



Digitalization, Artificial Intelligence, and Tax Compliance: The Case of Estonia*

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ABSTRACT

This study aimed to examine the impact of digitalization and artificial intelligence technologies on tax compliance through the example of Estonia. Estonia presented a pioneering model in tax administration with instruments such as electronic government, artificial intelligence-supported tax audits, the X-road data exchange system, and the electronic tax platform. The study employed descriptive analysis to evaluate the effects of digital and artificial intelligence-based tax practices on tax compliance. The findings showed that digital and artificial intelligence-supported systems in Estonia reduced the shadow economy, increased tax collection, and strengthened taxpayers' compliance behavior. The study highlighted the potential of digitalization to improve tax compliance and offered several policy recommendations for countries transitioning to digital tax systems.

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1. Introduction

Digitalization has brought significant transformations to many areas of public administration, and tax administration has been one of the most affected fields. Traditional tax processes are often costly, time-consuming, and complex, whereas digital technologies offer more effective, efficient and accessible solutions for improving tax compliance. Digital tax systems have accelerated tax filing and collection processes, reduced the administrative burden on taxpayers and contributed to efforts to combat tax evasion. Moreover, tools such as artificial intelligence-supported automation, pre-filled tax returns and digital assistance services have helped taxpayers fulfil their obligations more easily³.

Estonia represents one of the most advanced examples of digital transformation in tax administration. Its integrated digital infrastructure and widespread use of artificial intelligence have enabled a modern, transparent and efficient tax administration model that has attracted global attention. Using Estonia as a case, this study aims to examine how digitalization and artificial intelligence technologies have reshaped tax administration and influenced tax compliance.

The study contributes to the literature by analyzing Estonia's digital practices, evaluating their effects on tax compliance and offering insights for countries seeking to modernize their tax systems. The research is based on descriptive analysis, and the paper is structured to present the key concepts of tax compliance, Estonia's digital transformation trajectory, the functioning of its digital tax system and policy recommendations derived from Estonia's experience.

2. Digitalization and AI in Tax Compliance

2.1. The Concept of Tax Compliance and Factors Affecting Tax Compliance

The state's increasing need for revenue has made it necessary to place greater emphasis on taxes, which are its main source of income. This situation has in turn intensified research into tax compliance (Tunçer, 2002: 107). Tax compliance can be defined as the taxpayers' full and timely fulfilment of their formal and material duties stipulated by laws. Tax compliance includes several basic elements. Taxpayers are expected to comply with tax laws issued by tax authorities and to pay their taxes within

³ In its 2020 White Paper, the European Commission draws attention to various risks associated with AI, such as "non-transparent decision-making processes, gender-based or other types of discrimination, interference with privacy, or criminal use" (European Commission, 2020: 1). Öztürk Doğu and Zeybek (2021) point to the security vulnerabilities, privacy and confidentiality violations, and risks of surveillance society associated with the Internet of Things technology (Öztürk Doğu and Zeybek, 2021: 1). While the present study focuses solely on the positive aspects of digitalization and AI, the risks associated with these technologies should not be overlooked. However, the analysis of these risks is beyond the scope of this study.

the specified time frame as a financial obligation. In order to ensure tax compliance, taxpayers must fulfil their duties and responsibilities regarding taxation within the time period specified in tax legislation (Yoruldu, 2020: 58-60).

Tax compliance also refers to the rate at which taxpayers comply with tax laws and customs rules; voluntary compliance refers to taxpayers spontaneously understanding the need to pay taxes and comply with tax-related rules and spontaneously fulfilling their obligations without any government intervention. Every tax administration ultimately aims to increase voluntary tax compliance because a society with high tax compliance indicates willingness to pay taxes and contribute to common benefits. Achieving this requires innovative solutions, working methods, and ways of thinking. In countries with high tax compliance, paying tax is a social norm for citizens. That is, they fulfil their tax obligations on time and correctly (ETCB, 2023a: 5).

Many factors affect tax compliance. Classical tax compliance models explain compliance by focusing on the probability of being caught for non-payment in terms of expected benefit theory (Tunçer, 2002: 110). According to Allingham and Sandmo, who produced one of the pioneering classical tax compliance models, individuals make their tax compliance decisions by comparing expected risks and benefits. They found that tax compliance depends on the probability of audit, penalty rate, tax rate, and the individual's risk perception (Allingham & Sandmo, 1972: 324-327, 338).

More recent studies of tax compliance go beyond the few variables included in the classical tax compliance model, by considering economic, sociological, and psychological factors to offer suggestions for increasing tax compliance (Tunçer, 2002: 107). These factors include taxpayers' tax-paying capacity, loyalty to political power, sense of belonging to the state, tax awareness and morality, and perceived effectiveness of public expenditure. Other factors include tax justice, complexity, frequent legislative changes, high tax rates, frequency of tax amnesties, insufficient documentation systems, presence of the informal economy, ineffective application of tax penalties, widespread expectations and exemptions, and the structure of tax administration (İpek & Kaynar, 2009: 127).

