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Big Data Governance Framework for Trustworthy Artificial Intelligence Decision Systems

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ABSTRACT

The rapid adoption of Artificial Intelligence (AI) decision systems has increased organizational dependence on large-scale data, making big data governance a critical requirement for ensuring reliable and responsible decision-making. Although AI systems are often evaluated based on predictive accuracy and computational performance, their trustworthiness is strongly influenced by the quality, security, privacy, traceability, and fairness of the data used throughout the AI lifecycle. **This study aims to develop** a Big Data Governance Framework for Trustworthy AI Decision Systems by integrating key governance dimensions with trustworthy AI requirements. **A qualitative conceptual** framework development approach was employed, supported by structured literature review, thematic synthesis, and design science research principles. Relevant literature on big data governance, trustworthy AI, data quality, privacy, security, explainability, accountability, fairness, and AI decision systems was reviewed to identify recurring concepts and research gaps. **The results show that** trustworthy AI decision systems require seven core governance dimensions: data quality governance, security and privacy governance, metadata and data lineage, bias and fairness control, explainability support, accountability mechanisms, and continuous monitoring. These dimensions strengthen trustworthy AI capabilities, including reliability, transparency, explainability, fairness, privacy preservation, security, robustness, and auditability. The proposed framework demonstrates that trustworthy AI is not only determined by algorithmic performance but also by strong data governance across the AI lifecycle. **This study concludes** that effective big data governance can improve decision accuracy, traceability, accountability, risk reduction, and stakeholder trust in AI-based decision systems.

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1. INTRODUCTION

The rapid advancement of Artificial Intelligence (AI) has transformed the way organizations process information, generate insights, and support strategic decision-making [1]. AI decision systems are increasingly applied in various domains, including digital business, finance, healthcare, education, public services, cybersecurity, and smart city management. These systems are designed to analyze large-scale data, identify hidden

patterns, predict future conditions, and recommend actions based on computational intelligence [2]. As organizations continue to depend on automated and semi-automated decision systems, the quality and governance of the underlying data have become critical factors in determining the reliability, transparency, and trustworthiness of AI-based decisions. Big data plays a fundamental role in the development and operation of AI decision systems. Large volumes of structured, semi-structured, and unstructured data are collected from multiple sources, such as transactional systems, digital platforms, social media interactions, sensors, enterprise applications, and cloud-based infrastructures. This data enables AI models to learn complex relationships and produce decision outputs that may influence organizational performance and public trust. However, the use of big data also introduces significant challenges related to data quality, privacy, security, bias, interoperability, accountability, and regulatory compliance. Without proper governance, big data may become a source of uncertainty rather than a foundation for trustworthy intelligence [3, 4].

The trustworthiness of AI decision systems cannot be assessed only through predictive accuracy or computational efficiency. Although model performance remains important, AI systems must also be valid, reliable, explainable, secure, privacy-preserving, fair, and accountable. In practice, many AI failures are not caused solely by algorithmic limitations but also by weaknesses in data governance [5]. Incomplete data, inconsistent data formats, unverified data sources, biased historical records, weak access control, and unclear data ownership may lead to inaccurate predictions, unfair recommendations, and decisions that are difficult to justify [6]. Therefore, trustworthy AI requires not only advanced algorithms but also a strong governance framework that controls the entire data lifecycle. Big data governance refers to the policies, processes, roles, standards, and technologies used to manage data as a strategic organizational asset. It ensures that data is accurate, accessible, secure, traceable, usable, and compliant with ethical and regulatory requirements. In the context of AI decision systems, big data governance becomes more complex because data is not only stored and analyzed but also transformed into automated decisions. This requires governance mechanisms that cover data collection, data integration, data preprocessing, model training, model validation, decision explanation, audit logging, and continuous monitoring. By integrating governance into the AI lifecycle, organizations can reduce decision risks and improve the credibility of AI-generated outputs [7, 8].

Previous studies have discussed big data analytics, AI governance, data quality management, and trustworthy AI from different perspectives. However, many existing discussions remain fragmented because they often treat data governance and AI trustworthiness as separate domains. Studies on big data governance commonly emphasize data management, security, and compliance, while studies on trustworthy AI often focus on fairness, explainability, transparency, and accountability. Limited research has provided an integrated framework that clearly connects big data governance dimensions with the requirements of trustworthy AI decision systems [9]. This gap indicates the need for a conceptual model that explains how governance mechanisms can support the development of reliable and responsible AI-based decisions. Another important issue is that organizations frequently adopt AI decision systems without sufficient preparation in data governance maturity. AI implementation is often driven by technological enthusiasm, business efficiency, and competitive pressure, while governance structures are developed later as a corrective response to emerging risks. This reactive approach may expose organizations to problems such as data misuse, hidden bias, privacy violations, weak accountability, and low stakeholder confidence [10]. Therefore, a proactive big data governance framework is needed to guide organizations before, during, and after AI system deployment. Such a framework should help decision-makers align data management practices with trustworthiness principles and operational risk control [11, 12].

