



**MITIGATING THE RISK OF DATA LEAKAGE IN PUBLIC SERVICE
INNOVATION BASED ON BIG DATA, ANALYTICS AND MACHINE
LEARNING**

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Abstract

The development of digital technology encourages the transformation of public services towards a more effective, efficient, and transparent government system through the use of Artificial Intelligence, big data analytics, and machine learning. Although it is able to improve service quality, accelerate administrative processes, and support data-driven decision-making, the application of this technology also poses a risk of personal data leakage and cybersecurity threats. This study aims to analyze the risk of data leakage in public service innovation based on big data analytics and machine learning, as well as identify mitigation strategies that can be applied. The research method used is literature review by analyzing 30 national and international articles published in 2019–2025. The results of the study show that data leak risk mitigation can be carried out through strengthening Artificial Intelligence governance, improving cybersecurity, implementing Law Number 27 of 2022 concerning Personal Data Protection, implementing Data Protection Impact Assessment (DPIA), and strengthening good digital governance. Thus, the synergy between technology, regulation, and digital governance is an important factor in realizing safe, transparent, and accountable public services.

Keywords: Artificial Intelligence, big data analytics, data leakage, public services, personal data protection

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INTRODUCTION

The development of digital technology in the era of globalization has brought major changes in various aspects of life, including in the system of government and public services. Digital transformation is one of the strategies implemented by the government to improve the quality of services to the community through the use of information and communication technology. One of the technologies that is rapidly developing today is *Artificial Intelligence*, which is a technology that allows computer systems to automatically analyze, learn, and make decisions to help human activities. Development *Artificial Intelligence* also supported by the utilization of *BIG* data analytics and machine learning that are able to process large amounts of data quickly and efficiently so as to encourage the creation of digital-based public services that are more modern and adaptive to technological developments (Zhang & Lu, 2021).

Development *Artificial Intelligence* in Indonesia has also increased in line with the acceleration of the government's digital transformation. Utilization *Artificial Intelligence* It has begun to be applied in various digital public services, such as population administration services, health services, electronic taxation systems, to online-based licensing services. The presence of digital technology is considered to be able to increase bureaucratic effectiveness, accelerate the public service process, and assist the government in making more accurate and responsive data-based decisions. Research Dwivedi et al., (2023) Explains that the utilization of *Artificial Intelligence* can improve digital service innovation and organizational effectiveness in the face of modern technological developments.

Usage *Artificial Intelligence* in public services provides various benefits for the government and the community. System-based *Artificial Intelligence* able to support service automation so that the administrative process becomes faster, more efficient, and more transparent. In addition, *BIG* Data analytics allow the government to process public information in real time to support the formulation of more targeted public policies. *Artificial Intelligence* It is also considered to be able to improve the quality of public services through the integration of digital data and automated analysis systems that help the effectiveness of government bureaucracy (Dwivedi et al., 2023).

While providing a variety of benefits, the implementation of *Artificial Intelligence* Public services also present challenges, especially related to the security of people's personal data. System-based *Artificial Intelligence* requires the collection, storage, and



processing of large amounts of data to produce accurate analysis and predictions. This condition causes an increased risk of misuse of personal data, data leaks, and the threat of cyberattacks on the government's digital system. Several cases of data leaks in Indonesia, such as BPJS Kesehatan data leaks and population administration data, show that the security of digital systems in Indonesia still has various weaknesses. The problem of data leakage is not only detrimental to the public as data owners, but can also reduce the level of public trust in government digital services (Ismail et al., 2022).

In addition to data security risks, the use of *Artificial Intelligence* It also raises the issue of digital ethics in public services. Use of algorithms *Artificial Intelligence* has the potential to cause discrimination, misuse of personal information, lack of transparency of automation systems, and weak accountability in technology-based decision-making. Therefore, ethics *Artificial Intelligence* is an important aspect that must be considered in the implementation of government digital technology. The principles of transparency, fairness, security, privacy protection, and responsibility need to be applied in order for the use of *Artificial Intelligence* does not cause a negative impact on the community (Batool et al., 2025).

