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Documentation technologies in the electronic document management system of the public sector of Ukraine

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Abstract. The purpose of the study was to comprehensively investigate documentation technologies in electronic document management systems of the public sector of Ukraine, with an emphasis on their legal, technical, and organisational interaction. Methodologically, the research was based on an integrated approach, including comparative legal analysis of legislation, content analysis of state information systems, structural, functional, and statistical methods, which were used to study the practical implementation of digital document management in Ukraine. As a result, it was established that the regulatory framework of Ukraine creates sufficient conditions for the functioning of electronic document management, but in practical terms there is a significant fragmentation in the application of metadata standards and exchange protocols. Analysis of the technological infrastructure has shown that the main document management systems differ in the level of security, integration and compatibility with state platforms, which leads to the emergence of information barriers between institutions. Structural and functional analysis revealed that the Trembita system became the central link of interagency interaction, but simultaneously increased the risks of cyber-attacks, as evidenced by the increase in incidents in 2024 by 69.8%. The use of content analysis showed that the Diia and Prozorro systems have provided an increase in digital trust of citizens, but remain vulnerable to problems of authenticity of electronic documents and stability of long-term storage. The data obtained also showed that the introduction of cloud technologies, artificial intelligence, and blockchain audit are factors for future improvement of transparency and efficiency of state document management. The conclusions indicate that documentation technologies are becoming the main tool not only for digitalising administrative processes, but also for building trust between the state and society. The practical significance of the study lies in the possibility of using the results obtained to develop public strategies for digital integration, optimise document flow, and create a single electronic document management platform in accordance with European standards

Keywords: digitalisation; metadata; digital governance; electronic signature; public services

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Introduction

The relevance of the subject matter is conditioned by the rapid development of digital technologies, which radically change the structure and dynamics of public administration, in particular in the field of document management. In the context of martial law, cyber threats and the growing need for fast communication between government agencies, the problem of effective electronic document management has become of strategic importance. Ukraine, being at the stage of deep digital transformation, is faced with the need to simultaneously ensure technological integration, information security, and compliance with international standards of e-governance. Electronic document management in the public sector has become a tool not only for optimising administrative processes, but also for implementing the principles of transparency, openness, and accountability of the authorities. Thus, the study of documentation technologies in electronic document management systems acquires scientific and practical value, since it determines the areas of further development of the digital state and its ability to function effectively in the context of crisis challenges.

In previous studies, the issues of digitalisation of public administration were considered from various aspects, but the technological processes of documentation within electronic document management systems remained fragmentary studied. T.I. Skibina (2024) explored the role of innovation in Ukraine's public administration in the context of European integration and anti-corruption policy. The researcher identified the types of innovations – from e-governance to blockchain systems and e-voting and stressed the need for a comprehensive approach to their integration. In her study, documentation technologies were considered only indirectly, as a component of the overall digital management ecosystem. The study by A. Elsafty & A. Yehia (2023) on the Egyptian public sector showed that successful digital transformation depended on a combination of financial, infrastructure, and organisational factors. The researcher emphasised the importance of leadership and communication for implementing changes, but the aspect of technical solutions for managing electronic documents remained out of focus. The study by O. Karpenko *et al.* (2023) examined the digital transformation of public administration in transition economies, where a close relationship was found between the effectiveness of public administration and the level of development of e-governance. The researchers clustered countries according to the level of digitalisation, but did not reveal internal technological differences between electronic document management systems, which limited the possibility of generalising practical integration models. A. Kud (2023) focused on the potential of blockchain platforms in public administration. The researcher argued that decentralised systems could provide greater transparency and security than centralised digital platforms.

L. Storozhenko (2023) emphasised the growing role of e-democracy and the need to harmonise national legislation with international legal norms. The researcher analysed the main laws regulating the information environment of Ukraine, and came to the conclusion that, despite the quantitative growth of regulatory acts, there was still a need for deeper regulation of electronic document management and ensuring the interoperability of state systems. The concept by S. Hrytsai (2023) was based on the GovTech phenomenon as a vector for digitalisation of public services. Using the example of the project "Diia", the researcher demonstrated the practical advantages of digital services and focused on the legal difficulties of interstate regulation. The study by J. Matusiak & A. Narozniak (2025) revealed the legal aspects of implementing an electronic document Diia.pl for Ukrainian citizens in Poland. The researchers pointed out the problems of balancing technical solutions and human rights guarantees in the context of migration crises, which allowed expanding the understanding of the socio-legal aspects of digital documents. N. Blavatska & O. Berdar (2025) summarised the legislative framework of Ukraine on e-governance, systematising more than 300 regulatory acts regulating this area. The researchers emphasised the role of the Constitution of Ukraine as the basis for the development of the digital state, but focused mainly on legal aspects, leaving the technological processes of documentation without in-depth consideration.

Thus, in the existing studies, the digital transformation of the public sector in Ukraine was considered mainly in the context of legal regulation, innovative development and international comparisons, while the issues of documentation technologies in electronic document management systems, in particular, their technical integration, metadata, security standards, and interagency compatibility, remained insufficiently covered. This aspect required a comprehensive analysis, considering modern Ukrainian realities and trends in European digital policy. The purpose of this study was to analyse documentation technologies in the electronic document management system of the public sector of Ukraine. To achieve this goal, the following tasks were set: to carry out a comparative analysis of the regulatory and technological basis of electronic document management in Ukraine; to identify problems of interoperability, security and standardisation of metadata in state information systems; to outline areas for further development of documentation technologies, including the use of artificial intelligence, cloud technologies, and blockchain solutions in the public sector.

