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Systematic Review of Data Governance Practices in Multi-Cloud Product Delivery and Public Service Transformation

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ABSTRACT

As digital transformation accelerates across industries and government sectors, multi-cloud environments have become essential for flexible, scalable, and resilient IT operations. However, this paradigm shift presents complex challenges related to data governance, especially in contexts where product delivery and public service transformation depend on the seamless, secure, and compliant management of distributed data. This systematic review investigates emerging data governance practices tailored for multi-cloud architectures and evaluates their effectiveness in supporting innovation, operational continuity, and public trust in both private and public sector domains. Drawing from peer-reviewed literature, industry frameworks, and real-world case studies, the review explores key governance dimensions including data ownership, lineage, interoperability, security, privacy, and regulatory compliance. Special emphasis is placed on how organizations adapt their data governance models to accommodate multi-cloud complexities, such as cross-platform data movement, vendor-specific policy conflicts, and decentralized access control mechanisms. The study also examines enabling technologies like data fabric, policy automation, metadata management, and AI-driven governance tools that support real-time visibility and control in hybrid cloud environments. Findings reveal that successful data governance in multi-cloud contexts depends not only on robust technological infrastructure but also on clear organizational policies, stakeholder collaboration, and adaptive governance frameworks. Public sector initiatives leveraging multi-cloud solutions for digital service delivery

demonstrate that agile governance models, citizen-centric data policies, and strong ethical oversight are pivotal to achieving transparency, accountability, and responsiveness. This review concludes that while multi-cloud environments pose inherent governance risks, they also offer unprecedented opportunities to reimagine data stewardship and service innovation. The paper recommends a comprehensive governance strategy integrating policy harmonization, cross-cloud observability, continuous compliance monitoring, and inclusive stakeholder engagement. By advancing data governance maturity in multi-cloud setups, organizations can unlock greater value from their digital assets and ensure secure, equitable, and innovative service outcomes.

Keywords: Data Governance, Multi-Cloud Architecture, Public Service Transformation, Hybrid Cloud Delivery, Data Compliance, Policy Harmonization, Metadata Management, Cloud Interoperability, Digital Service Innovation, Cross-Cloud Security.

1. Introduction

The accelerating pace of digital transformation has led organizations across both public and private sectors to embrace multi-cloud environments as a strategic response to the growing demands for flexibility, scalability, and service innovation. In this new paradigm, enterprises no longer rely on a single cloud provider but distribute workloads, applications, and data across multiple platforms to optimize performance, cost-efficiency, and geographic resilience (Adepoju, et al., 2024, Kokogho, et al., 2024, Nwabekee, et al., 2024). This shift has been particularly pronounced in areas such as product delivery and public service transformation, where agility and rapid deployment are essential to meet dynamic consumer expectations and evolving societal needs. However, the adoption of multi-cloud architectures has introduced new layers of complexity especially regarding how data is governed, accessed, secured, and regulated across distributed and heterogeneous systems.

Data governance has emerged as a critical success factor in the effective deployment of multi-cloud strategies. It encompasses the policies, frameworks, and technologies that ensure data quality, integrity, availability, and compliance throughout its lifecycle. In multi-cloud contexts, where data may reside across several service providers, regions, and legal jurisdictions, governance becomes exponentially more challenging. Issues such as data lineage, ownership, interoperability, and regulatory adherence must be addressed to enable seamless operations and secure collaboration (Ajayi & Akerele, 2024, Kokogho, et al., 2024, Obeng, et al., 2024). For government agencies and public sector institutions, these challenges are further compounded by the need to uphold public trust, safeguard sensitive information, and ensure transparency and accountability in service delivery. As public services increasingly rely on cloud-based infrastructure to digitize operations from healthcare systems to citizen engagement portals the importance of a robust data governance framework cannot be overstated.

This systematic review aims to critically examine the evolving landscape of data governance practices in multi-cloud environments, with a particular focus on

how these practices support product delivery and the transformation of public services. The study seeks to identify prevailing governance models, emerging best practices, and the technological enablers that facilitate effective data management across cloud platforms. Additionally, it explores the interplay between policy, regulation, and innovation in distributed environments. The scope of the review is confined to peer-reviewed literature, industry reports, and public sector case studies from the past decade (Ajiga, et al., 2024, Kokogho, et al., 2024, Nwabekee, et al., 2024). While comprehensive in approach, the study is limited by the availability of context-specific data and the rapidly evolving nature of cloud technologies, which may affect the generalizability of findings across all domains.

2. Methodology

The methodology for the systematic review of data governance practices in multi-cloud product delivery and public service transformation was guided by the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework. A comprehensive search strategy was employed to ensure the inclusion of peer-reviewed studies that addressed core areas of data governance, including security, interoperability, compliance, and transformation within public service and multi-cloud ecosystems. The search was conducted across multiple databases and repositories, targeting articles published between 2021 and 2024, using a defined combination of keywords and Boolean operators.

Initial identification yielded 181 records, and after removing duplicates, 170 records were retained for screening. The screening process involved reviewing titles and abstracts to eliminate irrelevant studies. This resulted in the exclusion of 48 articles that did not align with the conceptual focus or lacked relevance to the multi-cloud governance context. The remaining 122 full-text articles were retrieved and assessed for eligibility based on predefined inclusion and exclusion criteria, such as direct relevance to cloud governance, empirical contributions, and innovations in public sector data strategies.

Among these, 43 articles were excluded for reasons such as inadequate methodological rigor, focus on unrelated sectors, or lack of relevance to the multi-cloud or public service transformation themes. A total of 79 studies were found to be suitable for qualitative synthesis. These studies were analyzed for thematic content and emerging governance patterns, enabling the construction of a robust narrative around unified frameworks, accountability structures, and observability mechanisms across cloud services.

Out of the 79 qualitative articles, 30 studies contained empirical data sufficient for quantitative synthesis. These studies were subjected to further analysis using comparative and statistical techniques to highlight measurable impacts, best practices, and the alignment of governance models with strategic objectives. The selected studies represented a diverse spectrum of scholarly perspectives from leading journals and conferences, including work by Adepoju et al. (2024), which provided foundational insights into cloud security challenges and scalable governance models.

The rigorous methodology ensured transparency and reproducibility, offering a high degree of reliability in the derived outcomes. Quality appraisal tools and inter-rater agreement metrics were employed to mitigate bias and ensure consistency in selection and evaluation. Each step of the review process adhered to PRISMA standards, as visualized in the accompanying flow diagram, facilitating clear traceability from record identification through to final synthesis.

