Data and Cybersecurity Governance Frameworks for Enhancing Land Registry Performance and Strengthening Data Security Posture: Case Study: Uganda Land Information System and National Valuation Information System.

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Summary

Uganda's overhaul of its land administration system through Uganda Land Information System (UgNLIS) and National Valuation Management Information System (NVMIS) aims to modernize land registration and valuation by making these services more accessible. However, while these digital platforms bring efficiency, rapid digitalization introduces significant data governance and cybersecurity risks. These vulnerabilities threaten the confidentiality, integrity, and availability of land data, and can erode trust in digital land services.

The absence of harmonized data standards and a comprehensive metadata catalogue applied in the UgNLIS and NVMIS has led to poor data quality, completeness, and minimal interoperability. This hinders reliable data governance, leading to incomplete, outdated, and inaccurate records. The study finds a need for better oversight of data governance throughout the data lifecycle. This includes archiving or retiring records and limiting access to sensitive information. Increased land disputes and litigation have resulted. These issues are made worse by gaps in legal and policy frameworks for data governance and by inadequate metadata and documentation for land Administration data and auxiliary datasets.

Uganda's strategic data governance frameworks for Land Administration and cybersecurity operate separately, impeding both Enterprise Data Governance and Risk Management. A unified model is necessary that integrates business and governance risk beyond IT to ensure effective risk management for both land information and valuation systems.

To address these challenges and bridge gaps, the paper proposes a Land Administration Data and Cybersecurity Governance Toolbox. This toolbox is tailored for Uganda and benchmarked to global practices. It aligns policies, procedures, and technical protocols with international, regional, and domestic laws. The toolbox also integrates cybersecurity maturity frameworks to protect cadastral and valuation data for all tenure systems, including freehold, leasehold, mailo, and customary.

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1.0 Introduction

Uganda's administration systems not only enhance the efficiency and resilience of its land registry systems but also contribute to lessons on securing land administration data at the continental and global levels in the era of digital transformation. Stakeholders and policymakers should draw on these findings to drive reforms and to prioritize the development of secure, interoperable land information systems at the regional and international levels.

Despite Uganda's Data Protection and Privacy Act 2019, the Uganda Land Information System and the National Valuation Management Information System have been partly configured to meet legal requirements for data governance due to the complexity of the land register and the outdated Registration of Title and Survey Laws. Both Acts require review and amendments to address emerging privacy concerns arising from the register's inclusion of records for citizens and foreign users.

UgNLIS and NVMIS depend on auxiliary datasets from multiple external agencies, including the National Forestry Authority, the Uganda Registration Service Bureau, and the Uganda Revenue Authority. These datasets contain sensitive information, such as payment card information (PCI) and personal data. Each of which requires distinct, robust security, access control, and security controls. Without a clear data governance framework, the risk of inappropriate data sharing among internal and external users of UgNLIS and NVMIS increases. The lack of metadata standards or schemes in UgNLIS and NVMIS, such as ISO/IEC 11179 and National Information Exchange Model (NIEM), prevents the use of a common vocabulary for effective information exchange across diverse public and private organizations. As a result, data inconsistencies arise, requiring transformation to different standards for use by different systems; this makes data not readily available when needed.

2.0 Data Governance in Land Administration and Management

Today, well-organized threats can affect multiple systems using a single piece of data. The UgNLIS holds important information that, if misused, could harm users across all sectors. This happens partly because there aren't enough legal frameworks and rules to ensure data is handled safely. Adopting simple yet strong rules grounded in good governance can help keep land system operations safe and Valuation data.

Data trust focuses on the legal framework, supported by infrastructure standards, to ensure that data sources are secured and that data operations adhere to defined roles and controls. Data

governance is the foundation for improving the data security posture in systems/infrastructure, the UgNLIS, ensuring spatial and non-spatial privacy and data quality are well implemented, and developing data governance frameworks that include location spatial details in the cadastral, which is key to the national security.

These frameworks for managing data and cybersecurity also include clear rules and security steps, linked to UgNLIS and NVMIS operations. Now, the focus is on privacy, making sure everyone is responsible, and keeping a close watch to compliance to data governance framework. This includes ways to prevent data loss, hide sensitive data, anonymize data, label data, and continuous monitoring of risks at all levels, such as business, operations, and policies.

