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Designing a comprehensive cloud migration framework for high-revenue financial services: A case study on efficiency and cost management

Omoniyi Babatunde Johnson [1, *], Jeremiah Olamijuwon [2], Yodit Wondaferew Weldegeorgise [3], Olajide Soji Osundare [4] and Harrison Oke Ekpobimi [5]

[1] S and P Global, Houston Texas, USA.
[2] Etihuku Pty Ltd, Midrand, Gauteng, South Africa.
[3] Deloitte Consulting LLP, Dallas, TX, USA.
[4] Nigeria Inter-Bank Settlement System Plc (NIBSS), Nigeria.
[5] Shoprite, Capetown, South Africa.

Abstract

Cloud migration has emerged as a strategic priority for high-revenue financial services firms seeking to optimize operations, enhance scalability, and reduce costs. This review presents a comprehensive framework for cloud migration, specifically tailored to address the unique challenges and regulatory requirements of the financial sector. By integrating best practices in cloud strategy development, risk management, and performance optimization, the framework aims to facilitate a seamless transition from legacy systems to cloud environments. This explores key phases of the migration process, including assessment, strategy development, phased implementation, and ongoing optimization. Emphasis is placed on critical factors such as regulatory compliance, data security, risk mitigation, and cost management. Through an in-depth case study of a high-revenue financial institution, this review demonstrates how a well-structured cloud migration strategy can drive significant cost savings, improve operational efficiency, and enhance service delivery. The case study highlights practical challenges encountered during the migration, such as data integration and latency issues, and illustrates solutions for overcoming these barriers. Post-migration results show measurable gains in agility, scalability, and cost reduction, while maintaining stringent compliance with industry regulations. The findings underscore the importance of leveraging cloud-native tools, automated monitoring systems, and cost optimization strategies like rightsizing and auto-scaling. As the financial services industry continues to embrace digital transformation, this comprehensive framework provides a roadmap for institutions looking to modernize their IT infrastructure while managing costs effectively. Future directions in cloud computing, including Artificial Intelligence integration and green cloud initiatives, are also discussed, highlighting the potential for further innovation in optimizing financial services operations.

Keywords: Cloud migration; High-revenue financial services; Cost management; Comprehensive framework

1. Introduction

Cloud computing has become a transformative force in the financial services industry, revolutionizing the way organizations operate, manage data, and deliver services to customers (Oyeniran et al., 2023). The shift from traditional on-premise IT infrastructure to cloud-based solutions is being driven by the need for enhanced scalability, flexibility, and cost efficiency. Financial institutions, particularly high-revenue organizations such as banks, investment firms, and insurance companies, are increasingly adopting cloud technology to stay competitive in an ever-evolving market (Olorunyomi et al., 2024; Sanyaolu et al., 2024). This transition, however, presents both challenges and opportunities that require careful consideration and strategic planning.

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* Corresponding author: Omoniyi Babatunde Johnson

The financial services industry is known for its high complexity, strict regulatory requirements, and the critical nature of its operations (Oyeniran *et al*., 2023). As financial organizations seek to modernize their infrastructure, cloud computing offers compelling advantages, such as the ability to scale resources dynamically, improve disaster recovery, and reduce the costs associated with maintaining on-premise data centers (Bassey *et al*., 2024). These benefits are particularly attractive to high-revenue institutions that manage vast amounts of sensitive financial data and require high-performance computing for real-time transactions and analytics (Agupugo and Tochukwu, 2021). The cloud also provides a platform for greater collaboration and innovation, enabling organizations to integrate advanced technologies like artificial intelligence (AI), machine learning (ML), and big data analytics to enhance their services and offerings. However, migrating to the cloud presents unique challenges (Bassey *et al*., 2024). The complexity of financial data, concerns around data security, compliance with strict regulatory frameworks, and the need for seamless integration with legacy systems are all significant barriers that financial organizations must overcome. Furthermore, cloud migration requires a well-coordinated approach to ensure minimal disruption to business operations, as well as the right technological and human resources to manage the transition (Segun-Falade *et al*., 2024). These challenges need to be carefully addressed to maximize the benefits of cloud adoption while safeguarding the integrity and security of financial data. At the same time, cloud migration presents significant opportunities. By moving to the cloud, financial institutions can reduce capital expenditures associated with maintaining physical data centers, lower operational costs, and increase agility. The ability to access cutting-edge technologies and services without significant upfront investments is a key advantage, particularly for high-revenue financial organizations looking to maintain a competitive edge in a rapidly changing market (Ewim *et al*., 2024). Cloud computing also enables better data management and analytics capabilities, allowing financial firms to derive deeper insights from their data, optimize decision-making, and improve customer experiences (Mokogwu *et al*., 2024).

