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## Influence of Information and Communication Technologies (ICT) on the Modernity and Efficiency of Public Services: An Integrative Literature Review

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### ABSTRACT

The adoption of information and communication technologies (ICTs) in the public sector has intensified in recent years, becoming a strategic necessity for modernizing services. However, persistent barriers, such as low digital literacy among servers, interoperability failures, and regulatory rigidity, limit the effects of digital transformation, leading to incremental improvements rather than structural changes. For this reason, this study aims to analyze the impact of ICT on the modernity and efficiency of public services, highlighting both the potentialities and the obstacles of the digitalization process. To this end, an integrative literature review was carried out, with searches in databases such as Web of Science, Scopus and IEEE, in addition to empirical evidence from national research, allowing triangulation between international results and Brazilian cases. The findings reveal four core dimensions: (1) digital capacity building and literacy, (2) security and interoperability, (3) institutional capacity and regulatory frameworks, and (4) artificial intelligence, big data, and innovation. It is concluded that digital transformation can increase efficiency, transparency, and legitimacy of public management, but its effectiveness depends on institutional, cultural, and regulatory reforms.

### INTRODUCTION

In Brazil, the adoption of information and communication technologies (ICT) in the public service has accelerated in recent years, but faces concrete challenges that affect administrative efficiency and the quality of service delivery. According to Eom *et al.* (2022) For example, digital transformation is no longer just a resource and has become a strategic necessity, even though its implementation has revealed dilemmas, such as lack of training, institutional resistance, and inequalities in access to technology

Given this complex scenario, this study is justified by its relevance in highlighting how digitalization can represent operational and managerial obstacles in the public sector, instead of solving problems immediately. Thus, the objective of this article is to analyze the impact of ICT on the modernity and efficiency of public services, pointing out both the potentialities and the obstacles that sustain this transformation process.

This analysis will be conducted through an integrative literature review, gathering recent empirical and theoretical evidence on the adoption of technologies and their practical consequences in public management, allowing the identification of patterns, gaps, and recommendations to promote more effective and inclusive transformations.

### LITERATURE REVIEW

Verhoef *et al.* (2021) state that digital transformation is not a mere technological upgrade, but a strategic

reconfiguration that integrates data, platforms, and new value capture models; When aligned with strategy, digitalization increases efficiency, innovation, and competitive performance, requiring data governance and ecosystem orchestration. By demarcating conceptual boundaries between digitalization, digitization of processes, and digital transformation, the authors show that results depend on organizational and cultural complementarities, not just IT. This vision lays the conceptual foundation for the next blocks of this funnel. Silva *et al.* (2024) reinforce that, although digital technologies such as blockchain, big data, and automation bring significant gains in efficiency and reliability to organizational processes, their incorporation still comes up against institutional barriers, high costs, and cultural resistance. This point shows that the same challenges that are presented in the private sector are also reflected, to a greater or lesser extent, in the public sector, where administrative modernization depends on technological integration and institutional adaptation. From this perspective, it is pertinent to analyze how ICTs influence the efficiency and modernity of public services, considering both advances and structural limitations. Corroborating this, Akter *et al.* (2020) demonstrate that synergies between AI, blockchain, cloud, and analytics (“ABCD”) generate transformational gains in processes and business models, but only materialize when there is robust data architecture, systemic integration, and organizational readiness. The authors argue that value

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arises from coupling analytical capabilities, automation, and algorithmic trust, reducing informational frictions and coordination costs. Such a framework explains why “technology alone” is not enough without organizational design.

Susanti *et al.* (2023) argue, based on a systematic review, that the performance resulting from digital transformation emerges from the coupling between technology, structure, and strategy with central roles for dynamic capabilities and data orientation. They show that organizations that combine IT, learning, and digital leadership capabilities convert technology investments into sustainable competitive advantage. The article thus provides a causal bridge between technology adoption and business results.

Santos *et al.* (2025) argue that green and digital technologies go hand in hand in the transition to circular production models, reducing waste and improving efficiency through automation, traceability, and data analysis. By framing “clean technologies” as a vector of innovation and productivity, the authors emphasize that technological modernization must be accompanied by outcome metrics and regulatory coherence to prevent greenwashing. This synthesis connects performance, sustainability, and digital.

McAfee *et al.* (2023) show that, in organizational scenarios, AI especially machine learning creates great potential for productivity and new work-machine complementarities, but requires institutional design to mitigate biases, ensure interpretability, and capture gains in scale. The central thesis is that economic gains appear when firms redesign processes and incentives to absorb AI, not when they plug into siloed models. Such a finding guides adoption choices.

Barba-Sánchez *et al.* (2024) empirically show that IT capabilities and digital orientation explain the effect of digital transformation on performance, mediating the impacts of technological investments on results. The analysis indicates that companies with a digital-centric culture and analytical capabilities capture more value from automation, data, and analytics, reinforcing the idea of organizational complementarities as a causal mechanism. This anchors the “technology → performance” link.