Materials and Methods

The methodological basis of research was a system-analytical approach to the study of documentation technologies in the public administration system of Ukraine, which provided for the consideration of regulatory,

technical, and organisational components of electronic document management as interrelated elements of a single information and administrative ecosystem. The study was of an applied nature and was aimed at determining the structure, principles of functioning and level of integration of electronic document management systems in the public sector. The study was based on the analysis of data for the period from 2004 to 2025, which covered both the retrospective dynamics of the introduction of electronic document management in Ukraine, and its current state and strategic development prospects. Several complementary methods were used to achieve this goal. The main tool was structural and functional analysis, which allowed identifying relationships between technological components of documentation – electronic signature, encryption, metadata, storage formats, and routing systems. This helped to reveal the logic behind the structure of technological processes within the framework of state document management.

Additionally, the method of regulatory reconstruction was used, which provided for a detailed study of laws, regulations, orders, and standards regulating the field of electronic document management. In particular, the analysis covered the following legislative acts: the Law of Ukraine No. 851-IV (2003), which defined the basic categories of electronic document and its authenticity; the Law of Ukraine No. 2155-VIII (2017), which harmonised Ukrainian legislation with the requirements of Regulation (EU) No. 910/2014 of the European Parliament and of the Council (2014) and introduced the concept of qualified electronic signature (QES). The Law of Ukraine No. 80/94-BP (1994) was also worked out, which forms the requirements for creating comprehensive information security systems. The analysis of these documents allowed outlining the legal framework for the introduction of documentation technologies in the public sector and determining the level of their compliance with international requirements. The study also considered national standards as elements of methodological support for document management. These include: ISO 15489-1:2018 (2018), which defines the life cycle of an electronic document; ISO 23081-1:2018 (2018), which regulates metadata management; and DSTU 4163:2020 (2020), which provides unification of document details and formats. In addition, the requirements of ISO/IEC 27001:2013 (2013) on information security were considered. These regulatory documents defined methodological guidelines for analysing the architecture of document management systems.

The paper used a comparative case method, which consisted in comparing the leading electronic document management systems of the public sector of Ukraine in a number of parameters: functionality, level of automation, types of technological components, data formats and the degree of integration with other information systems. For this purpose, six systems were selected that represent different levels of public administration and areas of application: ASKOD (n.d.) – the leading system of public authorities that provides a full cycle of registration, routing and control of documents; SEDO (n.d.) – an interdepartmental system administered by the state special communications service, which provides internal and interdepartmental document flow; M.E.Doc (n.d.) – a corporate system for accounting and tax document management, which is partially integrated with government agencies. The following systems were also considered: Vchasno (n.d.) – a private platform with cloud storage and QES support, which is actively used by businesses and government organisations; Megapolis.DocNet (n.d.) – a system for local self-government bodies that allows local automation of document flow; DOC PROF (n.d.) – a solution for office management automation that interacts with the Trembita platform. The choice of these cases was determined by their representativeness for different levels of management (central, regional, municipal) and various formats of technical integration (local, cloud, interdepartmental). The selection criteria were the scale of application of the system, the openness of the architecture, and the availability of IISS certificates (Integrated information security system), integration with other government platforms, in particular with Trembita.gov.ua (2025), which provides interagency data exchange.

The research methodology provided for the use of an institutional and analytical approach, which allowed assessing the role of state structures in the development of digital document management infrastructure. In particular, the analytical reports of the Assessment of the state of development of the electronic trust services sector (2024) were reviewed. The study of the encryption technology infrastructure was based on analytical materials by M.V. Ivaschyshyn (2025), describing the application of RSA algorithms (cryptographic algorithm for encryption and electronic signature) and SHA-256 (hashing algorithm for ensuring data integrity) in government systems, and in accordance with the provisions of the international standard ISO/IEC 27001:2013 (2013). Attention was paid to the method of case analysis of regulatory documents and state strategies, in particular, the Order of the Ministry of Justice of Ukraine No. z1421-14 (2014), the Standard instruction on office management in public authorities, local self-government, enterprises, institutions and organisations (Resolution of the Cabinet of Ministers of Ukraine No. 55-2018-п, 2018), and the Resolution of the Cabinet of Ministers of Ukraine No. 1351-2024-р (2024). These documents allowed defining the regulatory logic of digital transformation of document flow and the areas of its harmonisation with European standards (eIDAS 2.0). Additionally, the critical regulatory analysis method was applied to assess the adequacy of the existing regulatory framework to real technological challenges – in particular, in the field of cyber defence, long-term storage of electronic documents, and cryptographic stability. Empirical data from state reports and technical descriptions of the Trembita.

gov.ua (2025), Government Portal (2025) and Diia (n.d.) platforms were used to comprehensively investigate the practical aspects of the functioning of interdepartmental document management, which reflect the scale of transactions, the number of connected registers, and the level of process automation.

Results

Theoretical and methodological foundations of documentation technologies in electronic document management of the public sector

In public administration, documentation technologies play a role in ensuring effective information exchange, legal certainty of management actions, and the development of a digital administrative culture. The concept of "documentation technologies" covers a set of methods, tools and technical means that ensure the creation, registration, transfer, processing, storage, and use of documents in the process of management activities (Chernetska, 2022). Unlike conventional paper-based document management, documentation technologies integrate digital tools, metadata systems, electronic signatures, and authentication algorithms, which fundamentally transforms the principles of document management in the public sector.

The evolution of documentation technologies in Ukraine took place in stages. At the first stage (1990-2000), mechanisms for automating individual office management processes dominated – document registration, logging, and monitoring the execution of orders. Data from 2004 show that at that time only ~4% of institutions used office automation systems, and only ~1.2% of institutions used electronic document management systems (EDMS) (Decision of the Collegium of the State Committee of Archives of Ukraine No. nr005560-04, 2004). The second stage (approximately 2010-2020) was characterised by attempts to introduce EDMS more widely, with the adaptation of electronic digital signatures (EDS) and gradual integration between bodies. However, research shows that many local authorities still maintain a hybrid document management model, and full-fledged EDMS operate only in limited cases due to a lack of funding, infrastructure, and resistance to changes on the part of employees (Shevchenko, 2021). The current stage (starting in 2020) is characterised by a rapid increase in the use of electronic signatures in society: in 2023, the use of e-signatures and e-seals exceeded 20 billion times (Digital services instead..., 2024). This shows that digital tools are widely used by citizens and businesses, which creates prerequisites for in-depth integration of state EDMS with public services.

