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Public management of sustainable finance: Digital transformation and legal challenges

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Abstract. The purpose of the study was to analyse public administration strategies aimed at stimulating investment in a sustainable economy and to assess the possibilities of using artificial intelligence tools to improve the effectiveness of state supervision of financial markets. The paper examined public administration strategies focused on stimulating investment in a sustainable economy, and legal aspects of implementing intelligent systems in decision-making processes that contributed to ensuring financial security and stability of the financial system in the long term. In particular, attention was paid to the issues of transparency of algorithmic decisions, responsibility for the use of automated systems, and protection of financial and personal data in public financial management processes. The results of the study showed that the integration of digital technologies into the public financial management system significantly increased the effectiveness of financial supervision, improved transparency of operations, and developed sustainable financial instruments. However, the successful implementation of these transformations required improving the regulatory framework and creating mechanisms for regulating the use of artificial intelligence in the financial sector. In addition, artificial intelligence, due to its ability to automate big data analysis and quickly identify risks, has significantly improved the effectiveness of financial regulation. This has created legal challenges, in particular, regarding the definition of responsibility for automated decisions. The results of the expert survey confirmed the importance of integrating digital technologies with legal guarantees in order to ensure the ethics and stability of financial markets. The practical significance of the study lies

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in the development of scientifically based approaches to the integration of digital technologies into the public financial management system to ensure financial stability, increase investment activity, and support the long-term development of a sustainable economy

Keywords: digital financial regulation; regulatory technologies; artificial intelligence solutions; sustainable economy; financial security

Introduction

Sustainable development of the financial system has become a key factor in economic security and socio-economic stability of the state. Globalisation, increased financial flows, and competition have increased demands on the effectiveness of public administration, while conventional regulatory mechanisms have often failed to keep up with market changes. Digital transformation, in particular, the use of artificial intelligence and Big Data, has increased the accuracy of forecasting, automated control and contributed to the development of transparent financial institutions. Its implementation was accompanied by legal challenges, in particular, regarding the responsibility of algorithms, data protection, and adaptation of legislation that can affect trust and financial security. A.A. Davidescu *et al.* (2025) noted that digitalisation of public financial management is not just a technical process, but a complex transformational phenomenon that required a combination of technological, organisational, and legal approaches. S. Mirishli (2024) pointed out that the effective implementation of artificial intelligence (AI) in state supervision is possible only if there is an interaction between the technical capabilities of the systems and a clear legal framework governing the use of data, algorithmic solutions, and control mechanisms. The paper by O. Bashtannyk *et al.* (2025) found that the introduction of innovative human capital management practices in the security and defence sector increased the effectiveness of public administration, but simultaneously requires adaptation to new organisational and institutional challenges. O. Sydorchuk *et al.* (2024) proved that the integration of digitalisation into public administration, in particular through spatial planning, contributed to the strengthening of national security and economic development, ensuring more effective management decision-making.

H. Ferdman *et al.* (2025) noted that the development of a matrix of innovative competencies in public administration has become a key factor in ensuring sustainable development, financial efficiency, and national security in the context of digital transformation. The researchers stressed that the integration of digital skills, analytical tools, and strategic thinking helped to improve the quality of management decisions and the adaptability of state institutions to contemporary challenges. The study by S. Kanojia *et al.* (2024) showed that FinTech and RegTech play a key role in ensuring business sustainability by promoting economic growth, financial inclusion, and improving the efficiency of financial systems. The researchers found that RegTech is effective in reducing compliance costs, preventing financial crimes, and improving internal control systems. Simultaneously, the need to balance innovation and regulatory requirements was emphasised, since the introduction of digital financial technologies is accompanied by cybersecurity risks and regulatory uncertainty. C.J. Costa (2024) analysed the ecosystem of decentralised finance (DeFi), which was considered as a new stage in the development of financial systems based on blockchain technologies and smart contracts. The researcher stressed that DeFi creates an alternative financial infrastructure without intermediaries, which has increased the transparency, accessibility, and efficiency of financial transactions. M. Pisaniuc *et al.* (2024) analysed the development of FinTech, InsurTech, and RegTech as key components of the digital transformation of the financial sector, with a focus on their business models and technological underpinnings. The researchers stressed that the introduction of innovative financial technologies contributes to improving the efficiency of banking systems, developing financial services and strengthening the global competitiveness of financial markets. Despite a significant amount of research devoted to the digital transformation of financial systems and the development of sustainable finance, the issue of integrating artificial intelligence tools into the public management system of financial markets remained insufficiently studied. The purpose of the study was a comprehensive analysis of public administration strategies aimed at stimulating the sustainable development of finance through digital transformation, and an assessment of the legal aspects of the use of intelligent systems in state financial supervision. Research objectives: 1) to analyse current trends in digital transformation of public financial management and the role of AI in ensuring financial stability; 2) to identify the main legal challenges that have arisen during the integration of intelligent systems into regulatory practice; 3) to develop recommendations for legal support of the use of digital technologies in public financial management considering international practices.