3.0 Current UgNLIS Data Management Framework

The diagram below shows the current data management and data available in the UgNLIS within the existing legal frameworks in the land administration and information technology sectors in Uganda, and further summarizes the data governance gaps in the current framework.

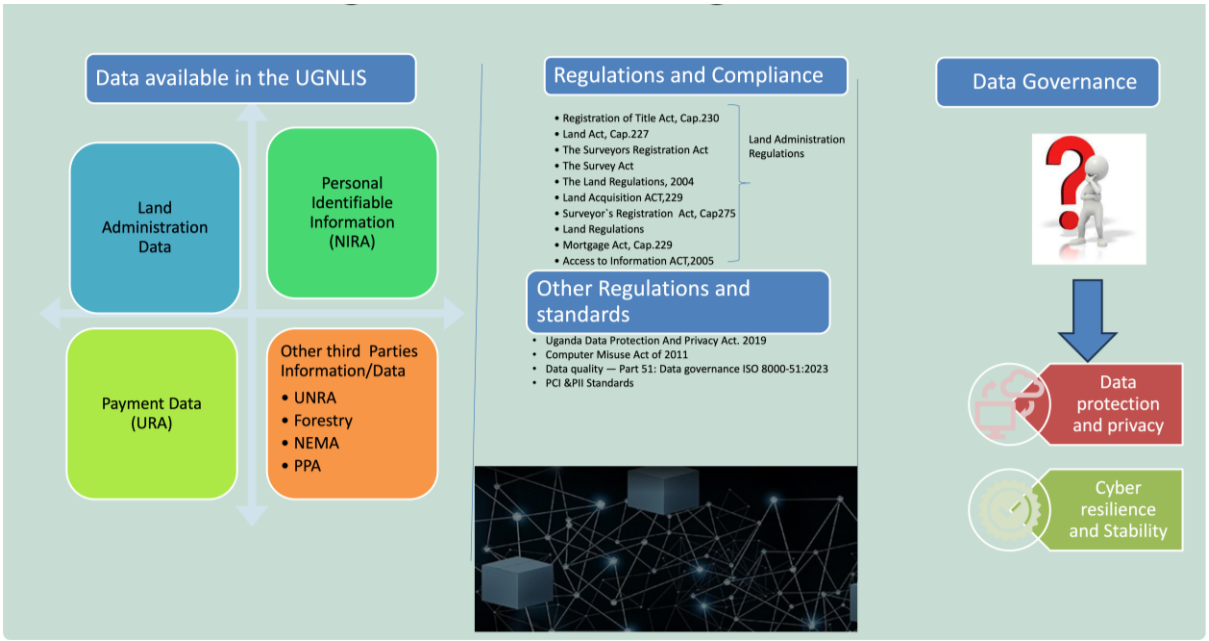

Figure 1: Current Uganda and LaVMIS data Management

4.0 Methodology

This study uses a qualitative approach that includes expert interviews, focus groups, regulatory gap analysis, and case studies. These methods help examine governance and security challenges in Uganda's land data ecosystem, as detailed below. There are still gaps in meeting national and international standards, such as Uganda's Data Protection and Privacy Act (2019) and ISO/IEC 27701:2025, which provides guidance on protecting personally identifiable information in cloud environments. The absence of robust systems for classifying, labelling,

and organizing data makes it harder for stakeholders across the land sector to share and integrate data.