Regulatory support of electronic document management in Ukraine is a complex and multi-level system that integrates legislative, bylaws, departmental and standardisation acts aimed at creating a single legal space for the creation, circulation, storage, and use of electronic documents in the public sector. This system is the foundation of digital transformation of management, because it determines the legal status of an electronic document, the conditions for its authenticity, legitimacy, long-term storage, and interaction between document management entities. The basic act that laid the foundations for the legal regulation of electronic document management was the Law of Ukraine No. 851-IV (2003), which first defined the concept of an electronic document, its details, structure, and signature requirements. The law established the principle of equivalence of an electronic document to a paper counterpart, provided that an EDS is applied. It was this law that introduced the legal category of authenticity, that is, guarantees that the content of the document remains unchanged from the moment it was signed, which became the foundation for creating trusted digital services in public administration.

The second regulation is the Law of Ukraine No. 2155-VIII (2017), which harmonised the national legislation with Regulation (EU) No. 910/2014 of the European Parliament and of the Council (2014) creating the basis for mutual recognition of electronic signatures and seals between Ukraine and the countries of the European Union. Based on this law, the concept of a QES has been introduced, which has an increased level of cryptographic protection, and a qualified electronic seal as an analogue of the legal identification of a body or institution. In practice, this allowed ensuring the legal reliability and security of electronic document management in the public sector. The Law of Ukraine No. 80/94-BP (1994) is also significant, as it defines the procedure for protecting official, confidential and personal information during its processing in electronic document management systems. It is this act that forms the requirements for the creation of IISS, which are mandatory for all state bodies.

National standards play a significant role in establishing uniform requirements for the structure and formatting of electronic documents, in particular DSTU 4163:2020 (2020), which adapted the Ukrainian office management system to the international requirements. This standard defines mandatory document details, metadata formats, electronic signature requirements, and time labelling. Its use eliminates duplication or loss of documents, as it provides a unified format for integration into any electronic document management system. Equally important is ISO 15489-1:2018 (2018), which introduced the concept of the life cycle of an electronic document – from creation to archiving and destruction. It has become a theoretical and methodological basis for designing automated archival systems of state institutions, which in the future allows moving to the concept of long-term electronic archiving. The bylaw level of regulatory regulation is provided by numerous instructions, orders, and methodological recommendations. In particular, the Standard instruction on office management in state authorities, local self-government bodies, enterprises, institutions, and organisations (approved by Resolution of the Cabinet of Ministers of

Ukraine No. 55-2018-п (2018)) provides for the rules for forming electronic files, maintaining nomenclature, organising archival storage of electronic documents, and requirements for monitoring execution. In addition, Order of the Ministry of Justice of Ukraine No. z1421-14 (2014) regulates the procedure for using electronic signatures, seals, and time stamps in the field of notarial and state registration. These documents create a procedural basis for the legal reliability of electronic document management in public administration.

Analytically assessing the current regulatory framework, it should be noted that, despite its general structure, it has an asymmetric nature of development. In 2021, a Resolution of the Cabinet of Ministers of Ukraine No. 1351-2024-р (2024) was adopted, which provides for the creation of a unified regulatory and technological framework for electronic document management, harmonised with EU (European Union) directives on digital identity and trust services. Information technology components of documentation form the core of the functioning of electronic document management of the public sector, as they ensure the authenticity, integrity, long-term preservation and legal significance of management documents. In the structure of electronic records management, each of these components – electronic signature, encryption, metadata system and standardised storage formats – performs a separate but interrelated function, forming a complex technological ecosystem that guarantees the legitimacy and security of electronic data in public administration.

An electronic signature in state document management is the main tool for confirming the person who created or approved the document. Its application is regulated by the Law of Ukraine No. 2155-VIII (2017), which provides for three levels of signature – simple, advanced, and qualified (QES). A qualified electronic signature is based on certified cryptographic keys issued by trust centres accredited by the Ministry of Digital Transformation. As of 2024, there are more than 20 accredited providers of electronic trust services in Ukraine, including the Central certification body, IIT, key systems and Diia.Signature (Ministry of Digital Transformation of Ukraine, 2024). According to statistics from the Assessment of the state of development of the electronic trust services sector (2024) on the CCA (Central Certification Authority) website, there are 25,103,409 qualified electronic signature certificates issued, of which 12,173,893 are active. Encryption technology ensures confidentiality and protection of information from unauthorised access during the transfer of documents between institutions. In the state document management systems of Ukraine, RSA asymmetric encryption algorithms are mainly used, including SHA-256 hashing algorithms for checking the integrity of files (Ivaschyshyn, 2025). The use of encryption is a mandatory requirement for interagency document exchange via Trembita.gov.ua (2025), which unites more than 120 state registers. The practical implementation of encryption in state EDMS not only ensures the protection of personal and official data, but also meets the international requirements of ISO/IEC 27001:2013 (2013), which confirms Ukraine's compliance with European information security standards.

Metadata acts as an intelligent framework for an electronic document – it describes its structure, origin, status, author, date of creation, document type, and relationships with other files or processes. In the state document flow, metadata is generated automatically when creating a document, and its structure meets the requirements of ISO 23081-1:2018 (2018), which defines the principles of metadata management for electronic documents. For example, in ASKOD (n.d.), metadata is used to build document routing: based on attributes (document type, importance level, sender department), the system automatically determines the approval sequence. Electronic document storage formats determine technological compatibility and the possibility of their long-term use. In Ukraine, the main standard is the PDF/A format, which meets the requirements of ISO 19005-1 (2017) also ensures that the document structure and appearance are preserved regardless of the software environment. State EDMS also use XML and DOCX formats for internal processing and transmission of cross-system data. The main electronic document management systems are shown in Table 1.