This study proposes a Big Data Governance Framework for Trustworthy AI Decision Systems. The framework is designed to integrate key governance dimensions, including data quality governance, data security and privacy, metadata and data lineage, bias and fairness control, explainability support, accountability mechanisms, and continuous monitoring. These dimensions are expected to strengthen trustworthy AI capabilities, such as reliability, transparency, fairness, robustness, privacy preservation, and auditability [13]. The proposed framework positions big data governance as a foundational layer that supports responsible AI decision-making across organizational and technological contexts. Furthermore, the framework provides a systematic governance structure that aligns data management practices with the ethical and operational requirements of AI systems throughout their lifecycle. Ultimately, the framework is intended to improve stakeholder trust by ensuring that AI-driven decisions are supported by high-quality, secure, transparent, and well-governed data resources [14].

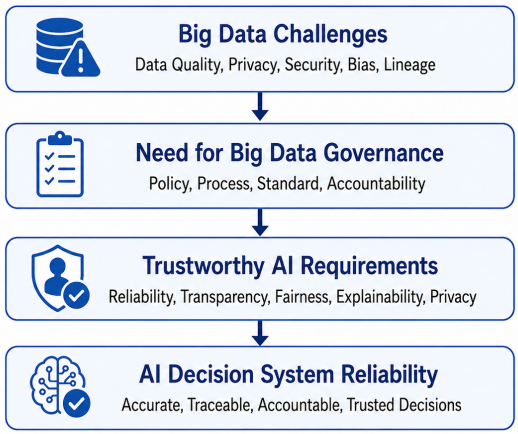

Figure 1. Conceptual Flow of Big Data Governance for Trustworthy AI Decision Systems

Figure 1 illustrates the conceptual flow of big data governance in supporting trustworthy AI decision systems. The flow begins with key big data challenges, including data quality, privacy, security, bias, and lineage, which can directly affect the reliability of AI-generated decisions. These challenges create the need for strong big data governance through clear policies, structured processes, standardized procedures, and accountability mechanisms. Through effective governance, organizations can strengthen trustworthy AI requirements such as reliability, transparency, fairness, explainability, and privacy protection [15]. As a result, AI decision systems can produce more accurate, traceable, accountable, and trusted decisions. Therefore, Figure 1 emphasizes that trustworthy AI decision-making is not only determined by algorithmic performance, but also by the quality and governance of the data used throughout the AI lifecycle [16, 17].

The novelty of this study lies in integrating big data governance and trustworthy AI into a unified conceptual framework that explicitly maps governance dimensions to AI trustworthiness requirements [18]. Unlike previous studies that examine big data governance and trustworthy AI separately, this study positions governance as a fundamental prerequisite for developing reliable, transparent, fair, secure, and accountable AI decision systems [19]. The framework contributes theoretically by clarifying the relationship between governance dimensions and AI trustworthiness principles, while providing practical guidance for organizations implementing AI-based decision systems. Accordingly, this study aims to:

- Identify the key dimensions of big data governance that support trustworthy AI.
- Explain how these dimensions enhance reliability, transparency, fairness, accountability, and risk mitigation in AI-driven decisions.
- Propose an integrated conceptual framework to guide future empirical research and organizational AI governance practices.

Furthermore, this study supports the Sustainable Development Goals (SDGs), particularly SDG 9 (Industry, Innovation, and Infrastructure) by promoting trustworthy AI and resilient digital infrastructure, and SDG 16 (Peace, Justice, and Strong Institutions) by strengthening transparency, accountability, auditability, responsible data governance, and ethical AI decision-making through secure, privacy-preserving, and sustainable digital governance practices [20, 21].

2. LITERATURE REVIEW

2.1. Big Data Governance

Big data governance refers to a structured set of policies, processes, standards, roles, and technological mechanisms used to manage large-scale data assets effectively and responsibly. In the digital era, organizations collect data from diverse sources, including enterprise systems, cloud platforms, social media, mobile applications, Internet of Things (IoT) devices, and transactional records. The characteristics of big data volume, velocity, variety, veracity, and value offer significant opportunities for data-driven decision-making while creating challenges related to data quality, security, privacy, interoperability, accountability, and regulatory compliance

[22]. Therefore, big data governance aims to ensure that data remains accurate, secure, accessible, and properly managed throughout its lifecycle by establishing clear policies for data ownership, stewardship, quality, metadata, access control, and compliance [23, 24].

In AI, big data governance is essential because AI models rely heavily on high-quality and trustworthy data for training, validation, and deployment. Weak governance, poor data quality, incomplete records, and biased datasets can produce unreliable or unfair AI outcomes. A comprehensive governance framework therefore includes key dimensions such as data quality, security and privacy, metadata and data lineage, bias and fairness management, accountability, and continuous monitoring [25]. These dimensions provide the foundation for trustworthy AI by ensuring that data are reliable, transparent, secure, and ethically managed throughout the AI lifecycle [26].

