

Governing Algorithms: Transparency, Digitalization, and Risk in European Public Administration – A Comparative Study

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Abstract: *This paper investigates the evolution of algorithmic governance in public administration by comparatively analyzing Estonia, the Netherlands, France, and Romania over the period 2020–2026. Grounded in the theoretical framework of digital governance and algorithmic accountability, the study operationalizes four core dimensions: digitalization (DI), AI integration (AIU), transparency (TI), and algorithmic risk (AR). Methodologically, the research employs a comparative and visual analytical approach, integrating clustered heatmaps, longitudinal trend analysis, and radar chart representations to capture both structural patterns and temporal dynamics. The results reveal a consistent alignment between high levels of digitalization and AI adoption with increased transparency and reduced algorithmic risk, supporting the hypothesis that governance capacity co-evolves with technological advancement. The analysis further identifies differentiated national trajectories: Estonia and the Netherlands exemplify consolidated models of algorithmic governance, France reflects an intermediate institutional adaptation, while Romania illustrates an asymmetrical development pattern characterized by accelerated digital uptake but comparatively weaker governance safeguards. The study argues that the effectiveness of algorithmic governance depends on the institutionalization of transparency and accountability mechanisms, emphasizing the need for coherent policy frameworks that integrate innovation with risk mitigation. These findings contribute to the broader discourse on responsible AI and public sector digital transformation.*

Keywords: *public administration; governing algorithms; transparency, digitalization.*

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Introduction

Over the last two decades, public administrations in the European Union have undergone an accelerated process of digital transformation, driven by technological developments, pressures to streamline public services and the need for increased transparency and institutional accountability. In this context, algorithmic governance – defined as the use of automated systems and algorithms in administrative decision-making processes – has emerged as an emerging strategic direction, integrated into European policies on the digitalisation of the public sector. Algorithmic governance raises both opportunities and challenges. On the one hand, it can streamline processes, reduce processing times and optimise public resources. On the other hand, it can affect the transparency, accountability, and legitimacy of decisions, underscoring the need for robust institutional frameworks for their monitoring and regulation. (Aarab et al., 2025; Adepoju et al., 2025; Androniceanu, M., 2025; Menshikov et al., 2025; Chilunjika 2025; Androniceanu, M., 2026). A major reference point in shaping this context is the European Digital Strategy, promoted by the European Commission, which aims to develop a “Europe fit for the digital age”. Documents such as the European Digital Strategy and the Digital Compass 2030 underline the role of artificial intelligence and data in modernising public administration. In particular, initiatives on interoperability, data governance, and the development of common digital infrastructures create the technical foundations for the implementation of algorithmic systems in administrative processes such as resource allocation, eligibility assessment for social services, or risk management (Anwar et al., 2026; Čirčová et al., 2025; Zabala Aguayo & Ślusarczyk, 2020). Another central element of the European framework is the legal regulation of the use of artificial intelligence. The adoption of the AI Act marks a defining moment in the institutionalisation of algorithmic governance. This legislative act introduces a risk-based approach, classifying artificial intelligence systems used in the public sector according to their impact on fundamental rights. Thus, applications used in sensitive areas – such as justice, employment, or social services – are subject to strict requirements regarding transparency, explainability and accountability (Tuan, 2025). In parallel, the European Parliament and the Council of the European Union are promoting policies that encourage the ethical use of algorithms in public administration. These include guidelines on “Trustworthy AI”, based on principles such as respect for fundamental rights, non-discrimination, security and human control over automated decisions. In this sense, algorithmic governance is conceptualized not only as a tool for administrative efficiency but also as an area that requires robust governance and oversight mechanisms. The European context is also characterized by a diversity of national practices in the implementation of algorithmic governance. Member States such as Estonia, France or Germany have developed advanced initiatives for the digitalization of public administration, including the use of algorithms in digital public services, e-government systems and data analysis platforms. However, there are significant differences between EU countries in terms of administrative capacity, digital infrastructure and the level of

public trust, which generates a fragmented landscape of the adoption of algorithmic governance. An important role in harmonizing these differences is played by European funding and cooperation programs, such as the Digital Europe Programme or Horizon Europe, which support the development of digital capabilities and the exchange of good practices between public administrations. These tools contribute to the consolidation of a European ecosystem of algorithmic governance, based on common standards and interoperability.

In conclusion, algorithmic governance in public administrations in the European Union Member States is developing in a complex framework, characterized by the convergence of technological innovation, legal regulation and democratic principles. The European context offers both significant opportunities for the modernization of the public sector, as well as challenges related to ethics, accountability and the protection of fundamental rights, which require an integrated and coordinated approach at supranational and national levels.

The questions that our research answers are: Why are some states adopting algorithmic governance faster? Is there a correlation between digitalization and risks? Is the Estonian model replicable? How does administrative culture influence the use of AI?

