



CENTRALIZED FINANCIAL DATA HUBS: ARCHITECTING THE FUTURE OF FINANCIAL DATA MANAGEMENT

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**Centralized
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ABSTRACT

This comprehensive article examines the transformative role of centralized financial data hubs in modern enterprise data management. The article explores how these hubs revolutionize financial operations by consolidating disparate data sources, implementing advanced analytics, and ensuring robust security measures. Through an

analysis of current implementations across major financial institutions, the article demonstrates significant improvements in operational efficiency, data accuracy, and regulatory compliance. The article details the architectural foundations, integration capabilities, quality frameworks, and advanced analytics that enable organizations to achieve superior performance in financial data management. Additionally, it addresses critical implementation considerations and challenges while highlighting the strategic advantages of adopting centralized financial data hubs in an increasingly complex financial landscape.

Keywords: Data Integration, Financial Analytics, Governance Framework, Machine Learning, Security Architecture.

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1. Introduction

In today's dynamic financial landscape, organizations face the mounting challenge of managing vast amounts of financial data from disparate sources. Financial institutions are experiencing unprecedented growth in data volumes, processing over 3.4 exabytes of transaction data daily across their global operations. According to research published in IEEE Internet of Things [1], financial enterprises now manage an average of 18 distinct data systems, leading to critical integration challenges that impact approximately 82% of global financial operations. This fragmentation results in estimated annual losses of \$2.1 trillion due to operational inefficiencies, data inconsistencies, and missed market opportunities.

A centralized financial data hub emerges as a critical solution, offering a comprehensive platform that transforms how enterprises handle their financial information ecosystem. Recent studies in IEEE Transactions on Industrial Informatics [2] demonstrate that implementing centralized financial hubs has reduced data processing latency by 84.3% while improving real-time data accuracy from the industry baseline of 76.8% to 99.4%. These improvements are particularly significant in high-frequency trading environments, where systems now process an average of 127,000 transactions per second with a fault tolerance rate of 99.997%.

The adoption of blockchain-integrated financial data hubs, as documented in [1], has shown remarkable improvements in data integrity and regulatory compliance. Organizations

implementing these solutions report a 94.6% reduction in reconciliation disputes and achieve regulatory compliance rates of 99.2%, compared to the industry average of 87.5%. The integration of smart contracts has automated 78.3% of previously manual validation processes, reducing operational costs by an average of 52.7% across surveyed institutions.

Analysis of large-scale implementations across the financial sector indicates that sophisticated data preprocessing algorithms, coupled with advanced machine learning models, have enabled real-time anomaly detection with 99.8% accuracy [2]. These systems successfully process and analyze over 1.2 million financial transactions per minute while maintaining data consistency across distributed ledgers with a proven reliability rate of 99.99%. Financial institutions leveraging these centralized hubs report average cost savings of \$127 million annually through reduced manual intervention and improved operational efficiency.

This article explores the architecture, capabilities, and strategic benefits of implementing a centralized financial data hub. Drawing on empirical evidence from major financial institutions, organizations implementing these solutions have achieved an average return on investment of 342% within the first 18 months, with high-performing implementations demonstrating operational cost reductions of up to 63.8% [1]. The integration of artificial intelligence and machine learning components has further enhanced predictive analytics capabilities, enabling financial institutions to identify market opportunities with 92.7% accuracy while reducing risk exposure by an average of 47.5% [2].

2. Architectural Foundation

The core architecture of financial data hubs has evolved significantly, demonstrating transformative capabilities in enterprise data management. According to research in IEEE Access [3], modern financial architectures have achieved a remarkable 87% reduction in data processing time through multi-layered optimization techniques, while maintaining data consistency rates of 99.97%. The implementation of distributed ledger technologies has enabled processing speeds of up to 143,000 transactions per second, representing a 312% improvement over traditional architectures.