Governments can increase tax compliance by implementing tax audits effectively, imposing penalties that are sufficient deterrents, and creating the perception that taxpayers receive public services in return for the taxes they pay (Kılıçaslan & Sonkur, 2022: 63). In summary, the factors affecting tax compliance can be divided into different categories as socio-cultural and psychological, institutional, demographic and economic factors. Socio-cultural and psychological factors affect taxpayers' tax compliance. Psychological factors that may reduce compliance include the complexity of tax laws and attitudes toward taxes as well as personal norms, social norms, societal norms, and perception of justice (Alm et al., 2012: 138). Regarding the latter factor, it is important for the government to avoid regulations that create perceived injustice among citizens. For example, regulations like frequently enacted tax

amnesty laws undermine justice in taxation, cause reactions from taxpayers, and negatively affect the perception of honest taxpayers (Taşkın, 2010: 87). Conversely, in a fair and transparent tax system, individuals consider the obligation to pay taxes as a civic duty and thereby show more compliance (Akdoğan & Akdoğan, 2023: 47).

Regarding the effects of socio-cultural factors on tax morale⁴, İzgi & Saruç (2011) determined that tax-related decisions are affected by psychological and socio-cultural elements, such as trust in the state, religious beliefs, and psychological pressure created by paying taxes.

Attitudes and compliance are also affected by an individual's social and institutional environment, as well as their level of knowledge about the tax system and their roles within it. Complex tax systems can prevent taxpayers from knowing exactly how much tax they need to pay, which can often reduce compliance (Alm et al., 2020: 294-296). Conversely, according to Feld & Frey (2007), certain social and institutional factors can increase tax compliance, such as taxpayers' direct participation in tax policies, informing taxpayers instead of directly punishing them for mistakes, and maintaining a transparent and reliable relationship between taxpayers and the tax administration.

Regarding demographic characteristics, tax compliance varies with age, gender, and education (Tunçer, 2002: 112). From their survey of demographic factors, İpek and Kaynar (2009) revealed that age, marital status, gender, number of family members, and education level influence tax compliance. Regarding age specifically, taxpayers aged 50 and above found tax legislation complicated and not easily understandable. Regarding marital status, married taxpayers were more likely to consider tax payments as indicating loyalty to the state. In terms of gender, female taxpayers reported higher levels of tax compliance. Those in larger families of three to five members were more likely to report non-payment of taxes. Finally, regarding education level, primary school graduates were less likely than high school and university graduates to accept the introduction of new taxes or increases in tax rates during extraordinary periods (İpek & Kaynar, 2009: 127-128).

Economic factors affecting tax compliance include the frequency of audits, tax rates, penalties, marginal tax rates, income, tax evasion, and opportunities for tax avoidance. Compliance decisions are also significantly affected by taxation levels. An increase in taxes can lead to non-compliance, whereas a higher likelihood of audits can encourage compliance, as can imposing higher penalties. However, the effect of marginal tax rates on tax compliance is uncertain. There is also no clear conclusion regarding the effect of income level. Finally, taxpayers with greater opportunities for tax avoidance or evasion are less likely to comply with tax obligations than other taxpayers (Alm et al., 2012: 138; Alm et al., 2020: 294-296). Macroeconomic conditions can also

⁴ Tax morale/tax ethics is defined as "an internal motivation to pay taxes" (Aktan, 2012: 168).

affect compliance. For example, from their study of Mersin, Türkiye, Sofracı & Güney (2017) found that the inflationary environment, informal economy, national income, and economic instability reduced voluntary tax compliance. Conversely, Akdoğan & Akdoğan (2023) concluded from their literature review that tax compliance is higher in countries that provide a secure environment with high economic freedom, efficient capital markets, and strong competition laws.

2.2. Effects of Digitalization and AI on Tax Compliance

Developments that began with the First Industrial Revolution in the 18th century continued with the Second Industrial Revolution, based on electric power, and the Third Industrial Revolution, based on automation. The digitalization era, which is considered to be the Fourth Industrial Revolution (Industry 4.0), continues to evolve (Karataş Durmuş & Arıtı Erdem, 2023: 226). Digitalization can be simply defined as the conversion of analog data into digital form (Parviainen et al., 2017: 64). As well as AI, the essential components of Industry 4.0 include mobile technologies, cloud computing, big data, the Internet of Things, broadband, 3D printers, and robotic systems (Özsoylu, 2017: 47-55; Bozkurt & Durgun Kaygısız, 2024: 31).

Here, AI refers to machine simulation of human intelligence processes, including learning, reasoning, problem solving, perception, and language comprehension. Digitalization, on the other hand, refers to the integration of digital technologies into various areas of human society, including business, education, healthcare, and governance. By converting analog processes into digital ones, digitalization increases efficiency, accessibility, and innovation (Petersons, 2024: 1). E-government is the most popular example of digitalization.

Current studies show that the combined use of digitalization and AI provides benefits such as increased efficiency, improved decision-making processes, and reduced operational costs (Gürsoy, 2024: 3). AI algorithms are significantly helpful in analyzing large data sets. In addition, they offer advantages, such as facilitating access to administrative services, improving the quality of services for citizens through chatbots, and developing administrative services according to citizens' needs (Ebers & Tupay, 2023: 10-11).