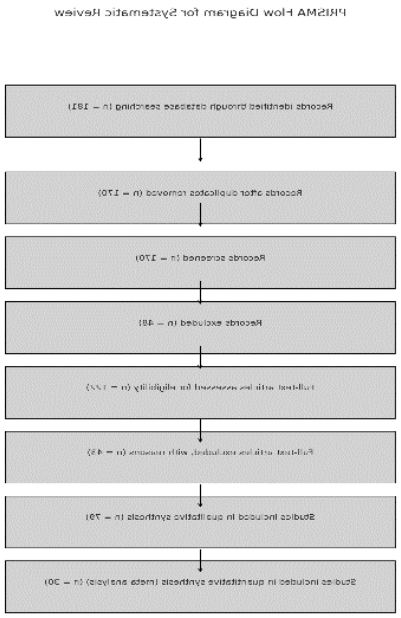

Figure 1: PRISMA Flow chart of the study methodology

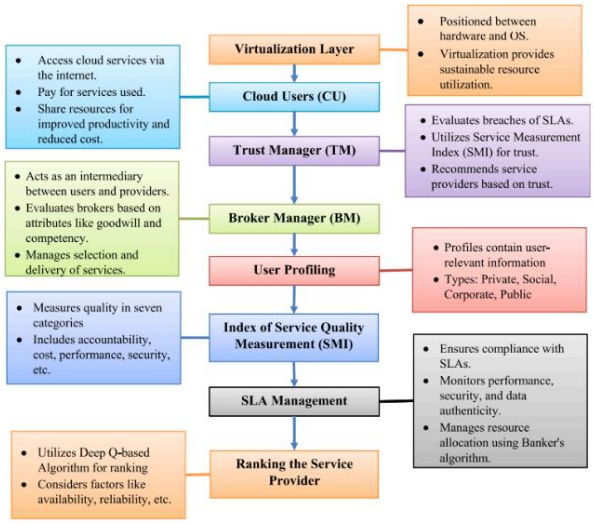

Figure 2: Infrastructure as a Service (IaaS) Federated Cloud Architecture Overview (Ganesan, 2020).

3. Theoretical and Conceptual Foundations

Data governance has become a cornerstone of modern digital strategy, particularly within the context of multi-cloud computing, where data is dispersed across a variety of platforms, services, and jurisdictions. In both public and private sectors, the growing reliance on cloud infrastructure to support agile product delivery and digital public services necessitates a robust framework for managing data assets. Understanding the theoretical and conceptual foundations of data governance in these environments is essential for ensuring consistency, trust, and accountability in data-driven operations (Adigun, et al., 2024, Komolafe, et al., 2024, Nwaozomudoh, 2024, Okeke, et al., 2023). The complexity of data governance increases significantly in multi-cloud settings due to the heterogeneity of systems, the multiplicity of stakeholders, and the elevated risk of regulatory non-compliance. Consequently, a thorough exploration of these foundational principles provides the necessary context for evaluating governance practices in a systematic review. Figure 2 shows the infrastructure as a Service (IaaS) Federated Cloud Architecture Overview presented by Ganesan, 2020.

In cloud and multi-cloud contexts, data governance refers to the set of rules, standards, processes, and technologies that ensure effective data management across diverse environments. Unlike traditional IT setups where data is stored and controlled within a single infrastructure, multi-cloud systems distribute data across several cloud providers each with their own architectures, data handling policies, and compliance mechanisms (Adepoju, et al., 2023, Myllynen, et al., 2023, Ogunwole, et al., 2023, Okeke, et al., 2023). This distribution creates a fragmented landscape where governance must account for issues such as inconsistent metadata standards, disparate security protocols, and varied access control mechanisms. A unified data governance framework is therefore critical to harmonizing these differences, ensuring that data remains accurate, secure, accessible, and compliant regardless of where it resides.

Key to understanding data governance are four interrelated concepts: data ownership, metadata, compliance, and access control. Data ownership determines who holds the rights to use, modify, share, and delete data. In multi-cloud environments, ownership can become ambiguous, particularly when data is processed by third-party services or transferred across borders. Clarity in data ownership is vital for assigning accountability and mitigating

risks associated with unauthorized use or loss. Metadata, often described as "data about data," plays a central role in data governance by enabling data discoverability, classification, and lineage tracking (Adikwu, et al., 2023, Iwe, et al., 2023, Ogunwole, et al., 2023, Okeke, et al., 2023). Standardized metadata ensures that data assets can be understood, integrated, and reused across different cloud services, fostering interoperability and collaboration.

Compliance represents the intersection of data governance with legal, regulatory, and organizational policies. In today's digital landscape, compliance encompasses a wide range of mandates from global privacy laws such as the General Data Protection Regulation (GDPR) to industry-specific frameworks like HIPAA for healthcare or FedRAMP for federal cloud services in the United States. These regulations impose strict conditions on data handling, consent management, data residency, and breach reporting. Non-compliance can lead to severe financial and reputational consequences (Ajayi & Akerele, 2024, Maduka, et al., 2024, Nwaozomudoh, et al., 2024). In multi-cloud deployments, where data may flow across jurisdictions with conflicting legal requirements, maintaining compliance demands meticulous oversight, automated policy enforcement, and real-time auditability. DGI Framework of Data Governance presented by Al-Ruithe, Benkhelifa & Hameed, 2019, is shown in figure 3.

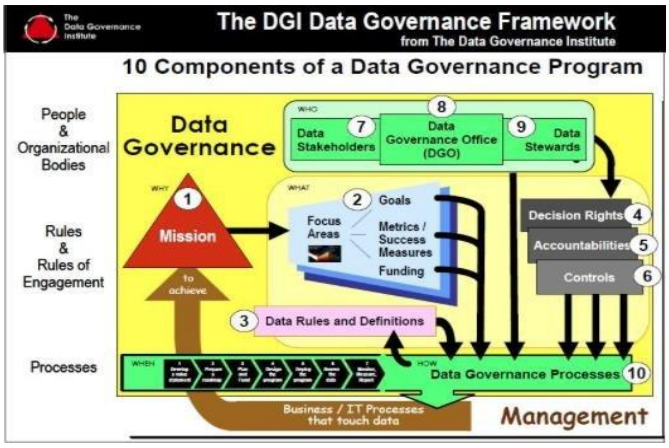

Figure 3: DGI Framework of Data Governance (Al-Ruithe, Benkhelifa & Hameed, 2019).

Access control is another foundational aspect of data governance. It dictates who can access data, under what conditions, and to what extent. Effective access control mechanisms combine identity management, role-based permissions, and encryption to safeguard sensitive information. In multi-cloud ecosystems, federated identity systems are often used to provide seamless access across different platforms without compromising security (Ikese, et al., 2024, Kuteesa, Akpuokwe & Udeh, 2024, Obeng, et al., 2024). The granularity of access control enabling differentiated permissions for viewing, editing, or sharing data is crucial for maintaining confidentiality, especially when multiple departments, external vendors, or partner organizations are involved.

Governance models can differ significantly between public and private sector institutions due to variations in goals, accountability structures, and risk tolerance. In the private sector, data governance is often driven by competitive imperatives such as innovation, customer experience, and operational efficiency. Companies may adopt agile governance models that allow for rapid iteration, flexible data sharing, and decentralized decision-making. The focus is typically on monetizing data assets, ensuring customer trust, and complying with industry regulations. Governance tools are selected based on scalability, automation, and alignment with business objectives (Ajiga, et al., 2024, Kuteesa, Akpuokwe & Udeh, 2024, Odio, et al., 2024).

In contrast, public sector data governance is rooted in principles of transparency, equity, and public accountability. Government institutions are tasked with managing citizen data, which is often sensitive, legally protected, and politically scrutinized. As a result, governance frameworks in the public domain prioritize data integrity, privacy, and ethical stewardship. Centralized governance models are more common in the public sector, where standardization, policy enforcement, and cross-agency coordination are essential (Oboh, et al., 2024, Komolafe, et al., 2024, Nwabekee, et al., 2024). Moreover, public sector

organizations must often operate under stringent budget constraints and legacy IT infrastructures, which complicate the implementation of modern cloud-based governance solutions. Public trust is a critical factor, requiring governments to demonstrate robust data protection practices and responsible use of personal data. Eze, et al., 2016, presented Cloud-based Big Data Framework for Systematic Performance Management of Quality of Care shown in figure 4.