Table 1. Key Concepts in Big Data Governance and Trustworthy AI

Concept	Definition	Relevance to This Study
Big Data Governance	A structured mechanism for managing data policies, standards, roles, quality, security, privacy, and accountability	Provides the foundation for managing data used in AI decision systems
Data Quality	The degree to which data is accurate, complete, consistent, timely, and relevant	Ensures that AI models produce reliable and valid outputs
Data Privacy	Protection of personal and sensitive data from inappropriate use or exposure	Supports ethical and lawful AI decision-making
Data Security	Protection of data from unauthorized access, manipulation, or breach	Reduces risks in AI data pipelines and decision systems
Data Lineage	The ability to trace data origin, transformation, and usage	Supports transparency, auditability, and decision traceability
Trustworthy AI	AI that is reliable, transparent, explainable, fair, secure, privacy-preserving, and accountable	Becomes the main objective of the proposed governance framework
AI Decision System	A computational system that supports or automates decision-making using AI techniques	Represents the system context where big data governance is applied

Table 1 presents the key concepts that form the theoretical foundation of this study, particularly in explaining the relationship between big data governance and trustworthy AI. The concepts include big data governance, data quality, data privacy, data security, data lineage, trustworthy AI, and AI decision systems, each of which is defined to clarify its role in supporting the development of reliable and responsible AI-based decision-making. The table demonstrates that trustworthy AI cannot be separated from strong data governance because the reliability, transparency, fairness, privacy, and accountability of AI systems depend heavily on how data is collected, managed, protected, traced, and used. Therefore, these concepts provide a conceptual basis for developing the proposed Big Data Governance Framework for Trustworthy AI Decision Systems [27, 28].

2.2. Trustworthy AI

Trustworthy AI refers to artificial intelligence systems that exhibit characteristics such as reliability, transparency, explainability, security, privacy preservation, fairness, robustness, and accountability. In addition to delivering high predictive performance, trustworthy AI highlights the importance of ensuring that AI systems operate in a manner that can be understood, assessed, and trusted by relevant stakeholders. As the adoption of AI expands across sectors including healthcare, finance, education, cybersecurity, public services, and business intelligence, the need to ensure trustworthiness becomes increasingly critical because decisions generated by AI may have substantial impacts on both individuals and organizations [29]. Therefore, trustworthy AI requires a holistic governance approach that combines technical, ethical, organizational, and societal dimensions, allowing stakeholders to understand how decisions are produced, which data are utilized, what potential risks may emerge, and who bears responsibility for the resulting outcomes [30, 31].

Several principles underpin trustworthy AI, including reliability, transparency, explainability, fairness, privacy preservation, security, and accountability. These principles should be embedded throughout the entire AI lifecycle, from data collection and preparation to model training, validation, deployment, monitoring, and continuous improvement. This lifecycle perspective highlights the close relationship between trustworthy AI and big data governance, as the quality, security, traceability, and integrity of data directly influence the reliability and fairness of AI decisions. Therefore, trustworthy AI depends not only on advanced algorithms but also

on effective governance mechanisms that ensure data are accurate, secure, unbiased, and responsibly managed throughout the AI lifecycle [32].

2.3. AI Decision Systems

AI decision systems are computational systems that use AI techniques to support, recommend, or automate decision-making processes. These systems employ technologies such as machine learning, deep learning, natural language processing, predictive analytics, recommendation systems, and anomaly detection to transform data into actionable insights across domains including healthcare, finance, education, cybersecurity, business intelligence, and public services [33]. Their ability to process large volumes of data, identify hidden patterns, improve prediction accuracy, and enable real-time decision-making makes them valuable for organizations operating in data-intensive environments. However, AI decision systems also introduce challenges related to explainability, biased data, poor data quality, privacy risks, and hidden assumptions embedded in model development [34, 35].

The effectiveness of AI decision systems depends on both model performance and data governance. From the model perspective, organizations must ensure accuracy, robustness, interpretability, and performance stability, while from the data perspective they must maintain data quality, security, metadata completeness, data lineage, privacy protection, and fairness. Since AI models learn directly from data, weak data governance can lead to unreliable or biased decisions regardless of algorithmic sophistication [36]. In addition, accountability is essential throughout the AI lifecycle, requiring clear responsibilities for data preparation, model development, deployment, decision validation, and risk management. Therefore, AI decision systems require a comprehensive governance framework that ensures decisions are not only efficient and accurate but also transparent, fair, secure, and accountable [37].