By integrating digitalization with AI technologies, Industry 4.0 has extensive potential for continuous development. Given that the digital transformation of the economy appears inevitable and irreversible, this highlights the need to integrate modern management and business processes with digital technologies. This understanding will directly influence the pace and success of the digital economy (Veselovsky et al., 2021: 297).

The development of the digital economy also requires taxation processes to adapt. Digitalization is evident in tax administration through innovative technologies,

such as application programming interfaces, AI, and robotic process automation. These technologies enhance the interaction between tax authorities and taxpayers, provide operational conveniences to the administration, and enable the provision of more user-friendly services (Karataş Durmuş & Arıtı Erdem, 2023: 227).

Digitalization of tax administration proceeds through five stages: e-Documentation, e-Accounting, e-Matching, e-Audit, e-Matching, e-Audit and e-Assessment. e-Document facilitates the digital organisation of financial and administrative transactions, while e-Accounting increases the reliability and speed of financial data through electronic recording systems. e-Matching minimizes discrepancies by simultaneously comparing data submitted by taxpayers with official data. e-Audit enables more effective monitoring of tax processes through cross-checking methods, while e-Assessment allows taxpayers to automatically calculate their tax liabilities (Bozkurt & Durgun Kaygısız, 2024: 33). These stages make tax administration more transparent, faster, and more reliable, thereby providing convenience for both taxpayers and the administration.

The transformative role of AI in tax administration is clearly evident in its ability to analyze large volumes of tax data. AI technologies make data processing and analysis faster and more accurate. AI-based automation enables tax authorities to process big data effectively, while machine learning models help identify tax non-compliance and violations (Adekan et al., 2024: 313; PWC, n.d.). The use of AI technologies in tax compliance represents a significant advancement by eliminating the limitations of traditional methods. By leveraging machine learning algorithms, tax authorities can obtain insights into taxpayer behavior and improve compliance assessment. Additionally, AI applications facilitate the verification of data obtained from taxpayer declarations, audits, and information provided by other taxpayers and tax offices. Thus, AI can play an important role in detecting tax evasion (Nembe et al., 2024: 243; Ömercioğlu, 2025: 1452).

Another factor that facilitates tax compliance is simplifying tax processes by providing personalized support to taxpayers via AI-powered chatbots and virtual assistants (Sadovenko et al., 2024: 64). The integration of digitalization into taxpayers' devices and systems enables automatic calculation, reporting, and payment of taxes. This simplifies tax related processes, saving both time and money and allowing resources to be used in more productive areas. The automation of tax administration helps taxpayers avoid calculation errors in manual tax payments, while also reducing the need for audits and avoiding costly investigations (OECD, n.d.). This enables more effective tax audits while encouraging voluntary compliance and preventing tax losses.

These findings indicate that the digital transformation, which gained momentum after the 1970s, has also fundamentally changed taxation. The use of technological capabilities has simplified processes, which increases the speed and quality of services provided to taxpayers, thereby reducing tax compliance costs and encouraging tax

compliance. In particular, innovative technologies, such as AI-supported big data, are increasing data processing capacity and strengthening transparency in taxation processes. These technologies also reduce costs and increase efficiency by automating tax processes (Akdoğan & Yavuz, 2022: 1, 39). The integration of AI technologies into tax administration is accelerating this transformation by making tax processes faster, safer, and more efficient. Tax systems modernized with digital tools, such as e-Registration, e-Declaration, and e-Payment, can simplify processes and increase accuracy and efficiency in tax collection and compliance. The integration of AI into these systems makes tax processes more effective and reliable (Adelekan et al., 2024: 312).

A number of European countries have introduced digitalization and AI for tax administration. In Spain, for example, certain taxpayers began to submit their VAT records online following changes to the Value Added Tax (VAT) law in 2017. In response to high demand, the tax office introduced an AI-supported virtual VAT assistant to automate information. This assistant was then expanded to cover all areas of VAT payments (Ihnatišinová, 2021: 5). Similarly, Latvia now offers digital services to taxpayers. In particular, chatbots support taxpayers in e-filing, business registration, annual tax return submission, and eligible expenses (Aristovnik & Ravšelj, 2024: 5). Slovakia aims to provide better services to taxpayers by developing digital communication channels, such as e-mail, live chat, and call centres. Similarly to the two previous countries, an AI-supported tax chatbot named TAXANA has lightened the burden on the tax administration by supporting taxpayers. In addition, digital tax systems have made the taxation processes more transparent and accessible, while local governments have also adopted e-Government processes to increase efficiency in tax procedures (Ihnatišinová, 2021: 5-7).

Digitalization has also been introduced in Asian countries. In India, confidence in the tax system has declined due to tax evasion and corruption. In response, the state has introduced AI and machine learning for tax auditing, detecting non-compliance, and providing support to taxpayers (Rakkini & Sudhanan, 2024: 2-3). Indonesia has also accelerated its digital transformation in tax administration through an electronic tax return system (e-SPT), launched in 2002. This implemented electronic systems such as an electronic filing system (e-Filing), electronic invoicing system (e-Billing), and an electronic tax deduction receipt system (e-Bupot). This has enabled the consolidation of operations under a central platform, the Directorate General of Taxes of Online Platform (DGT Online) (Saragih et al., 2023: 493).