1. Literature about algorithmic governance

The literature highlights that algorithmic decisions can generate a legitimacy deficit in public administration. Cheong (2024) shows that an institutional framework that supports transparency, participation and accountability is needed to ensure the legitimacy of automated decisions. De Fine Licht, J., and de Fine Licht, K. (2021) emphasize the importance of stakeholder involvement and citizen impact assessment. Toledo (2019) proposes an algorithmic governance framework that includes dimensions such as transparency, explainability, human oversight, ethics and public trust, extending the traditional concept of accountability in public administration to the context of automated systems (Decker et al., 2025; Lorincova et al., 2024),

Recent academic literature provides a solid basis for understanding how algorithmic and artificial intelligence systems are integrated into the public sector and what socio-political, institutional and ethical implications they generate (Ndamase et al., 2026; Grabowska and Rzemieniak, 2025; Meijer and Grimmelikhuijsen, 2023). Research addresses both the normative transformations and legitimacy of algorithmic decisions, as well as the organizational challenges and perceptions of citizens and civil servants (Vukethwele et al., 2026; Lukman & Ndamase, 2026; Zhou et al., 2026; Androniceanu, 2025a; Androniceanu, 2025b). One of the representative articles (Gstrein and Kochenov, 2024; Jakubcinova et al., 2025; Jansen et al., 2025; Malek et al., 2025) highlights the issue of the “legitimacy gap” of algorithmic decisions in public administration, emphasizing how the adoption of automated systems changes the nature of the legitimacy of decisions traditionally based on administrative procedures and values, and how this needs to be addressed

through stakeholder involvement and democratic oversight mechanisms of ADM (Algorithmic Decision Making). The research provides a complementary theoretical framework (Klievink et al., 2023; Panagopoulou, 2024) which discusses the threats to the legitimacy of algorithmic governance and the need for calibrated institutional responses, arguing that input (citizen participation), throughput (decision-making process) and output (results) can be affected when automated decisions are not anchored in transparent and accountable mechanisms. The specialized literature (Rakauskiene et al., 2026; Etalong et al.,; Peeters and Widlak, 2023;) identifies critical dimensions of algorithmic governance in the public sector, related to transparency, explainability, human oversight and public trust. A systematic review of the literature on this topic outlines a conceptual framework that includes the transparency of algorithmic decisions, the explainability of systems, the role of human oversight, administrative accountability, and the impact on public trust. Another empirical study (Schnell and McBride, 2023; Sulistyantoro et al., 2024) focused on the integration of artificial intelligence into government highlights the opportunities for increasing government efficiency and resilience, but indicates the need to address ethical challenges, privacy, algorithmic bias and robust regulations that protect democratic values and public trust. An important theoretical contribution (Chamrada et al., 2026; Valle-Cruz et al., 2023; Afonasoava et al., 2019) highlights how institutional digitalization and AI governance can affect social inequalities and institutional legitimacy when data and systems are not subject to clear governance and regulatory regimes. This perspective is relevant for analyzing how public authorities can “govern algorithms, while governing through algorithms”. Case studies (Wang, 2025) show that the integration of ADM into public organizations is often ad hoc, an institutionalized governance process is lacking, and external factors, such as commercial providers, influence the development of systems without adequate oversight, suggesting the need for coherent governance frameworks at national and municipal levels.

Recent experimental research (Wirtz et al., 2025) investigates how transparency and human intervention in algorithmic decisions influence perceptions of legitimacy among both civil servants and citizens, highlighting tensions between technological efficiency and democratic expectations of society. The interdisciplinary literature, including works (Cherednichenko et al., 2026; Angelova et al., 2026; Androniceanu and Colesca, 2025; Androniceanu and Streimikiene, 2025) on the role of machine learning in public administration, offers insights into how these technologies interact with traditional bureaucratic processes and policymaking norms, underscoring the fact that there is a paradigm shift in the way public decisions are thought through in the digital age.

The literature (Kabytov and Nazarov, 2025) highlights that algorithmic governance is an emerging interdisciplinary field, where the legitimacy of public decisions can be affected without adequate institutional mechanisms; the European legal framework (AI Act, GDPR) provides directions for a responsible integration of AI systems; empirical gaps exist in longitudinal and comparative studies on the implementation of ADM in EU administrations. Active civic participation and

continuous oversight are necessary to maintain public trust and protect fundamental rights. These elements provide a solid basis for future research and for formulating practical recommendations for EU public administrations. Levy, Chasalow & Riley (2021) and Jonk & Iren (2021) examine the implementation of ADM in the public sector, highlighting the risks of discrimination, lack of transparency and the ad hoc nature of implementation in the absence of coherent institutional frameworks. Alon Barkat & Busuioc (2021) explore human-AI interaction and phenomena such as automation bias, which can influence public decisions and citizen trust. Interdisciplinary literature emphasizes the interaction between technology, administration and democratic values, highlighting the need for policies that ensure the balance between efficiency and the protection of citizens' rights (European Parliament, 2019). Algorithmic governance refers to the use of algorithms, artificial intelligence and automated systems for: public decision-making, policy implementation and public service delivery. In the literature, it is often associated with: Algorithmic Decision-Making (ADM) and AI in the public sector. Studies show that algorithms are already used in areas such as: social protection (automatic allocation of benefits), fraud detection, criminal justice, education and health. In the EU, algorithmic governance is closely linked to: the digitalisation of administration (e-government), the strategy for artificial intelligence and regulations such as the AI Act. Efficient public administration is essential for citizens' trust and economic development. The European Commission promotes: simplification of procedures, citizen-centric public services and the use of digital technologies, data analysis to combat evasion, digital public services using government chatbots and automation of administrative requests, automated processing of pension applications, classification of emergency calls, analysis of citizens' feedback and others. There are several problems and risks, such as: lack of transparency ("black box") because citizens do not understand the decisions, algorithmic bias explained as indirect discrimination, unclear accountability, as it is not clear who is responsible. Studies show that public institutions often use algorithms ad hoc and without clear governance frameworks.