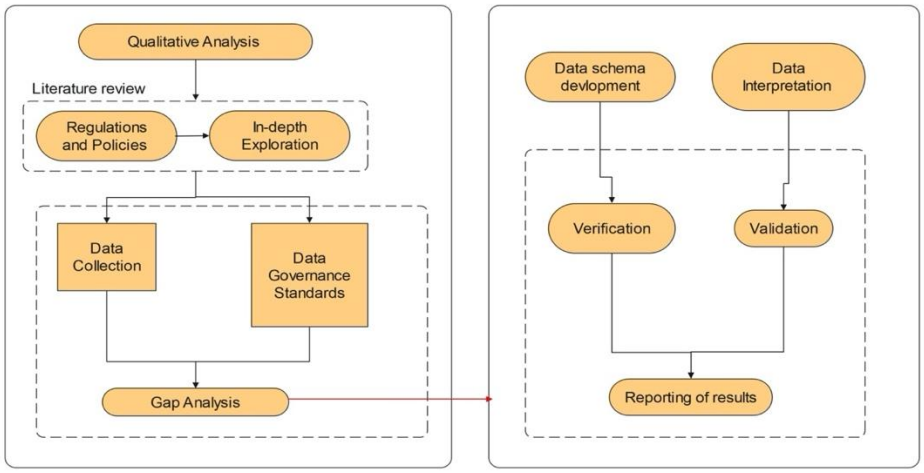

Figure 2: Summary of the Methodology

The approach used ensured the enhancement of the trustworthiness of land administration systems in the current digitalized environment, enabling interoperability of data governance within the proposed framework through continuous cybersecurity risk assessment of all critical assets.

The research employs concept-centric approaches to evaluate data privacy and protection concerning business, personal, and payment information. These issues are particularly important in the digital era, given the lack of data and cybersecurity governance frameworks within the Ministry of Lands, Housing, and Urban Development. Especially given that we are looking to implement Analytics, Machine Learning, and Blockchain which rely on data, if there are no clear Data protection standards, it will be very hard, if not impossible, to implement Data Governance and Responsible AI.

5.0 UGNLIS AND LAVMIS DATA GOVERNANCE FRAMEWORK

Under this section, the framework adheres to the **ISO 27001/27002, ISO/IEC 27018, ISO/TC 211, ISO/IEC 38505, ISO/IEC 29100,** and is summarized into the strategic, Data Core and Change management layers. This is illustrated in Figure three (3) below;

5.1 Strategic Layer

– **Law and Policy Coherence:** Alignment of the legal frameworks in the Land administration to cybersecurity controls to achieve resiliency against any threat.

– **Authority and ownership:** Clarification of data ownership, stewardship, and accountability that is controls on data access and ensuring data is secured at all times, and updates are made at near real time or as per the updating policy.

– **Stakeholder governance:** Mapping the key stakeholders and their respective importance to the data trusts.

– **Risk management:** Integrates risk assessments that consider threats to data quality, availability, and legal validity, all for land transactions, to create an enterprise risk management strategy, including Land dispute resolution.

5.2 Data Core Layer:

– **Data quality and integrity:** have standardized data models, mandatory metadata, and automated spatial integrity checks (topology, coordinate reference systems, lineage, and version control) improve data quality and registry performance by reducing overlaps, inconsistencies, and processing delays. Also, data masking, labelling, classification, and compliance with the principle of data quality.

– **Centralized control & security:** The framework focuses on implementing centralized control of data sharing at the business strategic layer within the Land administration legal framework. Strong identity and access management, segregation of duties, encryption, immutable audit trails, and continuous monitoring protect the registry from unauthorized access, manipulation, and data loss.

– **Data encryption:** Implementing data encryption recommended standards for data at rest, in transit and any other operations not limited for Machine and Deep learning modeling

– **System resilience:** a clear and well-defined recovery objective, secure backups, disaster recovery arrangements, and regular testing, ensuring continuity of critical land services.

– **Automation:** The legal framework is automated to ensure compliance with data protection and privacy requirements within UgNLIS and NVMIS. Shared personal information must be protected in line with key standards, such as ISO/IEC 27701, NIST Privacy Framework, PCI DSS, HIPAA, and CCPA.

5.3 Change Management:

- **Ownership Change Control:** Establishes the ownership of data for all data trust sources integrated in the UgNLIS and NVMIS and ensures accountability of data used against all datasets in the Land administration Infrastructure to support the updating of the cadastral data, Valuation, and Land registration.

- **Stakeholders and MLHUD staff:** Ensuring the continuous use of the identified models, such as the ADKAR Model and Kotter's 8-step process, across all business intelligence for land administration actors.

– **Operational model and business process Change:** The framework ensures that all agreed processes, both technical and administrative, are well defined, with clearly defined roles for data management across internal and external systems, and options for tracking accountability for data quality.

Figure 3 below presents the data governance framework and emphasizes its main parts: critical business activities and risks, supporting systems, and laws. It further details the distinct roles of land administration specialists, legal (regulatory compliance), public relations (stakeholder engagement), human resources (personnel matters), and IT infrastructure (technical support). The framework also considers five essential data governance components: people, data, technology, policies, and standards.

