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Article in *International Journal of Public Administration* · February 2024

DOI: 10.1080/01900692.2024.2316128

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To cite this article: Victor I. Espinosa & Antonia Pino (16 Feb 2024): E-Government as a Development Strategy: The Case of Estonia, International Journal of Public Administration, DOI: [10.1080/01900692.2024.2316128](https://doi.org/10.1080/01900692.2024.2316128)

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E-Government as a Development Strategy: The Case of Estonia

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ABSTRACT

This paper examines the role of e-government (EG) in fostering economic transition and development, focusing on the Estonian case. Positioned as a development strategy, EG utilizes information and communication technologies in the public sector to enhance competitiveness and well-being. Drawing from Weberian bureaucracy, it highlights two crucial institutions: secure property rights and governance rules emphasizing transparency, trust, and security (TTS). These institutions offer a comprehensive perspective on the positive impacts of EG. The paper suggests strategies for optimizing these effects, concluding with recommendations for EG implementation and proposing avenues for further research in developing country contexts.

KEYWORDS

Estonia; institutions; development; e-government

Introduction

Amid the knowledge society with increasingly complex social changes, in 2022, Estonia became the first transition economy to join the 20 leading countries in e-government (EG) evolution and digital competitiveness (Breaugh et al., 2023; Troitiño, 2023). After embracing EG as a long-term development strategy in 1998 with a real GDP per capita lower than the Latin American average, Estonia reached the threshold of developed countries such as Greece and Portugal in 2022 (doubling the Latin American average) by proactively applying information and communication technologies (ICT) to increase economic growth and development (Boltho, 2020; Szentmihályi, 2023).

EG consists of “digitalising and automating public administration through ICT as an integral part of governments” modernization strategies to create public value in more sustainable and resilient societies (Cordella & Bonina, 2012; Meynhardt, 2009; Twizeyimana & Andersson, 2019). Like other developing countries transitioning from a centrally planned to a free market economy, Estonia faced a lack of trust and transparency in public administration, insecurity in public data management, low productivity, and persistent poverty and inequality. Changes in governance rules allowed Estonia to build EG with majority support from citizens, thus overcoming these difficulties (Gërzhani & Cichocki, 2023; Tarko, 2020). However, EG creates new opportunities and risks. What are the effects of EG as a development strategy for transition economies?

Using Estonia as a case study, this paper builds a theoretical framework to explore how EG as a development strategy facilitates economic transition.¹ Then, two essential institutions of the EG are identified to achieve a Weberian standard (Boettke, 2018). The first is that property rights institutions facilitate entrepreneurship and capital accumulation (physical and human) as the primary objective to promote long-term economic growth and development.² The second is EG based on transparency, trust and security (TTS). ICTs, such as artificial intelligence, blockchain, machine learning, and the internet of things, promoted TTS-based EG conducive to the partnership flawed by a forward-thinking government, proactive entrepreneurs and NGOs, and a dynamic tech-savvy population. Therefore, the economic transition’s success depends on the cultural change toward private property institutions and TTS as the public value of conducting peaceful social cooperation (Espinosa et al., 2021; Redford, 2020; Zhang & Kimathi, 2022).

Two related concerns arise from this approach to property rights institutions with a TTS-based EG. First, as in many transition economies, anti-market policies generated economic and social crisis in Estonia (Mitchell et al., 2023). Second, a market policy consensus can be critical to achieving a successful EG adaptation in a post-COVID crisis world by accelerating the digitalization of public services (Castañeda, 2021). A deductive methodology that begins with a theoretical claim is applied to the case of Estonia. It examines its

validity concerning emerging and formative data based on processes and outcomes. International EG indices, official documents, government practices, and socioeconomic data are examined to assess whether this evidence shows a likely positive outcome of the EG development strategy consistent with theory.

The paper is structured as follows. [Section 2](#) reviews the literature on EG. [Section 3.1](#) situates private property institutions in post-Soviet Estonia in the 1990s. [Section 3.2](#) identifies the relevance of EG and blockchain as a development strategy. [Section 3.3](#) describes how Estonia's strategy works. [Section 4](#) assesses Estonia's policy lessons regarding the risks and challenges of implementing the EG in other transition economies. Finally, [Section 5](#) concludes with recommendations on EG and further research avenues in other developing country contexts.

Literature review

In economic development literature, developing countries' transition consists of the economic process and changes to a market economy. It investigates its effects on firms, industries, production, trade, employment, state agencies, institutions' growth, and development (Acs et al., 2018; Espinosa, 2023). The emphasis is the institutional change that facilitates the emergence of innovation (i.e., knowledge creation and human learning) and its dissemination in society (i.e., the sharing of experience-based knowledge across generations) (Foss et al., 2019; Potts, 2007).

A successful transition depends on two institutions. First, property rights institutions facilitate the emergence and dissemination of innovation through entrepreneurship and capital accumulation, resulting in a widening range of solutions to increasingly complex human problems (Bylund & Packard, 2022; Espinosa et al., 2021). Second, governance rules based on transparency, trust, and security (TTS) as public values prevent social dilemmas and economic and social decline. The question is how and why ICT can strengthen private property institutions and how these changes impact economic transition and development. ICT in public administration (PA), linked to organizational change and new skills, can improve public services and democratic processes toward the Weberian standard (Fountain, 2004, 2014; Tolbert & Mossberger, 2006).

An Inter-American Development Bank paper of 2022 noted that embracing ICT accelerates development. However, it has been partial in developing countries for different reasons, including the use of paper continues to reign in public administration; many

bureaucrats and pressure groups resist ICT for fear of losing their jobs and privileges; many institutions operate as they did in the last century; many governments provide e-services with uneven quality and limited use (Cubo et al., 2022). Adopting the ICT approach aims for a transversal paradigm shift that includes all sectors of society and all levels of government: how public resources are managed, how it is communicated, and how public service is accessed. The digital transition depends mainly on the central government's actions because no other actor can establish a regulatory framework, provide joint services, and bring together all segments of society (Zhang & Kimathi, 2022). On the one hand, governments need ICT to respond to the pressures of fiscal austerity and the gap in expectations among citizens. On the other hand, the economy requires technology and the Internet to bring more efficiency, transparency and trust to interactions and transactions, both public and private.