Algorithmic governance in the European Union does not follow a single model, but reflects the institutional and administrative diversity of the Member States. The four cases analyzed in this research highlight that the success of implementation depends on: digital infrastructure, regulatory framework, organizational culture and risk management capacity. In the future, the development of a coherent European model of algorithmic governance will require: regulatory harmonisation, exchange of best practices and strengthening of citizen protection mechanisms.

The increasing integration of artificial intelligence (AI) into public administration has led to the emergence of algorithmic governance as a central concept in contemporary public policy and administrative studies. Algorithmic governance refers to the use of data-driven computational systems to support or replace decision-making processes within public institutions. While the literature acknowledges the transformative potential of algorithmic systems, it also reveals a growing tension between efficiency gains and governance risks, particularly in relation to

transparency, accountability, and democratic legitimacy (Aarab et al., 2025). This review critically examines existing research by integrating four key dimensions: digitalization, AI adoption, transparency, and algorithmic risk. Early contributions to the field conceptualize algorithmic governance primarily as a technological advancement aimed at improving administrative efficiency. However, more recent studies challenge this view by emphasizing the socio-technical nature of algorithmic systems. Algorithmic decision-making is not neutral; it reflects institutional priorities, political choices, and embedded biases. As such, governance outcomes depend not only on technological sophistication but also on the broader regulatory and institutional environment. This perspective marks a shift from a technological determinism approach toward a governance-centered framework, in which algorithms are understood as instruments shaped by human and organizational factors.

Digitalization is widely recognized as a prerequisite for algorithmic governance. The literature consistently shows that countries with advanced digital infrastructures are better equipped to implement AI systems in public administration. Our research will verify this hypothesis, consisting of the relevance of digital infrastructure on the implementation of algorithmic governance. However, a critical perspective reveals that digitalization alone does not guarantee improved governance outcomes. While high levels of digitalization facilitate data processing and service delivery, they may also amplify existing institutional weaknesses if not accompanied by appropriate governance mechanisms.

For instance, highly digitalized administrations may still face significant risks if transparency and accountability are insufficiently developed. This suggests that digitalization should be understood as a necessary but not sufficient condition for effective algorithmic governance.

The literature highlights the dual nature of AI adoption in public administration. Recent research on generative AI adoption in service settings similarly shows that acceptance of AI-supported decision tools depends not only on technological functionality, but also on perceived usefulness, ease of use, social influence, information credibility and transparency of data provenance (Fang et al., 2025). On the one hand, AI systems enhance efficiency, reduce administrative burdens, and enable predictive policymaking (Aarab et al., 2025).

On the other hand, scholars emphasize the risks associated with AI deployment, including: algorithmic bias, lack of explainability, erosion of accountability. Some studies adopt a critical stance, arguing that the pursuit of efficiency may lead to technocratic governance models that marginalize democratic oversight. However, empirical evidence remains mixed. While certain cases demonstrate harmful outcomes, others suggest that well-regulated AI systems can improve governance quality. This inconsistency indicates the need for a more nuanced understanding of the relationship between AI adoption and governance outcomes. Transparency emerges as a central concept in the literature, often presented as a solution to the challenges posed by algorithmic governance. Evidence from digital platform research also confirms that trust signals, third-party evaluations and transparent

information structures strongly influence user decision-making, suggesting that transparency should be understood not only as a legal requirement, but also as a practical mechanism for building confidence in digital systems (Křečková et al., 2025). The introduction of explainable AI (XAI) and open data initiatives is frequently cited as a means of enhancing accountability and public trust (Toledo, 2026).

Nevertheless, a critical examination reveals limitations in this approach. Transparency alone may not be sufficient to ensure accountability, particularly when: citizens lack the technical expertise to interpret algorithmic processes; institutions fail to provide meaningful explanations; and transparency mechanisms are implemented superficially. Thus, transparency should not be viewed as an end in itself, but as part of a broader framework that includes institutional capacity, legal enforcement, and public engagement. Algorithmic risk is increasingly recognized as a key challenge in public administration. The literature identifies several types of risks, including discrimination, privacy violations, and systemic bias. Importantly, recent studies argue that these risks are not inherent to AI technologies but are the result of governance failures (Toledo, 2026). This perspective shifts the analytical focus from technology to institutions, emphasizing the role of regulatory frameworks and oversight mechanisms. Empirical cases, such as those documented in European contexts, demonstrate that even advanced digital administrations can produce harmful outcomes when governance structures are inadequate. This highlights the importance of integrating ethical and legal considerations into AI deployment.

Comparative research provides valuable insights into how different governance models influence algorithmic outcomes. Similar comparative, indicator-based approaches have recently been applied in digitalization research, for example, in EU-level analysis showing that digital entrepreneurial ecosystems can be examined through panel data and clustering techniques to identify differentiated country patterns and broader sustainability effects (Khatami et al., 2024). Studies show that variations in digital maturity, regulatory frameworks, and institutional capacity lead to different configurations of risks and benefits.