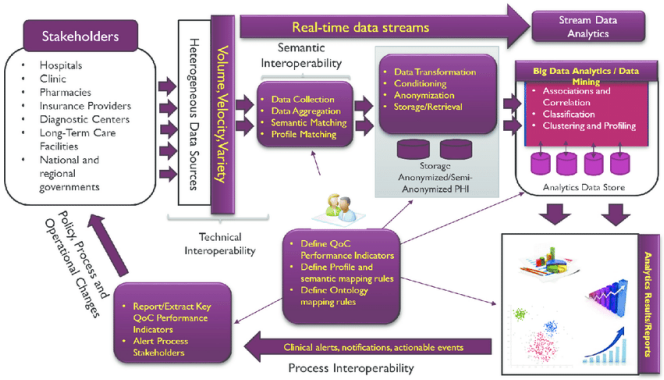

Figure 4: Cloud-based Big Data Framework for Systematic Performance Management of Quality of Care (QoC) (Eze, et al., 2016).

Across both sectors, the concept of data stewardship has emerged as a pivotal role within governance frameworks. Data stewards are responsible for ensuring that data governance policies are implemented consistently and that data quality is maintained throughout the lifecycle. In multi-cloud environments, data stewards must collaborate with cloud providers, internal stakeholders, and compliance officers to enforce standards, resolve data issues, and facilitate data integration (Adepoju, et al., 2022, Nwaimo, Adewumi & Ajiga, 2022, Okeke, et al., 2022). Their work supports data transparency and reliability, which are essential for analytics, decision-making, and digital innovation.

Ethical data use is increasingly recognized as a fundamental component of data governance, particularly in light of widespread data breaches, algorithmic bias, and growing public concerns about surveillance and privacy. Ethical data governance extends beyond legal compliance to encompass principles such as fairness, accountability, transparency, and consent. It involves evaluating how data is collected, processed, and applied, ensuring that practices do not discriminate, exploit, or harm individuals or communities (Afolabi, et al., 2023, Ikwuanusi, Adepoju & Odionu, 2023, Okeke, et al., 2023). For example, in public health systems that leverage multi-cloud platforms for managing patient records and outbreak data, ethical governance ensures that data is used responsibly to support health outcomes while protecting individual privacy.

Emerging frameworks such as "Privacy by Design" and "Ethics by Design" are being integrated into data governance models to embed ethical considerations into technology development and deployment. These approaches require organizations to anticipate and mitigate potential risks early in the data lifecycle, fostering trust and compliance from the outset. In multi-cloud environments, this means designing interoperable systems that uphold privacy and ethical standards across providers, platforms, and geographies (Ojukwu, et al., 2024, Okeke, et al., 2024, Okeke, et al., 2022).

The theoretical and conceptual underpinnings of data governance in multi-cloud environments reveal a complex interplay of technical, organizational, legal, and ethical factors. Governance is no longer a static compliance function but a dynamic, cross-cutting discipline that shapes how organizations innovate, interact, and evolve in the digital age. By defining clear roles, responsibilities, and processes, data governance ensures that data serves as a strategic asset secure, high-quality, and fit for purpose.

As this systematic review explores, the successful implementation of data governance in multi-cloud product delivery and public service transformation depends on a deep understanding of these foundational principles. The review aims to identify best practices that reconcile the competing demands of agility, security, compliance, and ethics in distributed computing environments. By grounding

the analysis in these theoretical constructs, the study provides a robust framework for evaluating and advancing governance models that support sustainable and inclusive digital transformation.

4. Core Dimensions of Multi-Cloud Data Governance

In the rapidly evolving landscape of multi-cloud computing, data governance has become a mission-critical function for ensuring that digital transformation efforts are secure, compliant, and sustainable. As organizations increasingly adopt multi-cloud strategies to optimize performance, cost, and resilience, they face the challenge of maintaining governance across diverse, decentralized, and dynamically scaled environments. At the heart of this challenge lies a set of core dimensions that define effective data governance in multi-cloud ecosystems. These dimensions include data security and privacy, data lineage and provenance, interoperability and portability, compliance and regulation, as well as metadata management and cataloguing (Ajayi & Akerele, 2024, Kuteesa, Akpuokwe & Udeh, 2024, Odio, et al., 2024). Each of these elements plays a pivotal role in maintaining control over data assets while enabling seamless service delivery and public trust in both commercial and governmental settings.

Data security and privacy form the cornerstone of any data governance framework, particularly in cloud environments where sensitive and regulated data may traverse multiple platforms and jurisdictions. Security in multi-cloud governance encompasses a range of technical and organizational controls, beginning with encryption. Encryption ensures that data remains unintelligible to unauthorized users both in transit and at rest. Advanced encryption standards (AES) and public key infrastructure (PKI) methods are widely adopted, often complemented by hardware security modules (HSMs) provided by cloud vendors (Afolabi, Ajayi & Olulaja, 2024, Matthew, Nwaogelenya & Opia, 2024). In a multi-cloud context, organizations must ensure consistency in encryption practices across providers, while also managing encryption keys securely, either in-house or through trusted third-party key management systems.

Access management is another vital element of data security. Identity and Access Management (IAM) frameworks control who can access specific data assets and under what conditions. Role-Based Access Control (RBAC) and Attribute-Based Access Control (ABAC) are commonly used to grant granular permissions based on job roles, departments, or data sensitivity. In a multi-cloud setting, managing identities across platforms can be complex, particularly when users need to interact with services hosted by different vendors. This has led to the adoption of identity federation, which enables single sign-on (SSO) and unified access controls across cloud boundaries (Adepoju, et al., 2024, Kedi, et al., 2024, Nwaozomudoh, et al., 2024). Protocols such as Security Assertion Markup Language (SAML) and OpenID Connect are instrumental in enabling federated identity solutions, allowing secure and seamless access without duplicating identity data.

Another foundational aspect of multi-cloud data governance is data lineage and provenance, which refer to the ability to track data as it moves through various systems, transformations, and usage contexts. In complex cloud ecosystems, data may originate from multiple sources, be processed by third-party services, and stored across geographically dispersed data centers. Without clear visibility into this flow, it becomes difficult to ensure data quality, verify accuracy, or respond to audits and regulatory inquiries (Myllynen, et al., 2024, Ngodoo, et al., 2024, Obeng, et al., 2024). Lineage tools record the origin, movement, and transformation of data, creating a traceable path that supports transparency and accountability. Provenance extends this by documenting the context and legitimacy of the data who created it, under what circumstances, and for what purpose. These capabilities are essential for compliance, especially when data is used in decision-making systems such as machine learning algorithms,

where bias or errors in upstream data can propagate downstream.