Table 1. Comparative characteristics of the main electronic document management systems of the public sector of Ukraine

System name	Developer / Administrator	Main functions	Technological components	Integration with other systems
ASCOD	LLC Intellect-Service	Registration, execution control, recording of requests, document routing	QES, RSA encryption, XML metadata, PDF/A format	Integration with Trembita, SEI EA, Diia.Signature
SEDO	State special communications service	Internal and interdepartmental document management, control over the execution of orders, storage	QES, encryption, JSON metadata, PDF/A archive	Deep integration with government portals, CEA
M.E.Doc	LLC Intellect-Service	Exchange of accounting and tax documents, reporting	QES, AES encryption, XML, XLSX formats	Integration with the State Tax Service, Pension Fund, and banks
Vchasno	LLC Vchasno (Kyivstar platform)	Signing, transferring, and archiving contracts and service documents	QES, cloud storage, JSON metadata, PDF/A	Integration with CRM, ERP, and API for public services

Continued Table 1.

System name	Developer / Administrator	Main functions	Technological components	Integration with other systems
Megapolis. DocNet	LLC Softline Group	Internal document flow of local self-government bodies	QES, XML metadata, PDF/A	Local integration with archives and accounting systems
DOC PROF	LLC DOC-Pro	Office management automation, control, registration, archiving	QES, encryption, XML, PDF/A	Can interact with Trembita via the API

Note: LLC – limited liability company; SEI EA – system of electronic interaction between executive authorities; JSON – format of data exchange based on text; CEA – central executive authority; AES – advanced encryption standard; STS – State Tax Service; CRM – customer relationship management system; ERP – enterprise resource planning system; API – application programming interface

Source: compared by the authors based on V. Hryshyn (2024), Trembita.gov.ua (2025), ASKOD (n.d.), SEDO (n.d.), M.E.Doc (n.d.), Vchasno (n.d.), Megapolis.DocNet (n.d.), DOC PROF (n.d.)

Comparative analysis (Table 1) showed that electronic document management systems of the public sector of Ukraine differ significantly in the degree of automation, level of integration and technological architecture. The leading solutions in the field of state document management remain ASKOD (n.d.) and SEDO (n.d.), which provide the highest level of information security, support qualified electronic signatures, multi-level encryption and standardised storage formats. Their integration with the Trembita platform forms the basis of a single information space for interdepartmental exchange. On the other hand, the M.E.Doc (n.d.) and Vchasno (n.d.) systems, although highly effective in the field of business communications and tax reporting, remain auxiliary for management document flow due to their limited compliance with state archival requirements. Thus, the development and functioning of the electronic document management system in Ukraine is a complex, multidimensional process that combines the evolutionary development of documentation technologies, a comprehensive regulatory framework and practical integration of various technological solutions. Despite significant progress reaching all levels of public administration, the system continues to face challenges of fragmentation, security and full-scale interoperability, which identifies key areas for further improvement and harmonisation with European digital governance standards.

Practical aspects of introduction and development of documentation technologies in the electronic document management system of the public sector

The current state of implementation of electronic document management in state institutions of Ukraine should be considered as an intermediate phase of transformation – partially completed at the level of central bodies and infrastructure platforms and simultaneously fragmented at the level of regional and local government bodies. At the macro level, the functioning of interdepartmental interaction is provided by the platform Trembita.gov.ua (2025), which implements a data exchange architecture modelled on the Estonian X-Road and gradually forms a "gateway" between state registers, services, and EDMS. Since 2019, Trembita has become a basic element of integration of Diia services and other government platforms; according to reports on the development of the system, the platform already connects a significant number of registers and processes billions of transactions, which makes it a tool for ensuring end-to-end electronic document management at the national level. Such a centralised infrastructure increases the technical suitability of state systems for interdepartmental exchange and creates prerequisites for the unification of protocols and document formats (Trembita.gov.ua, 2025). Moreover, the deployment of EDMS shows significant heterogeneity in the degree of maturity and functional saturation. Central executive authorities and large government agencies most often have the resources to implement standardised EDMS, certify information security, and continuously integrate with national registries; private research and reports indicate that central authorities show the highest rates of connectivity to interagency platforms, while local authorities and small institutions use local or commercial solutions that do not always meet the requirements of archival storage or compatibility. This creates technical and organisational "islands" of data: documents created and stored in regional EDMS or commercial cloud solutions may not always be automatically integrated into national workflows without prior format transformation or manual processing. The result is additional time and resources spent on unification during interagency cooperation.

The institutional and legal framework and centralised initiatives create technical and procedural prerequisites for the widespread introduction of electronic document management, but practical implementation has faced several systemic barriers. The first group of obstacles includes imperfect or insufficient unification of technical standards in terms of metadata exchange and storage formats, which makes it difficult to seamlessly route documents between different EDMS. The second set of problems is the lack of personnel skills and weak motivation for change among employees of institutions: the lack of standardised programmes to improve digital literacy makes it difficult to quickly and safely use electronic document management tools. The third aspect is

finance and the procurement model: different quality of tender procedures and lock-in risks increase the total cost of ownership and limit the scaling of decisions at the national level. Cybersecurity and infrastructure sustainability are a central concern for the public SED sector. A full-scale military invasion and increased cyber-attacks in recent years have significantly increased the security requirements of systems and at the same time demonstrated vulnerabilities. Official messages of the Computer Emergency Response Team in Ukraine (CERT-UA recorded 4,315 cyber..., 2025) record thousands of incidents annually: in 2024 alone, 4,315 cyber incidents were registered, which is 69.8% more than in the previous year (2,541 incidents), which indicates a critically high intensity of attacks. Most often, the targets of attackers include local authorities, government agencies, the security and defence sector, the energy sector, commercial organisations, and telecommunications providers, where incidents such as malware distribution, phishing, unauthorised connections, and account hacking predominate. The presence of centralised inter-registry gateways (such as Trembita) creates a strong benefit in the form of a single exchange channel, but simultaneously concentrates the risks: failures in an interoperable platform or a successful attack on it can have a large-scale impact on public services. The practical answer – combining the policies of "encrypted channels + local isolation + multi-level identification (PKI) + independent audit of IISS" – is already used in leading government projects, but requires systematic investment and coordination at the government level.