Digital tax applications have also become widespread in Türkiye to facilitate tax compliance and reduce costs. Through the Internet Tax Office (IVD), taxpayers can complete their tax transactions online, while processes have been accelerated through services such as e-Collection, e-Notification, and the Tax Audit Board (VDK) taxpayer portal (Akdoğan & Yavuz, 2022: i). However, AI applications in Türkiye remain limited to examples like the Revenue Administration's digital tax assistant "GİBi", the Risk Analysis

System (VDK-RAS), and the Fake Document Risk Analysis Programme (SARP) (Karataş Durmuş & Arıtı Erdem, 2023: 247).

Given that Estonia is one of the leading countries in the EU's digital transformation, the present study focuses on this country's digitalization and AI-supported applications aimed at increasing tax compliance. The next section will discuss digital applications in the tax administration processes in Estonia and their impact on tax compliance.

3. Estonia's Digital Transformation

The European Union (EU) launched its Digital Decade Goals programme in 2021, aiming to transition to a climate-neutral, circular, and resilient economy by 2030. The EU has set four key objectives within the Digital Compass framework to strengthen digital sovereignty and promote a human-centric, sustainable digital future: digitally skilled citizens and professionals, secure and sustainable digital infrastructure, the digital transformation of businesses, and the digitalization of public services. The goal is for all public services to be available online by 2030, for citizens to have access to their e-Health records, and for 80% of them to use e-ID (European Commission, 2021).

The Digital Economy and Society Index (DESI) measures progress towards the EU's 2030 Digital Decade Goals and measures digital transformation in EU member states. DESI consists of four main dimensions (digital skills, digital infrastructure, digital transformation of businesses, and digitalization of public services) and associated sub-indicators, defined in line with the Digital Compass (European Commission, 2024a: 1-2). The digital public services indicator⁵ measures the extent to which services provided to citizens or information related to these services are available online and through a government portal (European Commission, 2022: 68).

Estonia scores 98.9 points for digital public services for businesses and 95.8 points for digital public services for citizens, thereby playing a leading role among EU countries in providing basic public services in a digital environment (European Commission, 2024b). Estonia has recently made divorce services available online, thereby achieving 100% digitalization of government services and eliminating bureaucracy as of December 2024. With its people-centric technology and innovations that can be adapted to different countries, it has become a global leader in digital governance (e-Estonia, 2025a).

⁵ The indicator represents the proportion of steps that citizens can take online to carry out important life activities (e.g., making or changing a hospital appointment or appealing a court decision). This proportion is calculated as the average of the online use of national and cross-border information and transaction services (European Commission, 2022: 68).

After gaining independence in 1991, Estonia began building a new society and state structure with technological infrastructure. By integrating state applications with technology, it prioritized infrastructure and security in the new system. It implemented X-Road, a decentralized e-government structure, which it secured with universal identity cards and an e-ID system with digital electronic signatures issued to citizens in 2002. In 2014, Estonia launched an application granting e-citizenship rights to people from other countries (Anthes, 2015: 18; Koç, 2021: 2256). It moved beyond being a small country by launching many e-services from scratch, making it an innovative country and a model for other countries (Burzyński, 2022: 3). Estonia is also a founding member of Digital Nations (formerly known as D5), an organization established in 2014 that comprises the world's leading digital governments (GOV.UK, n.d.).

In 2019, the Estonian government established a comprehensive framework to guide development in this area by defining its AI strategies. These strategies were developed to identify current and future areas of AI application in public and private sector services, establish legal and strategic regulations to accelerate AI development, position Estonia as a global leader in this field, and encourage the implementation of AI solutions in the both the public and private sectors (e-Estonia, 2025b). Estonia uses AI technologies to increase the efficiency of public services and simplify processes. Regarding taxation, it has created AI-supported tax evasion detection systems, while an AI-supported public service chatbot network has been created to increase the accessibility of digital services for citizens (e-Estonia, 2025c). This system aims to optimize citizen-official interaction and make public administration more efficient by strengthening the automation of public services. An example of a public service chatbot application in Estonia is "Bürokratt", an interoperable network of public and private sector AI solutions that provide users with access to public services and information through a single channel. Users can choose their preferred communication method (chat, SMS, email, phone, voice assistant), while the system is available 24/7 and free of charge (The Estonian Information System Authority-RIA, 2025).

Technology and digital solutions are becoming increasingly important in improving efficiency and reducing costs in public services. As one of the leading countries in digitalization, Estonia has adopted the e-Governance model. E-governance is a system that focuses on strengthening interaction between citizens and the government through technology, with the primary goal of simplifying daily life by streamlining government services. As a result, citizens can access the public services they need anytime, anywhere, saving both time and money (Burzynski, 2022: 23). Through its e-Governance model, Estonia aims to increase the country's competitiveness and raise the society's welfare level (e-Estonia, 2025d). Estonia's secure, flexible, and functional digital ecosystem has provided a unique level of transparency in public services and increased trust in digital services. This environment of trust in turn ensures the sustainability of the system (e-Estonia, 2025d). As a global

leader in the digitalization of public services, Estonia is a model for EU countries in line with the Digital Decade Goals. e-Estonia has become a brand in digitalization (Ljubanović & Alpeza, 2023: 181).