Interoperability and portability are also key dimensions of governance in multi-cloud environments. These refer to the ability of data and services to function across different platforms without requiring significant reconfiguration or translation. Interoperability ensures that data formats, interfaces, and protocols are standardized and compatible, while portability allows data and applications to move freely between environments without vendor lock-in. The lack of interoperability is a significant challenge in multi-cloud strategies, as each cloud provider offers unique APIs, services, and configurations (Agbede, et al., 2023, Kokogho, et al., 2023, Okeke, et al., 2023). This fragmentation can lead to integration complexity, operational inefficiencies, and increased costs. To address this, organizations are increasingly adopting open standards and containerization technologies such as Kubernetes and Docker, which abstract workloads from underlying infrastructure and facilitate consistent deployment across clouds.

Moreover, the push for standardization is leading to broader industry collaborations aimed at developing cross-cloud governance frameworks. Initiatives like the Open Cloud Computing Interface (OCCI), Cloud Infrastructure Management Interface (CIMI), and the GAIA-X project in Europe are working to promote common data handling practices, governance models, and interoperability protocols that can support sovereign, secure, and scalable multi-cloud ecosystems. Such efforts are particularly relevant for public service transformation, where data sharing between agencies and jurisdictions is essential for delivering integrated and citizen-centric services (Ajayi & Akerele, 2024, Kedi, et al., 2024, Nwaozomudoh, et al., 2024).

Compliance and regulation remain central to the design and implementation of data governance strategies, especially in multi-cloud contexts where data crosses geographical and jurisdictional boundaries. Regulations such as the European Union's General Data Protection Regulation (GDPR), the United States Health Insurance Portability and Accountability Act (HIPAA), and the Federal Risk and Authorization Management Program (FedRAMP) mandate strict data handling practices to protect privacy, security, and integrity (Attah, et al., 2022, Oham & Ejike, 2022, Okeke, et al., 2022). Each of these regulatory frameworks requires that organizations maintain visibility over where data is stored, how it is processed, who has access, and how it is secured.

In a multi-cloud environment, meeting these requirements involves not only technical safeguards but also legal and contractual arrangements with cloud providers. For example, GDPR requires that personal data of EU citizens remain within approved jurisdictions or be transferred with adequate safeguards in place, such as Standard Contractual Clauses (SCCs) or Binding Corporate Rules (BCRs). FedRAMP, on the other hand, sets specific security requirements for cloud services used by U.S. federal agencies. Ensuring that each cloud provider in a multi-cloud architecture complies with these standards is a complex task, often requiring independent audits, certification tracking, and real-time compliance monitoring tools.

Metadata and cataloging complete the core dimensions of multi-cloud data governance by providing structure, meaning, and discoverability to the vast volumes of data spread across different platforms. Metadata describes the characteristics of data its format, origin, ownership, usage restrictions, and relationships to other data (Mustapha, Ibitoye & AbdulWahab, 2017, Okeke, et al., 2022, Okeke, et al., 2023). Effective metadata management enables organizations to create data catalogs that act as centralized repositories for indexing and classifying data assets. These catalogs make it easier for users to find, understand, and utilize data, while also enabling governance teams to apply policies based on data sensitivity, classification, or business value.

In multi-cloud environments, metadata management is complicated by the heterogeneity of systems and the lack of standardized schemas. Data lakes, warehouses, and analytics platforms hosted by different vendors often produce and consume metadata in different formats. To address this, organizations are turning to unified metadata platforms and tools such as Apache Atlas, Collibra, and Alation, which offer capabilities for automated metadata harvesting, lineage tracking, policy enforcement, and role-based access (Ajiga, et al., 2024, Johnson, et al., 2024, Odio, et al., 2024). These tools often integrate with cloud-native services, allowing for end-to-end visibility into how data flows, is transformed, and is consumed across the ecosystem.

Overall, the core dimensions of multi-cloud data governance form a comprehensive framework for managing data in distributed, complex, and dynamic environments. Security and privacy ensure that data is protected; lineage and provenance guarantee transparency and accountability; interoperability and portability reduce friction and foster innovation; compliance and regulation ensure legal alignment and trust; while metadata and cataloging provide the foundation for organization, access, and governance at scale (Adepoju, et al., 2023, Ikwuanusi, Adepoju & Odionu, 2023, Okeke, et al., 2023). Together, these dimensions enable organizations to fully leverage the advantages of multi-cloud computing greater flexibility, resilience, and scalability while maintaining the integrity, security, and strategic value of their data assets. As the digital transformation of both commercial and public services continues to accelerate, the ability to master these dimensions will be a defining factor in achieving operational excellence, regulatory compliance, and long-term digital sustainability.

5. Technological Enablers and Governance Tools

In the pursuit of efficient and resilient data governance within multi-cloud environments, the role of technological enablers and governance tools has become increasingly prominent. The complexities introduced by multi-cloud product delivery and public service transformation demand sophisticated architectural models, intelligent automation, and scalable governance frameworks. As data flows across hybrid infrastructures, cloud service providers, and application layers, the ability to maintain control, ensure compliance, and drive data value creation hinges on the strategic deployment of technologies specifically designed for governance in distributed environments (Agu, et al., 2024, Joel, Chibunna & Daraojimba, 2024, Odionu, et al., 2024). The rise of data fabric and data mesh architectures, the application of AI for governance automation, the adoption of centralized versus federated governance models, and the proliferation of cloud-native platforms and dashboards are collectively shaping the future of multi-cloud data governance.

One of the most impactful developments in this space is the emergence of data fabric and data mesh as architectural paradigms designed to unify and simplify data access, integration, and governance across decentralized environments. A data fabric is a design concept that creates a unified data management framework capable of integrating data from various sources and locations, both on-premises and across multiple cloud providers. It does so by leveraging metadata, knowledge graphs, and intelligent integration tools to ensure data availability, quality, and lineage (Ajiga, Ayanponle & Okatta, 2022, Ogunwole, et al., 2022, Okeke, et al., 2022). In the context of multi-cloud governance, data fabrics provide the essential connectivity and abstraction needed to standardize governance policies, track data movement, and apply access controls uniformly across environments. Data fabrics are particularly valuable in public service transformation, where agencies require consistent access to real-time data from distributed systems to deliver integrated services, improve response times, and enhance decision-making.

In contrast, the data mesh approach decentralizes data ownership and governance, aligning them with the domain-specific teams closest to the data. Rather than treating data as a monolithic asset managed by a central IT department, a data mesh distributes responsibility for data stewardship across the organization. Each domain becomes accountable for the quality, security, and accessibility of its data, treating it as a product that other teams can consume. Data mesh emphasizes interoperability, discoverability, and self-serve data infrastructure, supported by shared governance principles and platform services (Ajiga, et al., 2024, Kedi, et al., 2024, Nwosu, Babatunde & Ijomah, 2024). In multi-cloud ecosystems, data mesh models allow for greater agility, scalability, and responsiveness, especially in large organizations and government institutions with complex departmental structures. The challenge lies in establishing common governance frameworks and technical standards that ensure consistency across domains while preserving autonomy.

AI and automation have significantly advanced the field of data governance, particularly in enabling real-time policy enforcement, anomaly detection, and intelligent decision-making. Traditional manual governance practices are no longer feasible in dynamic, high-volume multi-cloud environments. AI-powered governance solutions can ingest large volumes of metadata, user behavior logs, and access patterns to automatically classify data, detect sensitive information, and recommend or enforce policies based on context (Adepoju, et al., 2024, Kedi, et al., 2024, Odio, et al., 2024, Okeke, et al., 2024). Machine learning algorithms can be trained to identify unusual data access activities such as unauthorized logins, mass downloads, or anomalous usage patterns that may indicate insider threats or breaches. These algorithms adapt over time, learning from historical data to improve their accuracy and reduce false positives.