Fugini et al. (2014) and Carter et al. (2022) stress that e-government (EG) based on ICT can increase citizen satisfaction by providing more efficient and effective services. First, open data policies allow citizens to access information efficiently through digital platforms. Second, the availability of detailed and up-to-date information promotes accountability because the EG becomes more susceptible to citizen oversight. Third, digital platforms offer channels for citizen participation in the decision-making process. Online surveys, discussion forums and electronic consultations allow greater participation in the formation of public policies. Fourth, EG facilitates direct communication between the government and citizens. Fifth, EG can improve efficiency by simplifying and streamlining government processes. It implies a significant reduction of time and money in the public and private sectors, allowing investment in more services and improvements for citizens. In public finances, EG can help free up public resources to reduce deficit spending and taxes (Piano & Salter, 2021). Sixth, cybersecurity contributes to trust by protecting citizens' sensitive information. In short, these reasons show how the EG can create a more transparent and participatory environment, increasing citizens' trust in the security of government institutions.

[Figure 1](#) shows the TTS-based EG virtuous circle.³ The theoretical and empirical studies show that EG success should address transparency, trust, and security to build a robust and positive relationship with citizens in the digital environment (Cucciniello & Nasi, 2014; Kim & Lee, 2012). Transparency depends on the openness and accessibility of government information. It contributes to accountability by allowing citizens to evaluate government activities. When information is

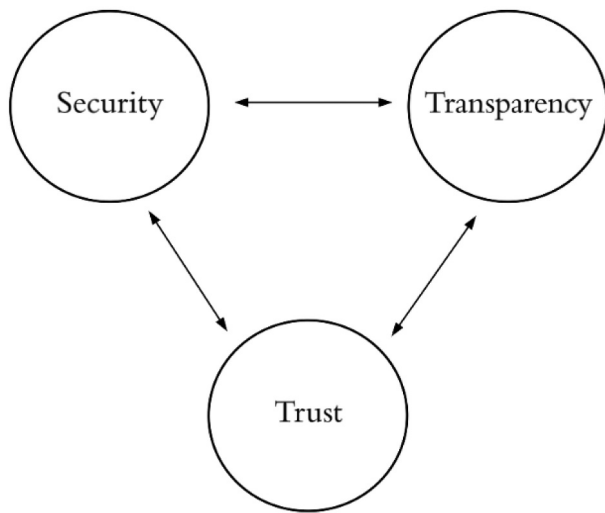


Figure 1. The TTS-based EG virtuous triangle. Source: Own elaboration.

easily accessible, corruption is reduced, and citizen participation is encouraged. Furthermore, trust is built when citizens perceive that the government is transparent, accountable, and competent in managing information and e-services. Trust is also linked to personal data protection. Citizens should feel confident with the government through digital platforms if handled securely and ethically. Regarding security, the systems, data, and e-services should be protected with mechanisms against cyber threats and attacks. Ensuring security is essential to protect information integrity, confidentiality, and availability. An adequate security infrastructure directly contributes to transparency and trust between citizens and government online platforms. When users trust that their data is secure, they are more likely to use e-services and engage in online interactions with the government (D'Hauwers et al., 2020; Grimmelikhuijsen, 2012).

In terms of EG cybersecurity risks, it is suggested that ICT, like blockchain, provides speed, security, and exchange transparency. Blockchain is an emerging technology based on “self-sovereign identity” that allows trust between different parties that do not know each other (both the public administration and citizens and firms) through the collection of evidence that pledges the transactions carried out between actors without having to resort to a trusted third party.⁴ Blockchain technology ensures the integrity of the e-services as a colossal database that collects and stores information in a shared and decentralized manner. A unique record generates synchronized copies, making it almost impossible to manipulate the data (Davidson et al., 2018; Ølnes et al., 2017). The decentralized nature of the Blockchain system reduces the chances of it being corrupted by a hacker, making it safe to use. Thus, EG can

strengthen and secure property rights through efficient and effective governance rules where citizens spend their intelligence, time and money on creativity and coordination of innovation in the entrepreneurial market process (Kirzner, 2017).

In terms of the EG implementation, it is suggested that TTS-based EG is more accessible in a small country with a Weberian bureaucracy. However, this claim does not invalidate the benefits of EG (Almarabeh & AbuAli, 2010). Even if it were true, although there is no evidence for it, it could be applied progressively at the regional level. Another concern with EG suggests that it can increase unemployment. However, the economic development literature clarifies that macroeconomic soundness before EG is a *sine qua non* condition to achieve a prosperous economic transition (Acemoglu et al., 2019; Bauer, 2000; Frølund, 2021). Evidence shows that in an economy with monetary and fiscal soundness and private property institutions, a TTS-based EG will rapidly reallocate labor from the public to the private sector (Acs & Szerb, 2007; Fleetwood, 2007).

E-government: Estonia's development strategy

Situating Estonia

Estonia is a country in northeastern Europe that belongs to the European Union (Taylor, 2020). The capital of Estonia is Tallinn, the official language is Estonian, and it is one of the three Baltic republics, with Latvia and Lithuania. It is ethnically and linguistically very close to Finnish. It is limited to the north with the Gulf of Finland and the Baltic Sea, east with Russia and Lake Peipus, south with Latvia, and west with the Baltic Sea again. Estonia has a surface area of 45,226 km², 633 km of borders, 3,794 km of coastline, and around 1.35 million inhabitants.

The tiny Baltic republic freed itself from the Soviet Union in 1918. Three decades later, in 1941, it was invaded by the Wehrmacht, the armed forces of Nazi Germany. In 1944, the Soviet reoccupation of Estonia led it to become one of its republics, establishing the Estonian Soviet Socialist Republic (ESSR) and the communist totalitarian regime (Mitchell et al., 2023). The ESSR was a one-party socialist republic led by the Communist Party of the Estonian Soviet Socialist Republic (CPSSR). The legislative body was the Supreme Soviet, representing the government body directing Estonia's socialist central planning. Extractive institutions were compelled and characterized by concentrating power and resources in the hands of the Supreme Soviet (Acemoglu & Robinson, 2019). Corruption was prevalent as it incentivized the design of laws and rules to maintain and perpetuate the control of the Soviet elite.