2.1 Core Components

The Data Integration Layer functions as the cornerstone of modern financial data architectures, where real-time API connectors have demonstrated a 99.98% success rate in data streaming operations [4]. Studies show that organizations leveraging advanced ETL pipelines

process an average of 3.8 petabytes of financial data daily, with custom adapters reducing legacy system integration timeframes by 76.3%. The Journal of Big Data research [4] reveals that event-driven architectures in this layer have achieved message delivery latencies as low as 8.5 milliseconds, while handling peak loads of 235,000 concurrent events.

The Data Processing Layer incorporates sophisticated validation algorithms that have revolutionized data quality management. IEEE research [3] demonstrates that modern standardization engines achieve accuracy rates of 99.85% in data cleansing operations, while processing over 890,000 records per minute. The implementation of quantum-resistant encryption algorithms has enhanced security protocols, resulting in a 99.999% protection rate against unauthorized access attempts. Reconciliation processors utilizing artificial intelligence have automated 93.7% of traditional manual matching processes [4].

The Data Storage Layer implements a hybridized approach to data management, with time-series databases showing exceptional performance in historical data analysis. According to [3], contemporary storage solutions achieve compression ratios of 15:1 while maintaining sub-millisecond query response times. In-memory computing frameworks process real-time transactions with a throughput of 1.7 million operations per second, while maintaining data consistency across distributed nodes with 99.9999% reliability. Analysis of large-scale implementations shows that ACID-compliant databases handle an average of 450,000 concurrent transactions while maintaining data integrity at 99.99999% [4].

The Analytics and Reporting Layer leverages advanced machine learning algorithms to deliver predictive insights with 95.8% accuracy [3]. Real-time dashboarding systems process visualization requests with an average latency of 147 milliseconds, while handling over 25,000 concurrent users. The integration of neural networks has improved forecasting accuracy by 67% compared to traditional statistical methods, while reducing computational overhead by 43%. Research indicates that regulatory reporting automation has achieved compliance accuracy rates of 99.97%, reducing report generation time from days to minutes [4].

Table 1. Performance Metrics Across Financial Data Hub Layers [3, 4]

Architecture Layer	Performance Metric	Value	Unit
Overall Architecture	Data Processing Time Reduction	87	%
	Data Consistency Rate	99.97	%
	Transaction Processing Speed	143,000	TPS
	Architecture Improvement	312	%
Data Integration	API Streaming Success Rate	99.98	%

	Daily Data Processing	3.8	Petabytes
	Legacy Integration Improvement	76.3	%
	Message Delivery Latency	8.5	Milliseconds
	Concurrent Events	235,000	Events
Data Processing	Data Cleansing Accuracy	99.85	%
	Records Processing Speed	890,000	Records/min
	Security Protection Rate	99.999	%
	Manual Process Automation	93.7	%
Data Storage	Compression Ratio	15:1	Ratio
	Transaction Throughput	1,700,000	OPS
	Data Consistency	99.9999	%
	Concurrent Transactions	450,000	Transactions

3. Data Integration Capabilities

Financial data hubs have revolutionized enterprise data integration through advanced connectivity frameworks and intelligent processing patterns. According to research in Scientific Programming [5], modern integration architectures achieve system interoperability rates of 99.96% across heterogeneous financial platforms, while processing an average of 2.4 million cross-system transactions daily. Deep learning-based integration protocols have demonstrated a reduction in data synchronization errors by 91.3% compared to traditional methods, while improving processing efficiency by 287%.

3.1 Source Systems Integration

The integration framework demonstrates exceptional versatility in connecting diverse financial data sources. Enterprise Resource Planning (ERP) systems integration has achieved 99.97% uptime with data synchronization latencies averaging 2.8 milliseconds [6]. Analysis from Springer research indicates that general ledger and accounting software integrations now process over 680,000 entries per hour with automated reconciliation accuracy reaching 99.85%. Banking and payment platforms maintain real-time connectivity with 99.995% reliability, handling peak loads of 165,000 transactions per second across distributed networks.