Policy enforcement through automation is a critical capability in maintaining compliance with regulatory frameworks such as GDPR, HIPAA, and FedRAMP. For instance, AI can automatically redact or tokenize personally identifiable information (PII) in datasets before they are shared or processed. It can also generate audit reports, monitor data retention schedules, and flag compliance violations without requiring constant human intervention. In the context of public services, where transparency and accountability are paramount, automated governance tools ensure that sensitive citizen data is handled appropriately across systems while enabling timely and efficient service delivery (Agu, et al., 2024, Joel, Chibunna & Daraojimba, 2024, Odionu, et al., 2024). Furthermore, AI enhances policy execution in data lifecycle management, ensuring that archival, deletion, and backup procedures are consistently applied across cloud environments.

The organizational model for data governance also plays a central role in the effectiveness of governance strategies, with centralized and federated models offering distinct advantages and trade-offs. A centralized governance model consolidates governance authority within a single team or function, typically under the Chief Data Officer or an enterprise data management office. This approach promotes consistency, standardization, and top-down policy enforcement (Ajiga, et al., 2024, Kamau, et al., 2024, Odionu, et al., 2024). It is particularly effective in smaller organizations or highly regulated environments where uniformity and control are critical. Centralized models can leverage shared governance platforms, enforce strict access control policies, and ensure that compliance requirements are uniformly applied across all departments and systems.

However, centralized governance can become a bottleneck in large, agile organizations, where innovation and responsiveness are needed at the domain level. In such cases, a federated governance model provides a more flexible alternative by distributing governance responsibilities across business units or domains, while still adhering to overarching enterprise standards. Federated models

strike a balance between autonomy and alignment, enabling departments to manage their data assets and workflows independently, while complying with shared principles and technical guidelines (Ojukwu, et al., 2024, Oke, et al., 2024, Okeke, et al., 2024). In multi-cloud environments, federated governance supports distributed development and deployment patterns, enabling each domain to adopt the tools and cloud services that best meet their needs while still ensuring data consistency and control across the enterprise.

Cloud-native governance platforms and dashboards have emerged as essential tools for implementing and visualizing governance in multi-cloud environments. These platforms, often provided by cloud vendors or third-party specialists, offer integrated services for policy management, access control, data classification, and auditing. Examples include Azure Purview, AWS Lake Formation, Google Cloud Data Catalog, and third-party solutions such as Collibra, Informatica, and Alation (Ajiga, et al., 2024, Johnson, et al., 2024, Odionu, et al., 2024). These platforms provide centralized interfaces through which governance teams can define and monitor data policies, assign stewardship responsibilities, track data lineage, and audit usage patterns across cloud services.

Dashboards are particularly important for enabling observability and accountability in governance practices. They present real-time metrics and visualizations that help stakeholders understand the state of data quality, access compliance, risk exposure, and policy adherence. Role-based access to dashboards ensures that users at different levels executives, data stewards, compliance officers, and system administrators can access insights tailored to their responsibilities. In public service transformation projects, dashboards allow governments to monitor key performance indicators (KPIs) for citizen engagement, service delivery timelines, and compliance with open data policies (Adepoju, et al., 2022, Ogunsola, Balogun & Ogunmokun, 2022, Okeke, et al., 2022). They also facilitate transparency by allowing stakeholders to trace the flow of data through the system, understand decision logic, and ensure that data is being used ethically and legally.

These cloud-native tools are designed to scale with growing data volumes and expanding cloud usage, supporting integrations with a wide range of services and APIs. They often include machine learning capabilities for automated classification, tagging, and risk scoring. By integrating with identity and access management (IAM) systems, they enforce consistent security policies across providers. Many also offer data catalogs that help users discover and access datasets based on metadata, sensitivity level, or business relevance, supporting the self-service models promoted by data fabric and data mesh architectures (Agu, et al., 2024, Jessa & Ajidahun, 2024, Ofoegbu, et al., 2024).

In conclusion, the technological enablers and governance tools that underpin data governance in multi-cloud environments are central to the success of digital transformation initiatives across industries and public services. By leveraging architectures such as data fabric and data mesh, organizations can harmonize data access and governance across distributed systems. The infusion of AI and automation into governance processes enables real-time enforcement, continuous monitoring, and intelligent decision-making, reducing the burden on human operators and enhancing regulatory compliance. The choice between centralized and federated governance models depends on organizational context, but both benefit from the availability of cloud-native platforms and dashboards that bring visibility, control, and accountability to complex multi-cloud ecosystems (Ajiva, Ejike & Abhulimen, 2024, Iyelolu, et al., 2024, Ogunwole, et al., 2024). As the demand for scalable, secure, and ethical data governance continues to grow, these tools and models will remain essential in navigating the challenges and opportunities of the digital age.

6. Governance in Public Service Transformation

The transformation of public services in the digital era is increasingly being shaped by the integration of multi-cloud architectures, which enable government agencies to deliver responsive, scalable, and innovative services to citizens. However, as public institutions embrace cloud-native tools and multi-cloud environments to modernize operations, the role of data governance becomes both more complex and more vital. Governance in this context extends beyond mere compliance; it is foundational to ensuring transparency, accountability, and ethical stewardship of public data (Ajiga, et al., 2024, Iyelolu, et al., 2024, Ogunnowo, et al., 2024). A systematic review of data governance practices in public sector digital transformation highlights several critical themes, including strategic cloud adoption by governments, the implementation of citizen-centric governance models, the growing importance of ethical frameworks, and the need for seamless cross-agency and intergovernmental collaboration.

Case studies of government cloud strategies across the globe demonstrate how cloud computing is being leveraged to support public sector innovation while also highlighting the challenges of governance in a distributed environment. In the United Kingdom, for instance, the Government Digital Service (GDS) established the "Cloud First" policy, which encourages public sector organizations to consider cloud-based solutions before other alternatives. This strategy has led to significant progress in the digitalization of services but has also required the development of governance frameworks to manage risk, ensure interoperability, and uphold public trust. Similarly, the United States government adopted the Federal Cloud Computing Strategy (Cloud Smart), which emphasizes the importance of shared services, security, and workforce readiness in federal cloud adoption (Adepoju, et al., 2024, Iyelolu, et al., 2024, Ogunwole, et al., 2024). As part of this initiative, the Federal Risk and Authorization Management Program (FedRAMP) was developed to standardize the security assessment of cloud services, demonstrating a clear link between governance and digital infrastructure expansion.

In Australia, the Digital Transformation Agency (DTA) has championed cloud adoption through its Secure Cloud Strategy, which focuses on agility, cost efficiency, and scalability while maintaining strong controls over data privacy and system integrity. These case studies reflect a common understanding: that successful public service transformation depends not only on technology acquisition but also on the implementation of robust data governance practices that can adapt to evolving cloud ecosystems. Governments must develop mechanisms to monitor compliance, manage access controls, track data usage, and ensure that cloud vendors meet contractual and regulatory obligations.