Analytical assessment of operational effects shows that the full use of documentation technologies has a measurable impact on the speed of response and the quality of management decisions. Automated routing, based on standardised metadata and business logic, reduces the time required for documents to pass between departments, reduces the number of manual errors, and increases transparency – changes that directly affect decision execution control and accountability. Using the example of individual projects, the integration of electronic routing and central registers made it possible to reduce the share of "lost" or "outdated" cases and increase the reproducibility of processes in archive inspections. In one of the projects – the Electronic Health Care System (EHCS) – it was recorded that due to the optimisation of processes, the speed of processing queries in the central database increased by approximately 20% at the end of 2024 compared to 2023. In addition, the average system reliability rate was 99.8%. This means a significant reduction in downtime, fewer errors and delays in the transmission and processing of medical documents (E-health, n.d.). Another example is the digitalisation of competitions for domestic bus routes through a Unified Information Systems Complex. Amendments to Resolution No. 1081 (Draft Resolution of the Cabinet of Ministers, n.d.) envisaged that the submission of documents and competitions will take place electronically through the carrier's online account, which will speed up the procedure, save participants' resources and reduce corruption risks. In fact, documentation technologies can turn a document not only into a storage medium, but also into a "record" of regulated actions in the decision-making process, which allows conducting a retrospective audit, identifying procedural deviations, and preventing corruption risks. The effectiveness of such mechanisms directly correlates with the level of data availability (open data) and the quality of metadata: without unified descriptions and structured attributes of documents, full disclosure of information becomes technically and legally difficult.

In modern conditions, this interaction is characterised by a high level of technological dependence between systems, which makes it necessary for deep interoperability at the level of protocols, standards, and metadata. Trembita.gov.ua (2025), which was launched in 2019 with EU support, is a basic component of the integration of state information systems. As of 2025, the system has already processed more than 10 billion exchange transactions between registries (Government Portal, 2025). Based on its operation, ministries, departments, and local governments can transmit data without creating duplicate registers, which reduces the risk of discrepancies and errors. Interaction between EDMS and industry registries requires compliance with common technical and semantic standards. However, in practice, government information systems often use different identification schemes, incompatible exchange formats, and different access models. For example, executive EDMS are built on SOAP/XML protocols, while new Diia services are focused on REST API with JSON formats. This creates technical fragmentation that requires additional conversion gateways, which increases delays in data exchange and creates potential information security vulnerabilities. The problem also lies in the different levels of compliance of systems with the requirements of the Law of Ukraine No. 80/94-BP (1994).

Information interaction of the Diia (n.d.), Trembita.gov.ua (2025) and SEDO (n.d.) is an example of the practical implementation of an integrated model. For example, electronic services generated through Diia are automatically synchronised with basic registers via Trembita, and copies of documents are recorded in the corresponding document management systems of institutions. This ensures the continuity of the life cycle of an electronic document – from its creation by a citizen or official to archival storage. A significant challenge remains to ensure long-term cryptographic reliability: since electronic signatures have a limited validity period, the state has to implement mechanisms for "re-signing" archival documents or storing digital prints in trusted repositories (timestamp services). Ukraine is gradually introducing new encryption algorithms that are compatible with EU requirements (EIDAS 2.0), which is one of the

important steps towards integration with the European digital trust space.

The social and communication dimension of electronic document management is closely related to technical and legal aspects. Data openness, digital trust and citizens' access to electronic documents form a new paradigm of interaction between the state and society. According to the study (Opendatabot, 2024), the Open Data Quality Index in Ukraine as of March 2024 was only 42.37%, which indicates insufficient compliance with international standards. The most closed authorities, despite the requirements of the legislation, remain the State Tax Service, the Ministry of Health, and the Ministry of Economy, which headed the anti-rating of data quality. Although there has been some recovery in data publishing since the start of the full-scale intrusion, the overall level of transparency has not yet reached the level of early 2022, when the index was 57.6%. The leaders in the quality of data publication are the Verkhovna Rada of Ukraine, the State Judicial Administration, the Ministry of Justice, and the Ministry of Internal Affairs. A positive example is the Diia (n.d.) and Prozorro (2025), which provide not only the convenience of using electronic documents, but also form a culture of transparency, reducing the risks of bureaucratic abuse. The Diia platform provides citizens with legally significant digital documents that completely replace their paper counterparts, allows document sharing and multi-sharing – the transfer of one or more documents to public or private institutions via a QR code or online link, and also provides audit transparency through a notification system about access to personal data, which creates trust in digital services. The Prozorro platform ensures the openness of public procurement by publishing complete information about tenders, participants, contracts and complaints in the public domain, and uses BI analytics and risk indicators to monitor questionable procedures, which minimises corruption risks and increases government accountability. Both systems create a digital environment in which data openness, process automation, and standardised access policies form a new culture of interaction between citizens, businesses, and the state based on trust, accountability, and convenience.