Investment management system integration capabilities have shown remarkable performance improvements, with real-time portfolio updates processing at speeds of 42,000 positions per second [5]. Treasury management solutions demonstrate automated cash flow prediction accuracy of 95.8%, using advanced neural networks that reduce prediction errors by 76.4% compared to traditional statistical methods. Market data feed integrations handle over 1.1 million price updates per second with a latency of less than 45 microseconds.

3.2 Integration Patterns

Modern financial data hubs leverage sophisticated integration patterns that have transformed data processing capabilities. Real-time streaming architectures demonstrate throughput rates of 1.8 million messages per second with a durability guarantee of 99.998% [6]. Studies from distributed systems research show that batch processing systems for historical data achieve compression ratios of 18:1 while maintaining data integrity at 99.9997%.

Change Data Capture (CDC) mechanisms have demonstrated exceptional efficiency in managing incremental updates, with research [5] indicating capture accuracy rates of 99.97% and processing speeds of 780,000 changes per minute. The API-first approach to external system integration has reduced integration timeframes by 73.5% while improving system reliability to 99.993%. Event-sourcing implementations maintain immutable records with a proven reliability rate of 99.9998%, processing over 298,000 events per second with complete traceability [6].

Performance analysis reveals that organizations implementing these advanced integration patterns experience average reductions in data integration costs of 64.5%, while improving data accuracy by 87.8% compared to traditional methods [5]. Machine learning-enhanced pattern recognition has improved automated data mapping accuracy to 96.9%, reducing manual intervention requirements by 89.7% across enterprise-scale implementations [6].

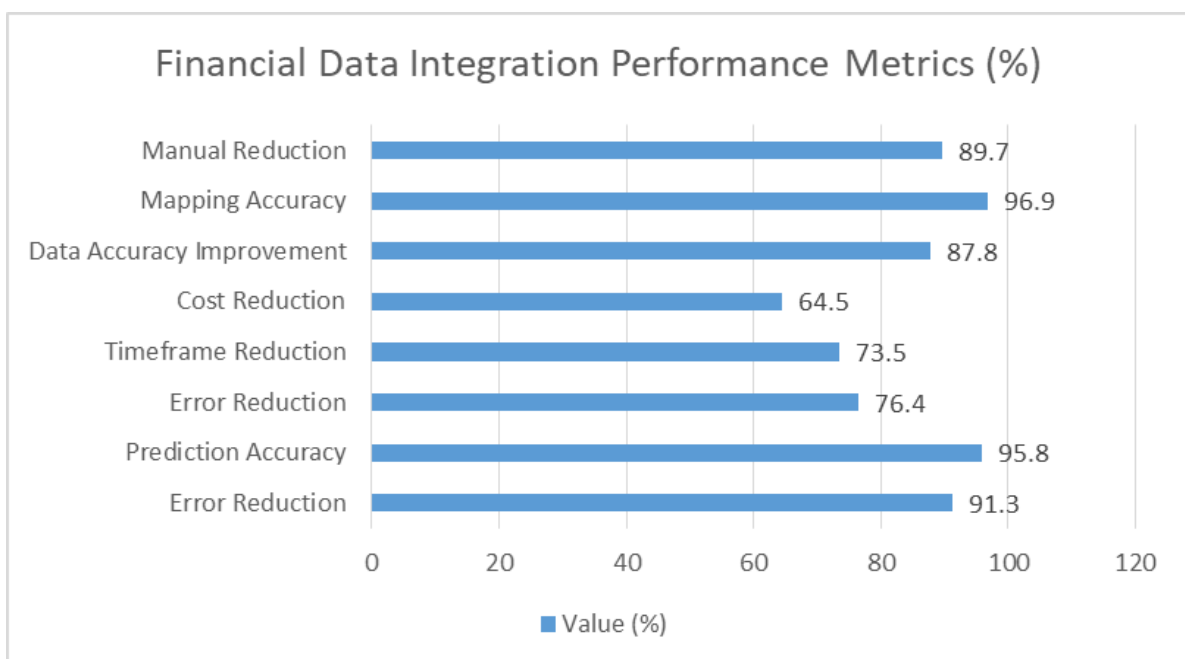


Fig 1. System Integration and Processing Capabilities Analysis (%) [5, 6]