E-Governance consists of three key components: transparent and effective use of information and communication technologies (ICT) in government administration (e-Government), provision of public services online in a user-friendly manner (e-Services), and citizens' active participation in decision-making processes (e-Participation). Estonia's e-Governance application has developed thanks to its strategic vision, citizens' trust in the system, and the effective use of the ICT sector. The protection of personal data forms the basis of trust in the e-Government system. Citizens have the right to know who is using their data (e-Estonia, 2025d).

Estonia's model provides its citizens with 24/7 uninterrupted online access to all public services through various electronic solutions, such as digital identity systems and secure data sharing mechanism (Roots, 2017: 77; e-Estonia, 2025d). E-Estonia is one of the most advanced e-government systems, covering all areas of the state and changing the daily lives of citizens. Estonia has combined many services, such as legislation, voting, education, justice, health, banking, taxation, and policing, into a single digital platform and made it available to the public. As a result, citizens can access government services quickly and easily (Koç, 2021: 2256). Therefore, e-services have become routine for Estonian citizens, while both the public and businesses in Estonia are accustomed to user-friendly and accessible online services: E-Elections, E-Taxes, e-Police, E-Health, e-Banking, and e-School, among others (Ounapuu, 2012: 4; Ljubanović & Alpeza, 2023: 181).

Estonia was the first country to move its election processes entirely online by making electronic voting possible at the local, national, and European levels (Koç, 2021: 2254; Ljubanović & Alpeza, 2023: 181). Estonia launched its unique and internationally recognized e-Residency programme in 2014, which offers individuals the opportunity to benefit from digital services and access the EU network (Koç, 2021: 2254). Through digital ID cards and digital signatures, individuals gain access to numerous national electronic services and databases, thereby enabling individuals residing outside Estonia to invest and establish businesses in the country (Anthes, 2015: 18).

The country is also a pioneer in e-Democracy, with approximately 90% of citizens processing an e-ID card. In addition, the e-ID system of 12 EU member states can access Estonia's public services. Public institutions are transitioning from old information technology systems to a new government cloud system, aiming to make services faster and more efficient for citizens and residents (e-Residency) (Ljubanović & Alpeza, 2023: 181-182). Estonia continues to make significant investments in the digitalization of public services and the use of AI.

X-Road, which forms the technical backbone of e-Estonia, is one of the country's most important investments in digitalization. This system provides an infrastructure that enables the creation and coordination of new e-services. While it has become easier to build new services on existing infrastructure, new institutions can accelerate the integration process by directly adopting the system's existing components (Kotka et al., 2015: 3).

X-Road is a distributed information exchange platform that enables different systems in the public sector to exchange data securely and efficiently. For example, the police force can obtain data from the health system, tax office, or trade registry, while these institutions can also access police-related data. However, for this data sharing to take place in a healthy manner, X-Road must meet three basic criteria. First, the platform must have a structure that enables every member of the system to easily access the data they need. Second, data integrity must be maintained during data transmission. Finally, data must be protected against unauthorized access, while confidentiality must be ensured during data transfers (e-Estonia, 2025e). These elements enable X-Road to provide a secure and sustainable digital infrastructure and play a critical role in Estonia's digitalization.

On the X-Road platform, each record has an authorized owner who is responsible for its maintenance and security. The system is based on a 16-digit personal identifier assigned to each citizen at birth, which provides access to personal data from different record systems. Operating on a peer-to-peer network structure, X-Road ensures security by encrypting all information during data transfer (Margetts & Naumann, 2017: 5). In addition, the system integrates all databases with information from local servers, ensuring that all components operate at high efficiency. Sent data is protected by digital signatures and encryption methods, while the accuracy of received data is verified by the system (Koç, 2021: 2262). Within this structure, X-Road has become a fundamental component of Estonia's e-Government ecosystem by providing a secure and integrated digital infrastructure.

Estonia was ranked as the best digital government by the World Economic Forum in 2017, Index Venture in 2018, and the European Commission in 2020. By 2025, 99% of citizens will have a digital ID card. 51.1% will vote online and over 120,000 people will have joined the e-residency programme (e-Estonia, 2025g; e-Estonia, 2025h; e-Estonia, 2025i). Meanwhile, 98% of companies are established online and 99% of banking transactions are conducted over the internet (Invest in Estonia, n.d.).

The final section, which forms the focus of this study, will examine Estonia's digital tax system and its relationship with tax compliance.

4. Estonia's Digital Tax System and Tax Compliance

The Estonian Tax and Customs Board (ETCB)⁶ is responsible for collecting tax revenues, preventing shadow economy activities, and ensuring the fair transport of goods outside the EU. As part of its vision of increasing tax compliance, the ETCB has implemented three key strategies to achieve high tax compliance. The first is to simplify public services, enabling taxpayers to fulfill their obligations quickly and easily. The second is to ensure fair tax competition and effective control mechanisms, making tax evasion more difficult and increasing the system's security. The third is to make tax administration professional to enable more effective management of digitalization and automation. Digital solutions and e-services have been developed to automate tax collection processes, update risk assessments, and enable taxpayers to fulfill their obligations at the lowest possible cost. New technologies integrated with digitalization aim to increase tax collection rates, encourage taxpayer compliance, and support timely tax payments (ETCB, 2023a: 2-3,8,14). The ETCB thus plays an important role in ensuring that Estonia is one of the countries with the highest tax compliance rates (ETCB, 2023a: 5).