As a form of legal protection for people's personal data, the Indonesian government has passed Law Number 27 of 2022 concerning Personal Data Protection. The regulation is the legal basis for the management, processing, storage, and protection of personal data of the Indonesian people. The presence of the Personal Data Protection Law is an important step in strengthening data security in the era of digital transformation, especially in the use of *Artificial Intelligence* and big data in the public sector. However, the implementation of these regulations still faces various challenges, such as weak supervision, low readiness of digital human resources, and suboptimal standardization of data management operational procedures in digital public services (Filal Khair & Sidi Ahyar Wiraguna, 2025).

Another challenge in the digital transformation of government is the importance of digital leadership in creating good digital governance. Digital leadership is the ability of leaders to utilize digital technology to encourage innovation, increase organizational effectiveness, and create a transparent and accountable governance system. Digital leadership is needed so that the government's digital transformation not only focuses on the use of technology, but also pays attention to aspects of data security, digital ethics, and the protection of people's rights in the use of digital services (Alenezi, 2022).

Based on this description, studies on data leak risk mitigation in public service innovations based on big data analytics and machine learning are important to be carried



out. The increasing use of *Artificial Intelligence* in the public sector needs to be balanced with strong data protection systems, adaptive regulations, and responsible digital governance. Through the literature review method, this study seeks to analyze various data leakage risks in the implementation of *Artificial Intelligence* in public services while identifying mitigation strategies through strengthening regulations, implementing *Artificial Intelligence* ethics, improving cybersecurity, and standardizing data management procedures to support the realization of *good digital governance* in Indonesia.

RESEARCH METHODS

The research methods used in this study are *literature review*, which is a method that aims to identify, study, evaluate, and synthesize various previous research results relevant to the research topic (Snyder, 2019). Literature search is carried out through Google Scholar using keywords *Artificial Intelligence*, *Big Data Analytics*, *Machine Learning*, *Data Leakage*, *Personal Data Protection*, *Cybersecurity*, *AI Governance*, and *Good Digital Governance*. The selected articles are national and international journals published in the 2019–2025 range and are related to mitigating the risk of data leakage in digital technology-based public service innovation. Furthermore, articles were selected based on the suitability of the title, abstract, content, and relevance to the focus of the research until 30 articles were obtained that met the criteria for analysis. The analysis was carried out by identifying information about the author, year of publication, research method, research focus, and research results which are then presented in Table 1. The results of the analysis are then synthesized and described descriptively to explain the relationship between the studies and answer the research objectives.

Table 1. Results of Literature Analysis

No	Author (Year)	Research Title	Research Methods	Research Focus	Research Results
1	Snyder, (2019)	<i>Literature Review as a Research Methodology: An Overview and Guidelines</i>	Literature Review	Metodologi literature review	Literature review is a systematic research method to identify, evaluate, and synthesize previous



					research so as to produce a comprehensive theoretical foundation.
2	Sousa, W. G., Melo, E. R. P., Bermejo, P. H. S., Farias, R. A. S., & Gomes, A. O. (2019)	<i>How and Where is Artificial Intelligence in the Public Sector Going? A Literature Review and Research Agenda</i>	Literature Review	Artificial Intelligence in the public sector	<i>Artificial Intelligence</i> has the potential to improve the efficiency, effectiveness, and quality of public services, but its implementation requires good governance and regulation.
3	Tangi, L., van Noordt, C., & Müller, A. P. (2023)	<i>The Challenges of AI Implementation in the Public Sector: An In-Depth Case Studies Analysis</i>	Case Study	Implementation of Artificial Intelligence	The main obstacles to the implementation of <i>Artificial Intelligence</i> in the public sector are regulations, data quality, human resources, and organizational readiness.
4	Kuziemski, M., & Misuraca, G. (2020)	<i>AI Governance in the Public Sector: Three Tales from the Frontiers of Automated Decision-Making in Democratic Settings</i>	Qualitative Study	<i>Artificial Intelligence Governance</i>	Artificial Intelligence <i>governance</i> is needed to ensure transparency, accountability, and protection