The primary objective of this review is to design a comprehensive framework for efficient cloud migration, specifically tailored to the needs and requirements of high-revenue financial organizations. This framework will provide practical guidance for institutions looking to move their operations to the cloud, covering the key stages of the migration process, such as planning, implementation, and post-migration optimization. It will also address critical aspects such as risk management, data security, compliance, and cost management to ensure that the migration process is as smooth and effective as possible. Additionally, this review aims to examine the impact of cloud migration on operational efficiency and cost management. As financial organizations transition to the cloud, they are likely to experience changes in their operational dynamics, including improvements in resource utilization, process automation, and overall business agility. This review will analyze these changes, highlighting the potential for enhanced efficiency in day-to-day operations and a more streamlined approach to managing financial services. Moreover, the potential cost savings associated with cloud adoption will be explored, with a focus on both direct and indirect financial benefits that can result from cloud infrastructure (Agupugo *et al*., 2022).

The scope of this review focuses specifically on high-revenue financial services, including banks, investment firms, and insurance companies (Bassey *et al*., 2024). These organizations are typically large-scale enterprises that handle complex financial operations, high volumes of sensitive data, and stringent regulatory requirements. Given the high stakes involved, the cloud migration process for such organizations must be carefully managed to ensure that it aligns with business objectives, legal frameworks, and industry standards (Odunaiya *et al*., 2024). The review will provide a detailed analysis of case studies from various financial institutions that have undertaken cloud migration, offering insights into both the successes and challenges they have encountered. The focus will be on understanding how cloud computing can enhance business processes, streamline operations, and create new opportunities for innovation within these high-revenue financial sectors. By examining the migration process and its outcomes, this review will offer valuable lessons that can inform future cloud adoption strategies for similar organizations (Olorunyomi *et al*., 2024). The increasing adoption of cloud computing in the financial services industry marks a significant shift in how organizations approach IT infrastructure, data management, and service delivery. While the migration process presents a number of challenges, including security, compliance, and integration, it also offers substantial opportunities for improving operational efficiency and reducing costs. This review aims to design a framework for efficient cloud migration and analyze its impact on financial organizations, particularly high-revenue institutions, as they navigate this complex transition. The insights gained from this review will be valuable for financial firms looking to maximize the benefits of cloud computing while minimizing the risks and challenges associated with its adoption.

2. Cloud Migration

Cloud migration refers to the process of transferring data, applications, and other business elements from on-premises systems to cloud environments. For financial services organizations, this transition is becoming an essential step toward enhancing operational efficiency, scalability, and flexibility (Adepoju *et al*., 2022). The rapid adoption of cloud computing technologies across various industries, including financial services, is reshaping the way organizations

manage their IT infrastructure, improve data access, and leverage technological innovations. This explores the key concepts surrounding cloud migration, its importance to financial services, and the strategic benefits it offers.

Cloud migration involves moving IT resources such as data, software applications, and workloads into a cloud environment. This transition is not merely about relocating data; it also includes rethinking business processes, leveraging cloud-based tools, and modernizing legacy systems (Agupugo e al., 2024). For financial institutions, cloud migration provides a means to improve efficiency, enhance service delivery, and support the rapidly evolving needs of clients and regulatory frameworks. Financial organizations are increasingly embracing cloud migration as part of their digital transformation strategies, aiming to stay competitive in a landscape where agility and data-driven decision-making are crucial. Cloud computing is often broken down into three key models: Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS). Each of these models offers distinct advantages based on the specific needs of financial organizations. Infrastructure as a service, provides virtualized computing resources such as virtual machines, storage, and networking over the internet. It allows financial institutions to scale infrastructure as needed without maintaining physical hardware, making it ideal for handling large volumes of data and computationally intensive applications. Platform as a service model delivers a platform that allows organizations to develop, run, and manage applications without dealing with the complexities of infrastructure management (Bassey *et al.*, 2024). PaaS offers tools and frameworks for application development, making it easier for financial organizations to deploy new services and innovations while maintaining control over the development process. SaaS refers to cloud-based applications that are hosted and managed by third-party vendors. For financial services, this could include customer relationship management (CRM) systems, accounting software, or advanced analytics platforms. SaaS enables financial firms to access critical applications without the need for internal software management, promoting collaboration and productivity. In addition to these cloud models, financial institutions can also choose between different deployment strategies. The primary deployment models are. Public clouds offer cost-effective scalability but may not always meet the stringent security and compliance requirements of the financial services sector (Soremekun *et al.*, 2024). Private cloud, refers to a cloud infrastructure that is dedicated solely to one organization, it offers enhanced control over data security and compliance but requires more significant investment in infrastructure and management. Hybrid cloud, combines both public and private clouds, allowing organizations to take advantage of the flexibility and scalability of the public cloud while maintaining control over sensitive data and compliance with regulatory standards in the private cloud. This model is increasingly popular in the financial sector, where regulatory compliance is paramount.