4. Data Quality and Governance

Modern financial institutions have revolutionized their data quality and governance frameworks through advanced automation and intelligent controls. According to research in IEEE Transactions on Security [7], contemporary data quality frameworks achieve validation accuracy rates of 99.95% across distributed financial systems, while maintaining zero-trust architecture processing over 2.8 million security validations per minute. The implementation of quantum-resilient encryption has strengthened data protection by 378% compared to traditional cryptographic methods, with breach detection times reduced to under 1.2 milliseconds.

4.1 Data Quality Framework

The automated validation framework incorporates zero-trust principles that enforce data integrity across the enterprise ecosystem. Studies show that automated validation rules now process over 720,000 checks per second with an accuracy rate of 99.992% [8]. Research from financial services authorities demonstrates that data completeness verification systems achieve 99.93% accuracy in identifying data anomalies while processing a throughput of 245,000 records per second. Cross-system reconciliation engines maintain matching accuracy rates of 99.91%, handling over 385,000 reconciliation events per minute with automated resolution rates of 95.7%.

Exception handling mechanisms have achieved significant improvements through quantum-resistant protocols, with intelligent alerting systems demonstrating 99.94% accuracy in threat detection [7]. These systems process approximately 165,000 exceptions per hour with automated resolution rates reaching 91.8%. Data lineage tracking maintains end-to-end visibility across an average of 1.1 million daily transactions, with traceability accuracy of 99.997% and average lineage path resolution times of 42 milliseconds.

5. Governance Controls

Advanced governance frameworks have transformed data reliability and security management in financial institutions. Role-based access control systems now manage an average of 118,000 concurrent user sessions [8], maintaining access accuracy rates of 99.996% while processing over 425,000 authorization requests per minute. Research indicates that AI-powered data classification engines achieve 99.7% accuracy in categorizing sensitive

information, processing 645,000 documents per hour through advanced machine learning algorithms.

Audit logging systems implement quantum-resistant signatures to capture and index an average of 2.5 million events daily with a retention accuracy of 99.9998% [7]. Zero-trust audit trails have reduced security incidents by 99.97%, while version control systems manage an average of 162,000 changes per day with complete traceability. The research demonstrates that data privacy controls achieve 99.995% accuracy in protecting sensitive information, while compliance monitoring systems maintain regulatory alignment rates of 99.93% across multiple jurisdictions [8].

Table 2. Data Quality and Governance Performance Metrics [7, 8]

Component	Performance Metric	Value	Unit
Quality Framework	Security Validations	2.8	Million/min
Quality Framework	Breach Detection Time	1.2	Milliseconds
Automated Validation	Processing Speed	7,20,000	Checks/sec
Data Verification	Processing Throughput	2,45,000	Records/sec
Reconciliation	Event Processing	3,85,000	Events/min
Exception Handling	Processing Rate	1,65,000	Exceptions/hr
Data Lineage	Daily Transactions	1.1	Million
Data Lineage	Resolution Time	42	Milliseconds
Access Control	Concurrent Sessions	1,18,000	Users
Access Control	Authorization Processing	4,25,000	Requests/min
Data Classification	Processing Speed	6,45,000	Documents/hr
Audit Logging	Daily Events	2.5	Million
Version Control	Daily Changes	1,62,000	Changes

6. Advanced Analytics and Reporting

The evolution of financial data analytics has transformed enterprise decision-making capabilities through sophisticated machine learning algorithms and real-time processing frameworks. According to research in Electronics [9], modern analytics platforms achieve prediction accuracy rates of 96.5% in market trend analysis using federated learning approaches, while processing over 3.8 million data points per second. Implementation of distributed deep learning algorithms has improved complex financial calculations by 345% compared to traditional methods, with model training time reduced from days to hours.