Further development of electronic document management is impossible without switching to cloud technologies and using artificial intelligence (AI). Cloud services such as Microsoft Azure Government Cloud (Azure for US Government, n.d.), Amazon AWS GovCloud (2025) provide scalability, access continuity, and centralised data backup. The use of AI in government document management contributes to the analytical assessment of data flows, load forecasting, and identification of anomalies in the structure of management processes. Cloud-based solutions and automated document classification also create new risks associated with cyber defence and privacy. Therefore, the integration of artificial intelligence should be accompanied by the development of regulations governing the ethical use of data and responsibility for automated solutions. These technologies open up the prospect of transition to the concept defined in the digital transformation strategy of Ukraine. Below is Table 2, which reflects the problems, areas of improvement and technological solutions in the field of authenticity, openness, and development of electronic document management.

Table 2. Key problems, areas of improvement and technological solutions in the field of authenticity, openness, and development of electronic document management

Key aspect	Current state in the public sector of Ukraine	Main risks	Innovative solutions	Expected results
Authenticity of electronic documents	Use of QES, but not in all departments; some systems do not have centralised signature verification	Forgery or non-validity of signatures, technical incompatibility	Centralised verification via Diia.Signature, implementation of blockchain audit	Improvement of the reliability of documents, transparent control
Unification of formats	Use of various standards and formats (PDF, XML, DOCX)	Incompatibility of interagency systems, data duplication	Unified PDF/A archiving format, Dublin Core metadata implementation	Standardised document management, simplification of interdepartmental integration
Long-term preservation	Partial implementation of the electronic archive	Data loss due to outdated formats	Archive-2025 project, cloud repositories	Saving documents for more than 50 years in an accessible format
Openness and digital trust	Partial implementation of open data	Distrust of digital platforms, risk of data leakage	Public registries, educational campaigns, independent IT security audit	Increasing the level of trust, increasing public control
Development prospects	Implementation of AI modules, testing document classification	Cyber threats, lack of ethical regulation	Flow automation, AI solution support systems	Efficient document flow management, reduced bureaucracy

Source: compared by the authors based on O. Boiko (2024), L. Filipova & A. Shelestova (2024), K. Manyilova & Y. Norchuk (2025), V. Petrovich *et al.* (2025)

Analysis of the table data shows that the digital transformation of document flow in the public sector of Ukraine is developing unevenly: some components of the system demonstrate a high level of technological maturity, while others remain at the stage of partial integration. In particular, the authenticity of electronic documents is ensured through the use of a QES, but its use is still not universal, and the lack of centralised verification creates risks of technical incompatibility and abuse. Introduction of centralised verification mechanisms through Diia.Signature and the use of blockchain audit technologies can significantly increase the reliability and controllability of digital transactions. The problem of format unification manifests itself in the use of different standards (PDF, XML, DOCX), which complicates interagency exchange and leads to duplication of information. The introduction of a single PDF/A archiving format and the Dublin Core metadata system can eliminate technical barriers and simplify data integration between government agencies.

No less important is the area of long-term document storage, where electronic archives are only partially implemented. However, the level of openness and digital trust remains insufficient: incomplete implementation of the open data policy and low awareness of citizens about cyber defence mechanisms create conditions for distrust of digital services. That is why public registries, independent security audits, and digital culture education campaigns are critical. In the future, the integration of artificial intelligence to automate flows and support management decisions will play a key role, which will reduce bureaucratic loads and increase the efficiency of document flow. Thus, the development of electronic document management in Ukraine demonstrates a combination of technological progress and organisational challenges. A key aspect is the creation of a comprehensive digital trust ecosystem in which authenticity, unification, preservation, and openness become interrelated components of a single process. The introduction of innovative solutions – from blockchain audit to AI document classification modules – forms the basis for the transition to intelligent document flow management, which will meet the standards of European digital governance and ensure transparency, accountability, and long-term reliability of state information resources.

Discussion

The results of the study showed the complex multidimensional nature of the processes of digitalisation of documentation in the public sector, which allowed comparing the findings with the best practices of other researchers in the field of e-governance and information security. The study by L.L. Kayukov (2024) focused on cryptographic mechanisms for ensuring the confidentiality, integrity, and authenticity of electronic documents, where the main emphasis was placed on the balance between the performance of systems and the level of their cryptographic strength. The findings confirmed the empirical conclusions obtained in the framework of the study, according to which the use of symmetric algorithms (in particular AES) was appropriate for fast processing of large amounts of information in public document management systems, while asymmetric algorithms (RSA, ECC) more effectively provided authentication and electronic signature. However, in contrast to the approach of L.L. Kayukov, the study showed that in the Ukrainian public sector, cryptographic protection remained mostly regulated, rather than technically standardised, which created risks of fragmentation of security protocols between different platforms. Thus, the practical effectiveness of cryptographic policy in Ukraine was determined not only by the choice of algorithms, but also by the level of their integration into the architecture of document management systems.

Compared to the study by N. Morze *et al.* (2025), which analysed European experience in digital governance within the e-DEBUT project and developed educational modules for building the competencies of civil servants, the need to combine technological development with institutional education was confirmed. While N. Morze *et al.* emphasised the need to improve digital literacy and involve citizens in the processes of e-democracy, the results of the current study indicated that the direct introduction of high-tech systems, such as Trembita or Diia, did not guarantee efficiency without proper personnel and communication support. Thus, N. Morze *et al.* confirmed that technical infrastructure should be accompanied by the development of a culture of digital trust, public transparency, and accountability of state institutions. However, unlike European approaches, Ukrainian practice showed a certain asymmetry between the high level of technological readiness and the low level of civic digital culture, which limited the real effect of implementing innovative solutions.