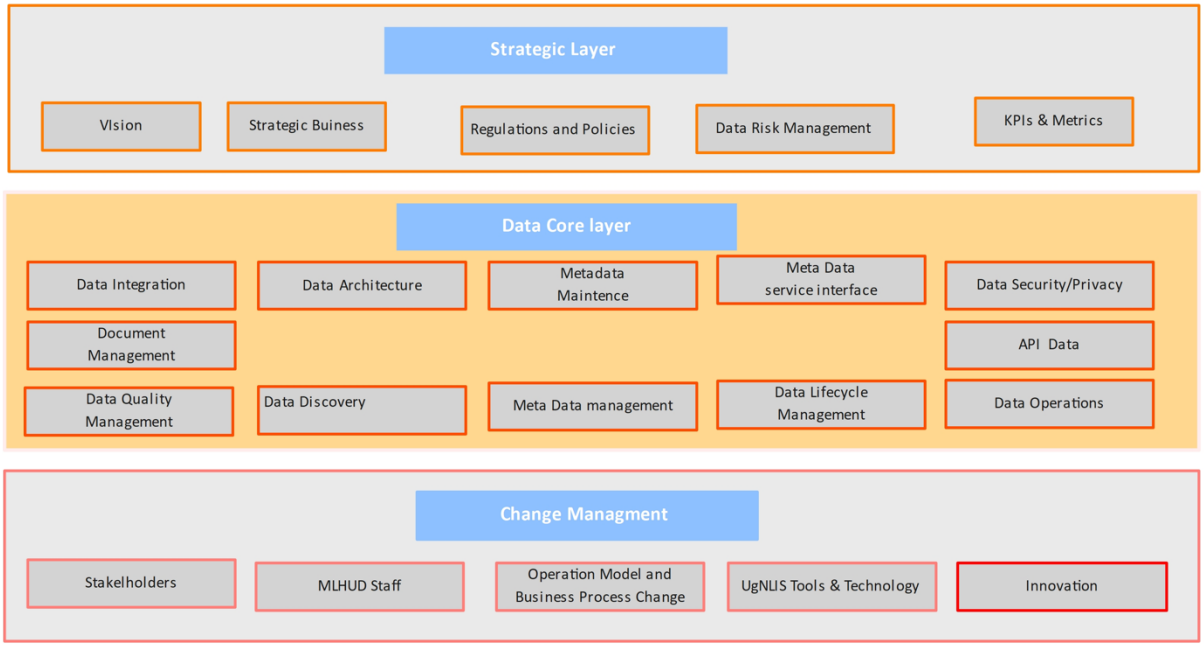

Figure 3: UgNLIS and NVMIS Data Governance Framework

6.0 Steps to Implementation of the UgNLIS and NVMIS Data Governance Framework

Below are the summarized steps taken to establish the data and cybersecurity governance frameworks for the UgNLIS and the NVMIS, focusing on ensuring the data infrastructure and continuous monitoring of defined, agreed metrics for all stakeholders.