2.4. Integration of Big Data Governance and Trustworthy AI Decision Systems

The integration of big data governance and trustworthy AI decision systems is founded on the principle that trustworthy AI requires trustworthy data. AI systems cannot produce reliable, fair, or accountable decisions if the underlying data are inaccurate, biased, insecure, incomplete, or untraceable. Big data governance provides the foundation for ensuring data quality, security, privacy, metadata management, data lineage, bias mitigation, and accountability throughout the AI lifecycle [38]. These governance dimensions directly support AI trustworthiness by improving data reliability, protecting sensitive information, enabling transparency and auditability, reducing bias, and establishing clear responsibilities for data and model management. Furthermore, continuous monitoring helps maintain data quality, model performance, fairness, and security after deployment, ensuring that AI systems remain reliable over time [39].

This relationship demonstrates that big data governance is not merely a data management function but a fundamental prerequisite for trustworthy AI decision systems. Organizations that implement AI without effective governance face risks such as inaccurate decisions, unfair outcomes, privacy violations, limited transparency, and weak stakeholder trust. Although previous studies have explored big data governance and trustworthy AI, these topics have often been examined separately, leaving limited research on their direct integration [40]. To address this gap, this study proposes a Big Data Governance Framework for Trustworthy AI Decision Systems that integrates data quality governance, security and privacy, metadata and data lineage, bias and fairness management, explainability support, accountability mechanisms, and continuous monitoring. The proposed framework provides a conceptual foundation for developing AI decision systems that are reliable, transparent, fair, secure, explainable, and accountable [41, 42].

3. METHODOLOGY

This study employed a qualitative conceptual framework development approach supported by a structured literature review, thematic synthesis, and design science research principles. The method was selected because the primary objective was to develop an integrated framework explaining how big data governance supports trustworthy AI decision systems rather than testing statistical relationships. Relevant literature published primarily between 2022 and 2026 was collected from reputable scholarly sources covering big data governance, AI governance, trustworthy AI, data quality, security, privacy, metadata, data lineage, explainability, fairness, accountability, and AI decision systems. The selected studies were screened using predefined inclusion and exclusion criteria to ensure their relevance, full-text availability, and conceptual or practical contributions to the research topic [43, 44].

Following the literature selection process, key concepts and findings were extracted and synthesized into major governance themes, including data quality, security and privacy, metadata and data lineage, fairness, explainability, accountability, and continuous monitoring. These themes were subsequently integrated into a conceptual framework that positions big data governance as the foundational layer for trustworthy AI decision systems [45]. Finally, the proposed framework was evaluated conceptually based on theoretical alignment and internal consistency to ensure that it provides a systematic and comprehensive foundation for developing reliable, transparent, secure, fair, and accountable AI-driven decision systems.

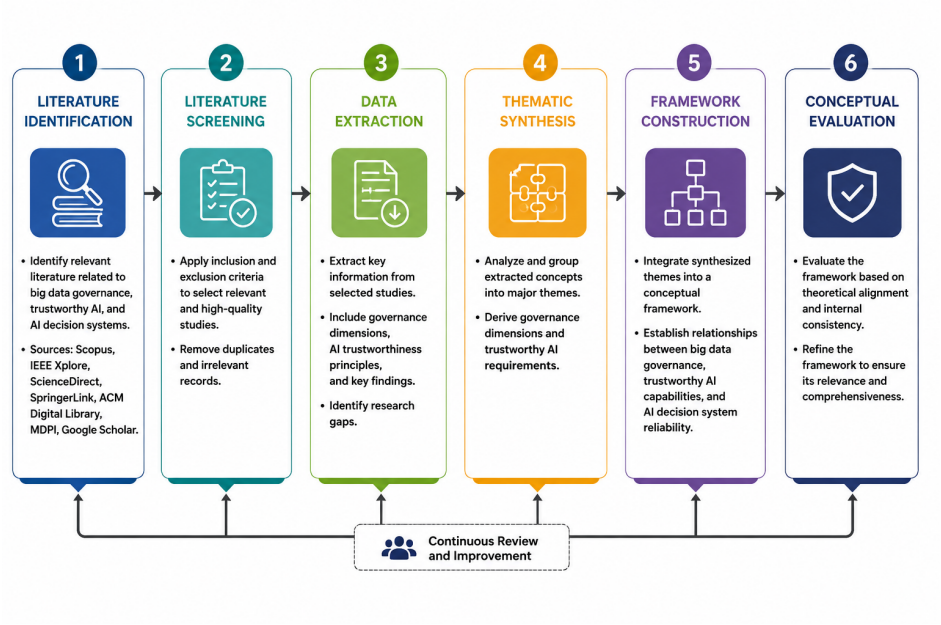

Figure 2. Research Method Flow

Figure 2 illustrates the research method flow used in this study to develop the Big Data Governance Framework for Trustworthy AI Decision Systems. The process begins with literature identification, where relevant studies related to big data governance, trustworthy AI, and AI decision systems are collected from reputable academic sources. The next stage is literature screening, which applies inclusion and exclusion criteria to ensure that only relevant and high-quality studies are selected. After that, data extraction is conducted to obtain key information, including governance dimensions, AI trustworthiness principles, methodological approaches, key findings, and research gaps. The extracted concepts are then analyzed through thematic synthesis to group recurring ideas into major themes, such as data quality governance, privacy and security, data lineage, fairness, explainability, accountability, and continuous monitoring. These themes are integrated in the framework construction stage to form a conceptual model that connects big data governance dimensions with trustworthy AI capabilities and AI decision system reliability. Finally, conceptual evaluation is conducted to assess the theoretical alignment and internal consistency of the proposed framework. The continuous review and improvement loop shown in Figure 2 emphasizes that framework development is not a linear activity only, but also requires refinement to ensure conceptual relevance, comprehensiveness, and academic validity.