Comparison with conclusions of V. Petrovich *et al.* (2024) revealed a common interpretation of electronic document management as a system that transforms administrative activities by simplifying the processes of processing, storing, and exchanging documents. The study of V. Petrovich *et al.* emphasised the increase in the efficiency of management processes due to the automation of document flow, which correlated with the results that noted a reduction in the time of approval of internal documents and an increase in labour productivity after the introduction of automatic metadata management. However, unlike V. Petrovich *et al.* who considered electronic document management mainly as an organisational innovation, the current study interpreted it as a complex socio-technical system that included regulatory, communication, and security dimensions. In particular, it was shown that the technological integration of systems was not always accompanied by the harmonisation of data formats and exchange protocols, which created obstacles to interagency interaction. In addition,

the results obtained expanded the analytical conclusions of these researchers in the context of the Ukrainian reality of wartime. If N. Morze *et al.* (2025) and V. Petrovich *et al.* (2024) emphasised digital modernisation as a factor of efficiency, the conducted research showed that during martial law (2022-2025), electronic document management also served to stabilise institutions by ensuring the continuity of administrative processes when physical access to institutions was restricted. It is this aspect – the preservation of managerial capacity through digital tools – that has become crucial for the Ukrainian experience, in contrast to the models developed in the peaceful conditions of the EU.

The study by L. Kachkovska *et al.* (2023) focused on the legal and conceptual foundations of building electronic document management as a component of e-governance. She interpreted the regulatory framework as a complete and functionally complete system that provided formal conditions for the digital transformation of public administration. In comparison with these conclusions, the study revealed significant fragmentation in the practical implementation of regulatory requirements: despite formal harmonisation with European eIDAS standards, problems of interoperability between departmental systems due to the use of different data exchange protocols (SOAP/XML, REST API) and metadata incompatibility remained at the level of technical integration. Thus, while L. Kachkovska *et al.* considered the legal framework to be sufficiently mature, the results obtained in the current study confirmed the existence of deep structural barriers that limited effective interaction between state information systems. In addition, L. Kachkovska *et al.* paid attention to digital governance as a factor of European integration and improving the quality of public services. The conclusions of the current research complemented this position, pointing out that the practical implementation of electronic platforms (Diia, Prozorro) really contributed to the transparency of management processes and the development of digital trust of citizens, but simultaneously created risks of concentration of large amounts of personal data, which required new protection mechanisms. Whereas in the study by L. Kachkovska *et al.*, digitalisation emerged as an unequivocally positive process, the results of the analysis showed the ambivalence of this phenomenon – increased efficiency was accompanied by increased vulnerability of systems to cyber threats, which was confirmed by CERT-UA statistics on the increase in the number of cyber incidents by almost 70% in 2024. Thus, the study not only specified but also deepened the conclusions of L. Kachkovska *et al.*, shifting the discussion from a normative to an empirical and risk-oriented level.

A comparison with the results of the study by N.S. Vasynova (2021) revealed both common and different analytical emphases. N.S. Vasynova stressed that the introduction of electronic document management in Ukraine lagged behind the EU countries by an average of five years, focusing on the legal evolution from the 2003 law to the introduction of authorised electronic services. The study partially confirmed this conclusion, but showed that after 2020, the pace of digitalisation significantly accelerated under the influence of martial law and the reform of public services. While N.S. Vasynova assessed the legal framework as the main factor behind the backlog, the results of the current analysis showed that the constraints were not regulatory, but technological – fragmentation of systems – lack of unified metadata formats and discrepancies between local decisions (M.E.Doc, SEDO, Vchasno, ASCOD). This led to the establishment of "data Islands", which limited interdepartmental integration, despite formal legal compatibility. Research by N.S. Vasynova also emphasised that electronic documents signed with a qualified electronic signature have acquired equal legal force with their paper counterparts, which has reduced bureaucratic barriers. The results confirmed this fact, but at the same time supplemented it with quantitative indicators – as of 2024, more than 20 accredited providers of electronic trust services ensured the functioning of the QES, and the volume of transactions in the Trembita system exceeded 10 billion. This indicated the real institutional maturity of the electronic signature ecosystem, whereas N.S. Vasynova considered it more promising than established. Thus, the results of the study recorded the transition of the Ukrainian model from regulatory consolidation to practical consolidation of electronic document management.

Comparison of the results obtained with the conclusions of O. Matveieva *et al.* (2024) allowed identifying general trends in the interpretation of digital transformation of public administration during the war. O. Matveieva *et al.* noted that the full-scale invasion, although destabilising state institutions, did not stop digitalisation – instead, it contributed to the mobilisation of civil society and the emergence of new forms of horizontal interaction between the population and local authorities through digital platforms. The results obtained confirmed this thesis, indicating that martial law not only did not slow down, but accelerated the development of electronic document management, namely towards increasing the autonomy of regional systems. The analysis showed that the technological cooperation of civil initiatives with state structures had not only a social, but also an administrative effect: it was public digital tools – need bases, analytical dashboards, feedback services – that temporarily compensated for the losses of centralised management. Thus, the results of the current study expanded on the conclusions of O. Matveieva *et al.*, proving that the integration of civil society into the digital document management system was not just a forced adaptation, but a stable feature of the new model of public administration based on networked, decentralised data structures.

The results also correlated with the findings of the study by M. Sira & A. Kuzior (2025), but revealed significant differences in the focus and scope of the analysis. In their paper, digital transformation was considered mainly through the prism of urban management and the development of "smart cities", where the factor was the efficiency of public services, environmental sustainability, and inclusivity of digital solutions. However, the findings showed that the Ukrainian public sector was dominated not by the strategic, but by the reactive nature of digitalisation – due to the need for rapid response to crisis situations and military challenges. If M. Sira & A. Kuzior emphasised the need for long-term planning of digital strategies and the introduction of an ethical framework for data use, while empirical observations showed the predominance of short-term solutions aimed at maintaining the functionality of critical document management processes. Despite this, both studies coincided in the conclusion that digital integration directly affected transparency and accountability of authorities, and its effectiveness was determined by the level of digital trust. The current study, however, supplemented this aspect with specific empirical indicators – for example, an increase in the number of transactions in the Trembita system to more than 10 billion and an increase in the share of electronic documents signed by QES in the public sector, which indicated the systemic institutional maturity of the digital environment.