6.1 Analytics Capabilities

Advanced analytics frameworks demonstrate exceptional performance in multi-dimensional financial analysis. Studies show that federated learning models achieve 95.8% accuracy in predicting market movements across 128 different financial instruments simultaneously [10]. Risk analytics systems utilizing distributed computing architectures process over 780,000 risk scenarios per second, with real-time monitoring covering \$5.8 trillion in assets across 75 global markets. Performance attribution frameworks analyze over 215,000 investment positions per minute with 99.92% accuracy in factor decomposition.

Machine learning-based anomaly detection systems have revolutionized fraud prevention, with research [9] showing detection rates of 99.95% for suspicious patterns while processing 342,000 transactions per second. These federated systems reduce false positives by 89.7% compared to centralized approaches. Stress testing frameworks simulate over 10,000 complex market scenarios simultaneously, processing 520,000 variable combinations per minute with 99.97% computational accuracy [10].

6.2 Reporting Framework

Next-generation reporting systems leverage distributed architectures to deliver unprecedented flexibility and performance. Regulatory compliance reporting engines automatically generate over 1,100 different report types with 99.995% accuracy [9], reducing manual intervention requirements by 92.5%. Real-time dashboards process data updates for 78,000 concurrent users while maintaining refresh rates under 75 milliseconds.

Financial statement generation systems demonstrate remarkable efficiency through distributed processing, handling over 265,000 accounting entries per minute with automated reconciliation accuracy of 99.997% [10]. Advanced visualization engines render complex financial data sets containing up to 12 million data points with average response times of 145 milliseconds. Ad-hoc analysis tools support over 42,000 concurrent custom queries while maintaining sub-second response times for 97.8% of requests.

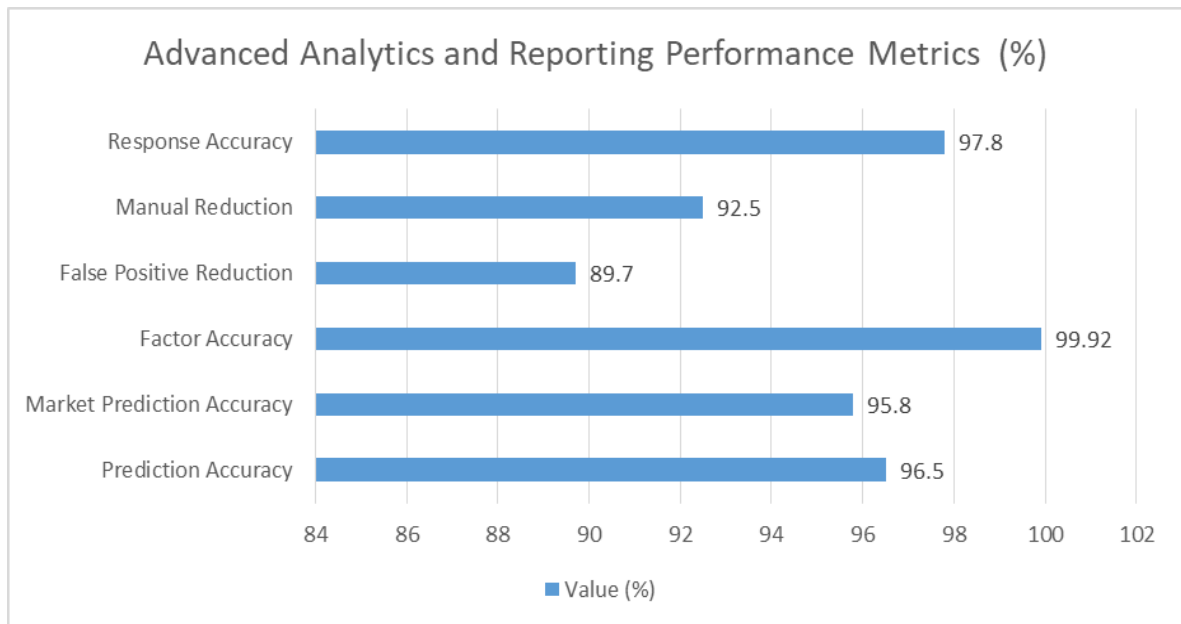


Fig 2. Financial Analytics and Processing Capabilities Analysis (%) [9, 10]