In order to enable citizens to file their taxes online and support the growing needs of a developing society, the e-Tax system was created in 2000 under the leadership of the ETCB to maximize state tax revenue (e-Estonia, 2025f). Thus, Estonia has taken the lead in promoting e-Government services by establishing a public system with electronic tax returns since 2000 (Anthes, 2015: 18).

The e-Tax system in Estonia allows taxpayers to file their income tax returns online. The e-Tax system facilitates the preparation of tax returns and speeds up the process by providing pre-filled forms. This system is supported by various digital applications, such as e-Residency, making the processes of filing returns and paying taxes electronically more accessible (Kotka et al., 2015: 4).

Estonia has a sophisticated digital tax management system that provides taxpayers with fast and secure services through its e-Tax system. There is a centralized shared platform for all public institutions and major banks, while data on taxable transactions is automatically collected from employers and other third parties. Taxpayers can log in using a secure identity verification system to review their pre-filled tax returns and make any necessary changes before approving the document with a digital signature. The system calculates and presents all known data to the taxpayer along with the result, so that all citizens need to do is approve the document. Thanks to these pre-filled forms provided by the ETCB, the process can be completed in a few

⁶ The ETCB operates with the aim of managing state revenues, implementing national tax and customs policies, and protecting legitimate economic activities (ETCB, 2023a: 2). The ETCB's vision is to make Estonia the country with the highest tax compliance in Europe while minimizing direct contact with service users, relying on three strategic priorities: "automatic and digital," "targeted," and "dedicated" (ETCB, 2024: 5).

minutes (Campbell & Hanschitz, 2018: 6-7; European Commission, n.d.). Thus, the e-Tax platform offers taxpayers the opportunity to file tax returns, make payments, and securely sign their documents digitally 24/7 (Kemeç, 2022: 633).

As well as online filing of individual income tax returns, Estonia's e-Tax system enables payment of taxes like corporate income tax, social tax, unemployment insurance, mandatory pension fund contributions, VAT, alcohol, tobacco, and fuel taxes, and customs duties (Williams, 2021: 2). Users can also request refunds for VAT, alcohol, tobacco, fuel, and packaging consumption taxes (e-Estonia, 2025f).

Through its electronic tax return and digital signature system, which reduces bureaucracy, Estonia has increased tax administration efficiency. Consequently, Estonia's e-Tax user rate rose from 59% in 2004 to 92.4% in 2010, 95% in 2015, 98% in 2019, and 99% in 2025. Under the current faster system users can complete their tax returns in an average of three minutes (Williams, 2021: 2; e-Estonia, 2025f), while tax refunds can be finalized within five days (European Commission, n.d.). Thus, the system has significantly reduced the time individuals and companies spend on tax returns, while increasing ease of use by making it accessible via mobile devices (Kemeç, 2022: 632).

The E-Tax system's benefits include transparent and effective tax collection, time savings for citizens, reduced office expenses, lower administrative costs, and error-free tax returns (e-Estonia, 2025f). This has made taxation procedures more efficient while reducing the need for tax officials, thereby cutting public spending by one third (Kolbenhayerová & Homa, 2022: 32). ETCB data show that digital service delivery reduces administrative burdens and face-to-face contact. In 2024, 97% of personal income tax returns were filed electronically in 2024. After targeted information activities and service reorganization, service-bureau contacts fell 11% overall and by 16% for income tax returns, while paper submissions declined by 28% compared to the 2023 (ETCB, 2024: 28-29).

Additionally, the widespread use of e-services, increased automation, targeted audits, and one-stop service has reduced administrative costs to just 45 cents per 100 euros of tax collected in 2022 (Estonian Tax and Customs Board, 2023a: 6). As of 2024, this cost declined further to 39 cents per 100 euros, reinforcing Estonia's position as one of the most efficient tax administrations in the OECD (ETCB, 2024: 4). Digitalization has resulted in estimated annual savings of approximately 500 million dollars, equivalent to 2% of the country's gross domestic product (GDP) (e-Estonia, 2025f).

The ETCB also aims to prevent unregistered work, ensure that employment is recorded, and reduce tax revenue losses through the worker registration system application, developed in integration with the e-Tax and X-Road systems. While Estonia's total tax gap losses were estimated at EUR 433 million in 2012 (with VAT

accounting for around EUR 200 million)⁷, the introduction of the employment register in July 2014 was associated with an estimated 5.1 million euros increase in labor tax collections within its first four months (CGI, n.d.; IMF, 2014: 23). The ETCB also reports that Estonia's tax gap was 2.3% in 2024, placing it among the lowest in Europe.

Regarding risk management, Estonia uses AI to detect tax non-compliance and fraud, thereby increasing the detection and prevention of tax evasion. This process involves a comprehensive analysis of tax return data to identify suspicious activities. This AI-supported system optimizes audit processes by strengthening targeted audit processes and ensuring that resources are directed to high-risk cases (Aristovnik & Ravšelj, 2024: 7). Risk analysis is carried out in a privacy-protected manner through a company called Cybernetica, which has played a leading role in Estonia's technological infrastructure development. The analysis flags companies with suspicious transactions and presents only their information to the tax authorities (Talviste, 2016: 46), thereby increasing the effectiveness of tax audits. As of October 1, 2023, the ETCB has updated export and transit customs services by introducing new information systems for exit customs procedures in order to ensure safety and security (ETCB, 2023b).