Citizen-centric data governance is a defining feature of modern public service delivery, placing the rights, expectations, and needs of citizens at the center of data management policies. In the context of multi-cloud governance, this approach requires public institutions to ensure that citizens have clear visibility into how their data is being collected, stored, used, and shared across agencies and platforms (Muyiwa-Ajayi, Sobowale & Augoye, 2024, Odonkor, Eziamaka & Akinsulire, 2024). It also demands the provision of mechanisms for consent, access, correction, and deletion in accordance with privacy regulations like the General Data Protection Regulation (GDPR). Moreover, citizen-centric governance requires transparency in data-driven decision-making processes, particularly where algorithms or AI systems are used to allocate resources, prioritize services, or enforce policies.

A notable example of citizen-focused data governance is Estonia’s X-Road platform, which underpins the country's digital government infrastructure. This platform facilitates secure data exchange between public and private sector entities, enabling seamless service delivery while maintaining strict data ownership and access rules. Citizens retain control

over their personal information and can audit who has accessed their data and for what purpose. The success of X-Road illustrates how strong governance, underpinned by transparency and control mechanisms, can foster citizen trust and engagement in digital government initiatives (Agu, et al., 2024, Iyelolu, et al., 2024, Ofoegbu, et al., 2024).

Ethical considerations are increasingly central to public sector data governance, especially as governments use data analytics, machine learning, and automation to enhance service delivery. Ethical data governance ensures that data is used in ways that are fair, equitable, and respectful of individual rights. It addresses concerns such as algorithmic bias, digital exclusion, and surveillance, all of which can erode public trust if not carefully managed (Afolabi & Olulaja, 2024, Iyelolu, et al., 2024, Ogunwole, et al., 2024). For instance, when predictive analytics are used in areas like social services or criminal justice, ethical governance frameworks must be in place to scrutinize the data inputs, validate model accuracy, and ensure that outcomes do not reinforce existing inequalities or discriminate against vulnerable groups.

Public service transformation must also contend with issues of transparency and accountability. Data governance frameworks should provide mechanisms for auditing data flows, evaluating decision-making processes, and assigning responsibility for data stewardship. This is particularly important in multi-cloud settings, where the complexity of data movement and processing can obscure lines of accountability. Open data initiatives are one way governments can promote transparency, by publishing non-sensitive datasets for public access, enabling independent analysis, civic innovation, and oversight (Ajayi, Olulaja & Afolabi, 2024, Ikwuanusi, et al., 2024, Oham & Ejike, 2024). However, open data must be balanced with privacy considerations and accompanied by metadata standards, usage guidelines, and access policies that uphold the principles of responsible data use.

Collaboration across agencies and levels of government is essential for achieving cohesive and efficient public service delivery. Yet, in many jurisdictions, data silos, inconsistent standards, and organizational inertia continue to hinder cross-agency data sharing. Effective data governance frameworks must therefore facilitate interoperability while respecting agency autonomy and data protection requirements. This involves establishing shared vocabularies, data models, and protocols that allow information to flow securely and meaningfully between systems (Adepoju, et al., 2023, Ikwuanusi, Adepoju & Odionu, 2023, Okeke, et al., 2023). Federated identity and access management solutions can enable authorized users to access shared data assets across departments without duplicating sensitive information or compromising security.

The European Union's interoperability framework and the ISA² programme offer instructive examples of efforts to harmonize cross-government data exchange. These initiatives provide practical tools and policy guidelines for improving semantic interoperability, legal alignment, and technical coordination among member states and institutions. In the United States, the Interagency Council on Statistical Policy (ICSP) promotes collaboration and standardization across federal statistical agencies, fostering data governance that supports integrated policymaking and program evaluation (Ajayi, et al., 2024, Ijomah, et al., 2024, Ofoegbu, et al., 2024). Likewise, the Canadian Digital Exchange Platform initiative is being designed to allow secure data sharing across federal, provincial, and municipal levels of government, with governance principles that prioritize transparency, ethics, and citizen empowerment.

Intergovernmental collaboration also extends to international partnerships, particularly in areas like climate data sharing, pandemic response, and disaster risk reduction. These global use cases further illustrate the need for interoperable governance frameworks that can operate across legal, linguistic, and cultural boundaries. Multilateral organizations

such as the OECD and the United Nations are increasingly advocating for global principles and guidelines on data governance, recognizing that effective public service transformation in the digital age requires alignment not just within countries, but also across borders (Ajiga, et al., 2024, Ijomah, et al., 2024, Ofodile, et al., 2024).

In sum, governance in public service transformation is a multifaceted and evolving discipline, particularly as governments navigate the challenges and opportunities of multi-cloud environments. Through the implementation of strategic cloud policies, citizen-centric governance models, ethical frameworks, and interagency collaboration mechanisms, public institutions can ensure that data is managed responsibly, transparently, and in the public interest. The experiences of leading digital governments around the world illustrate that technological advancement must be matched by a commitment to strong governance practices that safeguard citizen rights, enhance accountability, and promote sustainable innovation. As the digital public sector continues to grow in scope and sophistication, the principles and practices of data governance will remain central to its legitimacy, effectiveness, and long-term success.

7. Challenges and Gaps

Despite the remarkable potential of multi-cloud environments to enable more responsive, scalable, and citizen-focused public service delivery, the implementation of effective data governance within these ecosystems is fraught with challenges. As organizations across both the public and private sectors increasingly rely on multi-cloud strategies to support digital transformation, they must contend with significant gaps and systemic obstacles that hinder the seamless, secure, and compliant management of data. A systematic review of current governance practices reveals that while much progress has been made in developing frameworks, standards, and technologies, several enduring challenges remain (Adepoju, et al., 2024, Ijomah, et al., 2024, Ojukwu, et al., 2024). These include fragmented policy implementation across cloud service providers, the struggle to balance operational agility with regulatory compliance, persistent skills shortages and organizational silos, and deep-seated cultural and institutional resistance to change.

One of the most prominent challenges in multi-cloud data governance is the lack of unified policy implementation across cloud providers. Each provider typically offers its own proprietary tools, security models, APIs, and compliance frameworks, which can lead to inconsistencies when data is distributed across multiple environments. As organizations adopt services from different vendors such as AWS, Microsoft Azure, Google Cloud Platform, and Oracle Cloud they encounter a landscape of varied access control protocols, data residency configurations, encryption standards, and audit mechanisms (Ajayi & Akerele, 2021, Odio, et al., 2021, Okeke, et al., 2022). These differences complicate efforts to implement a cohesive governance strategy, particularly for public sector agencies that must adhere to strict national and sector-specific regulations. The absence of cross-provider policy standardization also impedes automation and monitoring, requiring agencies to manage and reconcile disparate governance rules manually. This fragmentation not only increases the risk of non-compliance but also creates operational inefficiencies, as data governance teams struggle to maintain consistency and oversight across a growing web of cloud assets.

Compounding this issue is the inherent tension between the need for agility and the obligation to maintain compliance. Multi-cloud environments promise flexibility, allowing organizations to rapidly scale resources, adopt new technologies, and respond dynamically to evolving user needs. However, this same dynamism presents a governance challenge, particularly in heavily regulated sectors such as healthcare, finance, and government (Ngodoo, et al., 2024, Nwabekee, et al., 2024, Oham & Ejike, 2024).