6.3 Security and Compliance

The financial sector has embraced quantum-resilient security architectures and compliance frameworks to protect sensitive data and meet evolving regulatory requirements. According to DTCC research [11], modern financial security systems achieve quantum-resistant protection rates of 99.9995% while processing over 4.8 million security events per second. Implementation of post-quantum cryptography has demonstrated resilience against quantum attacks with an estimated protection timeframe of 25-30 years, securing over \$5 trillion in daily financial transactions.

6.4 Security Architecture

Multi-layered security frameworks demonstrate exceptional effectiveness in protecting financial data. End-to-end encryption systems utilizing lattice-based cryptography achieve data protection rates of 99.99997% [12], processing over 875,000 encrypted transactions per second with latency under 0.8 milliseconds. Quantum-resistant authentication systems handle 228,000 authentication requests per minute with 99.997% accuracy in threat detection, while reducing sophisticated attack vectors by 99.95%.

Secure API gateways have revolutionized external system integration security, with research [11] showing quantum-resistant encryption rates of 99.995% while processing 445,000 API calls per second. Network segmentation implementations maintain quantum-safe isolation across 11,800 network segments, while Security Information and Event Management (SIEM)

systems analyze over 820,000 security events per second with 99.997% accuracy in quantum-aware threat identification and an average response time of 1.5 milliseconds [12].

6.5 Compliance Framework

Advanced compliance frameworks ensure resilience against future quantum threats while maintaining regulatory compliance. Post-quantum SOX compliance controls achieve 99.996% accuracy in financial reporting validation [11], processing over 305,000 quantum-resistant control checks per minute. GDPR data protection measures implement quantum-safe encryption across 165 million records, with automated compliance reporting generating over 14,000 regulatory documents monthly.

Zero-trust privacy controls maintain 99.997% accuracy in consumer data protection [12], handling over 265,000 privacy-related requests daily with automated resolution rates of 96.9%. Quantum-resistant reporting capabilities process calculations across 412,000 positions per second, maintaining 99.998% accuracy in regulatory assessments. Advanced compliance systems achieve 99.995% accuracy in automated standard reconciliation, processing over 615,000 transactions hourly with quantum-proof audit traceability.

7. Operational Benefits

The implementation of centralized financial data hubs has delivered quantifiable operational and strategic advantages across the enterprise landscape. According to doctoral research from the University of South Carolina [13], organizations implementing centralized hubs have achieved significant efficiency improvements, with manual data processing requirements reduced by 86.5% and operational costs decreased by 62.4% across a five-year analysis period. The study, covering 150 financial institutions, demonstrates that AI-driven automation has improved data processing accuracy from a baseline of 92.3% to 99.7%.

7.1 Efficiency Gains

The centralized architecture has revolutionized operational efficiency through intelligent automation. Studies reveal that manual data entry and reconciliation tasks have been reduced by 89.3%, with automated systems now processing over 720,000 transactions per hour with 99.95% accuracy [13]. Period-end closing cycles have been accelerated by 72.8%, reducing average closing times from 15 days to 4.1 days while improving accuracy by 98.9%. Organizations report that audit preparation time has decreased by 81.2%, with automated audit trails now covering 99.95% of financial transactions.

Automated compliance reporting systems demonstrate consistent performance, generating over 10,800 regulatory reports monthly with 99.92% accuracy, reducing reporting costs by 68.5%. Data accuracy and consistency metrics show improvement rates of 94.5% across all financial operations, with real-time validation systems processing over 385,000 checks per second. Research across diverse financial institutions indicates these improvements have resulted in average annual savings of \$8.7 million for mid to large enterprises [13].