Property rights were abolished in 1947 with forced labor as part of the Soviet system, inhibiting economic growth and development by creating an environment where citizens have no incentive to invest, innovate or work hard due to insecurity and legal inequality.

The Estonian economy faced the inefficiency of socialist systems. Without property rights, there can be no market. Without a market, there are no market prices. Without prices, economic calculation (i.e., the guide to coordinate the production and distribution of goods based on the changing needs of others, saving resources through, for example, accounting and expectations) became impossible (Espinosa, 2021; Huerta de Soto, 2024). Hence, the Baltic country experienced economic stagnation, exacerbated by the growth of underground markets, and the economy lagged its Western European counterparts. In 1940, Estonia's standard of living was similar to Finland, its neighbors across the Finnish Bay. In 1990, Finland's Gross Domestic Product (GDP) was \$28,364 per capita with 6% inflation, but Estonia's GDP was \$4,000 per capita with 1000% inflation (after independence, it rose to 10,000%!). The Baltic country had nothing to sell to world markets because it depended on Russia for 92% of its international trade. The ESSR public administration resembled a cumbersome and highly centralized colossus, feared for its power and influence in the Estonians' lives, but ridiculed for its inability to manage public resources efficiently (Klesment, 2009).

Political indoctrination programs, cultural repression and Russification accompanied this process. During the Cold War, the Estonian Soviet Socialist Republic experienced political repression, with arrests and persecutions of dissidents and human rights activists. The new authorities deported more than 100,000 Estonians to be replaced by other ethnic groups, preferably Russians and Belarusians (Taylor, 2020). Nearly 180,000 of the one million inhabitants of the Baltic country at the beginning of the Soviet invasion died due to deportations to inhospitable places, forced labor camps and mass executions. Seventeen percent of the Estonian population died. Widespread poverty and inequality with long lines and empty shops became features of daily life in ESSR, generating frustration and resentment among the citizens toward the Soviet Union.

Since 1986, Gorbachev's openness policies allowed citizens to criticize the Soviet system and increasingly demand Estonia's right to independence. The peak of the protests was the Baltic Way on August 23 1989, a human chain of two million people about 600 km from Tallinn to Vilnius to press for the independence of Estonia, Latvia, and Lithuania in front of television screens worldwide. The independence referendum was

held on March 3, 1991, and was approved by 78.4% of the votes (before the Soviet Union dissolution on December 26, 1991). After 50 years of foreign invasion, Estonia was finally free again on August 20, 1991 (Miljan, 2015).

The first democratic election in decades was held on June 28, 1992, with a referendum to establish a new Constitution based on property rights institutions, marking the beginning of a transition toward a free market economy (Liuhto, 1996). Property rights institutions distribute power and resources more equitably, promoting entrepreneurship and capital accumulation (Acemoglu & Robinson, 2019). The rule of law is essential to guarantee property rights and citizen participation in the economy and political decision-making. Thus, citizens brought the center-right Pro Patria Bloc (a coalition of conservative and liberal parties) to power on September 20, 1992, promising a radical break with the Soviet past through a decisive pro-market reform program. Radical reformer Mart Laar led Estonia's first post-communist government (1992–1994) at 32 years old, laying the foundation for Estonia's rapid economic growth and development in the 1990s.⁵

After establishing property rights institutions, Mart Laar began a development strategy based on macroeconomic soundness through shock therapy. It was essential to be decisive about adopting reforms as quickly as possible and stick with them despite the short-term discomfort they caused because “bitter medicine is easier to take in one dose than in a long series” (Laar, 2008, p. 68). A legitimate consensus to achieve radical reforms was possible through democracy, free and fair elections, and a clear long-term vision to end totalitarianism. Between 1992 and 1994, Laar's government introduced market prices and flat-rate personal income tax, privatizing most national industries in transparent public trends. It abolished tariffs and subsidies to establish a free foreign trade regime and balanced the budget (cutting deficit spending). It created the Estonian kroon (fixed to the German mark) with an autonomous central bank to attain an inflation targeting of 3% and reestablished diplomatic relations with Western countries (Purju, 1995).

A development strategy based on EG and blockchain

The bitter memories of the Soviet public administration required radical reform to restore trust in Estonian bureaucratic institutions. Laar (2008, p. 69) stresses that “the transitional governments tried to start with liberalising the economy, but the reforms were not decisive enough. Estonia set the achievement of macroeconomic soundness as its first primary objective.” It resulted in the

emergence of property rights institutions, followed by a macroeconomic stabilization that started to be seen from 1993 until fully realized in 1999—achieving the inflation target of 3% per year, a budget balance, and the doubling of GDP per capita to \$16,216 (World Bank, 2024). However, more than property rights institutions were required to encourage economic growth and development.

Laar's second objective of his development strategy was a radical public administration reform based on EG to guarantee transparency, trust, and security (TTS). EG as a development strategy, better known as e-Estonia, stems from the experience of digitizing and automating the privatized Estonian banking system services since 1996. The phrase "going to the bank" has disappeared: 99.6% of Estonians prefer online services due to the efficiency in reducing transaction costs (Chavan, 2013). Banks promoted the national electronic identification (eID) card by providing free readers for simple, transparent, and secure transactions. In addition, they partnered with telecommunications companies to offer free courses on computing and the safe use of smart devices for adults throughout Estonia. Accordingly, Estonia has one of the most influential and least corrupt banking systems in the European Union (Kočišová & Stavárek, 2018).