Agile development and deployment processes, such as DevOps and continuous integration/continuous deployment (CI/CD), prioritize speed and innovation but they can bypass or dilute governance checks if not properly integrated into workflows. The challenge lies in embedding compliance controls into agile processes without stifling innovation or slowing down development cycles. This requires the automation of governance policies, real-time monitoring, and policy-as-code approaches that can enforce rules dynamically within cloud-native environments.

The pressure to innovate can also lead to the use of shadow IT systems and services procured or developed without formal IT approval. In multi-cloud settings, shadow IT can result in data silos, unauthorized data flows, and governance blind spots, undermining visibility and control. The consequences of such unsanctioned activity can be particularly serious in the public sector, where citizen data must be handled with the highest levels of care and compliance. Balancing the need for rapid service delivery with the requirement to uphold data privacy, security, and integrity thus becomes a complex governance dilemma (Ajiva, Ejike & Abhulimen, 2024, Ijomah, et al., 2024, Okeke, et al., 2024).

Another critical gap identified in the systematic review is the shortage of skilled personnel capable of designing, implementing, and maintaining comprehensive data governance frameworks in multi-cloud environments. Data governance is inherently multidisciplinary, requiring expertise in data management, cybersecurity, legal and regulatory affairs, cloud architecture, and change management. Yet, many public sector organizations and even large enterprises struggle to recruit and retain talent with the requisite skill sets. This challenge is exacerbated by the pace of technological change in the cloud domain, where tools, standards, and best practices evolve rapidly (Ajiga, et al., 2024, Ijomah, et al., 2024, Ofoegbu, et al., 2024). As a result, governance teams are often under-resourced, overextended, and ill-equipped to keep up with the complexities of managing data across diverse cloud platforms.

Skills shortages also contribute to the persistence of organizational silos, where data governance is handled in isolation by IT departments, compliance teams, or business units. Such fragmentation hampers collaboration, impedes holistic oversight, and leads to the inconsistent application of governance policies. In multi-cloud environments, where data must flow freely between departments, agencies, and even governments to enable integrated service delivery, the lack of a unified approach to governance can significantly hinder transformation efforts (Adepoju, et al., 2023, Ijomah, Okeleke & Babatunde, 2023, Okeke, et al., 2023). Silos not only limit operational efficiency but also reduce an organization's ability to leverage data as a strategic asset, stalling progress in areas such as data analytics, AI adoption, and evidence-based policymaking.

Organizational silos often reflect deeper cultural and institutional resistance to change a final but no less significant challenge in the implementation of effective multi-cloud data governance. While technology adoption may be rapid, the transformation of institutional culture tends to lag behind. Many public sector organizations are built on hierarchical, risk-averse structures that prioritize stability over innovation. In such environments, the introduction of new governance models, data-sharing protocols, or cross-agency collaboration initiatives can be met with skepticism or resistance (Ikese, et al., 2024, Ikemba, Akinsooto & Ogundipe, 2024, Okeke, et al., 2023). Concerns about data ownership, loss of control, and accountability frequently arise, particularly when governance responsibilities are decentralized or when external cloud providers are involved.

Furthermore, cultural barriers often manifest in the reluctance to adopt open data principles, embrace interoperability, or share sensitive information with other departments or jurisdictions even when such sharing is essential for efficient service delivery. This

reluctance is sometimes rooted in a lack of trust or a fear of reputational damage in the event of data misuse or breach. Overcoming these barriers requires not just new technologies or policies, but also strong leadership, stakeholder engagement, and a shift in organizational mindset that views data not as a proprietary asset to be guarded, but as a shared resource to be leveraged for public good (Ajayi & Akerele, 2022, Ogunmokun, Balogun & Ogunsola, 2022, Okeke, et al., 2022).

Institutional resistance also arises from legacy systems and bureaucratic processes that are poorly suited to the demands of multi-cloud governance. Many agencies continue to operate with outdated IT infrastructures, rigid procurement rules, and cumbersome compliance procedures that make it difficult to adopt modern cloud-native tools or agile governance models. Even when digital transformation initiatives are underway, governance practices often remain tethered to traditional paradigms, creating a mismatch that hampers innovation and scalability (Ike, et al., 2021, Ogunnowo, et al., 2021, Okeke, et al., 2022).

In response to these challenges, leading organizations and governments are beginning to invest in cross-functional governance bodies, capacity-building programs, and policy frameworks designed to promote coordination and flexibility. However, progress remains uneven, and the path forward requires sustained effort and strategic vision. Data governance must be integrated into digital transformation agendas from the outset, not treated as an afterthought. Investments in workforce development, cross-agency collaboration, and technology standardization are critical. Equally important is the cultivation of a governance culture that prioritizes transparency, trust, and shared responsibility (Ajiga, et al., 2024, Ijomah, et al., 2024, Odonkor, Eziamaka & Akinsulire, 2024).

In conclusion, while the transition to multi-cloud infrastructures offers immense promise for modernizing public services and enabling innovative product delivery, it also presents a host of governance challenges that must be addressed holistically. Fragmented policies across cloud providers, the delicate balance between agility and compliance, shortages in skilled personnel, entrenched silos, and cultural resistance collectively hinder the realization of effective, secure, and citizen-centric data governance. Addressing these gaps requires a coordinated approach that blends technological sophistication with organizational reform and cultural change. Only through such comprehensive efforts can multi-cloud data governance mature to support sustainable, inclusive, and future-ready public service transformation.

8. Recommendations and Future Directions

Based on the findings of the systematic review of data governance practices in multi-cloud product delivery and public service transformation, it is evident that organizations and governments must adopt a forward-looking, adaptive, and unified approach to governance. As multi-cloud environments become central to digital infrastructure and service delivery, governance must evolve to meet the unique demands of scalability, interoperability, and regulatory complexity. The recommendations and future directions outlined here are aimed at enabling institutions to transform governance from a reactive compliance mechanism into a proactive strategic function that supports innovation, protects data integrity, and ensures public trust.

The first and most foundational recommendation is the strategic alignment of governance practices with multi-cloud goals. For many organizations, especially in the public sector, data governance is still treated as a peripheral concern something implemented after cloud adoption rather than as a core component of cloud strategy. This misalignment results in fragmented policies, duplicated efforts, and increased risk (Adepoju, et al., 2024, Ige, Kupa & Ilori, 2024, Okeke, et al., 2024). To address this, data governance must be embedded into the very fabric of multi-cloud

architecture planning and decision-making. Leaders must articulate clear goals for their cloud strategies whether they prioritize agility, cost-efficiency, service interoperability, or geographic resilience and then align governance mechanisms accordingly. For example, an agency aiming to enable cross-border data collaboration will need governance tools that support dynamic consent management and international compliance, whereas an organization focused on rapid product iteration will benefit from automated policy enforcement and integrated governance in DevOps pipelines. The clearer the articulation of cloud goals, the better tailored and more effective the governance strategies will be.