Materials and Methods

The study was based on an interdisciplinary approach that combined the analysis of digital technologies in public financial management and the assessment of the legal aspects of the application of intelligent systems. To ensure the complexity and reliability of the results, mixed methods research was used, which included both quantitative and qualitative research methods. Key components of the methodology included content analysis of scientific sources and regulations governing the use of artificial intelligence in the financial sector. In particular, data from the European

Commission (2025) was analysed, which indicates the EU requirement for large companies to disclose information on sustainable development, including Environmental, Social, and Governance aspects, to increase transparency and ensure comparability of reporting; EFRAG (n.d.), which considered specific areas of ESRS development, in particular, sectoral standards, standards for SMEs, digital taxonomy; European Securities and Markets Authority (n.d.), who coordinated supervision at the national level of companies' reporting on sustainable development, participated in the development of ESRS standards, and monitored the development of IFRS Sustainability Disclosure standards. Regulation (EU) No. 2024/1689 (2024), Council of Europe (n.d.) and Commodity Futures Trading Commission (n.d.) were also considered.

The study analysed and compared the international experience of implementing intelligent systems in government agencies, in particular, in the EU, USA, and Singapore. An expert survey was conducted to supplement the results of the analysis of scientific sources and obtain practical assessments on the introduction of digital technologies in the field of financial regulation. The research method involved conducting unstructured interviews with RegTech specialists who had experience working in financial regulators, FinTech companies, and international consulting organisations. The study involved 10 experts from different countries representing the professional environment of the European Union, North America, and Asia. The sample was formed on the principle of targeted sampling, which allowed including specialists with practical experience in the field of digital financial regulation, the use of artificial intelligence technologies in financial monitoring, and the development of RegTech solutions. The respondents included representatives from regulatory bodies, FinTech companies, RegTech start-ups, and consultancy firms operating in the field of digital financial regulation. The profile of the experts is presented in Table 1.

Table 1. *Expert profile*

No.	Country	Sector	Professional specialisation	Work experience
1	Germany	Financial regulator	Digital financial supervision	12 years
2	Singapore	RegTech-company	Development of SupTech platforms	10 years
3	USA	FinTech company	AI-financial risk analytics	11 years
4	United Kingdom	Consulting	Regulatory technologies	14 years
5	Canada	Financial sector	Compliance and financial monitoring	9 years
6	Netherlands	RegTech-startup	Algorithmic control systems	8 years
7	France	Public sector	Digital financial regulation	13 years
8	Estonia	GovTech	Digital governance	10 years
9	Australia	Fintech industry	Risk management	12 years
10	Switzerland	International consulting	Regulatory policy	15 years

Source: *compiled by authors*

Interviews were conducted in the format of open conversations, which allowed experts to freely express their own assessments of current trends in the digital transformation of financial regulation. The main thematic blocks of the interview covered the following issues: 1) the role of artificial intelligence technologies in the modernisation of financial supervision; 2) the possibilities of using RegTech and SupTech tools to improve the effectiveness of state control; 3) key legal risks of using algorithmic systems in financial regulation; 4) prospects for the development of sustainable finance in the context of digitalisation of financial markets. The results of the interview were analysed using the method of thematic analysis, which allowed identifying the main conceptual categories and repeated semantic patterns in the respondents' answers. Based on an integrated approach, the research provided: integration of theoretical and practical aspects of digital transformation; assessment of potential legal risks and challenges; development of scientifically based recommendations for optimising public financial management.

Results and Discussion

In the current conditions of globalisation, digitalisation, and high volatility of financial markets, the issues of sustainable development of the financial system have come to the forefront of academic, practical, and political discourses. The financial system was not only a mechanism for redistributing resources, but also an indicator of economic stability, social well-being, and the state's ability to withstand internal and external shocks. With this in mind, public financial management required not only conventional regulatory approaches, but also advanced tools that can ensure transparency, efficiency, and predictability of management decision-making. The use of digital technologies in the field of state regulation of finance has become particularly relevant in the context of expectations for the creation of adaptive, intelligent surveillance systems. Systems of AI, machine learning and Big Data processing (Big Data) have opened up new prospects for improving the efficiency of state supervision, automating analytical functions, and optimising procedures for monitoring financial activities.

In a number of developed countries, including the European Union, the United States, and Singapore, government regulators have already implemented elements of "RegTech" and "SupTech" – technologies for regulatory and supervisory functions based on algorithmic data analysis and predictive models. For example, European

Central Bank (n.d.) and the Financial Conduct Authority (n.d.) used algorithmic systems to detect anomalies in financial flows, which helped to strengthen the fight against financial crimes and improve the quality of risk assessment. In the USA, U.S. Securities and Exchange Commission (n.d.) used machine learning to integrate data from multiple sources to better monitor capital markets. Singapore's regulatory pilot testing platforms have supported FinTech innovation through close collaboration between government agencies and the private sector, including the use of AI to assess credit risks and market behaviour patterns (Luo *et al.*, 2025). The digital transformation of public financial management was accompanied not only by technical, but also by fundamental legal challenges. State regulators are faced with the need to build a legal environment that will ensure: 1) clear mechanisms of responsibility for automated solutions; 2) balance between the openness of algorithms and the protection of commercial and personal information; 3) compliance of national legislation with international standards in the field of data processing, cybersecurity and AI ethics; 4) adaptation of legal tools to regulate the impact of algorithmic models on competitive processes (Singh *et al.*, 2025).