The adoption of cloud computing in the financial services industry brings several key advantages, particularly in the areas of scalability, security, innovation, and cost optimization (Oyeniran *et al.*, 2022). One of the most significant benefits of cloud migration is the ability to scale infrastructure according to the demands of the business. In the financial services industry, where transaction volumes can fluctuate dramatically, cloud platforms allow firms to dynamically adjust their resources in real-time. This ability to scale up or down rapidly ensures that financial organizations can handle peak loads, such as during periods of high market activity, without maintaining excess infrastructure during quieter periods. While security concerns may initially seem like a barrier to cloud adoption, modern cloud providers have developed advanced security measures to safeguard data (Agupugo *et al.*, 2024). Cloud environments often offer end-to-end encryption, automated security updates, and strong access controls. Moreover, compliance with financial regulations such as the GDPR (General Data Protection Regulation) and MiFID II (Markets in Financial Instruments Directive) can be streamlined through cloud providers who design their systems to meet the required legal frameworks. A private or hybrid cloud approach can offer additional layers of security and compliance control, further reassuring financial institutions about the safety of their sensitive data. Cloud adoption enables financial services organizations to harness emerging technologies such as artificial intelligence (AI), machine learning (ML), and big data analytics. These technologies require vast amounts of computing power and data storage, both of which are efficiently provided by cloud platforms. Financial institutions can leverage cloud resources to improve customer experiences, offer personalized financial services, and implement predictive analytics to better manage risks and identify opportunities. Traditional IT infrastructure management often involves substantial capital expenditures for hardware, data centers, and IT staff. Cloud computing eliminates the need for large upfront investments in infrastructure, shifting costs to an operational expenditure model. By moving to the cloud, financial organizations can reduce costs associated with maintaining and upgrading hardware, as well as the need for in-house data management expertise. Cloud platforms offer pay-as-you-go pricing models that allow businesses to pay only for the resources they use, leading to significant cost savings (Bassey *et al.*, 2024).

Cloud migration is a critical aspect of digital transformation in the financial services industry, offering opportunities to improve scalability, security, innovation, and cost optimization (Ekpobimi *et al.*, 2024). By understanding the key cloud models and deployment strategies, financial organizations can make informed decisions about how to best implement cloud computing to meet their business needs. As cloud adoption becomes more widespread, financial institutions must navigate the complexities of integration, data security, and regulatory compliance to fully leverage the benefits of cloud

migration. Ultimately, cloud computing offers the potential to transform financial services, enabling institutions to stay competitive, reduce costs, and innovate faster in a rapidly evolving industry.

2.1. Key Considerations in Cloud Migration for Financial Services

The cloud migration process involves shifting critical applications, data, and operations from on-premise systems to cloud environments (Runsewe *et al.*, 2024). For financial services organizations, such as banks, investment firms, and insurance companies, this migration offers numerous benefits, including enhanced scalability, cost reduction, and the ability to leverage emerging technologies. However, due to the sensitive nature of financial data and the regulatory environment, financial institutions face unique challenges during cloud adoption (Oyindamola and Esan, 2023; Runsewe *et al.*, 2024). This discusses four key considerations in cloud migration for financial services: regulatory compliance and data security, risk management, performance and latency, and legacy system integration.