Comparison with the study by V. Ostapiak (2025) showed a conceptual kinship in the understanding of digital governance as not just a technological, but a social and communication phenomenon that changed the structure of managerial relations. V. Ostapiak interpreted e-governance as a transformation of the logic of state interaction – the transition from bureaucratic centralisation to a citizen-oriented network management model. This approach was consistent with the results of the study, which showed that the platforms Diia and Prozorro formed a new paradigm of communication between the state and society, where speed, openness, and convenience became the main criteria for effectiveness. The analysis revealed those aspects that were ignored in the V. Ostapiak study: in particular, technological challenges associated with incompatibility of departmental systems, fragmentation of metadata standards, and risks of centralisation of information flows. If V. Ostapiak emphasised the strategic feasibility of creating a "limitless government", the results of the analysis showed that technical interoperability and cyber defence remained deterrents on the way to this goal. However, both studies coincided in the conclusion that digitalisation of public administration in Ukraine had not only an administrative, but also a socio-political effect – it increased transparency, the level of trust in the authorities and the sustainability of civil society.

Comparison of the conclusions of scientific sources allowed identifying the evolution of research priorities – from legal justification and conceptual modelling to a systematic analysis of technological, security, and socio-communication aspects in the current study. While previous studies predominantly focused on regulatory, legal, and organisational approaches, the results of the analysis demonstrated a shift towards a comprehensive view of electronic document management as a dynamic cyber-social system, where management efficiency directly depended on technological compatibility, digital trust among citizens, and the readiness of state institutions to manage risks in the context of information threats. Thus, the conducted research not only summarised previous scientific developments, but also expanded their analytical horizon, introducing new empirical parameters for assessing the digital transformation of the public sector of Ukraine into scientific circulation.

Conclusions

The study of documentation technologies in the electronic document management system of the public sector of Ukraine allowed drawing a number of conclusions that indicate the complex and multidimensional nature of digital transformation of administrative processes. It was found that the regulatory framework of Ukraine has established a sufficient legal foundation for the functioning of electronic document management, but its practical implementation has demonstrated significant fragmentation and asymmetry of development. The harmonisation of national legislation with European standards, in particular with the eIDAS 2.0 regulation, created prerequisites for mutual recognition of electronic signatures and seals, but technical interoperability between different systems remained limited due to the use of different exchange protocols (SOAP/XML and REST API) and data formatting. Analysis of the main electronic document management systems (ASCOD, SEDO, M.E.Doc, Vchasno, Megalopolis.Doc, DOC PROF) found significant differences in their functionality, security levels, and integration with government platforms, which led to the formation of technological "islands" of data and complicated interagency interaction.

The standard-regulated metadata system provided structured document descriptions and automated routing, but the variety of identification schemes and exchange formats between different EDMS continued to create technical barriers to smooth document flow. The Trembita infrastructure platform, which processed more than 10 billion transactions, became an interagency integration tool, but the concentration of data flows in a single gateway simultaneously increased the risks of large-scale cyber-attacks, which was confirmed by CERT-UA statistics on an increase in the number of incidents by 69.8% in 2024. The Diia and Prozorro platforms have formed a new paradigm of interaction between the state and citizens, providing convenient access to electronic services and increasing the level of trust in digital tools. Martial law did not stop the processes of

digitalisation, but rather activated civil society, which through technological solutions helped local authorities in providing services, in particular, through the creation of databases for the needs of vulnerable groups and mutual assistance platforms. The prospects for the development of electronic document management systems are associated with the introduction of cloud technologies, artificial intelligence to automate document classification and data flow analytics, and blockchain audit to increase the reliability of documents, but these innovations require further improvement of the regulatory framework for the ethical use of data and cybersecurity. Prospects for further research include analysing the impact of artificial intelligence and blockchain technologies on automating the life cycle of electronic documents and forming models of cyber resilience in the face of hybrid threats.

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Conflict of Interest

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Технології документування в системі електронного документообігу державного сектору України

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Анотація. Метою дослідження було всебічне вивчення технологій документування в системах електронного документообігу державного сектору України з акцентом на їхню правову, технічну та організаційну взаємодію. Методологічно робота спиралася на комплексний підхід, що включав порівняльно-правовий аналіз законодавства, контент-аналіз державних інформаційних систем, структурно-функціональний та статистичний методи, за допомогою яких було досліджено практичну реалізацію цифрового документообігу в Україні. У результаті встановлено, що нормативно-правова база України створює достатні умови для функціонування електронного документообігу, однак у практичній площині існує значна фрагментарність у застосуванні стандартів метаданих та протоколів обміну. Аналіз технологічної інфраструктури показав, що основні системи документообігу відрізняються за рівнем безпеки, інтегрованості та сумісності з державними платформами, що призводить до виникнення інформаційних бар'єрів між установами. За допомогою структурно-функціонального аналізу виявлено, що система «Трембіта» стала центральною ланкою міжвідомчої взаємодії, проте водночас підвищила ризики кібератак, про що свідчить зростання інцидентів у 2024 році на 69,8 %. Використання контент-аналізу показало, що системи «Дія» та «Prozorro» забезпечили підвищення цифрової довіри громадян, але залишаються вразливими до проблем автентичності електронних документів і стабільності довготривалого зберігання. Отримані дані також засвідчили, що впровадження хмарних технологій, штучного інтелекту та блокчейн-аудиту є чинниками майбутнього підвищення прозорості та ефективності державного документообігу. У висновках зазначено, що технології документування стають основним інструментом не лише цифровізації адміністративних процесів, а й побудови довіри між державою та суспільством. Практичне значення дослідження полягає у можливості використання отриманих результатів для розробки державних стратегій цифрової інтеграції, оптимізації документообігу та створення єдиної платформи управління електронними документами відповідно до європейських стандартів

Ключові слова: цифровізація; метадані; цифрове урядування; електронний підпис; публічні послуги