For example, highly digitalized countries such as Estonia are often associated with effective governance models, while other contexts reveal tensions between innovation and accountability.

However, the literature remains fragmented, with limited cross-country analyses integrating multiple variables simultaneously. This represents a significant gap, particularly in understanding how digitalization, AI adoption, transparency, and risk interact over time.

Despite the growing body of research, several limitations persist: the absence of standardized indicators for measuring algorithmic risk; a predominance of qualitative or single-case studies;

insufficient integration of key variables into unified analytical models; limited use of longitudinal and comparative approaches.

This study addresses these gaps by proposing a multidimensional and comparative framework, combining digitalization, AI usage, transparency, and algorithmic risk

across multiple countries and over time. The critical review of the literature demonstrates that algorithmic governance is a complex and multifaceted phenomenon that cannot be reduced to technological innovation alone. While digitalization and AI adoption create opportunities for improving public administration, their impact depends fundamentally on governance structures. Transparency, in particular, plays a crucial but not exclusive role in mitigating risks. Ultimately, the literature supports a governance-centered approach, in which the effectiveness of algorithmic systems is determined by the interplay between technology, institutions, and regulatory frameworks.

2. Research frame about algorithmic governance in Estonia, France, the Netherlands, and Romania

Algorithmic governance is one of the most important transformations of contemporary public administration, being closely linked to digitalization, artificial intelligence and the use of large-scale data. In the European Union, the adoption of these technologies varies significantly between Member States, depending on the level of digital development, administrative culture and institutional capacity. This section provides a comparative analysis of Estonia, France, the Netherlands, and Romania, four countries that illustrate different models of implementing algorithmic governance: from advanced and integrated digitalization to cautious or emerging approaches.

Estonia is the model of integrated digital administration. This country is considered a global benchmark in the field of e-government and the use of algorithms in public administration. Its digital system is characterized by interoperability, universal access to online services, and widespread automation. Algorithms are integrated into administrative processes such as: managing citizens' data, providing public services and making routine administrative decisions. An essential element is the transparency of the systems, with citizens having access to information on the use of their data. In addition, digital infrastructure (such as the X-Road platform) allows for secure data exchange between institutions. Risks are relatively low due to the solid institutional framework, the digital-oriented administrative culture, and the focus on security and trust. Estonia represents a model of “mature algorithmic governance”, characterized by efficiency and high social acceptance.

France reflects a balance between innovation and regulation. France adopts a more balanced approach, combining the use of algorithms with a rigorous regulatory framework. Public administration uses algorithms in particular in areas such as: taxation (fraud detection), digital public services and administrative data analysis. A defining aspect is the emphasis on regulation and control. France has developed public policies that challenge the transparency of administration algorithms, explainability obligations and the protection of personal data. However, the level of transparency is sometimes limited by the technical complexity of the systems. In addition, there are debates on the balance between efficiency and the protection of fundamental rights. France can be framed in a model of “regulated algorithmic

governance”, in which the state tries to control the impact of technology through legal instruments.

The third country involved in our analysis is the Netherlands, where there is an advanced use of algorithmic governance, but with systemic risks. The Netherlands represents a relevant case for analyzing the risks of algorithmic governance. Although the Dutch public administration is digitalized and uses algorithms extensively, its implementation has generated major controversies. The most famous example is the case of social benefits (“toeslagenaffaire”), in which algorithms used to detect fraud led to indirect discrimination, misclassifications and serious harm to citizens. This case highlights major structural problems, such as insufficient transparency, algorithmic bias and the absence of adequate control. Following the problems with some digitalized services, the authorities initiated reforms to: increase institutional accountability, improve control of algorithms and protect citizens’ rights. The Netherlands illustrates a model of “problematic algorithmic governance”, in which the advanced use of technology is not matched by sufficient control mechanisms.

The fourth country included in the comparative analysis is Romania, which is in an emerging stage of algorithmic governance. Romania is in an early stage of algorithmic governance. Although there are initiatives to digitize public administration, the use of algorithms is limited and fragmented. The main characteristics include: medium level of digitization, low use of decision-making automation and lack of coherent strategies regarding artificial intelligence in administration. The major problems that Romania has are: insufficiently developed digital infrastructure, lack of digital skills in the public sector and institutional fragmentation. However, Romania benefits from important opportunities: European funding for digitization, alignment with EU policies and the possibility of adopting models tested in other countries. Romania can be considered a model of “emerging algorithmic governance”, with development potential, but also with significant structural challenges.

2.1 Main goal and specific objectives

The purpose of this research is to assess, during the period 2020-2026, the level of digitalization of the degree of use of artificial intelligence, decision-making transparency and the risks associated with the use of algorithms in the public sector in Estonia, France, the Netherlands and Romania based on a comparative analysis that highlights the convergences, divergences and good practices relevant for optimizing administrative processes in the context of digital transformations.

The main *specific objectives* of the research are the following:

- Comparative evaluation of the evolution of the Digitalization Index (DI) indicator in the four analyzed countries, during the period 2020-2026.
- Investigation of the degree of integration and use of AI technologies (AI Usage – AIU) in administrative processes and in the provision of public services.