The e-Estonia policy began in 1998 when the parliament adopted the Estonian Information Policy Principles, which were revised and updated in 2006 and 2013. The guiding principle is to empower citizens through digital solutions led by a PA that facilitates economic transition and development (e-Estonia, 2024). It required a forward-thinking government, a proactive ICT sector, and a connected and tech-savvy population. Political consensus promotes innovation through EG of public services, facilitating entrepreneurship and capital accumulation as the pivotal elements of economic growth and development. The structure of e-Estonia involved considering three leading ideas:

- Restructure systems and processes: Eliminate all unnecessary and time-consuming aspects.
- Empower citizens: Allow them to carry out their procedures from the same place in various ways and quickly.
- Minimise bureaucracy: Digital tools allow authentication processes to be faster.

The Ministry of Economic Affairs led these policies, and their implementation in the public sector was decentralized in public-private partnerships (including companies, academia, and NGOs), accompanied by citizens' savvy tech education and training. In 2000, the second

Laar government (1999–2002) declared internet access a fundamental human right by the law, and free Wi-Fi became commonplace in Estonia. Hence, the evolution of e-Estonia has been based on three pillars: electronic national identification (e-ID), X-Road and blockchain.⁶ While X-Road (open-source software that allows the data exchange on a single platform, automatically integrating it in a standardized, transparent, and secure process) ensures the EG's transparency, e-ID encourages trusted access to all e-services and signs documents electronically. Blockchain is a cybersecurity tool to improve trust and transparency in governance rules (Allen et al., 2020).

As Figure 2 shows, the milestones of e-Estonia as a development strategy are the following. In 2000, an e-tax board was inaugurated to declare taxes automatically, and m-parking was introduced to allow drivers to pay for public or private parking using mobile phones. In 2001, X-Road integrated the national public and private services database. In 2002, the e-school web and e-ID were used to access all e-services and digital signatures through a device with an internet connection. Since 2003, e-ID has been used to buy bus tickets and monthly public transport passes. The e-Land Registry contains information about recorded properties. In 2004, the Estonian educational information system allowed to gather information related to education in Estonia. In 2005, I-voting was launched to engage people in the governance process. In 2007, Mobile-ID allowed people to use their mobile phones as a secure form of digital ID, and the e-police system allows officers to access vital security information on a mobile Workstation instantly.

In 2008, the KSI blockchain offered secure connections of e-services while maintaining 100% data privacy, and e-Health system integrated Estonian healthcare data, creating an authoritative record for each patient. In 2010, e-Prescription centralized the digital issuance and management of medical prescriptions. In 2011 and 2012, Smart Grid improved the profitability and sustainability of electricity services and the EV quick-charging network to ensure freedom of movement for electric car drivers. In 2013, X-Road Europe expanded data exchanges in the European Union. In 2014, e-Residency developed transnational digital identification for nonresidents, allowing nonresidents access to all the necessary tools to run a company in Estonia as a gate to the global market. As of 2017, e-Estonia evolved cybersecurity through the data Embassy in Luxembourg and automating e-services with AI to reduce bureaucracy as much as possible (known as the zero-bureaucracy plan). Both notarial procedures have been online since 2020, and the hydrogen-powered automatic public transport plan of 2021 is supported

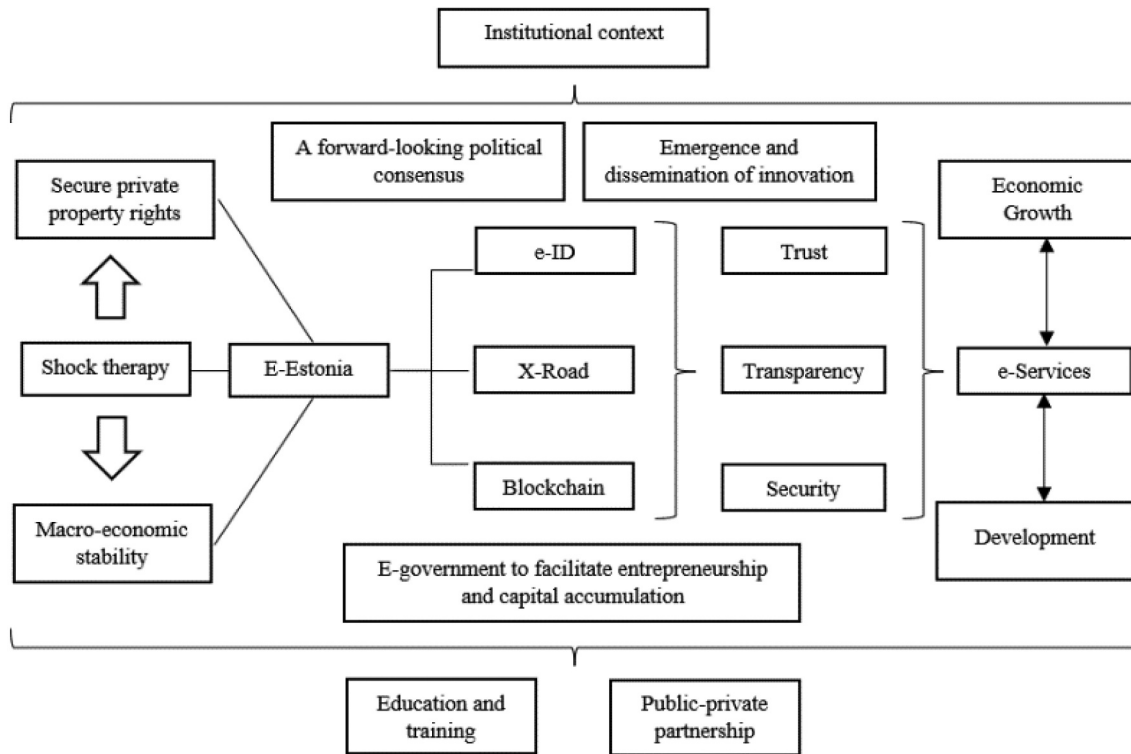


Figure 2. Illustrating Estonia's development strategy: structure and mechanism. Source: Own elaboration from e-Estonia (2024).

by blockchain (Sokolov & Kolosov, 2021). Consequently, 99% of public services are online 24/7, including getting divorced.