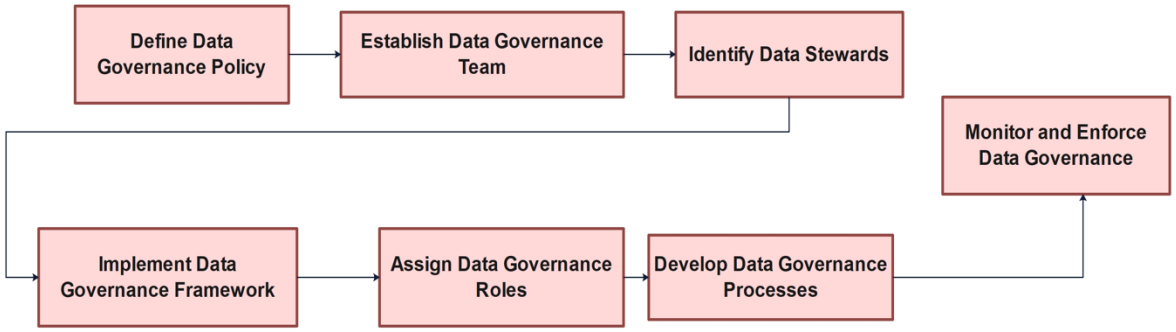

Figure 4: Steps towards the Data and Cybersecurity Governance Framework

7.0 UgNLIS and NVMIS Security Data Governance Framework: Data Flow

As described above in the Data Governance Framework, this section focuses on cybersecurity controls that are closely aligned with the framework. The technical implementation includes security controls in the data core layer, which are technical measures designed to protect core organizational data. These controls are implemented to ensure the security and privacy of data, in accordance with widely recognized cybersecurity frameworks and standards, such as the International Organization for Standardization (ISO), National Institute of Standards and Technology (NIST), and Control Objectives for Information and Related Technologies (CoBIT). Below is the compliance data flow for different business processes and access to land administration information.

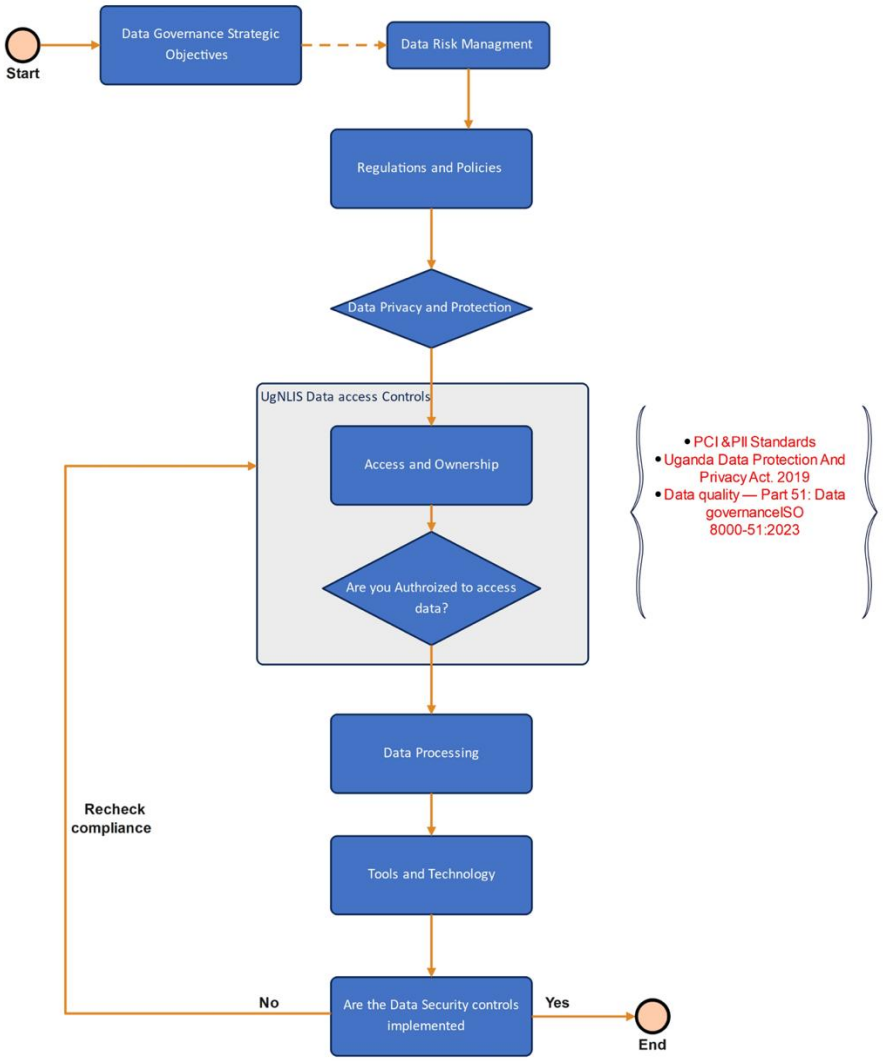

Figure 5NVMIS and UgNLIS Security Data Governance Framework Data Flow

8.0 Conclusion

This paper identifies several issues in the current land administration and cybersecurity data governance for land reforms in Uganda. These issues affect efforts to automate land registration and valuation services. Data governance is the foundation for security controls in information systems. It ensures systems work together and protect data from unauthorized changes, inconsistencies, and inaccuracies. Validating automation compliance, including policies, standards, and accountability, is essential for current and future land reforms. It is also necessary when adopting new technologies like blockchain and artificial intelligence. These measures help guarantee data privacy within the land data and cybersecurity governance framework. Together, robust governance and cybersecurity controls not only strengthen legal and public trust in land records but also enable modern, efficient, and resilient survey and mapping operations capable of supporting long-term land administration reforms.