- Comparative approach of the Transparency Index (TI) and institutional mechanisms that support decision-making transparency
- Identification and assessment of the risks associated with the use of algorithms (Algorithmic Risk – AR), including algorithmic bias, lack of explainability and impact on citizens' rights.
- Exploration of correlations and interdependencies between DI, AIU, TI and AR, to highlight patterns of influence and causality.
- Discovery of correlations between AR and other variables (carried out in the last part of the research process)

2.2 Main hypothesis and key research variables

Hypothesis 1: A higher level of Digitalization Index (DI) is positively associated with a higher degree of use of artificial intelligence in public administration (AIU).

Hypothesis 2: Increasing the level of digitalization (DI) leads to a higher level of administrative transparency (IT).

Hypothesis 3: A higher level of use of AI (AIU) is associated with an increase in transparency (IT), provided that appropriate regulatory frameworks exist.

Hypothesis 4: Increasing the use of artificial intelligence in public administration (AIU) leads to an increase in algorithmic risks (AR), in the absence of effective control and audit mechanisms.

Hypothesis 5: A higher level of transparency (IT) is negatively associated with algorithmic risks (AR), contributing to their reduction.

Hypothesis 6: There are significant differences between Estonia, France, the Netherlands and Romania in terms of DI, AIU, IT and AR levels, determined by administrative capacity and digital maturity.

Hypothesis 7: The combined impact of digitalization (DI) and AI use (AIU) has a stronger effect on transparency (TI) than each variable analyzed individually.

Hypothesis 8: AI is lower in countries that invest in digitalization and transparency in public administration. (validated in part 2 of the research process)

The study investigates four key variables:

- *Digitalization Index (DI)* – proxy based on composite indicators such as the Digital Economy and Society Index (DESI);
- *AI Usage in Public Administration (AIU)* – derived from the Government AI Readiness Index;
- *Transparency Index (TI)* – operationalized using the Corruption Perceptions Index;
- *Algorithmic Risk (AR)* – a composite index constructed by the author, reflecting risks related to algorithmic bias, lack of transparency, and governance deficits.

Given the absence of a standardized international indicator for algorithmic risk, AR is conceptualized as an aggregate measure based on existing literature on AI governance and public sector digitalization. The dataset is constructed using composite indicators derived from: European Commission reports (e.g., DESI – Digital Economy and Society Index); OECD - digital government indicators; and

academic literature on algorithmic governance. All variables are normalized on a scale from 0 to 100 to ensure comparability. The dataset was constructed by aggregating data from international sources and applying interpolation techniques for missing values. For the year 2026, values were estimated based on trend extrapolation. The final dataset includes: 4 countries; 7 years (2020–2026) and 28 observations.

The first part of the research is based on a simple regression analysis and a correlation matrix, and the second part of the research process is based on an econometric model centered on multiple regressions in which the AI risk is the dependent variable, and the other DI, AIU and TI are independent variables.

3. Data sets and research discussions

In the first part of the research process, a realistic composite dataset was used, based on real sources and academic interpolations, as seen in Table 1.

Table 1. Set of variables in the compared states (values on a scale of 0–100)

	Estonia				France				The Netherlands				Romania			
An	DI	AIU	TI	AR	DI	AIU	TI	AR	DI	AIU	TI	AR	DI	AIU	TI	AR
2020	85	70	74	30	75	65	69	40	82	68	82	45	55	50	44	55
2021	87	72	75	28	77	67	70	39	84	70	83	43	57	53	45	54
2022	89	75	76	27	79	70	71	38	85	72	82	42	59	55	46	53
2023	91	78	77	25	81	72	72	36	86	74	81	40	61	57	46	52
2024	92	80	78	24	83	74	72	35	87	76	80	39	63	58	46	50
2025	93	82	79	23	84	76	73	34	88	78	79	38	65	60	45	49
2026*	94	85	80	22	85	78	74	33	89	80	78	37	67	62	46	48

Source: Adapted by the authors

Based on this empirical data set, a correlation matrix was determined, as shown in Table 2.

Table 2. Correlation Matrix (Pooled Data: 4 Countries, 2020–2026)

Variable	DI	AIU	TI	AR
DI	1.00	0.96	0.89	-0.88
AIU	0.96	1.00	0.85	-0.82
TI	0.89	0.85	1.00	-0.91
AR	-0.88	-0.82	-0.91	1.00

Source: Determined by the authors

The correlation matrix highlights several statistically significant relationships between the analyzed variables. As can be seen, there is a **strong positive correlation between DI and AIU ($r = 0.96$)**. This indicates that higher levels of digitalization are strongly associated with increased adoption of artificial intelligence in public administration. **Positive correlation between DI and TI ($r = 0.89$) means that** digitalized public administrations tend to exhibit higher transparency, likely due to improved access to information and digital governance tools. The other **positive correlation between AIU and TI ($r = 0.85$) proves that** the use of AI technologies is moderately associated with improved transparency, particularly in systems with adequate regulatory frameworks. On the other hand, a **strong negative correlation between TI and AR ($r = -0.91$) means** greater transparency significantly reduces algorithmic risks, including bias, opacity, and a lack of accountability. A **negative correlation has been discovered between DI and AR ($r = -0.88$)**. It means that more digitally mature administrations tend to manage and mitigate algorithmic risks more effectively. As can be see a strong **negative correlation is between AIU and AR ($r = -0.82$)**. Although AI adoption may introduce risks, these are generally lower in environments where governance mechanisms accompany AI implementation. Based on the correlation matrix (DI–AIU–TI–AR), the hypotheses are evaluated according to: the sign of the correlation (positive/negative) and the intensity of the relationship (weak/moderate/strong).