Why is blockchain used in e-Estonia to ensure TTS in its development strategy? KSI Blockchain, initially called “hash-linked timestamping,” became the cornerstone of TTS to mitigate threats of internal data manipulation in Estonian records after the 2007 cyberattacks. Blockchain works like a traffic radar that identifies who, how and when attempts have been made to modify digital data immediately and with zero errors, guaranteeing the integrity of data and government systems from corruption and misuse (Kassen, 2022). Blocks of “digital defence dust” are connected and form a chain distributed to millions of computers worldwide. The string instantly reflects all changes that do not match the math code because it leaves a trace in the pattern. The Information Systems Authority (ISA) guarantees access to the blockchain for public administration through the X-Road technological infrastructure.

Effect of introduction of EG in Estonia

This section defines two complementary ways to evaluate whether the e-Estonia performance is consistent with theory. The first is international indices, official documents, and government practices on institutions and EG, and the second is socioeconomic data before

and after e-Estonia. The study here focuses on the TTS-based EG as the public value of e-services for increasing the efficiency and effectiveness of economic transition (Hooda et al., 2022; MacLean & Titah, 2022).

First, the Economic Freedom Index (EFI) is the most internationally recognized measure to evaluate the degree of economic freedom of countries, which the Heritage Foundation and the Wall Street Journal developed (Gwartney & Lawson, 2003; McMahon, 2014). EFI shows that countries with greater economic freedom perform better than repressed countries in socioeconomic data and well-being. It is based on indicators that affect entrepreneurship and capital accumulation, grouped into the security of property rights and the integrity of government (Feldmann, 2017; Hall & Lawson, 2014). The index classifies the economy according to whether it is free, with a score between 80 and 100, mostly free, 70-79.9, moderately free, 60-69.9, mostly not free, 50-59.9, and repressed, 0-49.9.

After Estonia gained independence in 1991, the EFI reports that it applied radical economic reforms, including market liberalization, privatization of public firms, and macroeconomic soundness (Miller et al., 2022). Estonia pursued trade openness in the global economy. Its accession to the European Union in 2004 and the eurozone in 2011 facilitated trade and foreign investment with 58 tax agreements. Implementing TTS-based EG reduced bureaucracy and facilitated the creation and

management of businesses. As e-Estonia (2024) shows, the country established and protected property rights institutions. It adopted a flat tax of 20% on corporate and personal income (0% for reinvested profits), which has helped attract investment and increase economic activity. This highly digitized system led to Estonia having the most competitive tax system in the OECD (Tax Foundation, 2023). Starting a business takes 20 minutes, and a tax declaration takes 3 minutes. As a result, Estonia went from a score of 65 in 1995 (the first year of measurement) to a score of 69 in 1998, when e-Estonia began (an increase of 6%) and reached a score of 78.6 in 2023 (an increase of 20% compared to 1995 and 15% compared to 1998), being the only country in transition to join the ten leading countries in economic freedom worldwide.

The United Nations E-Government Development Index (EGDI) presents the status of UN member states regarding the development of TTS-based EG (United Nations, 2024). Along with assessing website development patterns in a country, the EGDI incorporates access characteristics, such as infrastructure and educational levels, to indicate how a country uses ICT to promote access and inclusion of its people. The EGDI measures three critical e-government dimensions: online service provision, telecommunications connectivity, and human capacity (Doran et al., 2023). Within the 0 to 1 range of EGDI values, countries are grouped into four mathematically defined levels as follows: very high EGDI values range between 0.75 and 1.00 inclusive, high EGDI group values range from 0.50 to 0.7499 inclusive, medium EGDI values range from 0.25 to 0.4999 inclusive, and low EGDI values range from 0.0 to 0.2499 inclusive.

Following the EFI results, the EGDI reports that Estonia positively impacted several aspects, transforming how the government interacts with citizens and manages its operations. Estonia has improved the efficiency of e-services, allowing citizens to execute procedures and access information more quickly and easily through online platforms. Digitalisation and automation reduced bureaucracy and saved time and money for citizens and government institutions. For example, 100% of Estonians have an e-ID for 24/7 access to 99% of online public services. EG saves taxpayers 2% of GDP annually for every 20% of bureaucrats replaced by software, and e-services save 820 years of work per year for the government and citizens by linking thousands of databases. The report also stresses that e-residency attracts foreign talent to its country, either to join startups already established there or to create their own in the country without living in it, accessing to do business both in the European Union and globally through e-services (Tammpuu & Masso, 2019). Entrepreneurs can

open a bank account without physically going to the bank or being in Estonia. More than 20,000 people worldwide apply to this program annually. In 2017, Startup Visa started a project to support non-European Union entrepreneurs growing their startups in Estonia. By 2025, Estonia aims to provide a world-class e-services and business environment for 10 million e-residents.

Consequently, Estonia has Europe's largest per capita unicorn index, stressing TransferWise and Skype. More than 20 companies are created for every 1,000 inhabitants annually, six times more than the European Union average (World Bank, 2024). Estonia is home to 1,452 startups, one of the highest startup rates in the world (e-Estonia, 2024). Thirty-five percent are under 5 years old, employing around 50 thousand people. Approximately 5.9% of workers are hired in the ICT industry, generating over 1,000 million euros in gross income during the last decade.

Since 2005, e-voting has been twenty times cheaper than regular voting and has allowed citizens to vote in elections through secure digital platforms, being preferred by 53% of voters in 2023. This innovation has increased voter turnout and made the voting process more manageable (Ehin et al., 2022). Estonia has also invested significantly in blockchain-based cybersecurity to protect its digital services. Robust security infrastructure is essential to ensure citizen trust and prevent cyber attacks (Semenzin et al., 2022). Thus, e-Estonia efficiency positively influences citizens' quality of life: 80% of e-services users report greater accessibility, saving time and money. It is home to the NATO Cooperative Cyber Defense Center of Excellence (CCDCOE) and the EU Agency for Cybersecurity (ENISA). Estonia has been elected member of the UN Security Council, active since 2020. These transparency, trust and security improvements led Estonia to move the EGDI from 0.5 to 2001 (first year of measurement) to a very high value of 1 in 2022 (ranked eighth globally).