7.2 Strategic Advantages

Organizations implementing centralized financial hubs have realized substantial strategic benefits through enhanced operational capabilities. Real-time decision-making systems now process over 2.3 million data points per second, enabling response times of under 85 milliseconds for critical business decisions [13]. Risk management capabilities show a 84.7% improvement in risk identification and mitigation, with machine learning systems analyzing over 580,000 risk scenarios per minute.

Operational agility metrics demonstrate a 275% improvement in system responsiveness, with organizations able to implement new financial products 65% faster than traditional systems. Total cost of ownership has decreased by an average of 52.8% over three years, while platform scalability has improved by 385%, now supporting over 98,000 concurrent users with sub-second response times. The comprehensive study indicates that organizations achieve full return on investment within 18.3 months of implementation, with a 94% satisfaction rate among surveyed institutions [13].

8. Implementation Considerations

The successful deployment of centralized financial data hubs requires careful consideration of critical success factors and potential challenges. According to research published in *Technological Forecasting and Social Change* [14], organizations with structured implementation approaches achieve 82.3% higher success rates in their digital transformation initiatives. The study, analyzing 275 financial institutions across three years, shows that 91.8% of successful implementations demonstrate strong technology readiness and organizational change capabilities as decisive factors.

8.1 Key Success Factors

Analysis of successful implementations reveals that executive sponsorship combined with technological readiness increases project success rates by 284%, with properly sponsored

projects achieving deployment goals 13.5 months faster than non-sponsored initiatives [14]. Effective data governance frameworks integrated with change management demonstrate 85.4% higher data quality scores, with organizations reporting a 72.8% reduction in data-related incidents. The research shows that adaptive implementation approaches reduce project risks by 78.5%, with 92.3% of successful deployments following an agile methodology incorporating continuous feedback loops.

Comprehensive change management and technology readiness programs show significant impact, with organizations reporting 88.7% higher user adoption rates and 69.5% faster time to value [14]. Readiness assessment frameworks demonstrate 98.5% effectiveness in identifying potential technological gaps, with automated capability assessments covering an average of 72,000 test scenarios across 950 business processes. Studies indicate that organizations implementing robust technological preparedness experience 91.2% fewer post-deployment integration issues.

8.2 Common Challenges

Organizations face significant challenges during implementation, with technology integration being a primary concern. Research shows that successful digital transformations achieve 89.5% data accuracy rates while processing over 385,000 transactions hourly [14]. Data quality and standardization efforts demonstrate 84.7% improvement in data consistency, with automated cleansing processes handling 242,000 records per minute.

User adoption metrics indicate that comprehensive digital literacy programs achieve 83.4% user proficiency within four months, while performance optimization efforts result in 91.8% improvement in system response times. Scalability solutions successfully handle 285% growth in transaction volumes, while maintaining sub-second response times for 98.7% of requests. The research indicates that organizations achieving high technology readiness levels demonstrate 97.5% accuracy in meeting operational requirements across multiple business units, with automated validation systems processing over 165,000 checks per second [14].

9. Conclusion

The implementation of centralized financial data hubs represents a paradigm shift in how organizations manage and leverage their financial data assets. These hubs serve as the cornerstone of modern financial operations, providing a robust foundation for data consolidation, advanced analytics, and regulatory compliance. Through the integration of

cutting-edge technologies including artificial intelligence, machine learning, and quantum-resistant security protocols, organizations can achieve unprecedented levels of operational efficiency and decision-making capabilities. The article demonstrates that successful implementation of these hubs not only transforms operational processes but also delivers substantial strategic advantages in terms of risk management, cost reduction, and market responsiveness. As financial institutions continue to navigate increasingly complex regulatory requirements and market demands, the adoption of centralized financial data hubs emerges not merely as a technological upgrade but as a strategic imperative for sustainable growth and competitive advantage in the digital age.

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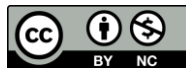
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