Insufficient attention to the legal dimension of digital transformation can lead to legal uncertainty, undermine the confidence of financial market participants, and create risks to national financial security. That is why scientific interest has shifted from narrowly technical discussions to interdisciplinary research that combines technological, economic, and legal aspects of public administration. J.C. Crisanto *et al.* (2024) noted that the effective use of AI in public financial management is possible only if technological capabilities interact with regulatory and legal guarantees. The advantages of digital technologies in government regulation of finance – such as improving the accuracy of forecasts, automating routine processes, and early detection of risks – must be balanced with the requirements of legal certainty, ethics, and transparency of algorithms. The analysis of the survey experts' responses showed that the majority of respondents considered the digital transformation of financial regulation as one of the key factors for improving the effectiveness of state supervision of financial markets. According to the interviewed experts, the use of artificial intelligence tools has significantly expanded the capabilities of financial regulators to process large amounts of data, identify financial risks and automate control procedures. Experts noted the existence of a number of significant challenges associated with the use of algorithmic systems in financial regulation. The main problems identified were issues of transparency of algorithms, the possibility of system errors in the processes of automated data analysis, and the complexity of determining legal liability in cases where decisions are made with the participation of artificial intelligence systems. In addition, respondents stressed the importance of developing international cooperation in the field of RegTech regulation. According to their estimates, the effective implementation of intelligent systems in financial supervision required harmonisation of regulatory approaches at the international level, which will ensure the compatibility of digital financial infrastructure and increase the level of trust in digital financial technologies. A summary of the results of the expert survey is presented in Table 2.

Table 2. *Summarising the results of an expert survey*

Evaluation area	Main opinions of experts
Use of AI in financial supervision	Improvement of the efficiency of data analysis, quick identification of risks
RegTech and SupTech	Automation of regulatory processes, reduction of administrative burden
Main legal challenges	Transparency of algorithms, responsibility for automated solutions
Development prospects	Integration of digital technologies with the sustainable finance system
International cooperation	Need to harmonise regulatory approaches

Source: *compiled by authors*

Convergence of sustainable finance, digital technology, governance, and law has stimulated a new paradigm, often referred to as "sustainable digital finance" or "green fintech", which aims to align financial systems with the 2030 Sustainable Development Goals (SDG) (Global Compact Network Ukraine, n.d.). In 2024-2026, this area moved from voluntary ESG initiatives to mandatory, proven and technologically supported reporting, with a major focus on mitigating "greenwashing" through a robust digital legal framework. Table 3 summarises the main characteristics of this convergent landscape. Thus, digital tools and innovative technologies, in particular artificial intelligence, blockchain, and the Internet of Things, are actively used to increase transparency and responsibility in the field of sustainable financing, contributing to the fight against "greenwashing". S. Kumar *et al.* (2022) identified seven major research themes for sustainable finance, namely: socially responsible investment, climate finance, green finance, impact investment, carbon finance, energy finance, and sustainable finance and investment management. The researchers also suggested that more work is needed to promote sustainable finance, such as developing innovative sustainable finance tools, managing the returns and returns of sustainable investments, improving the sustainability of sustainable finance, developing policies and frameworks for sustainable finance, and combating "greenwashing" in sustainable finance by enterprises. P.J. Morgan (2022) called for caution in the use of digital sustainable finance products. The researcher noted that while digital financial technologies or FinTech can

promote green finance, they also create new risks and unintended consequences for the environment and users due to digital technology vulnerabilities such as identity theft and cybersecurity risks.

Table 3. *Converged landscape of sustainable finance, digital technology, governance, and law*

Sustainable finance and digital convergence
Technologies such as artificial intelligence, blockchain, and the Internet of Things have been used to improve ESG tracking, reporting, and accountability by mitigating "greenwashing" by providing tracked data
Green fintechnology and Finance 5.0: Finance 5.0 has gone beyond automation (Finance 4.0) to human-centred, ethical artificial intelligence in finance, seeking to strengthen financial inclusion and align capital with ESG goals
Ways to influence: digital finance has been used to improve access to capital for small and medium-sized enterprises, provide green financing related to digital currency, and support carbon credit trading
Development of public administration and regulation (2024-2026)
Mandatory standards: the European Union has become a leader in implementing the Corporate Sustainability Reporting Directive (CSRD), which obliges more than 50,000 companies to report in accordance with the European Sustainable Development Reporting Standards (ESRS), starting in 2025/2026, often with eXtensible Business Reporting Language (XBRL)
The stricter ESMA guidelines, which came into force in 2024/2025, required funds with ESG names to have at least 80% of their assets focused on Sustainable Development Goals, which prevents "greenwashing" in financial products.
ESG rating oversight: new EU regulations (2025) require ESG rating providers to be authorised and supervised by the ESMA, ensuring methodological transparency
Global harmonisation (ISSB): the International Sustainability Standards Board (ISSB) has issued IFRS S1 and S2 to establish a global baseline for climate-related disclosure, in line with regional regulations such as the EU CSRD.
Legal and institutional framework
Anti-corruption and transparency: anti-money laundering (AML) and anti-corruption laws are increasingly integrated with ESG governance requirements, linking financial integrity to sustainability
Artificial intelligence and data ethics: legal frameworks have evolved to address algorithmic bias and data discrimination, and new standards have been aimed at ensuring that financial decisions made based on artificial intelligence are accountable and respect for human rights
Digital identity and privacy: data protection modernisation (Convention 108 +) has become essential for digital governance, ensuring the secure and appropriate use of data in financial technologies
"Stop counting" and regulatory flexibility: to manage the "burden" of new reporting, the EU has adopted temporary "stop counting" directives to facilitate the transition for companies (2025)
Key challenges and future directions
Regulatory fragmentation: despite ISSB's work, various regional sustainability taxonomies (EU, US, and Asia) have continued to complicate global compliance
"Double transition": legal and financial structures should consider the interaction of digital transformation and sustainability, since the energy consumption of digital technologies (for example, blockchain) may run counter to "green" goals
Nature-related risks: the financial framework has expanded beyond carbon emissions to cover biodiversity and nature dependencies under the leadership of the Taskforce on Nature-related Financial Disclosures (TNFD)
Key trends for 2026
Mandatory digital marking of all ESG data
Implementation of the EU "stop the countdown" directives and completion of the development of reporting standards for voluntary reporting of VSME
Expansion of AI audit requirements in the financial decision-making process