The Digital Competitiveness Index (DCI) from the International Institute for Management Development (IMD) is another leading indicator in TTS-based EG. It evaluates the state's capacity to adopt and explore digital technologies in various sectors. It examines technological infrastructure, adoption, regulation and society's readiness for digital transformation. Consistent with the EFI and EGDI results, the DCI reports that Estonia in 2022 became the first transition economy to join the 20 leading digital competitiveness countries (International Institute for Management Development [IMD], 2024). TTS-based EG helped to reduce direct interaction with officials

and minimize opportunities for corruption. Similarly, participation in international initiatives for good governance standards has strengthened Estonia's position.

The IMD (2024) explains that savvy tech education as human capital accumulation was essential for adopting e-Estonia. It has applied the "e-Estonia at School" project to integrate ICT into education early on. It is based on three pillars: society values education, access is universal and free, and there is broad autonomy for competing educational projects (Mehisto & Kitsing, 2022). It includes teacher training, developing digital materials, and introducing technological classroom tools. The use of mobile devices and digital platforms in schools has been encouraged. Students can access educational resources online, participate in interactive activities, and use digital tools to enhance their learning experience. Also, eKool is an online school management system used in many Estonian schools. It allows parents, students and teachers to access information about academic progress, assignments and other education-related activities. Thus, the Programme for International Student Assessment (known by its acronym, Pisa) ranks Estonia among the top three worldwide, the best education in Europe, and even the best in the West.⁷ The program objective is to measure the ability of 15-year-old students to use their knowledge and skills in reading, mathematics, and science to face real-life challenges, and it ranks seventh worldwide (Programme for International Student Assessment [PISA], 2024).

Second, the indices examined can shed light on Estonia's socioeconomic performance based on the World Bank (2024). Genuine saving is crucial to accumulating physical and human capital by facilitating innovation of an increasingly complex production structure, such as technology, while increasing the supply of loanable funds, reducing interest rates and creating more favorable conditions to access the financial market (Endres & Harper, 2020). As a % of GDP, Estonia's gross savings increased from 24% in 2000 to 31% in 2022, higher than the EU's average saving rate of 23% in 2000 and 25% in 2022. The increase in investment backed by genuine savings explains why Estonia's GDP per capita, PPP (constant 2017 international \$) increased 11-fold between 1990 and 2022, reaching \$37,826 per capita (77% of Finland's GDP per capita and 61% of the United States) and surpassing developed countries such as Portugal (\$35,746) and Greece (\$31,517). It is important to note that 81% of that increase occurred since 1998 (when e-Estonia started), combined with a robust real growth wage of 7% annual average between 2017 and 2022.

Estonia's fiscal deficit was close to 0%, with public spending at 40% as a percentage of GDP between 1995 and 2022 to finance public goods. Estonia's tax system collected 20% more than the OECD average. Public debt as a % of GDP was below 10% between 1995 and 2019, rising to 20% between 2020 and 2022 due to the COVID crisis and returning to the previous situation. In contrast, the average debt of OECD members was 130% of GDP in 2022. This difference is explained theoretically because a tax cut has an arithmetic effect by reducing tax revenue in the short term, such as in Estonia in the 1990s. However, it has a long-term economic effect by positively impacting capital accumulation, production, employment, and the tax base by providing incentives to improve these activities. The opposite also applies (Laffer, 2004).

Estonia's inflation rate averaged 3% per year between 2000 and 2022, with 6% unemployment (as a percentage of the total labor force). These outcomes are similar to the performance of OECD members and two and three times better than the average for Latin America and Africa, respectively. In 2022, the Baltic country reached 2% in absolute poverty (people who cannot meet their basic needs), but 20% of its population is at risk of poverty (people who can earn a good income, but inequality arises from the fact that other people have even higher incomes). Regarding income inequality as measured by the Gini index (0 represents perfect equality, while an index of 100 represents perfect inequality), Estonia has reduced its inequality from 37 in 2003 to 30 in 2022, in line with the average for 25–35 of the OECD and a more egalitarian model of society in wealth than other transition regions, such as Latin America, which averages 50.

Finally, the United Nations Human Development Index (HDI) classifies countries into four groups: low human development (0.0 to 0.556), medium human development (0.557–0.699), high human development (0.700 to 0.800), very high human development (0.801 to 1.0). The higher the ranking of a country, the higher the standard of living and the capabilities of its inhabitants to achieve economic, political, and social development. The HDI ranked Estonia 43rd in 1995. However, Estonia now ranks 31st in 2022 with an HDI of 0.890, higher than the Europe and Central Asia average of 0.796 and even higher than the global average of 0.732 (United Nations Development Programme [UNDP], 2023). The capital of Estonia, Tallinn, received the European Green Capital Award 2023 in recognition of its entrepreneurial innovation for the environmental achievements of the United Nations (UN) Sustainable Development Goals (SDGs) with an emphasis on eradicating poverty, promoting sustainable cities and energy

sustainability, more significant economic growth (European Commission, 2023).

Policy lessons

The Estonian experience with e-government (EG) as a development strategy represents a multi-faceted policy involving numerous challenges and risks. It transcends the mere adoption of new technologies, entailing a profound transformation in how society organizes and interacts with the government. Successfully realizing and managing these changes necessitates technological competencies, strategic vision, and adaptability at both societal and organizational levels. Following Davison et al. (2005), a comprehensive approach to secure the effective and equitable performance of a TTS-based EG, as observed in Estonia, should comprehensively address political, social, economic, technological, and ethical aspects.

Ahn and Bretschneider (2011) emphasize the fundamental role of trust, transparency and security in Estonia's effective political engagement with EG. They stress the need for robust leadership, like Laar's, to foster enduring commitment across all government levels. A well-defined and progressive plan for digitizing and automating PA was imperative to ensure trust and transparency in the e-Estonia development. Regular cost-benefit assessments were critical in Estonia to guarantee long-term sustainability and foster trust in the government's responsible resource allocation. Establishing a responsive regulatory framework in 1998, coupled with continuous innovation through the X-Road, served as the bedrock for the Estonian development strategy.