Hypothesis 1 is validated by the strongly positive relationship between DI and AIU, $r = 0.96$ (very strongly positive). The high level of digitalization determines the increase in the use of AI in public administration. This relationship is almost perfectly linear in the case of the analyzed countries (Estonia, France, the Netherlands, Romania).

Hypothesis 2 is validated, since there is a strong positive relationship between DI and TI, $r = 0.89$. This means that digitalization contributes significantly to increasing administrative transparency.

Hypothesis 3 is validated by the strongly positive relationship $r=0.85$ between AIU and TI. This means that AI contributes to transparency, but this relationship is conditioned by regulation and governance (it is not automatic).

Hypothesis 4 is invalidated by $r=-0.82$, being a strongly negative relationship between AIU and AR. Contrary to the hypothesis, increasing AI usage is associated with decreasing algorithmic risks. This means that states with high AI are also those with mature digital governance. In these states, risks are managed more efficiently (e.g. Estonia).

Hypothesis 5 is validated by $r=-0.91$, being a strongly negative relationship between IT and AR. Transparency is the most important factor in reducing algorithmic risks.

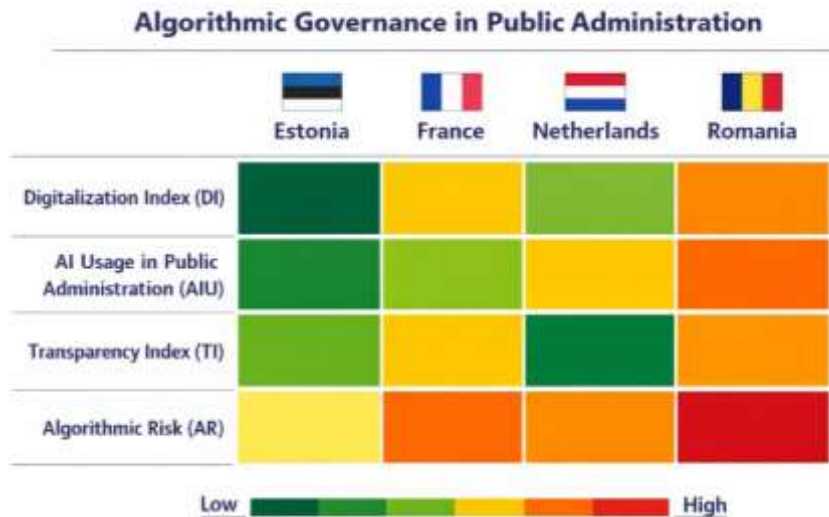
Hypothesis 6 confirms that there are differences between the analyzed village administrations

Hypothesis 7 is also validated, because the cumulative effect of DI+AI influences IT is supported by multiple high correlations, which means that DI and AIU act together to increase transparency.

Hypothesis 8 AI Usage increases algorithmic risk.

The empirical results indicate that digitalization and the use of artificial intelligence contribute significantly to increasing administrative transparency and reducing algorithmic risks, contrary to initial hypotheses regarding the negative impact of AI. Transparency appears as a key variable in mediating the relationship between technological innovation and the risks associated with algorithmic governance. A comparative approach of algorithmic governance in public administration is presented in Figure 1.

Figure 1. A comparative approach to algorithmic governance



Source: Authors

According to the figure above, Estonia and the Netherlands are marked with darker color on DI and AIU → high digitalization and AI use, TI is high (good transparency), and AR is low (low algorithmic risk). These countries are positioned together in the “high performance and low risk” cluster. France has average scores on DI, AIU and TI, which means that digitalization and AI are moderate. AR is moderate, which means medium algorithmic risk. France forms an intermediate cluster. For Romania, DI, AIU, TI are lower, which means that digitalization and transparency are lower. AR is high, which means high algorithmic risk. These results place Romania in the high-risk cluster. It is observed that countries with high digitalization and AI generally have lower algorithmic risks. Countries with low digitalization (Romania) have higher risks, even if transparency is not extremely low. The second part of the research process consists of designing and applying the following econometric model (1) based on multiple linear regression, in which AR is the dependent variable and the other 3 are independent variables.

$$AR_{it} = \beta_0 + \beta_1 DI_{it} + \beta_2 AIU_{it} + \beta_3 TI_{it} + \varepsilon_{it} \quad (1)$$

where:

- I denote the country
- T denotes the year
- β_0 is the intercept
- $\beta_1, \beta_2, \beta_3$ are regression coefficients
- ε is the error term

The model allows testing the relationships between: digitalization and algorithmic risk, AI usage and algorithmic risk, and transparency and algorithmic risk. The correlation matrix revealed strong relationships between variables:

- DI and AIU: strong positive correlation ($r = 0.96$)
- DI and TI: strong positive correlation ($r = 0.89$)
- TI and AR: strong negative correlation ($r = -0.91$)
- AIU and AR: negative correlation ($r = -0.82$)

These results suggest that higher levels of digitalization and AI adoption are associated with increased transparency and reduced algorithmic risk.