The study also adopted design science research principles because the proposed framework can be considered a conceptual artifact. In design science research, an artifact may take the form of a model, framework, method, or system architecture designed to solve a relevant problem [46]. In this study, the problem addressed is the lack of an integrated governance framework that connects big data governance dimensions with trustworthy AI decision system requirements. The proposed framework was designed to provide a structured reference for researchers, practitioners, and organizations seeking to develop responsible and reliable AI-based decision systems.

To ensure conceptual relevance, the framework was evaluated through theoretical alignment and internal consistency. Theoretical alignment was used to examine whether each governance dimension corresponded with trustworthy AI requirements. Internal consistency was used to ensure that the relationships among big

data governance, trustworthy AI capabilities, and AI decision reliability were logically connected. This evaluation helped ensure that the framework was not merely a collection of concepts, but an integrated model that explains how governance mechanisms contribute to trustworthy AI-based decision-making.

Table 2. Research Method Protocol

Stage	Activity	Output
Literature Identification	Collecting relevant studies from academic databases related to big data governance, trustworthy AI, and AI decision systems	Initial literature collection
Literature Screening	Selecting relevant studies based on inclusion and exclusion criteria	Selected literature
Data Extraction	Extracting key concepts, governance dimensions, AI trustworthiness principles, and research gaps	Extracted conceptual data
Thematic Synthesis	Grouping recurring concepts into major themes	Thematic categories
Framework Construction	Integrating governance dimensions and trustworthy AI requirements into a conceptual model	Proposed framework
Conceptual Evaluation	Evaluating the framework based on theoretical alignment and internal consistency	Refined conceptual framework

Table 2 presents the research method protocol used in this study to ensure that the development of the Big Data Governance Framework for Trustworthy AI Decision Systems follows a systematic and academically valid process. The protocol consists of six main stages, beginning with literature identification, which focuses on collecting relevant studies related to big data governance, trustworthy AI, and AI decision systems. The next stage is literature screening, where inclusion and exclusion criteria are applied to select studies that are conceptually and methodologically relevant. After the relevant literature is selected, data extraction is conducted to identify key concepts, governance dimensions, trustworthy AI principles, and research gaps. These extracted elements are then analyzed through thematic synthesis to group recurring concepts into major thematic categories. The synthesized themes are further integrated during the framework construction stage to develop a conceptual model that connects big data governance dimensions with trustworthy AI requirements. Finally, conceptual evaluation is conducted to assess whether the proposed framework demonstrates theoretical alignment and internal consistency. Therefore, Table 2 strengthens the methodological foundation of this study by showing a clear, structured, and traceable process for developing the proposed conceptual framework.

4. RESULTS AND DISCUSSION

This section presents the results of the conceptual synthesis conducted in this study. Since this research applies a qualitative conceptual framework development approach, the results are not presented in the form of statistical testing, but as thematic findings and conceptual relationships derived from the structured literature review. The synthesis identifies several key governance dimensions that are essential for supporting trustworthy AI decision systems. These dimensions are then integrated into a proposed Big Data Governance Framework that explains how governed data can strengthen AI trustworthiness and improve decision system reliability.

4.1. Key Dimensions of Big Data Governance for Trustworthy AI

The thematic synthesis shows that big data governance plays a foundational role in ensuring the trustworthiness of AI decision systems through seven key dimensions. First, data quality governance ensures that AI systems use accurate, complete, consistent, timely, and relevant data, thereby reducing the risk of inaccurate or misleading decisions caused by missing values, duplicated records, inconsistent formats, or outdated information. Second, data security and privacy governance protects sensitive data, including personal, financial, health, educational, behavioral, and organizational information, through mechanisms such as access control, encryption, anonymization, pseudonymization, privacy impact assessment, and secure data processing. Third, metadata and data lineage governance support transparency and auditability by documenting data definitions, sources, ownership, structures, transformations, and usage across the AI lifecycle. Fourth, bias and fairness control helps identify, evaluate, and reduce unfair patterns in datasets and outputs so that AI decision systems do not generate discriminatory or harmful decisions. Fifth, explainability and transparency support enables

organizations to provide understandable reasons behind AI-generated decisions and reduce the black-box problem. Sixth, accountability and auditability mechanisms clarify responsibility for data collection, processing, model development, deployment, validation, and risk mitigation, while allowing decisions to be reviewed and corrected when necessary. Seventh, continuous monitoring and feedback ensure that trustworthy AI is maintained after deployment by detecting data drift, model degradation, emerging bias, security risks, and decision inconsistencies, while supporting governance improvement and model refinement over time.