Source*: Regulation (EU) No. 2024/1689 (2024), T. Gulati et al. (2025), European Commission (2025), EFRAG (n.d.), Council of Europe (n.d.), Commodity Futures Trading Commission (n.d.)*

P.K. Ozili (2025) noted that many digital finance and FinTech investors have become conventional investors, meaning they have focused on the short-term financial performance of the financial technology companies they have invested in. Investors sought high returns, low risk, and focused on short-term financial performance rather than non-financial performance (Janicka *et al.*, 2021). A significant number of these investors were not interested in investing in sustainability-focused digital finance innovations that became long-term and offered low returns, high risk, and relied on non-financial performance. A small number of investors interested in sustainable digital finance innovations may not be enough to scale supply-side sustainable digital finance initiatives. This situation is further compounded by the fact that the number of investors who are not focused on sustainability is significantly higher than the number of investors who are focused on it. The Global Sustainable Investment Alliance (n.d.) showed that aggregate investments in sustainable development from the United States, Canada, Japan, Australia, and Europe accounted for only 35.9% of total assets under management at the beginning of 2020, meaning that the remaining 64.1% of investments were directed to assets that were not focused on sustainable development. Moreover, investment in sustainable development increased by only 20% in 2022 compared to 2020. However, the organisation has tried to persuade a large number of investors in digital financial instruments to shift their focus from short-term financial results to long-term non-financial indicators and to investments that consider social and environmental impact (Impact Investing). These efforts can positively change investors' attitudes towards Impact

Investing focused on sustainability, although this change will not happen immediately. Many digital financial service providers were reluctant to include sustainability principles in their service offerings because they did not see a clear way in which implementing sustainability principles would increase their profitability or improve the efficiency of providing digital financial services. Digital financial service providers can include sustainability principles in their offerings if they believe that changes will be costly and may negatively affect the foundations of their business, even if they lead to the greater good of the planet and society. Here, the role of competent public administration is of particular importance. Public administration plays a crucial role in promoting sustainable digital finance by acting as a catalyst, creating a supportive framework, and providing regulatory oversight to ensure that digital financial instruments (such as artificial intelligence, blockchain, and big data) are aligned with Environmental, Social, and Governance (ESG) goals. Governments have transformed digital finance into sustainable digital finance by integrating ESG principles into digital financial services, promoting financial inclusion, and leveraging technology to achieve zero-emission goals. The key roles of public administration in digital sustainable finance, and the key results of active management, are presented in Table 4.

Table 4. *Impact of public administration on sustainable financial development*

Key roles of public administration
Regulatory framework: develop and enforce ESG-compliant digital finance standards, including data standardisation, enhanced cybersecurity, consumer protection, and reduction of "greenwashing" risk
Incentive mechanisms: offering tax breaks, subsidies, or grants to companies and financial institutions that have implemented sustainable experiences, such as investing in green technologies or promoting financial inclusion
Infrastructure and data initiatives: investing in digital and physical infrastructure (e.g. mobile banking, data exchange platforms) that supports sustainable financial development, especially in underserved regions. This included creating affordable, high-quality ESG datasets to increase transparency
Integrating sustainable development into public services: applying digital technologies (mobile payments, Smart City applications) as tools to encourage consumer behaviour to engage in low-carbon activities, such as using reward systems for public transport or recycling
Promoting financial inclusion: using digital financial services to reduce transaction costs and improve access to finance for marginalised groups, in line with social development goals
Ensuring ethical AI and data protection: implementing management structures focused on digital transformation quality, data privacy, and mitigating algorithmic bias in AI financial applications
Key results of active management
Increasing green investment: the development of digital finance, supported by government green subsidies and environmental regulation, significantly reduces carbon emissions in manufacturing companies
Increased transparency: digital dashboards and blockchain-based auditing have improved tracking of sustainable investments and prevented "greenwashing"
Digital sustainability of SMEs: government-supported platforms gave SMEs access to digital marketing and financial instruments that they would not otherwise have

Source: *based on A.M. Elhady & S. Shohieb (2025)*

Therefore, active management in the field of digital finance includes the development of ESG standards, encouraging sustainable investment through financial instruments, implementing infrastructure initiatives to increase transparency and financial inclusion, and ensuring the ethical use of digital technologies, which helps to reduce emissions and supports the sustainability of small and medium-sized businesses. Y. Coskun & I. Unalmis (2022) argued that new research on sustainable finance has shown that improvements in digital finance have a limited positive impact on the green finance agenda. This discrepancy has raised concerns about their sustainability preferences and led to reflection on the role of policy development in improving the structure of green digital finance. The researchers examined the role of public policy in developing a more efficient system of green digital finance based on the goals of the Paris Climate Agreement and the Sustainable Development Goals (United Nations, n.d.). In addition, researchers noted that digital finance initiatives can be aimed at green digital finance in a well-designed ecosystem. In particular, governments can support green digital finance by implementing sound regulatory policies, and creating incentives through green data initiatives, tax cuts, and investment in technology infrastructure. I. Mavlutova *et al.* (2025) concluded that policymakers need to strike a balance between regulation, oversight, and administrative burden to maximise the potential of digital financial technology and ensure that digital technology maximises the contribution to sustainable economic development. As shown in Figure 1, the use of digital tools was crucial to achieving the sustainable development goals. Green digital finance was seen as a multidimensional concept that covered the full range of financial mediation solutions, targeted risk management implementation, and related regulatory functions that created a positive impact on the environment. Digitalisation opportunities have been integrated into green digital financial services chains and driven sustainable growth, contributing to the achievement of the UN Sustainable Development Goals (Mpofu & Mpofu, 2024).