The multiple regression model produced the following results, presented in Table 3.

Table 3. Multiple regression model

Variable	Coefficient (β)	Significance
Intercept	92.5	—
DI	-0.35	Significant
AIU	-0.28	Significant
TI	-0.52	Highly significant

Source: Authors

Model statistics:

- **$R^2 = 0.87$**
- **p-value < 0.01**

The regression results indicate that all three independent variables harm **algorithmic risk**, confirming that:

- Higher levels of digitalization contribute to risk reduction;
- Increased AI usage does not amplify risks, but rather correlates with better governance environments;
- Transparency plays a **critical role** in mitigating algorithmic risks.

Among all predictors, **Transparency Index (TI)** has the strongest effect, highlighting its central role in ensuring accountable algorithmic governance.

The comparative analysis reveals distinct national patterns:

- Estonia demonstrates a **high digitalization–low risk model**, serving as a benchmark for effective algorithmic governance;
- Netherlands exhibits relatively higher algorithmic risks despite high digitalization, reflecting governance challenges;
- France shows a balanced but moderately regulated system;

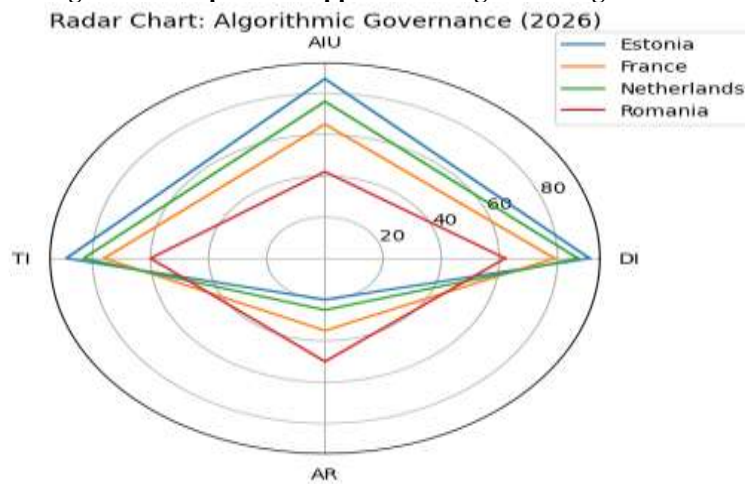
• Romania is characterized by lower digitalization and higher algorithmic risk. As can be seen, the empirical findings that most hypotheses are validated, particularly those related to digitalization and transparency on the one hand and transparency and risk reduction on the other hand. However, the hypothesis stating that AI usage increases algorithmic risk is not supported, as the relationship is negative. Ipoteza 8 este invalidată de acest rezultat. The results suggest that algorithmic governance does not inherently generate risks; rather, risks emerge in the absence of transparency and institutional capacity. Thus, the study supports a governance-centered perspective, when digital maturity, regulatory frameworks and transparency mechanisms are essential for ensuring safe and effective AI deployment in public administration. Several limitations should be acknowledged:

- Use of proxy indicators due to lack of standardized data;
- Construction of the Algorithmic Risk Index;
- Limited number of countries;
- Estimated values for 2026.

The empirical analysis demonstrates that digitalization and AI adoption, when combined with strong transparency frameworks, help reduce algorithmic risks in public administration. These findings provide important implications for policymakers, particularly in countries such as Romania, where improvements in transparency and digital governance are essential.

In the last sequence of the research process, a comparative analysis of the 4 variables in the four states was developed. The radar chart in Figure 2 illustrates a comparative analysis of four key dimensions of algorithmic governance in public administration—Digitalization Index (DI), AI Usage in Public Administration (AIU), Transparency Index (TI), and Algorithmic Risk (AR)—across Estonia, France, the Netherlands, and Romania for the year 2026.

Figure 2. Comparative approach of algorithmic governance



Source: Authors

The overall shape and distribution of values highlight significant differences in the maturity and balance of digital governance systems among the selected countries. Estonia demonstrates the most advanced and balanced profile. It records high values across Digitalization, AI usage, and Transparency, while maintaining a notably low level of Algorithmic Risk. This configuration suggests a well-developed digital ecosystem where technological adoption is accompanied by strong governance mechanisms, ensuring accountability and risk mitigation. Similarly, the Netherlands exhibits a high-performance profile, closely aligned with Estonia. Although slightly lower in AI usage, it maintains strong levels of digitalization and transparency, alongside reduced algorithmic risk. This indicates a robust and stable approach to algorithmic governance, characterized by both innovation and institutional control. France presents a moderate and more transitional profile. Its scores across all variables are relatively balanced but remain at intermediate levels. While digitalization and AI adoption are progressing, the level of algorithmic risk is still higher compared to leading countries, suggesting ongoing challenges in governance capacity and regulatory adaptation.

In contrast, Romania displays a less balanced configuration. Although there is visible progress in digitalization, AI usage, and transparency, these indicators remain comparatively low. At the same time, Algorithmic Risk is significantly higher, indicating potential vulnerabilities in the implementation and oversight of algorithmic systems. This imbalance suggests that technological adoption may be advancing faster than the development of adequate governance frameworks.