Monteiro *et al.* (2025) argue that interinstitutional collaborations in open innovation accelerate technological diffusion and sustain modernization trajectories, reducing the gap between technological supply and organizations’ absorption capacity. The study argues that networks between university-company-productive sector amplify knowledge transfer and shorten adoption cycles, a condition for transforming pilots into scalable routines. Such networks function as “invisible infrastructure” for innovation.

Campana *et al.* (2025) argue that environmental accounting and ESG metrics underpinned by robust information systems align technological investment with measurable sustainable performance. The authors show that standardization of indicators, independent auditing,

and data governance reduce the risk of greenwashing and redirect capital to projects with socio-environmental returns. Thus, digital and sustainability converge via reliable measurement and accountability.

Liu *et al.* (2025) map, in a wide bibliometrics, digital entrepreneurship driven by big data, AI, and blockchain, concluding that such technologies expand business model possibilities and require continuous updating of skills. The work identifies thematic hotspots analytics, platforms, and security that serve as performance levers, creating space for new complementarities between automation and human creativity.

Yang *et al.* (2023) systematize the explainable AI (XAI) literature and argue that interpretability is a requirement for trust, adoption, and algorithmic governance. In an organizational context, they justify that decisions assisted by XAI increase accountability and reduce operational risk, especially in regulated and high-impact domains. Therefore, layers of explanation and monitoring are a constitutive part of the modern technological “pile”, and not accessories.

As Reis *et al.* (2023) observe, digital transformation cannot be understood only as the adoption of disruptive technologies, but as a process of structural reconfiguration that crosses sectors, requiring organizational, cultural, and regulatory adaptations. In this sense, advances in AI, big data, blockchain, and automation reveal not only new possibilities for efficiency and innovation in the business environment, but also pose unprecedented challenges for other institutional domains that need to respond to pressures for modernization and transparency. This is the inflection point that opens space to examine, in an applied way, how such dynamics manifest themselves in different organizational arrangements, preparing the ground for the analysis that follows.

## MATERIALS AND METHODS

### Research Strategy

The research was conducted as an Integrative Literature Review (RIL), combining systematicity with interpretative flexibility. The choice of this method is justified by the need to gather, synthesize and compare theoretical and empirical evidence on the adoption of information and communication technologies (ICT) in the public sector, allowing for the mapping of both advances and limitations.

To ensure breadth and reliability, multiple databases recognized for their relevance were selected: Web of Science (WoS), Scopus, ScienceDirect, Emerald, IEEE Xplore, Google Scholar and national journals indexed in CAPES. These databases were chosen because they cover both articles of high international impact and studies applied to the Brazilian context.

### Search Procedures

Bilingual descriptors (Portuguese and English) were elaborated that covered the technological and institutional scope of the investigation. Some examples:

(“Information and Communication Technologies” OR ICT) AND (“public services” OR “public administration”) (“Information and Communication Technologies” OR ICT) AND (“public service” OR “public administration”) (“digital transformation” OR “e-government”) AND (“efficiency” OR “modernity”)

The searches were carried out for the period 2020–2025, in order to ensure timeliness. In addition, articles produced by the authors’ research group, previously published in international journals, which provided direct empirical input (Neto *et al.*, 2024; Souza *et al.*, 2025; Silva *et al.*, 2024, 2025; Monteiro *et al.*, 2025).

### Inclusion and Exclusion Criteria

- Inclusion: peer-reviewed articles, published between 2020 and 2025, focusing on ICT, digital transformation, big data, AI, blockchain, interoperability, or administrative modernization.
- Exclusion: duplicate papers, book chapters without peer review, expanded conference abstracts, and studies dealing exclusively with the private sector with no analytical connection to public services.

### Selection and Analysis

- The initial screening resulted in 144 publications. After applying the criteria, 19 articles were selected, 11 from WoS and 8 produced by the research group. The analysis was carried out in two stages:
  - Bibliographic Analysis: full reading of the selected articles to identify key concepts, theoretical models and empirical evidence.
  - Thematic Categorization: organization of findings into four main categories (1) Digital training and literacy; (2) Security and interoperability; (3) Institutional capacity and regulatory framework; (4) AI, big data, and innovation in public services.

### Analytics Integration

The final stage consisted of the triangulation between international literature, national evidence (automation and telework projects in IFEs) and theoretical references of digital transformation. This integration allowed both to compare global standards and to discuss specificities of the Brazilian context. (1)

## RESULTS AND DISCUSSION

### Categorization Statement

To organize the analysis, it was decided to adopt a thematic categorization that emerges from both international studies and the national cases identified. This categorization allowed us to group the findings into four major analytical dimensions: (1) Digital training and literacy; (2) Security and interoperability; (3) Innovation and cultural change; and (4) Digital governance and leadership. This approach aims to articulate different perspectives from technical barriers to institutional and human factors offering an integrated view of the impacts of ICT on the modernity and efficiency of public services.