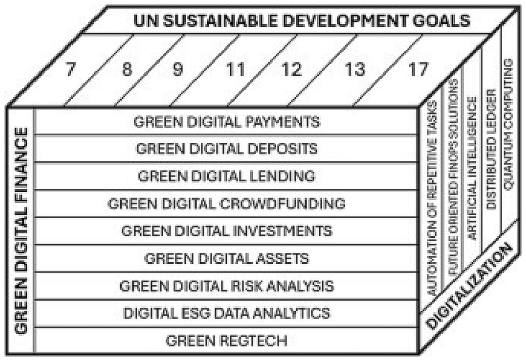

Figure 1. *Progress towards green digital finance at the intersection of digitalisation and Sustainable Development Goals*
Source: *based on P. Tamasiga et al. (2022), I. Mavlutova et al. (2025)*

Green financial technologies, by integrating green financial services into production and service delivery chains, could become an effective tool for achieving the following Sustainable Development Goals: affordable and clean energy, decent work and economic growth, industry, innovation and infrastructure, sustainable cities and communities, responsible consumption and production, climate action, and partnerships for the UN SDG. Critical areas for the development of green FinTech were new blockchain applications in all areas of environmental sustainability with the support of regulators and governments, and socially and environmentally responsible policies that encouraged the development of green financial products (Wasan *et al.*, 2021). "Green" FinTech projects can become a powerful tool for developing "green" financing, which has become part of sustainable financing. However, there was a gap in research, as "green" funding and "green" FinTech projects were not sufficiently studied (Puschmann & Quattrocchi, 2023).

Government support has been essential to encourage the development of green digital finance, especially through the introduction of incentives in the form of tax cuts and investment projects in technology infrastructure, and that funding regulation has contributed to the improvement of renewable energy use (Cheng *et al.*, 2023). Legal aspects and related challenges have become a critical area of the public management landscape for sustainable finance development. Artificial intelligence has transformed the regulation of financial markets by improving monitoring, reporting, and compliance with sustainable finance standards (ESG), moving from manual, sporadic inspections to real-time automated surveillance. Given that, according to van Maarseveen's projections (2025), sustainable investment assets are set to reach USD 50 trillion by the end of 2026, AI has been crucial in combating "greenwashing", managing financial risks associated with climate change, and processing vast unstructured datasets on sustainable development. Table 5 summarises the role of AI in regulating and complying with sustainable finance requirements, and key regulatory approaches and challenges.

Table 5. *Artificial intelligence-based regulation in sustainable finance*

AI in the field of regulation and compliance with sustainable finance requirements
ESG data processing and standardisation: AI, in particular natural language processing (NLP), analysed unstructured data – corporate reports, news, and social media data – to verify sustainability claims and fill in gaps in missing corporate data (e.g., greenhouse gas emissions)
"Greenwashing" detection: AI tools such as ASKCLIMATE and ASKNATURE at the University of Zurich have enabled independent verification of ESG corporate reports, identifying inconsistencies between stated commitments and actual practices
Real-time risk monitoring: AI combined geospatial data (satellite imagery) with corporate reports to track environmental impacts (deforestation, pollution) at the asset level, enabling regulators to identify risks faster than conventional report-based methods
Regulatory reporting automation: generative AI has increasingly been used to automate sustainability reporting (e.g. CSRD, SFDR) in the EU, reducing high labour costs and improving consistency
Key regulatory approaches
EU (proactive and strict law): Regulation (EU) No. 2024/1689 (2024) classified AI systems designed to assess creditworthiness, often considering ESG factors, as high-risk, requiring strict transparency and human control
UK (step-by-step and risk-based): UK regulators (FCA, PRA) have used the rules to address AI risk issues, focusing on operational sustainability and the use of AI-based tools to analyse surveillance data
US (innovation-oriented): regulatory approaches are less directive, they focus on executive orders that emphasise fairness and non-discrimination, rather than strict industry-specific AI laws
Challenges and risks of AI-based regulation
Black box dilemma: complex AI models, especially deep learning, can make it difficult for regulators to understand the rationale behind automated decisions, undermining accountability
Data quality and bias: the effectiveness of AI depended on the quality of training data; inconsistent or inaccurate ESG data can lead to false positives (false detection of "greenwashing") or false negative results
Model grouping: reliance on similar third-party AI models in multiple companies can create systemic risks and sudden crashes
Regulatory fragmentation: different regional approaches to AI regulation have created compliance challenges for global financial institutions

Source: *based on M. Florez (2025)*

To ensure effective regulation, the authorities switched to systems involving humans, requiring 30% of human control when making final decisions, while artificial intelligence automated 70% of repetitive data processing.