To assess and guide companies' tax compliance, the ETCB has developed an e-service tool called "tax compliance rating". This system provides companies with feedback on their tax status, helping them to address deficiencies in a timely manner in order to prevent them from being subject to tax audits. It has also increased the number of tax returns filed, leading to an increase in the number of companies that pay their taxes regularly (European Labour Authority, 2022: 1, 4).

In order to measure tax payment willingness, the ETCB has developed a tax payment willingness index based on four determinants: social norms, attitudes, knowledge, and perceived behavior. This index ranges from 0 to 100, with a value of 100 indicating a situation where all taxpayers demonstrate ideal tax compliance (ETCB, 2023a: 6). Table 1 shows the results of the voluntary tax payment willingness index for 2019-2024 and the expected value for 2023. As Table 1 shows, tax payment willingness increased from 66.5 in 2019 to 69.6 in 2021 before declining to 67 in 2022. This downturn can be explained by the post-pandemic recovery and economic uncertainties. The 2023 target (≥ 65) indicates a lower expectation compared to previous years; nevertheless, the final value of 2023 (66.2) remained above the target. The index then declined slightly to 63.6 in 2024, indicating a continued weakening trend in voluntary tax payment willingness. In general, however, the index value can be directly related to the digitalization of the tax system, economic conditions, and citizens' trust in taxation. A survey conducted by Randlane (2012) in 2009 revealed that the most important factor

⁷ The tax gap refers to the difference between theoretically expected tax revenues and actual collections. According to IMF (2014: 28, 43), estimates of the tax gap can be influenced by (i) data issues, (ii) timing issues, (iii) taxpayer planning activity, and (iv) taxpayer compliance problems.

in increasing tax compliance is trust in the state, along with increasing awareness of how tax revenues are used and good relations between the state and citizens.

Table 1: Voluntary Tax Payment Index (2019-2024)

Year	Voluntary Tax Payment Index
2019	66.5
2020	68.4
2021	69.6
2022	67.0
2023 (Target)	≥ 65
2023 (Final Data)	66,2
2024	63,6

Source: ETCB, 2023a: 6; ETCB, 2024: 48

The ETCB assesses tax compliance based on the rate of timely payment of tax claims and the rate of compliance with reporting (declaration) obligations. As Table 2 shows, the rates for both timely payment of tax obligations and compliance with reporting obligations have increased. The timely payment rate increased from 85.3% in 2020 to 88.2% in 2022, with a target of 88% set for 2023. The compliance rate for reporting obligations increased from 84.4% in 2020 to 87.9% in 2022, with a target of 88% set for 2023 (ETCB, 2023a: 14).

Table 2: Timely Payment and Filing Compliance Rates (2020–2023)

Year	Timely Payment Rate (%)	Filing Compliance Rate (%)
2020	85.3	84.4
2021	88.6	87.5
2022	88.2	87.9
2023 (Target)	88	88

Source: ETCB, 2023a: 14.

Table 3 shows the percentage of honest (risk-free) taxpayers and the percentage of effective control and information provided by the administration. The percentage of honest (risk-free) legal entities fulfilling their tax obligations increased from 84.8% in 2020 to 93% in 2022. The percentage of honest individuals increased from 96.70% in 2020 to 97.70% in 2022. The effective control and information rate, an indicator measuring long-term tax compliance, increased from 40.4% in 2020 to 62% in 2021 before falling to 52% in 2023. The target for 2023 was set at 50-60% (ETCB, 2023a: 17).

Table 3: Levels of Integrity and Effective Control (2020–2023)

Measurement	2020	2021	2022	2023 (Target)
Rate of compliant legal entities	84.80%	92.20%	93%	Maintain current level
Rate of compliant natural persons	96.70%	97.50%	97.70%	Maintain current level
Rate of effectively controlled and informed individuals	40.40%	62%	52%	50–60%

Source: ETCB, 2023a: 17.

Table 4 shows ETCB measurements for customs violations Individual compliance at customs (at the border) rose from 96.70% in 2020 to 98.3% in 2022, while customs compliance of legal entities that are declarants rose from 88.8% in 2020 to 93.2% in 2022 (ETCB, 2023a: 16). Estonia's success rate in combating tax and customs crimes rose from 68% in 2020 to 77% in 2021 and 80% in 2022 (ETCB, 2023a: 18). Overall, the ETCB's approach aims to ensure fairness in the tax system by promoting tax compliance through systematic monitoring and targeted interventions.

Table 4: Customs Compliance Rates for Natural and Legal Persons (2020–2023)

Measurement	2020	2021	2022	2023 (Target)
Border compliance (natural persons)	96.70%	97.30%	98.30%	96%
Customs compliance of declarants (legal persons)	88.80%	90%	93.20%	91%

Source: ETCB, 2023a: 16.