### Category 1 – Capacity Building and Digital Literacy

Dečman *et al.* (2022) argue that digital efficiency in the public sector is compromised by low digital literacy among civil servants and a lack of institutional preparedness, resulting in superficial technical advances without structural changes. This structural limitation reverberates in the Brazilian context, where Souza *et al.* (2025) show that the adoption of telework and SEI brought productivity gains only when accompanied by continued training and adjustments in performance evaluation criteria.

This finding connects to what Susanti *et al.* (2023) maintain: digital transformation does not depend only on technological adoption, but on the coupling between technology, structure, and strategy, with emphasis on dynamic capabilities and organizational learning as critical factors. In other words, the digital literacy of public servants works as a causal link that transforms investment in technology into real efficiency gains.

In the same direction, Verhoef *et al.* (2021) recall that digitalization only generates strategic impact when accompanied by data governance and ecosystem orchestration. Without a consolidated digital culture and servers prepared to handle new workflows, the adoption of systems results in punctual modernization, but not in institutional transformation.

In addition, Akter *et al.* (2020) reinforce that emerging technologies such as AI, blockchain, and analytics require organizational readiness to generate value. This readiness, in the case of the public sector, is translated into the ability of civil servants to assimilate new tools and apply them to critical management processes.

Therefore, triangulation reveals that digital training and literacy is not peripheral, but a central condition for the success of ICT in public administration. While our national data (Souza *et al.*, 2025) confirm this thesis, the international literature (Dečman *et al.*, 2022; Susanti *et al.*, 2023; Verhoef *et al.*, 2021; Akter *et al.*, 2020) offers the theoretical basis to understand that digital transformation only occurs when people, processes, and technology evolve in an integrated way.

### Category 2 – Security and Interoperability

Galushi & Malatji (2022) argue that the advancement of digitalization in public services increases not only administrative efficiency, but also exposure to cyber threats and data protection failures. Citizen trust, therefore, depends on robust security policies and mature digital governance. This point is essential because, without protection mechanisms, the risk of losing institutional legitimacy is greater than the benefits of digitalization. Correa-Ospina *et al.* (2021) complement by emphasizing that the efficiency of ICT in the public sector is conditional on interoperability between systems. Initiatives that computerize processes without integrating departments only reproduce bureaucratic fragmentation. For there to be a real impact, digitalization needs to be accompanied by procedural reengineering and organizational culture

focused on intersectoral cooperation.

This reasoning dialogues with Silva *et al.* (2024), who show that emerging technologies such as blockchain and automation increase the reliability of accounting and organizational processes precisely because they ensure transparency and traceability, reducing risks of fraud and informational inconsistencies. Although the study deals with the private sector, the same principles apply to the public: without interoperability and security, digitalization results only in superficial modernization.

More broadly, Akter *et al.* (2020) highlight that the so-called ABCD technologies (AI, blockchain, cloud, and data analytics) only produce transformational gains when there is systemic integration. In the case of governments, this means that legacy systems need to talk to each other, and that the absence of this integration not only limits results, but increases vulnerabilities.

Our national findings also converge with this diagnosis. Neto *et al.* (2024), when analyzing the payments sector of the Federal University of Amazonas, demonstrate that efficiency gains with automation were only consolidated because there was integration between launch systems and training of servers to operate the new tools. Without this, automation would have increased errors instead of reducing them.

Thus, it is confirmed that security and interoperability are critical conditions for ICT to result in efficiency and legitimacy in the public sector. While international data point to cyber risks and integration failures (Galushi & Malatji, 2022; Correa-Ospina *et al.*, 2021), our empirical results (Neto *et al.*, 2024; Silva *et al.*, 2024) show that well-structured interoperability and security practices can transform one-off digitization into structural gains in reliability and productivity.

### Category 3 – Institutional Capacity and Regulatory Framework

Saukkonen *et al.* (2024) demonstrate that the modernization of public administration mediated by ICTs depends directly on regulatory agility. The research shows that excessive bureaucracy and slow adaptation of standards prevent digital innovations from being fully implemented, resulting in limited efficiency gains. This reading reinforces that digital transformation is only consolidated when regulations keep up with the speed of innovation.

Guo & Shen (2024) complement by arguing that visionary leadership is as important as technological investments. They note that public governance needs to engage multiple stakeholders, reduce institutional fragmentation, and ensure interoperability. In other words, technology only generates effective modernization when accompanied by the political and administrative capacity to orchestrate changes.