However, along with technological advantages, there were also legal problems: responsibility for decisions made by algorithms; opacity of artificial intelligence models; risks of data privacy violations; the need for new regulatory mechanisms. Therefore, the digitalisation of financial management required a combination of technological solutions with appropriate legal regulation. Integration of intelligent systems into the system of state financial regulation required a comprehensive analysis of the legal aspects of their use. The development of digital technologies in the field of finance has created new challenges for the legal system, since conventional regulatory mechanisms have not always considered the specifics of the functioning of algorithmic systems. In particular, the definition of responsibility for decisions made with the participation of artificial intelligence systems, ensuring transparency of algorithmic models, and creating effective mechanisms for controlling the use of digital technologies in public administration processes remained important issues. In addition, the use of intelligent systems in the financial sector required proper legal regulation in the field of personal data protection, information security, and ensuring the cyber stability of the financial infrastructure.

In this context, an important component of the contemporary public administration policy was the development of a comprehensive regulatory framework that regulated the use of digital technologies in the financial sector. Such a framework should ensure transparency in the functioning of algorithmic systems, establish clear rules for their use in state financial supervision, and provide for effective mechanisms for liability for violations of established norms. Singapore has actively integrated artificial intelligence into financial market surveillance to deal with complex threats. Monetary Authority of Singapore (MAS) (n.d.) stimulated implementation by allocating SGD 100 million for financing, developing new AI risk management guidelines for 2025/2026, and focusing on AML and trade oversight. Key applications included AI fraud detection, behavioural anomaly detection, and RegTech compliance tools aimed at balancing innovation and robust security. Singapore has used joint regulation and recommendations (guidelines) to implement mandatory legislation. MAS emphasised that financial institutions should implement a robust management framework for AI, including risk management systems, internal audits, and human control. The existing framework actually included two "pillars": the FEAT principles (fairness, ethics, accountability, transparency) for AI in the financial sector, established in 2019, which remained the foundation of AI ethics (Monetary Authority of Singapore (MAS), n.d.); Personal Data Protection Act 2012 (2020) (Personal data protection act covered data security and privacy in AI systems). Singapore has been at the forefront of developing AI recommendations and collaboration to ensure compliance with AML regulations. Regulators in Singapore have taken a position to promote AI innovation, and it is one of the few markets where there have been guidelines for implementing AI for use under AML control.

W.O. Benaissa *et al.* (2025) saw the UK and Singapore as leaders in AI-based AML innovation, balancing regulatory oversight and technological progress. Both countries have set global standards by implementing flexible, scalable artificial intelligence systems that have improved compliance, reduced the risks of financial crime in fast-growing financial centres, and supported sustained growth in an emerging digital economy. From evolving AML typologies to ever-changing regulatory frameworks and constantly updated watch lists, the lesson from these innovative markets was the following: the key to successfully implementing AML measures was the regulator's collaboration and an approach that encouraged innovation. In the USA, in 2026, surveillance of the US financial market using artificial intelligence was regulated by a hybrid approach that combined existing regulations (SEC, CFTC) and new risk assessment frameworks. Key initiatives included the AI-related risk management framework adopted by U.S. Department of the Treasury (n.d.) in February 2026 and memorial for the Heads of Executive Departments and Agencies (2025), which prioritised responsible, proven and secure AI implementation. Proposed legislation, such as the financial artificial intelligence Risk Reduction Act, was intended to toughen penalties for AI fraud. Key legislative and regulatory changes (2025-2026) included the following: 1) Ministry of Finance and federal government guidelines: the Ministry of Finance has published the AI-related risk management framework (FS AI RMF) and a joint dictionary of AI terms, with a focus on AI cybersecurity and operational sustainability; 2) SEC oversight focus: the SEC has identified more than 30 AI use cases for 2024, focusing on identifying manipulative trading operations. Among the new regulatory proposals are the mandatory maintenance of audit traces for transactions that were carried out using AI, and the introduction of an "algorithmic penalty" for illegal actions (U.S. Department of the Treasury, n.d.); 3) CFTC requirements: CFTC rule 38.156 required automated trade surveillance systems to detect market manipulation, requiring AI to comply with existing trade practice rules; 4) proposed legislation: the financial artificial intelligence Risk Mitigation Act proposed stricter penalties for AI market manipulation and increased oversight of AI service providers by the NCUA and FHFA; 5) state-level actions: by early 2026, 38 states had passed or enacted AI-related risk-elimination legislation – all 50 states have taken appropriate measures, indicating a broad and fragmented regulatory framework (Cornell Law School, n.d.).

In the EU Regulation (EU) No. 2024/1689 (2024) provided for strict regulation of AI in finance based on risk assessment, focusing on transparency, risk management, and human control. Financial regulators have used AI to monitor market integrity, assess creditworthiness, and systemic risks, requiring compliance with data management, tracking, and robust security measures. The AI law supplemented EU financial services laws (such as CRD, GDPR), rather than replacing them, requiring AI providers to

implement quality management systems and technical documentation. In general, AI-based regulatory technologies (RegTech) have used machine learning, natural language processing (NLP), and automation to optimise compliance, reducing costs by 30-50% while improving the accuracy of risk management, KYC, and AML monitoring. These systems have helped to detect anomalies in real time and automate reporting to effectively respond to complex changes in legislation. The rationale for AI problems and issues is presented in Table 6.