Citizen engagement in decision-making processes related to e-Estonia was crucial for establishing trust, preventing conflicts, ensuring transparency, and eliciting feedback for ongoing adjustments and improvements to policies and e-services (Fung, 2015). This participatory approach bolstered the public's trust in the government's dedication to their interests. Implementing comprehensive training and digital literacy programs to facilitate this trust-building process was essential, ensuring the population possesses the necessary skills to engage with EG and reap its benefits effectively. Efforts were channeled toward enhancing internet connectivity and accessibility, mainly through developing robust digital infrastructure and providing e-services around the clock. This commitment extended to rural or poor areas. As Brown (2005) argues, e-Estonia can underscore effective governance and contribute to its citizens' sustained trust in EG's evolution as a reliable and inclusive development tool, preventing

redundant efforts and increasing efficient implementation.

Regarding social aspects, Gibreel and Hong (2017) emphasize the significance of fostering trust, transparency, and security in e-Estonia to address access, digital inclusion, and civil rights protection. Achieving equity in access and promoting digital inclusion, mainly by providing affordable digital devices, was crucial in diminishing disparities and building public trust in e-services's commitment to serving their needs fairly. Interactive platforms and digital education were pivotal in encouraging citizen participation, empowering the population to perceive a transparent EG that actively engages with its citizens. Educating the public about the importance of data privacy and the responsible use of personal data in e-Estonia was indispensable in cultivating trust.

Ensuring the protection and privacy of data further strengthened citizens' self-confidence that their interactions with e-services are secure and that their personal information is kept secure. E-Estonia development demonstrated cultural sensitivity to promote inclusivity by respecting the diversity of society and actively involving ethnic and cultural minorities in the design and implementation of e-services (Barbosa et al., 2013). This dedication required making e-services accessible to individuals with disabilities, aligning with web accessibility standards. Clear and straightforward language on digital platforms promoted transparency and enhanced understanding for most users, contributing to a more inclusive and trustworthy digital environment.

In the realm of economic considerations, institutional changes to establish secure property rights were crucial in fostering trust, transparency, and security within the Estonian business environment (Espinosa et al., 2021; Foss et al., 2019). These changes facilitated entrepreneurship and contributed to capital accumulation, instilling trust in a stable economic framework. Such institutional changes promoted local technological development by establishing businesses and job opportunities within the ICT industry. Property rights institutions also fostered public and private sector cooperation, emphasizing transparency and mutual trust. Using EG to automate administrative processes served as a mechanism to reduce operating costs, ultimately enhancing the efficiency of the public sector. It freed up resources for the private sector, supporting the perception of an EG committed to fostering economic growth and development transparently and securely. Encouraging innovation in the technological sector through policies that support research and development contributes to the growth of new technologies in EG, fostering a business environment of trust in EG's

commitment to staying at the forefront of economic freedom and technological advancements.

Furthermore, policies supporting digital entrepreneurship and creating an ecosystem conducive to the emergence and growth of startups were critical for Estonian economic vitality (Acs et al., 2018). Executing policies that fostered e-commerce, reduced legal barriers, and promoted the participation of small and medium-sized businesses enhanced economic efficiency in resource management and supported trust in EG's overall development strategy (Hellmann & Thiele, 2023). It impacted the perception of economic transparency significantly, demonstrating a commitment to creating an open and accountable economic environment.

Janowski (2015) stresses the role of technological aspects in establishing a secure technological infrastructure, a foundation essential for the dependable implementation of widespread e-services. The integration of advanced security measures in e-Estonia has become paramount in safeguarding citizens' data privacy and countering cyber threats, thereby fostering trust in the integrity of digital systems, as West (2005) emphasized. E-Estonia's proactive embrace of emerging technologies, including artificial intelligence, blockchain, and data analytics, was an imperative strategy for augmenting the efficiency and quality of e-services. This promise of innovation reflected a dedication to technological advancement and underscored EG's unwavering commitment to delivering e-services that are secure and progressive. Adherence to open standards also assures interoperability between different systems and platforms, facilitating the seamless integration of services (Gil-Garcia et al., 2018). This collaborative approach underscored a promise of transparency, reflecting a cohesive effort in the public's interest. Prioritising the development of intuitive and user-friendly interfaces ensured that e-services were accessible to everyone, regardless of technological proficiency. This inclusivity further built trust among users, reinforcing the perception of an EG that prioritizes user experience and accessibility.

Ethical aspects in e-Estonia encompassed nondiscrimination policies based on specific technologies and an unwavering promise of technological neutrality (Pakhnenko & Kuan, 2023). It ensured that solutions were fair and equitable, promoting trust in EG's adherence to unbiased and ethical decision-making. Incorporating ethical policies regarding data collection and use, as well as ethical decision-making in artificial intelligence (AI), further strengthened trust in the ethical conduct of EG (Lips, 2019). Transparency in ethical practices, including informed consent and clear explanations of AI algorithms, fostered trust and acceptance

among the public. Similarly, ethical security measures involved digital practices to respect privacy and individual rights, actively avoiding any misuse of information. This commitment to ethical security upheld the e-Estonia integrity standards, contributing to a digital environment built on trust, transparency, and security.

Suppose the Estonian government plans to continue developing EG. In that case, it must address the risks and challenges inherent to any transition economy that require meticulous attention to maximize benefits and minimize adverse effects, as Weerakkody et al. (2015) stated. A primary concern is the digital gap, wherein unequal access to technology and connectivity can lead to the exclusion of specific population segments from e-services. Addressing this issue is paramount, as disparities in digital infrastructure and technological device accessibility may exacerbate the gap, deepening existing inequalities. The limited technological capacity in transition economies poses a substantial obstacle. Establishing EG systems demands robust infrastructure and trained personnel, a resource supply that can need to increase in these regions. Insufficient capacity can result in unstable systems, rendering them susceptible to cyber threats—the need for cybersecurity measures is a critical risk. The digitization of government information increases exposure to potential cyber-attacks, jeopardizing citizen privacy and the integrity of governmental systems.