Table 3. Mapping of Big Data Governance Dimensions and Trustworthy AI Requirements

Big Data Governance Dimension	**Trustworthy AI Requirement**	**Expected Impact on AI Decision Systems**
Data Quality Governance	Reliability and Validity	Improves accuracy, consistency, and relevance of AI decisions
Data Security Governance	Security and Resilience	Protects AI systems from data breaches, manipulation, and cyber risks
Data Privacy Governance	Privacy Preservation	Reduces misuse of sensitive data and strengthens stakeholder trust
Metadata and Data Lineage	Transparency and Auditability	Enables tracing of data sources, transformations, and decision processes
Bias and Fairness Control	Fairness and Non-discrimination	Reduces biased outputs and supports ethical decision-making
Explainability Support	Interpretability and Transparency	Helps stakeholders understand AI-generated decisions
Accountability Mechanism	Responsibility and Governance Control	Clarifies responsibility for data use, model operation, and decision outcomes
Continuous Monitoring	Robustness and Risk Control	Maintains system performance, detects drift, and reduces long-term decision risks

Table 3 shows that each governance dimension has a direct relationship with trustworthy AI requirements and expected decision system outcomes. The table emphasizes that trustworthy AI cannot be achieved only by improving algorithmic performance. Instead, it requires an integrated governance structure that manages data quality, privacy, security, traceability, fairness, explainability, accountability, and monitoring. This mapping becomes the conceptual basis for constructing the proposed Big Data Governance Framework.

4.2. Proposed Big Data Governance Framework for Trustworthy AI Decision Systems

Based on the thematic synthesis and conceptual mapping, this study proposes a Big Data Governance Framework for Trustworthy AI Decision Systems [47]. The framework consists of three main layers. The first layer is the Big Data Governance Layer, which includes data quality governance, security and privacy governance, metadata and lineage governance, bias and fairness control, explainability support, accountability mechanisms, and continuous monitoring. This layer functions as the foundation that ensures data is reliable, protected, traceable, fair, interpretable, and accountable.

The second layer is the Trustworthy AI Capability Layer. This layer represents the trustworthiness outcomes that emerge from strong governance practices. These capabilities include reliability, transparency, explainability, fairness, privacy preservation, security, robustness, accountability, and auditability. The framework suggests that these capabilities are not produced only by AI algorithms, but are shaped by how data is governed before, during, and after AI model operation [48].

The third layer is the AI Decision System Reliability Layer. This layer represents the final expected outcome of the framework. Reliable AI decision systems are characterized by accurate decisions, consistent outputs, traceable decision processes, accountable responsibility structures, reduced ethical and operational risks, and increased stakeholder trust. This layer shows that the ultimate goal of big data governance is not only to improve data management, but also to strengthen the quality and responsibility of AI-based decision-making.

The proposed framework positions big data governance as a strategic control mechanism in the AI lifecycle. Data governance begins before AI model development through data collection, validation, standardization, and protection. It continues during model development through bias evaluation, metadata documentation, privacy control, and data lineage tracking. It also extends after deployment through monitoring, auditing, feedback, and continuous improvement. This lifecycle orientation ensures that trustworthy AI is maintained across all stages of system development and operation.

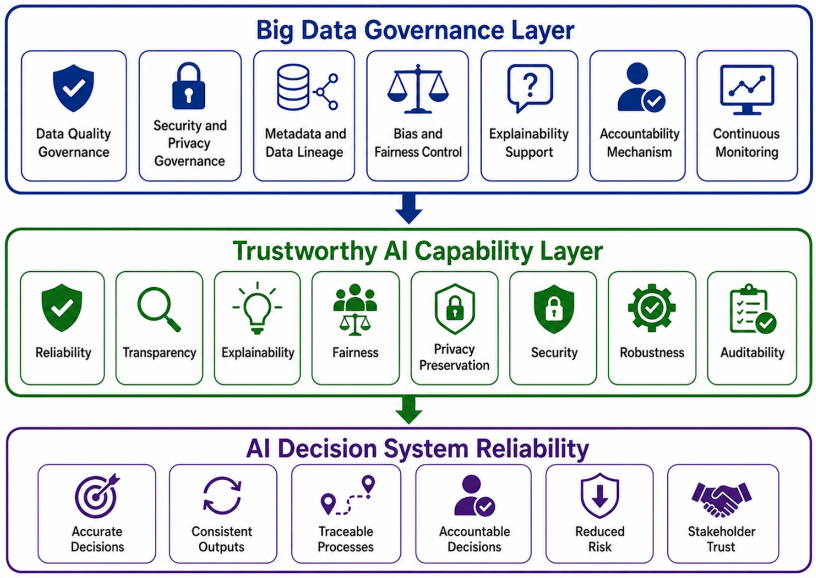

Figure 3. Proposed Big Data Governance Framework for Trustworthy AI Decision Systems