					of people's rights in digital public services.
5	Zhang, C., & Lu, Y. (2021)	<i>Study on Artificial Intelligence: The State of the Art and Future Prospects</i>	Literature Review	Artificial Intelligence	<i>Artificial Intelligence</i> is growing rapidly and has a significant impact on various sectors, including government, through improved efficiency and data analysis.
6	Alenezi, M. (2022)	<i>Understanding Digital Government Transformation</i>	Literature Review	Digital Government	The digital transformation of government requires digital leadership, organizational readiness, and continuous technology development.
7	Corrêa, N. K., et al. (2022)	<i>Worldwide AI Ethics: A Review of 200 Guidelines and Recommendations for AI Governance</i>	Literature Review	<i>Artificial Intelligence Ethics, Artificial Intelligence Governance</i>	Various Artificial Intelligence <i>ethical guidelines</i> emphasize transparency, fairness, accountability, security, and privacy protection as the



					main principles of <i>Artificial Intelligence</i> implementation.
8	Dwivedi, Y. K., et al. (2023)	<i>So What if ChatGPT Wrote It? Multidisciplinary Perspectives on Opportunities, Challenges and Implications of Generative Conversational AI for Research, Practice and Policy</i>	Literature Review	Artificial Intelligence	<i>Artificial Intelligence</i> provides great opportunities in public service innovation, but it needs to be supported by regulations, ethics, and personal data protection.
9	Ismail, H., Febiyanto, F., & Moniaga, J. V. (2023)	<i>Methods to Prevent Privacy Violations on the Internet on the Personal Level in Indonesia</i>	Literature Review	Data Privacy	Data leakage prevention can be done through improving digital literacy, information security, and personal data protection.
10	Ruijer, E., Porumbescu, G., Porter, R., & Piotrowski, S. J. (2023)	<i>Social Equity in the Data Era: A Systematic Literature Review of Data-Driven Public Service Research</i>	Systematic Literature Review	Data-Driven Public Service	The use of data in public services improves the quality of services, but must still pay attention to aspects of social justice, transparency, and protection of public privacy.



11	Wirtz, B. W., Weyerer, J. C., & Sturm, B. J. (2020)	<i>The Dark Sides of Artificial Intelligence: An Integrated AI Governance Framework for Public</i>	Literature Review	<i>Artificial Intelligence Governance</i>	Develop an Artificial Intelligence governance framework to minimize ethical, regulatory, and security risks in public administration.
12	Sun, T. Q., & Medaglia, R. (2019)	<i>Mapping the Challenges of Artificial Intelligence in the Public Sector: Evidence from Public Healthcare</i>	Systematic Literature Review	Artificial Intelligence, Public Healthcare	The main challenges of implementing Artificial Intelligence include data privacy, algorithm transparency, accountability, and human resource readiness.
13	Mikhaylov, S. J., Esteve, M., & Campion, A. (2018)	<i>Artificial Intelligence for the Public Sector: Opportunities and Challenges of Cross-Sector Collaboration</i>	Conceptual Review	<i>Artificial Intelligence</i> , Public Sector Collaboration	Collaboration between governments, academia, and the private sector is needed to support the effective and sustainable implementation of Artificial Intelligence.
14	Valle-Cruz, D., Criado, J. I., Sandoval-Almazán, R., &	<i>Assessing the Public Policy-Cycle Framework in the</i>	Literature Review	Artificial Intelligence, Public Policy	<i>Artificial Intelligence</i> can be used in every stage of the



	Ruvalcaba-Gómez, E. A. (2020)	<i>Age of Artificial Intelligence</i>			public policy cycle from formulation to data-driven policy evaluation.
15	Mökander, J., Morley, J., Taddeo, M., & Floridi, L. (2023)	<i>Auditing of AI: Legal, Ethical and Technical Approaches</i>	Literature Review	<i>Artificial Intelligence Auditing, Artificial Intelligence Governance, Artificial Intelligence Ethics</i>	Artificial Intelligence audits are an important mechanism to ensure that Artificial Intelligence systems meet legal, ethical, transparent, accountable, and security aspects so that they can minimize the risk of misuse of technology.
16	Camilleri, M. A. (2024)	<i>The Ethical Implications of Artificial Intelligence Technologies in Public Services and Government</i>	Literature Review	<i>Artificial Intelligence Ethics, Public Services</i>	The application of Artificial Intelligence must pay attention to ethical principles such as transparency, fairness, accountability, data security, and privacy protection.
17	Ongena, G., & Davids, A. (2023)	<i>Big Data Analytics Capability and Governmental</i>	Quantitative Research (PLS-SEM)	Big Data Analytics Capability,	The capabilities of big data analytics have a