Distrust and resistance within the population pose significant challenges, driven by concerns about corruption, transparency deficits, and inadequate management that can impede the adoption of e-services. Building public trust is urgent, necessitating governmental efforts to enhance transparency and citizen participation. Thus, privacy concerns arise due to extensive data collection, potentially compromising citizens' privacy rights and fostering mistrust without adequate protection measures. Financial considerations also play a role, with the costs of implementing EG technologies—such as infrastructure, staff training, and maintenance—being substantial and challenging for developing countries (Maharaj & Munyoka, 2019). Ensuring the long-term sustainability of these initiatives is crucial, prompting governments to explore adequate funding and maintenance strategies.

Linking these risks to private property institutions underscores the transformative impact of EG on the interplay between the public and private sectors (Kassen, 2022). The dependency on third-party vendors accentuates the critical necessity for formulating and implementing robust policies and agreements. These measures support the security of government data. As EG initiatives evolve, collaborative efforts between public and private entities become increasingly intricate,

demanding a proactive approach to delineating clear guidelines. Establishing robust policies safeguards against potential breaches and fosters a more transparent, accountable, and resilient ecosystem. The strategic formulation of agreements becomes a linchpin in fortifying the integrity of government data, assuring citizens of the responsible stewardship of their information. By navigating the complex e-governance landscape, these proactive measures mitigate risks and establish a relationship where innovation, efficiency and security merge for both public and private stakeholders.

Addressing educational challenges involves confronting the digital gap and enhancing technological capabilities, emphasizing the importance of widespread investment in education and training. As Evans and Yen (2006) stressed, digital education is decisive in bridging gaps and providing all citizens with the skills necessary to thrive in the digital age. Furthermore, cybersecurity education becomes indispensable to mitigate risks associated with online threats, nurturing a digitally literate and resilient community. Prioritising comprehensive educational strategies empowers individuals to navigate the complexities of the digital landscape, fostering inclusivity and providing a defense against emerging cybersecurity challenges. This approach ensures a well-equipped society ready to embrace the opportunities and address the evolving dynamics of the digital era.

Thus, while transition economies present substantial opportunities to achieve a successful TTS-based EG as a development strategy, it is decisive to consider the associated risks concerning private property institutions and education. The case of Estonia shows a path to establish a robust and equitable foundation for developing e-society in these contexts.

Conclusion

This paper examines the impact of e-government (EG) as a developmental strategy in transition economies, focusing on Estonia's remarkable case. The study delves into the synergy between property rights institutions and transparent, trustworthy, and secure (TTS) digital governance rules, revealing Estonia's progressive shift from traditional to e-government models. The country achieved this transition within 24 years, reaching a developmental threshold. Estonia's journey began with establishing property rights institutions, fostering a market-friendly environment that facilitated entrepreneurship and capital accumulation, ultimately achieving macroeconomic soundness. Implementing TTS-based EG improved public administration efficiency, reducing time and costs for both sectors. The Estonian experience

provides essential lessons for transitioning economies, highlighting the need to address various challenges comprehensively. Despite inherent risks like the digital gap and cybersecurity issues, Estonia's success underscores the potential benefits of a well-executed EG strategy.

Estonia's experience emphasizes the necessity for a nuanced comprehension of EG development strategy, underscoring the significance of examining various phases and interactions between private property institutions and TTS-based EG. Scholars and policymakers are urged to delve into Estonia's economic transition, exploring potential applications of insights in diverse contexts. The paper also recognizes the essential need to adapt to emerging challenges, encompassing the shift to quantum-resistant algorithms and heightened security measures while safeguarding EG's integrity. Proactive research is necessary to counter the impending threat posed by the exponential processing speed of quantum computers, potentially jeopardizing the security of encrypted communications, including blockchain.

Notes

1. This paper does not assert that the Estonian strategy is devoid of challenges. Instead, its primary aim is to examine it as an innovative approach to addressing the complexities inherent in the knowledge society.
2. In economic theory, the concept of property rights asserts that every individual is the owner and steward of their body and mind. Thus, they bear responsibility for their labor and, by extension, any property created, acquired through contractual agreements, or accumulated without prior ownership. Secure property rights necessitate the presence of legal and cultural mechanisms that impose sanctions for both systematic and unsystematic aggressions, as outlined by Huerta de Soto (2024). This framework underscores the idea that individuals possess ownership over tangible assets and require protection and acknowledgment of their rights through legal and cultural norms.
3. The conceptualization of property rights and governance rules used in this paper comes from the Heritage Foundation's Index of Economic Freedom (EFI) and the World Bank's World Governance Indicators (WGI), respectively (Handoyo, 2023; Miller et al., 2022).
4. As Davidson et al. (2018, p. 639) observe, "The technological novelty of blockchain is that it can create consensus about the true state of a ledger (which might, for instance, record exchanges, contracts, ownership, identity or data) without needing to trust any centralised or intermediating party—such as an auditor, a corporation, a market exchange or a government."
5. The development of the government program was completed within a few weeks, aided by input from academics affiliated with diverse think tanks, including

The Heritage Foundation, the Adam Smith Institute, and the International Republican Institute (Laar, 2008).

6. Distinguishing between blockchain and bitcoin is crucial. Blockchain is a tool to guarantee data integrity, while Bitcoin is a cryptocurrency stemming from this technology (Nofer et al., 2017). Notably, the Estonian government initiated testing blockchain technology six months before Bitcoin launched.
7. The PISA report faces valid criticisms: 1) The leniency in data collection can allow governments to manipulate results; 2) Governments may be incentivized to make hasty political decisions to improve future test scores; 3) The tests overly emphasize economic analysis in education; and 4) There is concern that excessive quantification may undermine critical thinking, reducing autonomy for teachers and schools. However, these critiques do not render the tool invalid: 1) Results indicate a correlation between student performance and national accountability; 2) PISA is not responsible for flawed government policies; 3) Leading countries in PISA adapt curricula to market needs; and 4) They maintain a high degree of autonomy for teachers and schools (Araujo et al., 2017).

Disclosure statement

No potential conflict of interest was reported by the author(s).

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