Figure 3 illustrates the proposed Big Data Governance Framework for Trustworthy AI Decision Systems developed in this study. The framework is organized into three interconnected layers. The first layer, namely the Big Data Governance Layer, consists of the core governance dimensions required to manage data responsibly, including data quality governance, security and privacy governance, metadata and data lineage, bias and fairness control, explainability support, accountability mechanisms, and continuous monitoring. These governance dimensions serve as the foundational controls that ensure data used in AI systems is accurate, secure, traceable, fair, and well-managed. The second layer is the Trustworthy AI Capability Layer, which represents the main trust-related attributes strengthened by effective governance, including reliability, transparency, explainability, fairness, privacy preservation, security, robustness, and auditability. These capabilities indicate that AI trustworthiness is not generated solely by algorithmic performance, but is strongly influenced by the quality of governance applied throughout the data lifecycle. The third layer, AI Decision System Reliability, represents the ultimate outcome of the framework, including accurate decisions, consistent outputs, traceable processes, accountable decisions, reduced risk, and stakeholder trust. Therefore, Figure 3 demonstrates that strong big data governance forms the basis for trustworthy AI capabilities, which in turn improve the overall reliability and credibility of AI decision systems.

4.3. Discussion of Conceptual Contributions

The proposed framework contributes to the literature by integrating big data governance and trustworthy AI into a unified conceptual model [49]. Previous discussions often examine data governance and AI trustworthiness separately. Big data governance studies commonly emphasize data management, data quality, security, and compliance, while trustworthy AI studies often focus on fairness, explainability, transparency, and accountability [50]. This study bridges these two perspectives by showing that trustworthy AI decision systems require governed data as their foundation.

The framework also expands the understanding of AI trustworthiness. Trustworthy AI should not be viewed only as a model-level issue related to algorithmic transparency or predictive accuracy [51]. Instead, trustworthiness must be understood as a system-level property shaped by data, governance policies, technical controls, organizational responsibility, and continuous monitoring. This perspective is important because many AI risks originate from weak data governance rather than from algorithmic design alone [52].

From a technical perspective, the framework provides a structured reference for designing AI decision systems with governance mechanisms embedded into the data pipeline [53]. For example, data quality validation can be implemented before model training, privacy protection can be applied during data processing, data lineage can be recorded throughout the pipeline, bias detection can be conducted during model evaluation, explainability methods can be integrated into decision output, and audit logs can be maintained for accountability [54]. These mechanisms can help reduce decision errors, improve system reliability, and support responsible

AI implementation.

From an organizational perspective, the framework highlights the need for clear governance roles and responsibilities [55]. Organizations should define data owners, data stewards, AI developers, compliance officers, system auditors, and decision validators. These roles are necessary to ensure that data and AI systems are not managed in isolation. Effective governance requires collaboration between technical teams, management, legal units, ethics committees, and end users. Therefore, trustworthy AI should be treated as an organizational responsibility rather than merely a technical achievement.

4.4. Practical Implications

The findings of this study provide practical implications for organizations seeking to implement trustworthy AI decision systems. First, organizations need to strengthen data governance maturity before adopting AI at scale. AI implementation should begin with clear data standards, data ownership, data quality procedures, access control, privacy protection, and metadata documentation. Without these foundations, AI systems may produce outputs that are difficult to trust, explain, or audit.

Second, organizations should integrate governance mechanisms into the AI lifecycle. Governance should not be applied only after problems occur, but should be embedded from data collection to model deployment and monitoring. This proactive approach can reduce risks related to data misuse, biased decisions, privacy violations, and weak accountability. By embedding governance into the AI lifecycle, organizations can develop AI decision systems that are more transparent, responsible, and sustainable.

Third, organizations should establish continuous monitoring mechanisms to ensure that AI systems remain reliable over time. AI models may experience performance degradation when data patterns change, a condition commonly known as data drift. Continuous monitoring allows organizations to detect changes in data quality, model performance, fairness, security, and decision consistency. This helps organizations maintain trust in AI systems after deployment. Fourth, organizations should improve stakeholder trust by providing explainable and traceable decisions. Users and decision-makers are more likely to trust AI systems when they understand how decisions are generated and when they can verify the data and logic behind those decisions. Therefore, explainability, transparency, and auditability should become essential components of AI decision system design.

4.5. Summary of Result and Discussion

Overall, the result of this study shows that big data governance is essential for developing trustworthy AI decision systems. The key dimensions identified through conceptual synthesis include data quality governance, data security and privacy governance, metadata and data lineage governance, bias and fairness control, explainability and transparency support, accountability and auditability mechanisms, and continuous monitoring. These dimensions support trustworthy AI requirements such as reliability, fairness, transparency, explainability, privacy preservation, robustness, accountability, and auditability.