		<i>Performance: An Empirical Examination</i>		Government Performance	positive effect on the effectiveness, efficiency, and fairness of government performance.
18	Shrestha, Y. R., et al. (2024)	<i>Navigating Artificial Intelligence to Unpack Privacy Concerns: A Systematic Literature Review</i>	Systematic Literature Review	<i>Artificial Intelligence</i> , Data Privacy	The use of <i>Artificial Intelligence</i> increases the risk to privacy, requiring stronger regulations, data governance, and information security systems.
19	Busuioc, M. (2021)	<i>Accountable Artificial Intelligence: Holding Algorithms to Account</i>	Conceptual Review	Artificial Intelligence, Public Accountability	The use of <i>Artificial Intelligence</i> in the public sector must be accompanied by accountability mechanisms, algorithm transparency, and human oversight so that the risk of data misuse and automated decisions can be minimized.
20	Janssen, M., van der Voort, H., & Wahyudi, A. (2017)	<i>Factors Influencing Big Data Decision-Making Quality</i>	Quantitative Research	Big Data Analytics, Decision Making	Big data improves the quality of government



					decision-making when supported by data quality, technological infrastructure, and human resource competence.
21	Khair, F., & Wiraguna, S. A. (2025)	<i>Data Protection Impact Assessment (DPIA) as a Key Instrument to Ensure Compliance with the 2022 Personal Data Protection Law in Indonesia</i>	Normative Law Research	Personal Data Protection	DPIA is an important instrument to minimize the risk of data leakage and support the implementation of the PDP Law.
22	Pratiwi, A., Rahmawyanet, M. E., Putra, P. A. W., & Sensuse, D. I. (2025)	<i>Systematic Literature Review on Artificial Intelligence in Indonesia's Public Sector: Reimagining Digital Government</i>	Systematic Literature Review	<i>Artificial Intelligence, Digital Government</i>	The implementation of <i>Artificial Intelligence</i> in Indonesia's public sector has the potential to improve service quality, but it still faces challenges in regulation, infrastructure, data security, and human resource readiness.
23	Agustian, D., Regif, S. Y., Botha, H. H., Pattipeilohy,	<i>Artificial Intelligence in the Implementation of Public Governance:</i>	Literature Review	<i>Artificial Intelligence</i> , Public Data Security	The use of <i>Artificial Intelligence</i> in government increases



	A., & Ode, S. (2025)	<i>Public Data Security Vulnerabilities in Indonesia</i>			service efficiency, but there are still vulnerabilities in public data security, so regulation and strengthening cybersecurity are needed.
24	24	Sulistyantoro, G. T., Khaq, A., Khan, M. Z. K., Al Amin, & Hussain, A. M. (2024)	<i>Shaping Artificial Intelligence Governance and Risk Management in the Public Sector: Regulatory Insights</i>	Literature Review	<i>Artificial Intelligence Governance, Risk Management</i>
25	Aryanti, D. R. (2025).	<i>Cybersecurity Governance in Public Institutions: Managing Digital Risks and Resilience</i>	Literature Review	Cybersecurity Governance	Good cybersecurity governance increases the resilience of public organizations to the threat of data leaks and cyberattacks.
26	Wahyudi, E., & Wiredarme (2025)	<i>Literature Analysis on the Role of Artificial Intelligence in Strengthening Cybersecurity in E-Government Services</i>	Systematic Literature Review	<i>Artificial Intelligence</i> , Cybersecurity, E-Government	<i>Artificial Intelligence</i> is able to improve cyber threat detection, real-time monitoring, and data protection in digital



					government services.
27	Henman, P. (2020)	<i>Improving Public Services Using Artificial Intelligence: Possibilities, Pitfalls, Governance</i>	Literature Review	<i>Artificial Intelligence , Public Service, Governance</i>	The implementation of <i>Artificial Intelligence</i> is able to improve the quality of public services, but must be balanced with governance, transparency, accountability, data protection, and supervision of the risk of algorithmic bias.
28	Batool, A., Zowghi, D., & Bano, M. (2025)	<i>AI Governance: A Systematic Literature Review</i> <i>Systematic Literature</i>	Systematic Literature Review	<i>AI Governance, AI Ethics</i>	Research shows that AI governance needs to apply the principles of transparency, accountability, fairness, security, and privacy protection in order for AI implementation to take place responsibly and be able to minimize the risk of technology misuse.