Table 6. *Applications and problems of AI in regulated technologies*

Key applications of AI in RegTech
AML and fraud detection: algorithms analysed large amounts of transaction data to identify suspicious patterns, reducing the number of false positive results
"Know Your Customer" verification (KYC): RPA and artificial intelligence have automated the adaptation process by instantly scanning and verifying documents
Regulatory reporting and monitoring: NLP tools have read and interpreted new regulations, allowing companies to quickly adapt their policies
Risk assessment: AI provided real-time multivariate analysis to identify potential risks
Benefits and impact
Cost reduction: automating routine tasks reduced labour costs ensuring compliance with regulatory requirements
Efficiency: faster decision-making, with some companies reducing fraud verification time by 30%
Scalability: AI systems have easily scaled along with business growth, enabling automated and consistent surveillance
Challenges and trends
Data privacy and security: processing confidential information required strong protection
Model transparency: explaining AI solutions was crucial for regulatory audits
Integration: combining new AI tools with old banking systems created technical obstacles
New trend: growing adoption of agent-based AI for autonomous compliance, where AI agents automatically detect and fix regulatory compliance issues

Source: *based on M. Florez (2025)*

The general trend of using artificial intelligence in the field of RegTech is important from statistical data. The global AI market in RegTech is expected to reach approximately USD 29.6 billion by 2033, compared to USD 1.3 billion in 2023, growing at a compound annual growth rate (CAGR) of 36.7% over the forecast period from 2024 to 2033 (Fig. 2). Key drivers of this market's growth were the need for risk management solutions and increasing pressure from global regulatory requirements. As AI technologies improved, they offered more accurate analytics and stronger predictive capabilities, making them indispensable for companies that sought to remain leaders in regulatory compliance. This market trend is expected to continue, and AI will play a key role in transforming the way companies manage regulatory compliance issues and address regulatory issues.

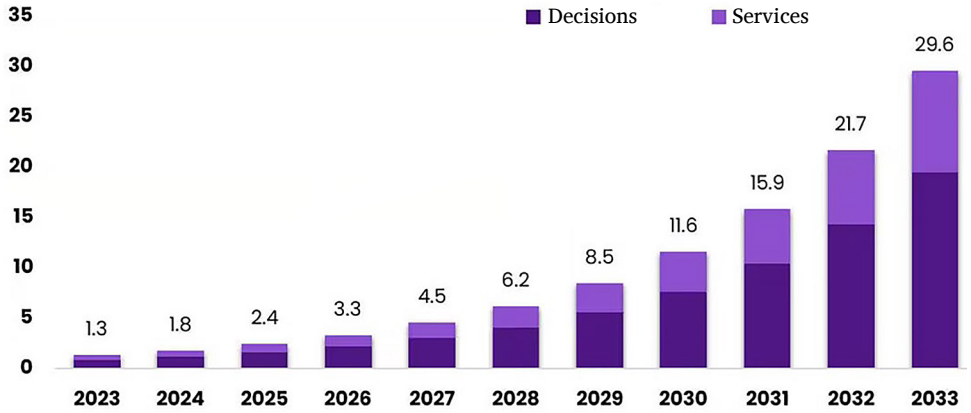

Figure 2. *Global artificial intelligence market in RegTech, billion USD*

Source: *Market.us (2024)*

AI-based solutions, such as compliance software, risk management systems, and audit systems, were in high demand because they provided comprehensive and seamless management of regulatory processes. Implementing these solutions has allowed businesses to adapt faster to regulatory changes, while ensuring accuracy and reducing the likelihood of non-compliance penalties. In addition, artificial intelligence solutions in the RegTech sector have proven effective in analysing large amounts of data to identify potential risks and regulatory compliance issues before they escalate. This proactive approach to risk management has been crucial for sectors such as banking, financial

services, and healthcare, where regulatory requirements have become stringent and the cost of non-compliance can increase. The integration of artificial intelligence into these solutions has enabled continuous learning and improvement, increasing their effectiveness and making them the best choice for many organisations.

In 2023, North America dominated the artificial intelligence market in RegTech, gaining more than 36.7% of the share (Global AI in RegTech Market By Type, 2024). This dominance was conditioned by the high concentration of financial institutions and developed technological infrastructure in the region, especially in the United States and Canada. These countries have become leaders in introducing new technologies, including artificial intelligence, to improve regulatory processes and manage regulatory compliance. The presence of large technology companies and startups focused on AI-based solutions to meet regulatory requirements further contributes to this trend. Moreover, North America's tight regulatory environment required robust compliance solutions, which stimulated demand for RegTech's AI-based services. Regulators in the United States, such as the U.S. Securities and Exchange Commission (n.d.) and the Federal Reserve Board (n.d.), constantly updated regulations to address new financial risks and complexities, which required flexible and effective compliance tools offered by artificial intelligence technologies. In addition, the region's openness to cloud solutions has increased the integration of artificial intelligence into RegTech, making compliance processes more adaptive and less resource-intensive. This technologically advanced approach, combined with significant investment in artificial intelligence research and development from the private and public sectors, has ensured that North America remains at the forefront of the global artificial intelligence market at RegTech.

Thus, the integration of AI into RegTech offered advantages and opportunities. Firstly, AI can help automate compliance tasks, such as monitoring and analysing large amounts of financial data to identify potential risks and breaches. Using machine learning algorithms, artificial intelligence systems can learn from historical data and identify patterns and anomalies that indicate potential regulatory violations. This automation has reduced reliance on manual processes, improved accuracy, and provided real-time analytics, enabling organisations to proactively address compliance issues. The artificial intelligence market in RegTech has also created challenges and considerations. One of the main issues was data privacy and security. RegTech systems depended on access to sensitive and sensitive data, including customer information and financial records. Ensuring reliable data protection measures and compliance with regulations such as the General Data Protection Regulation (EU GDPR) (2018) was critical to maintaining trust and protecting against potential breaches. Interpreting and explaining artificial intelligence-based decision-making processes has become another challenge. Regulators and auditors needed transparency and clarity in artificial intelligence systems to accurately assess compliance. The development of clear models and structures of artificial intelligence that can provide insight into the decision-making process has become important for solving this problem. Moreover, the introduction of artificial intelligence in RegTech required qualified specialists with both regulatory and technical expertise.