The proposed framework demonstrates that trustworthy AI is not only determined by algorithmic performance but also by strong data governance across the AI lifecycle. To strengthen its technical contribution, the framework can be operationalized through governance workflow stages (data collection, preprocessing, model training, deployment, and monitoring), supported by measurable operational indicators such as data accuracy rate, privacy compliance score, bias detection ratio, explainability index, and system auditability score. In addition, a multi-level governance maturity model (basic, intermediate, advanced) can be introduced to evaluate organizational readiness in implementing big data governance for trustworthy AI. A technical architecture can also be added to illustrate how governance modules interact with AI pipelines in real decision systems, including data ingestion layers, governance control layer, AI model layer, and decision output layer. Strong big data governance can improve decision accuracy, reduce risks, support traceability, strengthen accountability, and increase stakeholder trust. Therefore, the framework provides both theoretical and practical value for researchers and organizations seeking to build reliable, responsible, and trustworthy AI decision systems.

5. MANAGERIAL IMPLICATIONS

The findings of this study provide several managerial implications for organizational leaders, technology managers, policymakers, and AI practitioners. Organizations should recognize that trustworthy AI is not only a technological challenge but also a strategic governance responsibility. Therefore, management should

establish comprehensive data governance practices covering data ownership, quality standards, access control, privacy protection, and compliance requirements to ensure reliable and accountable AI-driven decisions.

Organizations should also invest in governance capabilities alongside AI implementation by developing supporting infrastructures such as data quality management, metadata management, data lineage tracking, audit mechanisms, and continuous monitoring systems. In addition, cross-functional AI governance teams involving technical experts, business leaders, compliance officers, legal specialists, and risk managers are needed to address challenges related to transparency, fairness, accountability, and security throughout the AI lifecycle.

Furthermore, organizations should continuously evaluate AI trustworthiness through measurable governance indicators, including data accuracy, privacy compliance, bias monitoring, explainability, and model robustness. The proposed framework can also serve as a reference for policymakers in developing responsible AI guidelines and regulatory standards. By integrating data governance with trustworthy AI principles, organizations can support sustainable digital transformation while maintaining innovation, accountability, and stakeholder trust.

6. CONCLUSION

This study concludes that big data governance is a fundamental requirement for developing trustworthy AI decision systems. The increasing use of AI in organizational decision-making has created a strong dependency on large-scale data collected from various sources, including digital platforms, enterprise systems, cloud infrastructures, transactional records, and user interaction data. However, the reliability of AI-generated decisions cannot be achieved only through advanced algorithms or high predictive accuracy. It also depends on how data is governed, protected, validated, traced, and monitored throughout the AI lifecycle. Therefore, weak data governance may lead to inaccurate predictions, biased outcomes, privacy risks, poor transparency, and limited accountability.

The proposed Big Data Governance Framework for Trustworthy AI Decision Systems integrates several essential governance dimensions, including data quality governance, security and privacy governance, metadata and data lineage, bias and fairness control, explainability support, accountability mechanisms, and continuous monitoring. These dimensions support trustworthy AI capabilities such as reliability, transparency, explainability, fairness, privacy preservation, security, robustness, and auditability. The framework shows that trustworthy AI is not only a technical property of the model but also a governance-based outcome shaped by data management practices, organizational responsibility, and continuous risk control. By strengthening these governance dimensions, organizations can improve the accuracy, consistency, traceability, accountability, and trustworthiness of AI-based decisions.

The contribution of this study lies in developing a conceptual framework that connects big data governance with trustworthy AI decision system requirements. The framework provides a theoretical foundation for future research and a practical reference for organizations seeking to implement responsible AI systems. It also emphasizes that AI governance should begin before model development and continue after system deployment through monitoring, auditing, and improvement. Nevertheless, this study is conceptual in nature and does not include empirical validation. Future research is recommended to validate the proposed framework through expert judgment, Delphi studies, case studies, or quantitative testing in specific domains such as finance, healthcare, education, cybersecurity, or smart city systems. Further studies may also develop operational indicators or maturity assessment models to measure the readiness of organizations in implementing big data governance for trustworthy AI decision-making.

7. DECLARATIONS

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7.2. Author Contributions

Conceptualization: AF; Methodology: AA; Software: AI; Validation: NS; Formal Analysis: KV; Investigation: AF; Resources: AA; Data Curation: AI; Writing Original Draft Preparation: NS; Writing Review and Editing: KV; Visualization: AF; All authors, AF, AA, AI, NS and KV have read and agreed to the published version of the manuscript.

7.3. Data Availability Statement

The data presented in this study are available on request from the corresponding author.

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7.5. Declaration of Conflicting Interest

The authors declare that they have no conflicts of interest, known competing financial interests, or personal relationships that could have influenced the work reported in this paper.

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