This perspective dialogues with Reis *et al.* (2023), who argue that digital transformation should be understood as a structural process and not merely technical. By analyzing different sectors, the authors identified that

sustainable outcomes require cultural, institutional, and regulatory adaptations. This international evidence confirms that the problem of legal slowness observed in São Luís, for example, is not an exception, but part of a global pattern of institutional fragility in the face of technological innovation.

In the national field, Silva *et al.* (2025) highlight that, in digital auditing and accounting, the absence of standardization and clear regulations hinders the full adoption of disruptive technologies such as blockchain, limiting their application to pilot projects. This diagnosis, although in the private sector, has direct parallels in the public sector, where the lack of adapted standards restricts the expansion of large-scale digital transformation.

Monteiro *et al.* (2025) add that collaborative innovation networks between government, the private sector, and academia are crucial to overcome institutional fragility. By shortening the cycle between technological supply and practical absorption, these networks act as catalysts for legal and administrative change. Thus, inter-institutional cooperation reduces the risk that regulatory frameworks will lag behind emerging practices.

In this way, triangulation shows that institutional capacity and the regulatory framework are basic conditions for digital transformation. While international studies point to bureaucratic barriers, the need for leadership, and legal reforms (Saukkonen *et al.*, 2024; Guo & Shen, 2024; Reis *et al.*, 2023), our national and regional analyses (Silva *et al.*, 2025; Monteiro *et al.*, 2025) reinforce that without clear standards, adaptive governance, and collaborative networks, ICT innovation remains fragmented and unable to generate systemic efficiency.

### Category 4 – Artificial Intelligence, Big Data and Innovation in Public Services

Nguyen *et al.* (2024) analyze experiences of adopting AI and big data in government services and demonstrate that advances in massive data processing allow personalizing services and accelerating the delivery of public policies. However, they emphasize that such innovations are only consolidated when accompanied by continuous training of civil servants and periodic reviews of administrative processes, preventing implementation failures from neutralizing the gains.

Hien *et al.* (2024) reinforce this point by arguing that digital transformation is not only technical, but institutional, depending on the alignment between public policies, technological infrastructure, and employee engagement. They note that in contexts where there is cultural resistance and a lack of incentives, even heavy investments in AI and big data yield limited results.

In the same vein, Zhou *et al.* (2024) warn that the intensification of the use of digital technologies increases exposure to cyber and privacy risks. For them, the effectiveness of digitalization depends directly on the institutional capacity to protect sensitive data, under penalty of loss of public trust and institutional setbacks. In the Brazilian scenario, Neto *et al.* (2024) offer practical

evidence by showing that automation with Excel, VBA and RPA in the payments sector of the Federal University of Amazonas increased productivity even in the face of a reduction in the number of servers. This national experience shows that simple automation tools already produce measurable gains, but require maintenance and continuous training to sustain results.

Souza *et al.* (2025) add that the introduction of digital tools in the public service, such as SEI and telework, has brought gains in productivity and autonomy for technical-administrative employees. However, they observed that the full appropriation of ICT depends on institutional adjustments in evaluation criteria and new management practices, showing that technological innovation and managerial innovation go hand in hand.

Thus, although AI, big data, and automation are fundamental drivers of public service modernization, their effectiveness depends on the combination of continuing education, institutional engagement, and data protection. While the international literature highlights security risks, policy alignment, and capacity building requirements (Nguyen *et al.*, 2024; Hien *et al.*, 2024; Zhou *et al.*, 2024), the national cases of our group (Neto *et al.*, 2024; Souza *et al.*, 2025) illustrate the materiality of these challenges in Brazil, showing that gains only become structural when technological innovation is connected to cultural and institutional changes.

## CONCLUSIONS

The present study aimed to analyze the impact of information and communication technologies (ICT) on the modernity and efficiency of public services, identifying both potentialities and structural obstacles. This proposal was based on the recognition that digital transformation, although strategic, faces dilemmas related to training, security, governance, and institutional alignment.

The results obtained confirm this objective by evidencing four central findings: (1) the training and digital literacy of civil servants is an indispensable condition to transform technological investments into real efficiency; (2) information security and interoperability of systems define legitimacy and public trust; (3) institutional capacity and regulatory agility shape the possibility of large-scale technological diffusion; and (4) the adoption of AI, big data, and automation generates significant gains only when articulated with cultural, institutional, and data protection changes. In this way, it was found that digital transformation is not sustained autonomously, but depends on human, political, and regulatory factors.

It is therefore concluded that ICT has the potential to modernize and make public administration more efficient, but only when accompanied by integrated strategies of training, digital governance and adaptive leadership. Digital transformation does not eliminate, by itself, the historical dilemmas of public management; on the contrary, it highlights them, requiring multisectoral and collaborative approaches. Responding to the objective of this study means recognizing that technology is a means,

not an end, to efficiency: without institutional integration, social participation, and adequate regulation, digital runs the risk of producing only superficial modernization, and not true transformation.

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