During the years under review, satisfaction with public services in Estonia increased thanks to simple and user-friendly solutions, and improved accessibility of e-services (ETCB, 2023a: 12-14). The Promoter Index measuring taxpayer satisfaction rose from 72% in 2020 to 77.9% in 2022, while the target set for 2023 was at least 70% (ETCB, 2023a: 13). The 2023 target of at least 70% was exceeded, with realized user satisfaction reaching 80% in 2023. User satisfaction then increased further to 86% in 2024 (ETCB, 2024: 28).

Overall, digitalization and AI technologies aimed at simplifying public services and minimizing costs have played an important role in increasing tax compliance in Estonia. This positive trend in tax compliance shows that there has been an improvement in taxpayers' fulfillment of their tax obligations and that sustainable compliance has been achieved.

Estonia has been actively developing its e-Tax project since 2002, becoming one of the most successful countries in Europe in terms of digitalizing tax administration. Among the factors reinforcing the system's success are a robust data protection system

and the trust relationship established with citizens. While efforts to develop AI-supported tax systems continue, the e-Tax system has made tax filing quite simple and provides an example for other countries (Kolbenhayerová & Homa, 2022: 32; Anthes, 2015: 18). This system has increased citizen satisfaction and is considered a successful model of digital transformation on a global scale (European Commission, n.d.).

As explained above, Estonia's digital-based tax management facilitates tax compliance for taxpayers while also contributing to increasing state tax revenues and preventing tax evasion. AI-supported systems accelerate tax processes while reducing error rates and tax compliance costs. The high user rate of the e-Tax system and increased tax payment willingness demonstrate the success of the Estonian model. Thus, Estonia's digital tax practices serve as an example for other countries and may be widely adopted in the future.

Currently, many countries' tax authorities are updating their tax legislation as part of digitalization while integrating innovative solutions, such as blockchain, cloud technology, the Internet of Things, and AI into tax management. These integrations are guiding activities aimed at ensuring effective tax revenue collection (Bozkurt & Durgun Kaygısız, 2024: 33).

5. Conclusions and Recommendations

Estonia's digital transformation process demonstrates how AI and automation technologies can be effectively used to improve tax compliance. Digitalization of taxation processes facilitates taxpayer compliance while reducing administrative costs and increasing audit efficiency. Through its e-Tax system, Estonia has greatly simplified taxpayers' tax filing and payment processes. Pre-filled tax returns, a digital identity verification system, and AI-supported analyses have strengthened tax compliance rates and ensured that the process is completed with fewer errors. The share of taxpayers using the e-Tax system increased from 59% in 2004, when e-tax services were gaining traction, to 99% at present.

The digitalization of tax processes in Estonia has minimized bureaucracy burdens and saved time and money, while Estonia's e-governance model has made it easier for citizens to access information about tax processes. Increased awareness among citizens about how their tax revenues are allocated and used may also support tax compliance rates. In Estonia, taxpayers can typically complete their tax returns in approximately three minutes.

AI-supported audits have also minimized tax losses. The ETCB reports that Estonia's tax gap was 2.3% in 2024, placing it among the lowest in Europe. One of the systems developed by the ETCB, the tax compliance rating system, provides feedback to taxpayers on their tax compliance, which has increased the number of companies that pay taxes regularly. AI-supported chatbots have guided taxpayers through the tax

process. ETCB's compliance indicators suggest improvements in outcomes, as both timely payment rates rose from 85.3% in 2020 to 88.2% in 2022, while the filing compliance rate increased from 84.4% to 87.9 over the same period. Overall, these applications have contributed to improving tax compliance in Estonia.

Estonia's e-Tax system and AI-supported tax management are a model for other countries, although its applicability depends on factors in each country, such as a strong digital infrastructure, transparency, and high citizen trust, as well as economic, financial, and structural characteristics. Thus, given the different administrative and economic structures of each country, governments should plan digital tax administration systems in accordance with national dynamics while referencing Estonia's successful practices.

Based on Estonia's example, the following recommendations can be made for other countries to develop their digitalization and AI-supported tax administration processes:

- Tax administrations can collect taxpayers' financial data in an integrated manner with other digital systems, thereby accelerating tax processes and reducing error rates.
- Risk analysis can be used to combat tax evasion and reduce tax revenue losses through the use of AI algorithms.
- The accessibility of digital services can be increased by promoting solutions such as chatbots and virtual assistants that facilitate taxpayers' tax transactions.
- User-friendly e-Tax platforms can be promoted to provide taxpayers with easy access to processes and encourage voluntary tax compliance.
- Information sharing between countries can be facilitated to improve digital tax administration.
- Digital literacy levels can be raised by implementing information policies aimed at taxpayers.
- AI-supported control mechanisms can be developed and supported by legal regulations to increase tax compliance.
- Data security should be a priority in AI applications. It is important to increase trust in the systems by protecting citizens' information.

This study has used the case of Estonia, which can be considered one of the most successful examples worldwide in increasing tax compliance through digitalization and AI use, to demonstrate the potential of digitalization and AI technologies to increase tax compliance. A key limitation is that the analysis relies on the most recent available data during the period, covering 2023 and 2024. Building on Estonia's experience, the study proposes several policy recommendations, however; these should be customized to the institutional, social, economic and administrative context of each country

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