digitalization will help consumers integrate into the energy service market and control their energy usage. They provide services to transmission system operators in the balancing or aggregator markets. The implementation of electronic databases and digital real-time energy production controls will support the implementation of energy origin guarantees, allowing consumers to choose "green" energy consumption. As the number of energy market participants increases, the collection of personal data requires the development of database protection and autonomous critical infrastructure management systems.

As the technological transition progresses from analogy to digital technologies, the latter will make energy systems more interconnected, intelligent, efficient, reliable, and resilient over the next few decades. With the development of such applications, the level of intelligence will increase owing to precise data on individual and collective energy consumption obtained from "smart" household devices, plugs, meters, and other intelligent monitoring and measuring devices, as well as the implementation of artificial intelligence.

Also, the Order of the Cabinet of Ministers of Ukraine No. 908-r "On Approval of the Concept for the Implementation of Smart Grids in Ukraine until 2035". (2022) was adopted. The goal of the concept and the action plan for its

implementation set the framework for introducing modern technologies into the Ukrainian electric power industry, including the reconstruction and restoration of energy infrastructure after the destruction caused by the Russian aggressor.

Traditional approaches for designing power grids are based on determining the location of large centralized production complexes and the geographic distribution of generating resources. Power grids are designed and optimized according to regional or national needs. Initially, this was to provide mutual support between countries and regions during emergencies and to facilitate trade between states. The prerequisites for implementing “smart grids” were created primarily through the implementation of national regulations and methodologies for assessing the cybersecurity status of power grids in Ukraine. The implementation of a pilot project called the “smart city”, based on the assets of economic entities (operators of energy storage facilities, transmission system operators, distribution system operators, electricity producers), with subsequent dissemination of positive experiences, plays an important role. During the reconstruction of Ukraine’s power complex, the following measures are worth considering: focusing on the user; considering the need for renovation and innovation of power grids; promoting distributed generation and renewable energy sources; improving regulatory aspects of development; and facilitating the harmonization of policy and regulatory frameworks within the context of European Union integration.

The expected outcomes of implementing this concept include increased energy efficiency, leading to reduced losses in the electric grids of transmission and distribution system operators, improved load management efficiency, and a reduction in carbon emissions (an expected reduction in energy technological costs of at least 30% by 2030). This means providing consumers with the opportunity to manage electricity consumption, reduce energy costs, and save without compromising their lifestyle or excessively limiting electricity consumption to satisfy their household needs. An important factor in implementing this concept is enhancing the transparency of the system, which is achieved through the Energy Transparency Index.

Index-2022 was calculated after the full-scale invasion of Russian forces on February 24, 2022, and covers 228 indicators grouped into eight categories based on specific regulatory requirements. This year’s edition of the index includes new indicators based on provisions of the Clean Energy Package, the current framework rules for energy markets in the EU. Notably, indicators of energy security and supply reliability, pricing, consumer protection, and efficiency of state governance were added, and the content and basis of all index indicators were updated based on current EU legislation. The assessment within the Index is

the result of processing data from open sources about the functioning and development of the energy sector in the chain “from producer to consumer”. The final score for Ukraine, based on the assessment conducted in 2022, was 39 out of 100 possible points, which was the lowest score in the past five years.

Conclusions

This study provides significant insights into the relationships among electronic governance, criminal corruption perception, and various governance indices. Highly developed countries occupying prominent positions on the global stage have achieved commendable scores on the EGDI for 2020. An examination of Ukraine's legal framework revealed a concerted effort by the government to positively impact e-governance through legislative measures, ultimately leading to improved EGDI ratings. These measures signify a strong commitment to enhancing the transparency of public services.

An in-depth analysis of the EGDI data underscores the prowess of Europe and other nations in the e-government realm. The OSI, TII, and HCI are pivotal components of the EGDI, underscoring the worldwide drive for electronic public services and robust infrastructure development. However, existing data emphasize that the population yearns for greater transparency from public authorities to improve their quality of life and the calibre of public services. Citizens' active engagement in e-governance development is integral, whereas a negative stance towards corruption crimes serves as a catalyst for positive change.

This study employs rigorous data analysis to illuminate the interplay between e-government and corruption perceptions, revealing the potential positive impact of e-government on reducing corruption and crime. In conclusion, the empirical analyses conducted in this study revealed intricate connections between e-government implementation, corruption perceptions, and governance metrics. The findings highlight diverse countries' advancements in bolstering e-governance, offering invaluable insights for policymakers and stakeholders as they chart pathways to efficient and transparent governance. Further, the mathematical analysis unequivocally showed a notably robust influence of e-governance implementation on the CPI, signifying a favourable effect on curbing corruption. This underscores the imperative to persist with electronic governance reforms, particularly during wars.

The CPI assessment offers a snapshot of Ukraine's stance on corruption perception. Despite encountering challenges, the country has pursued its anti-corruption endeavours. However, recent trends have indicated a plateau. The juxtaposition of the EGDI data from Ukraine with nations excelling in e-governance implementation reveals a nuanced picture. This dispels the notion of a

direct correlation between a country's income level and the digitization of public services and e-government implementation. Notably, each country's e-governance implementation has improved, with electronic services effectively catering to citizens, including retirees, immigrants, and low-income families.

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