29	Khalidah, A. N., Ragil, Yudianto, R. P. W., Saputra, D., Tramajie, M. S., & Yunita (2025)	<i>Public Data Leakage and IT Ethics in BPJS-PDN Cyber Governance and Resilience 2024</i>	Qualitative Comparative Literature Review	Data Leaks, Cyber Resilience	Studies show the need to improve cybersecurity governance, data backup systems, and IT ethics to prevent public data leaks.
30	Aarab, A., Marzouki, A. E., Boubker, O., & Moutaqi, B. E. (2025)	<i>Integrating AI in Public Governance: A Systematic Review</i>	Literature Review	<i>Artificial Intelligence Governance</i>	The integration of Artificial Intelligence in public governance requires regulation, transparency, data security, and accountability to build public trust.

RESULTS AND DISCUSSION

Based on the results of the analysis of 30 articles that met the research criteria, it was obtained that the use of *Artificial Intelligence (AI)*, *big data analytics*, and *machine learning* has become an important part of the transformation of public services in various countries. Most studies use the *literature review*, *systematic literature review*, as well as conceptual studies to examine the implementation of digital technology in government. The results of the study show that the application of this technology is able to increase bureaucratic efficiency, speed up service processes, and support more appropriate decision-making through the use of data. However, various studies also highlight the emergence of new challenges in the form of data leak risks, privacy protection, cybersecurity, and the need for better digital governance (Dwivedi et al., 2023; Sousa et al., 2019; Zhang & Lu, 2021).



The use of Artificial Intelligence in public services is considered to be able to increase the effectiveness of government administration through automating administrative processes, quickly analyzing data, and providing more responsive services to the community. Sousa et al., (2019) explains that *Artificial Intelligence* has the potential to improve the quality of public services if supported by adequate governance. The findings are reinforced by Zhang & Lu, (2021) which states that the development of *Artificial Intelligence* It opens up great opportunities for the government to improve the quality of data-based decision-making. In addition, Dwivedi et al., (2023) confirms that the development of *Artificial Intelligence* generative is increasingly expanding opportunities for public service innovation, although its implementation still requires supervision so that the benefits generated are in line with the interests of the community.

While providing a variety of benefits, the implementation of *Artificial Intelligence* in the public sector still faces a number of challenges. Tangi et al., (2023) Identifying that digital infrastructure readiness, data quality, regulation, and human resource competence are factors that greatly determine the success of implementation *Artificial Intelligence*. In line with this, Sun & Medal, (2019) explains that the use of *Artificial Intelligence* It also raises issues regarding algorithm transparency, system accountability, and user privacy protection. Therefore, the application of digital technology requires not only technological innovation, but also organizational readiness to manage these changes.

The results of the study also show that *Artificial Intelligence governance* is an important element in supporting the implementation of *Artificial Intelligence* responsibly. Kuziemski & Misuraca, (2020) emphasizing that governance *Artificial Intelligence* must be able to ensure transparency, accountability, and protection of people's rights in the algorithm-based decision-making process. Wirtz et al., (2020) added that the Artificial Intelligence governance framework needs to be designed to anticipate various risks, including ethical issues, security, and regulatory compliance. The findings are in line with Aarab et al. (2025) who stated that the successful integration of *Artificial Intelligence* In government, it is greatly influenced by the existence of clear regulations, supervision, and accountability mechanisms.

In addition to the governance aspect, various studies place ethics *Artificial Intelligence* as an integral part of the digital transformation of government. Corrêa et al., (2023) explained that the principles of transparency, fairness, accountability, security, and privacy protection are the basis for development *Artificial Intelligence* who are responsible. This is reinforced by Mökander, (2023) which emphasizes the importance of audits *Artificial Intelligence* to ensure that the system used meets the legal, technical, and



ethical aspects. Camilleri, (2024) also stated that the implementation of *Artificial Intelligence* In public services, social impacts and protection of people's rights must be considered so that technology does not cause inequality or misuse of information.