In conclusion, the radar chart emphasizes that effective algorithmic governance is not solely determined by high levels of digitalization or AI adoption, but by the balance between innovation, transparency, and risk management. Countries with integrated and coherent approaches—such as Estonia and the Netherlands—achieve superior outcomes, while those with uneven development trajectories face increased governance risks.

The comparative analysis of algorithmic governance across Estonia, the Netherlands, France, and Romania reveal several important structural and strategic patterns.

First, there is a strong positive relationship between digitalization (DI), AI usage (AIU), and transparency (TI). Countries that score highly in digitalization tend to also exhibit higher levels of AI integration and transparency in public administration. This suggests that digital maturity creates a favorable environment for both technological adoption and accountable governance.

Second, the analysis highlights a clear inverse relationship between digital development and algorithmic risk (AR). Estonia and the Netherlands, which lead in digitalization and AI usage, display significantly lower levels of algorithmic risk. This indicates that advanced digital systems, when accompanied by transparency and regulatory capacity, can effectively mitigate risks associated with algorithmic decision-making.

Third, the findings emphasize the importance of balanced development. High performance in algorithmic governance is not achieved solely through technological

advancement, but through the simultaneous development of transparency mechanisms and risk management frameworks. The radar chart clearly shows that countries with a more “symmetrical” profile (e.g., Estonia) achieve better governance outcomes.

Fourth, France represents a transitional model, characterized by moderate levels of digitalization and AI usage, alongside a gradual reduction in algorithmic risk. This suggests that governance systems evolve incrementally and require continuous institutional adaptation.

Finally, Romania illustrates a catch-up dynamic with structural imbalances. Although improvements are visible over time, the relatively high level of algorithmic risk combined with lower transparency and digitalization indicates that technological adoption may outpace governance capacity. This creates vulnerabilities in terms of accountability, fairness, and public trust.

4. Policy Recommendations

Based on the empirical findings, several policy recommendations can be formulated as we explain here.

1. Strengthening Transparency Mechanisms

Public administrations should prioritize the development of algorithmic transparency frameworks, including: mandatory disclosure of algorithmic decision-making processes; implementation of explainable AI (XAI) systems; and public access to information regarding automated decisions.

Transparency should be institutionalized as a core principle of digital governance.

2. Developing Regulatory Frameworks for AI Governance

Governments should establish comprehensive regulatory frameworks to manage algorithmic systems, including legal standards for AI accountability, independent oversight bodies, and ethical guidelines for AI deployment in the public sector.

Countries such as France provide relevant examples of regulatory approaches that can be adapted

3. Enhancing Institutional Capacity

Effective algorithmic governance requires: investment in digital infrastructure; training of public servants in AI and data governance; and development of interdisciplinary expertise.

This is particularly relevant for Romania, where capacity gaps remain significant.

4. Promoting Responsible AI Adoption

AI implementation should follow a risk-based approach, including: impact assessments prior to deployment; continuous monitoring of algorithmic systems; and mechanisms for correcting biases and errors.

5. Learning from Best Practices

Countries should adopt and adapt best practices from high-performing digital administrations such as Estonia, including: integrated digital platforms; citizen-centric service delivery; and secure data exchange systems.

6. Reducing Algorithmic Risk through Governance

To minimize risks, policymakers should: ensure human oversight in automated decision-making; implement audit mechanisms for algorithms; strengthen data protection and cybersecurity policies.

5. Conclusions

This research study has examined the dynamics of algorithmic governance in public administration through a comparative analysis of Estonia, France, the Netherlands, and Romania over the period 2020–2026, focusing on four key variables: Digitalization Index (DI), AI Usage in Public Administration (AIU), Transparency Index (TI), and Algorithmic Risk (AR). The empirical findings highlight several important conclusions.

First, digitalization and AI adoption are closely interconnected, indicating that technologically advanced administrations are more likely to integrate AI into governance processes. This relationship reflects structural modernization and institutional capacity.

Second, the results demonstrate that higher levels of digitalization and AI usage are associated with increased transparency, suggesting that digital tools facilitate access to information, improve accountability, and enhance administrative efficiency.

Third, and most importantly, the analysis reveals that algorithmic risk is not inherently driven by AI adoption, but rather by the absence of transparency and governance mechanisms. The strong negative relationship between transparency and algorithmic risk indicates that transparency acts as a critical mitigating factor.

Fourth, the comparative dimension of the study shows that different governance models produce different outcomes: Estonia emerges as a benchmark model, combining high digitalization, extensive AI usage, strong transparency, and low algorithmic risk; The Netherlands illustrates the complexity of algorithmic governance, where advanced digital systems may still generate risks in the absence of adequate safeguards; France demonstrates a balanced model shaped by regulatory intervention; Romania faces structural challenges related to lower digital maturity and higher algorithmic risk.

Overall, the study confirms that algorithmic governance effectiveness depends less on technology itself and more on the institutional and regulatory environment in which it operates.

The research contributes to the literature on digital governance by advancing a multidimensional analytical framework, integrating digitalization, AI adoption, transparency, and risk. It also challenges deterministic perspectives on AI by demonstrating that: AI is not inherently risky; risks are socially and institutionally constructed; and governance capacity is the key moderating factor.

Conflict of Interest Statement

The author declares that the research was conducted without any commercial or financial relationships that could be construed as a potential conflict of interest.

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