The regulation of sustainable funding through AI-based solutions included the use of machine learning, natural language processing, and big data analytics to automate ESG compliance, improve risk assessment, and prevent "greenwashing". Since significant growth in sustainable investment assets is projected for the 2030s, artificial intelligence is a key tool for scaling and verifying these investments by processing massive, unstructured data sets into practical, transparent and relevant findings. Artificial intelligence platforms such as those developed by MSCI and Clarity AI have used machine learning to identify inconsistencies, exaggerated statements, and misleading wording in corporate sustainability reports, increasing accuracy by up to 85% (Abikoye *et al.*, 2024). Artificial intelligence-based solutions, such as those used by P.J. Morgan (2022), optimised reporting by reducing compliance costs by 70-85% by automating data collection and verification, thereby addressing the complexity of regulations such as SFDR and CSDR. Artificial intelligence and blockchain technology have been combined to track the use of funds from green bonds to ensure their use for environmental purposes, reducing the risk of misuse of funds. Conflicting or inaccurate ESG data can lead to suboptimal AI-based decisions. The complexity of some AI models has made it difficult for regulators to understand how decisions are made, raising concerns about transparency, bias, and accountability.

Conclusions

The results of the study showed that contemporary financial systems operated in an environment of high technological dynamics, which necessitated the transformation of conventional financial supervision mechanisms and development new public administration tools. The introduction of digital technologies, in particular artificial intelligence tools, significantly increased the efficiency of state financial control, contributed to the automation of analytical processes and provided more accurate forecasting of financial market risks. Digitalisation of the financial sector was accompanied by the emergence of new legal challenges. Key issues included ensuring transparency of algorithmic solutions, determining responsibility for the use of artificial intelligence systems in public administration processes, and adapting the regulatory framework to the rapid development of digital technologies. An important aspect was the need to develop effective mechanisms for controlling the use of intelligent systems in financial regulation and ensuring a balance between stimulating innovation and maintaining financial stability.

Integration of digital technologies into the public financial management system can contribute to the

development of sustainable financial instruments, increase the investment attractiveness of the economy, and strengthen the financial security of the state. The effectiveness of such processes largely depends on the creation of a comprehensive legal system that ensures transparency, accountability, and security of the use of digital technologies in the financial sector. In the EU, artificial intelligence systems designed to assess creditworthiness were classified as high-risk, which required high transparency and human control. In the UK, regulators have focused on a risk-based approach, with a focus on operational sustainability and the use of AI to analyse observational data. In the US, regulatory approaches have focused on ensuring fairness and non-discrimination through executive orders, without strict industry laws on AI. The study had limitations, in particular, the analysis was based mainly on theoretical approaches and generalisation of international experience, which may require further empirical verification. The rapid development of digital technologies in the financial sector has made it necessary to constantly update regulatory and institutional approaches to regulation. The prospects for further research are related to the development of models of digital management of sustainable finances, assessment of the effectiveness of the use of artificial intelligence in the financial supervision system, and the development of new international standards for the legal regulation of algorithmic financial systems.

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Conflict of Interest

None.

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Публічне управління сталим розвитком фінансів: цифрова трансформація та правові виклики

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Анотація. Метою дослідження став аналіз стратегій публічного управління, спрямованих на стимулювання інвестицій у сталу економіку, а також оцінка можливостей використання інструментів штучного інтелекту для підвищення ефективності державного нагляду за фінансовими ринками. У роботі було досліджено стратегії публічного управління, орієнтовані на стимулювання інвестицій у сталу економіку, а також правові аспекти впровадження інтелектуальних систем у процеси прийняття рішень, що сприяли забезпеченню фінансової безпеки та стабільності фінансової системи в довгостроковій перспективі. Зокрема, було приділено увагу питанням прозорості алгоритмічних рішень, відповідальності за використання автоматизованих систем і захисту фінансових та персональних даних у процесах державного фінансового управління. Результати дослідження показали, що інтеграція цифрових технологій у систему публічного управління фінансами дозволило значно підвищити ефективність фінансового нагляду, покращити прозорість операцій та розвивати сталий фінансовий інструментарій. Однак, успішна реалізація цих трансформацій вимагала удосконалення нормативно-правової бази та створення механізмів регулювання використання штучного інтелекту в фінансовому секторі. Крім того, було визначено, що штучний інтелект, завдяки своїй здатності автоматизувати аналіз великих даних та оперативно виявляти ризики, значно покращив ефективність фінансового регулювання. Проте, це створило правові виклики, зокрема щодо визначення відповідальності за автоматизовані рішення. Результати експертного опитування підтвердили важливість інтеграції цифрових технологій із правовими гарантіями, щоб забезпечити етичність і стабільність фінансових ринків. Практична значущість дослідження полягає у формуванні науково обґрунтованих підходів до інтеграції цифрових технологій у систему публічного управління фінансами з метою забезпечення фінансової стабільності, підвищення інвестиційної активності та підтримки довгострокового розвитку сталої економіки

Ключові слова: цифрове фінансове регулювання; регуляторні технології; рішення штучного інтелекту; стала економіка; фінансова безпека