On the other hand, the utilization of *big data analytics* contribute to improving the quality of government decision-making. Ongena & Davids, (2023) It found that the ability of organizations to manage big data has a positive effect on the effectiveness and efficiency of government performance. The findings are in line with Janssen et al., (2017) which states that the quality of public decisions will improve if supported by accurate data, adequate technological infrastructure, and human resource competence. However, the increasing volume of data managed by the government also increases the potential for data leaks if it is not managed safely.

The issue of personal data protection is one of the most dominant issues in various studies. Ismail et al., (2022) explained that the increase in the use of digital services causes the risk of misuse of personal data to be greater so that it is necessary to increase information security literacy and better data protection. Shrestha et al., (2024) also shows that the development of *Artificial Intelligence* This has led to increasing concerns about user privacy, so regulations are needed to ensure data security. In the context of Indonesia, Filal Khair & Sidi Ahyar Wiraguna, (2025) affirms that the implementation of *Data Protection Impact Assessment* (DPIA) is one of the important instruments to support the implementation of Law Number 27 of 2022 concerning Personal Data Protection while minimizing the risk of data leakage.

The results of the study further showed that the strengthening of *cybersecurity governance* It is a very important strategy in mitigating the risk of data leakage. Aryanti, (2025) Explains that good cybersecurity governance is able to increase the resilience of public organizations to various digital threats. Erfan Wahyudi & Wiredarme, (2026) adding that the utilization of *Artificial Intelligence* in cybersecurity systems can help detect threats *real-time* so that the response to attacks becomes faster. The findings are reinforced by Khalidah et al., (2026) which emphasizes the importance of increasing cyber resilience, strengthening data backup systems, and applying information technology ethics in preventing data leaks in the public sector.

Hence, the results of *the literature review* show that public service innovations based on *Artificial Intelligence*, *big data analytics*, and *machine learning* have great potential to improve the quality of public services. However, the success of its implementation is greatly influenced by regulatory readiness, the implementation of *Artificial Intelligence governance*, strengthening cybersecurity, personal data protection, and the government's



commitment to building *good digital governance*. Thus, the development of digital technology must be balanced with a governance system that is transparent, accountable, and oriented towards the protection of people's rights so that digital transformation can provide benefits in a sustainable manner.

Conclusion

Based on the results *of a literature review* of 30 articles, it can be concluded that the application *of Artificial Intelligence (AI), big data analytics, and machine learning* is able to increase the effectiveness, efficiency, and quality of public services through the use of data in the decision-making process. However, the implementation of this technology also presents challenges in the form of data leak risks, cybersecurity threats, and the need for personal data protection. Therefore, the success of digital transformation in the public sector requires strengthening *Artificial Intelligence governance*, implementing *cybersecurity*, implementing Law Number 27 of 2022 concerning Personal Data Protection, implementing *Data Protection Impact Assessment (DPIA)*, and improving the competence of human resources so that digital public services can run safely, transparently, and accountably.

Recommendations

1. The government needs to strengthen the governance of digital public services through the responsible implementation *of Artificial Intelligence*, improving cybersecurity systems, preparing operational standards for data management, implementing *Data Protection Impact Assessment (DPIA)*, and periodic evaluation of *Artificial Intelligence* systems to minimize the risk of data leakage.
2. Public service providers need to improve the competence of human resources in the fields of digital technology, cybersecurity, and *Artificial Intelligence governance* so that technology implementation can run effectively, safely, and in accordance with the principles *of good digital governance*.
3. The next research is suggested to use quantitative, qualitative, and *mixed methods approaches* to test the effectiveness of the application *of Artificial Intelligence, big data analytics, and machine learning* in mitigating the risk of data leakage in various public service sectors.



4. Future research can also examine other factors, such as organizational readiness, digital culture, quality of governance, and the level of public trust in technology-based public services so that they can contribute more comprehensively to the development of digital public service policies and practices in Indonesia.

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