To ensure the sustainability of Uganda's National Information System and National Valuation Management Information System, it is essential to establish a strong Land Administration Data and Cybersecurity Governance Framework. This framework must align with local, national, and international laws, regulations, polices and standards. Proper alignment ensures privacy and helps protect Uganda's critical land infrastructure, supporting national security.

Future work should pretest the proposed framework. This will ensure that all stakeholders, at every level, are considered. It will also help confirm that specialized skills are available to support implementation across strategic, data core, and change management layers, as discussed in this paper.

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BIOGRAPHICAL NOTES

William KAMBUGU is an information technology and cybersecurity professional with extensive experience in applying digital systems to land administration and management. His work spans in land registration, surveying and mapping, physical and urban planning, valuation and Fit – for – Purpose Land Administration approaches to securing land rights. He has served with Uganda's Ministry of Lands, Housing and Urban Development since 2010, contributing to major land administration reform initiatives, including the establishment of the Land Information System, the Uganda Geodetic Network, customary land rights documentation, and Land Valuation Information Systems.

His current professional focus is on leveraging emerging technologies to advance e-services and data driven decision making in land administration and environmental management, particularly at lower administrative levels. He holds a Bachelor' of Computer Science from Makerere University, a Master of Professional Studies in Cybersecurity Risk Management from Georgetown University, and a Master's degree in Geo-Information Science and Technology from Makerere University.

Ronald BYARUHANGA has over 20 years of experience providing Information Technology services to busy organizations. He has a good understanding of information systems and system security. Ronald holds a master's in business administration, a Master of Science in Information Systems, and a bachelor's in computer science. He previously worked in the water sub-sector, where he spearheaded automation of operations and established a countrywide branch network. Ronald demonstrates strong people management, communication, and interpersonal abilities. He is recognized for resolving problems, enhancing team satisfaction, and driving operational efficiency. Over his career, Ronald advanced from entry-level officer to Assistant Commissioner, his current position in the lands sub-sector.

Ibrahim MAGEMESO is the Acting Commissioner for Surveys and Mapping, Uganda, with over seventeen (17) years of professional experience in cadastral surveying, land administration, engineering surveys, resettlement action plans (RAPs), land acquisition and expropriation, and project management. He holds a Master of Science in Geo-Information Science and Technology from Makerere University and a Bachelor of Science in Surveying and Land Information Systems and provides strategic and technical leadership in the modernization of Uganda's surveying and mapping sector.

His workplaces strong emphasis on geospatial policy and legal reform, institutional strengthening, and the development of national geodetic infrastructure. Ibrahim actively engages with regional and international partners, promoting standards harmonization, interoperability, and regional cooperation.

In addition, Ibrahim has a growing strategic focus on data governance and cybersecurity frameworks for land administration systems, with particular attention to enhancing land registry performance, data integrity, and system resilience. He has contributed to initiatives aimed at strengthening the data security posture, access controls, auditability, and interoperability of national land administration platforms. His work emphasizes secure digital transformation, risk management, and trusted geospatial and land data infrastructures to support transparent, efficient, and resilient land governance.

Solomon RUZIMA has over 10 years of experience delivering IT services and is currently a Platforms Engineer who designs and implements secure DevSecOps pipelines for the development, testing, and deployment of software and AI models across multiple industries. He holds an MSc in Cybersecurity from Northeastern University and is a candidate in the Master of Science in Applied Machine Intelligence program at Northeastern University, and he actively researches ethical AI and AI security. He previously led security efforts at the Ministry of Lands, Housing and Urban Development during the implementation of the Uganda National Land Information System and has broad hands-on expertise in infrastructure operations, IAM, vulnerability management, and cloud/automation. He is also the CEO & Founder of Technovate

LLC, providing IT infrastructure, cybersecurity consulting, and Applied AI services including AI proofs of concept and implementation to improve efficiency, decision-making, and risk reduction.

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