Alongside strategic alignment, there is an urgent need for the development of unified governance frameworks that span cloud providers, organizational departments, and jurisdictional boundaries. Multi-cloud governance today is often constrained by the diversity of tools, protocols, and policies provided by different vendors. This results in disjointed practices that are difficult to manage, audit, and scale (Ajayi & Akerele, 2024, Ige, Kupa & Ilori, 2024, Ojukwu, et al., 2024). A unified framework does not necessarily imply centralization, but rather a consistent set of principles, roles, metadata standards, and lifecycle policies that can be applied flexibly across environments. Such frameworks should define core elements like data classification, retention schedules, access protocols, and incident response procedures in a manner that is technology-agnostic yet comprehensive. Importantly, these frameworks must support both centralized and federated governance models, allowing institutions to maintain local autonomy where necessary while ensuring enterprise-wide alignment on security, compliance, and ethical use.

To support these unified frameworks, the implementation of real-time monitoring, continuous compliance, and cross-cloud observability must become a standard feature of multi-cloud governance. Traditional governance approaches, which rely on periodic audits or static policy documents, are ill-suited for cloud-native environments characterized by rapid change and dynamic workloads. Continuous compliance refers to the ability to enforce and verify adherence to data policies in real time as data moves through various systems, platforms, and applications. This requires integration between governance policies and infrastructure-as-code, CI/CD pipelines, and cloud-native monitoring tools (Ajiga, et al., 2024, Ige, Kupa & Ilori, 2024, Oham & Ejike, 2024). By using policy-as-code techniques, institutions can automate rule enforcement for access control, encryption, data masking, and retention, reducing the risk of human error and improving responsiveness.

Cross-cloud observability extends this by providing comprehensive, real-time insights into data flows, user behavior, policy violations, and system performance across multiple cloud services. Observability platforms must be capable of aggregating telemetry data, audit logs, and access events from diverse sources and presenting them in a unified interface for governance teams, compliance officers, and data stewards (Ajayi & Akerele, 2022, Ogunmokun, Balogun & Ogunsola, 2022, Okeke, et al., 2022). This transparency supports not only operational effectiveness but also trust and accountability, particularly in public sector scenarios where agencies are custodians of citizen data and must demonstrate compliance with data protection laws.

The future of data governance in multi-cloud environments also depends on increased international collaboration and the development of global interoperability standards. In an era of cross-border data flows, digital government partnerships, and multinational cloud operations, it is no longer sufficient for governance to be confined within national or institutional boundaries. Fragmented regulatory regimes, inconsistent data transfer rules, and incompatible technical standards create friction, increase costs, and limit the potential of digital public services. International cooperation is needed to

harmonize data protection requirements, align certification and auditing procedures, and create mutual recognition frameworks for cloud service compliance.

This cooperation must involve not only governments and intergovernmental organizations but also cloud vendors, industry groups, and civil society. For example, initiatives such as the European Union's GAIA-X, which aims to build a federated, interoperable cloud data infrastructure with common governance principles, offer a promising model for how data sovereignty and interoperability can coexist (Ike, et al., 2021, Ogunnowo, et al., 2021, Okeke, et al., 2022). Similar efforts should be expanded to include public sector service providers from multiple regions and supported by a commitment to open standards and transparent governance practices.

In addition to regulatory harmonization, international standards are also needed at the technical level to ensure semantic interoperability, data lineage tracking, and metadata portability across clouds. Bodies such as the International Organization for Standardization (ISO), the Institute of Electrical and Electronics Engineers (IEEE), and the World Wide Web Consortium (W3C) have begun developing relevant frameworks, but further work is required to translate these into actionable, widely adopted specifications for multi-cloud governance (Adepoju, et al., 2024, Ige, Kupa & Ilori, 2024, Okeke, et al., 2024). The adoption of standards like OpenAPI for APIs, FHIR for healthcare data, and DCAT for data catalogs can accelerate this process and support global data collaboration.

To prepare for the governance demands of tomorrow, organizations must also invest in capacity building, culture change, and cross-functional collaboration. Data governance cannot succeed in isolation; it requires active participation from IT teams, legal advisors, business units, and executive leadership. Institutions should establish cross-functional data governance councils or committees tasked with overseeing policy development, evaluating risks, and driving alignment between technology and mission outcomes (Nwaimo, et al., 2023, Ogunnowo, et al., 2023, Ogunwole, et al., 2023). Training and professional development programs should be implemented to upskill staff in areas such as cloud governance, data ethics, compliance engineering, and data stewardship. Moreover, a cultural shift is needed to move governance from being viewed as a compliance burden to a value enabler one that supports innovation, empowers users, and builds public trust.

Finally, governance must evolve in parallel with the technologies it seeks to manage. As emerging trends such as edge computing, artificial intelligence, and decentralized data architectures gain traction, governance models will need to adapt to new paradigms. For instance, edge computing introduces governance challenges related to data residency, device-level security, and localized compliance (Adepoju, et al., 2022, Jessa, 2022, Ogunwole, et al., 2022, Okeke, et al., 2022). Similarly, AI systems require explainability, fairness, and accountability in their data pipelines demands that extend beyond traditional governance controls. Anticipating these trends and building governance agility into frameworks today will position organizations to remain resilient, responsible, and responsive in the face of ongoing digital evolution.

In conclusion, the future of data governance in multi-cloud product delivery and public service transformation will be shaped by the institutions' ability to align governance with strategic objectives, implement unified and adaptive frameworks, embed compliance into operational workflows, and participate in international efforts to create shared standards. These directions are not only vital for minimizing risk and ensuring legal compliance, but also for enabling the transformative potential of cloud technologies to be realized equitably and sustainably. Through proactive investment, collaboration, and innovation in governance, public and private sector

leaders alike can ensure that data remains a trusted, secure, and valuable asset in the digital age.

9. Conclusion

This systematic review of data governance practices in multi-cloud product delivery and public service transformation has underscored the urgent need for cohesive, adaptive, and forward-looking governance strategies in an increasingly decentralized digital environment. The review revealed that while multi-cloud adoption offers immense benefits in terms of flexibility, scalability, and service delivery efficiency, it also introduces complexities related to data security, privacy, compliance, interoperability, and ethical use. Key insights from this study highlight the critical dimensions of effective governance ranging from metadata management, data lineage, access control, and cross-cloud observability to policy enforcement and real-time compliance monitoring. It became evident that governance is no longer a back-office function but a strategic necessity, central to achieving sustainable innovation and maintaining public trust.

For policymakers, Chief Information Officers (CIOs), and digital transformation leaders, these findings carry significant implications. Policymakers must prioritize the development of harmonized regulatory frameworks and encourage international cooperation to address cross-border data governance challenges. CIOs and technology executives must integrate governance into the core of their cloud strategy, ensuring that it evolves in lockstep with enterprise objectives, risk management requirements, and user expectations. Governance cannot remain siloed within compliance or IT departments it must be embraced as a shared responsibility across all organizational layers. For leaders driving digital transformation, the review underscores the importance of investing in governance tools, workforce capacity, and cultural change that fosters collaboration, transparency, and continuous improvement.

Looking ahead, the evolution of data governance in the multi-cloud era will be defined by its ability to adapt to emerging technologies, regulatory shifts, and increasingly complex user demands. Governance frameworks must be both resilient and flexible, capable of ensuring data integrity and accountability while enabling agility and innovation. As data becomes more distributed, dynamic, and democratized, the governance models of the future must move beyond rigid control structures to embrace automation, AI, open standards, and inclusive policies. Ultimately, effective data governance will be a decisive factor in how well organizations harness the full potential of multi-cloud systems to deliver trusted, responsive, and transformative digital services.

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