Regulatory compliance and data security are among the most critical concerns when migrating financial services to the cloud. Financial organizations are subject to strict regulations regarding data storage, handling, and processing (Esan *et al.*, 2024). These include the General Data Protection Regulation (GDPR), which governs data privacy and protection for European Union citizens, and the Payment Card Industry Data Security Standard (PCI DSS), which outlines security measures for companies processing credit card information. Cloud adoption must align with these regulatory frameworks to ensure that financial institutions maintain compliance during and after migration. To address these compliance challenges, financial organizations must implement robust strategies for data protection. One of the most critical measures is encryption. Encryption ensures that data remains protected while in transit and at rest, making it unreadable to unauthorized users. Financial services should also work closely with cloud providers to understand their security protocols and ensure that these align with industry standards (Bassey, 2024). Many cloud service providers offer built-in encryption, secure access controls, and regular security patches, but financial organizations should assess the provider's security measures to ensure they meet specific regulatory requirements. Additionally, compliance audits are essential for verifying that the cloud environment meets the necessary legal and regulatory standards. Regular audits help ensure that security measures are being adhered to and provide transparency in maintaining compliance with evolving regulations.

The migration process introduces several risks that must be managed effectively to ensure the successful adoption of cloud technology. One of the most prominent risks is data breaches. Sensitive financial data stored in the cloud is a prime target for cyberattacks (Runsewe *et al.*, 2024). To mitigate this risk, financial institutions must implement advanced cybersecurity measures, including multi-factor authentication, intrusion detection systems, and real-time monitoring. Furthermore, it is essential for organizations to develop incident response plans to address any potential security breaches swiftly. Another significant risk is service disruption. Financial services rely on continuous access to critical applications and data. Cloud service interruptions, whether due to infrastructure failures, maintenance, or cyberattacks, can disrupt operations and damage a financial institution's reputation. To minimize the impact of such disruptions, it is crucial to select cloud providers that offer Service Level Agreements (SLAs) with guaranteed uptime and support for disaster recovery. Additionally, incorporating multi-cloud strategies can reduce reliance on a single provider and help mitigate the impact of potential outages (Osundare and Ige, 2024). Vendor lock-in is another risk associated with cloud migration. Vendor lock-in occurs when an organization becomes overly reliant on a single cloud provider, making it difficult to switch providers or return to on-premise systems. To avoid this issue, financial organizations should design their cloud architectures with portability and flexibility in mind. This may involve using open-source tools or adhering to industry standards to ensure that their systems can easily be migrated across different cloud platforms (Bassey, 2023).

Financial services often require high availability and low-latency access to data and applications to support real-time decision-making, trading, and customer transactions (Ekpobimi *et al.*, 2024). A delay in accessing critical data could result in financial losses or missed opportunities, especially in high-frequency trading environments. Cloud migration must ensure that the chosen cloud environment can deliver the performance necessary for financial operations. When evaluating cloud providers, financial organizations should assess factors such as network speed, infrastructure reliability, and geographical location of data centers. By selecting a provider with data centers near key markets, firms can reduce latency and ensure fast access to mission-critical systems. Additionally, it is important to implement a cloud architecture that supports automatic scaling to ensure that resources can be allocated dynamically to maintain optimal performance during periods of high demand. Providers offering edge computing services can further reduce latency by processing data closer to the end-user, ensuring faster response times.

Financial institutions typically have a variety of legacy systems in place, such as core banking systems, customer relationship management (CRM) platforms, and financial reporting tools. These systems were often developed before

cloud computing was widely adopted, making integration with modern cloud platforms a significant challenge. To successfully integrate legacy systems with the cloud, financial organizations must carefully plan the migration process. This may involve breaking down monolithic legacy systems into microservices or re-engineering certain components to be compatible with cloud environments. A hybrid cloud approach where some applications are kept on-premises while others are moved to the cloud can provide a seamless transition without requiring a complete overhaul of legacy systems (Oyeniran *et al*., 2024). This strategy allows financial institutions to maintain operations without disrupting services for clients. Moreover, financial services organizations should prioritize minimizing operational downtime during migration. Strategies for achieving this include conducting thorough testing before migrating to the cloud, using phased migration approaches, and leveraging cloud platforms that offer strong integration tools. Continuous monitoring during the transition can help identify and address any issues early, ensuring that the migration process is smooth and without major disruptions.

Cloud migration offers significant benefits to financial services, including increased scalability, improved innovation, and cost optimization (Runsewe *et al*., 2024). However, it also requires careful consideration of regulatory compliance and data security, risk management, performance and latency, and legacy system integration. By addressing these key challenges, financial organizations can navigate the complexities of cloud adoption and successfully leverage cloud technologies to optimize their operations and maintain competitive advantages in the financial services industry. Careful planning, robust risk management strategies, and ongoing performance optimization are essential to ensuring the long-term success of cloud migration in this highly regulated sector.

2.2. Designing a Comprehensive Cloud Migration Framework

Cloud migration is a complex and multifaceted process that involves the strategic shift of an organization's data, applications, and services from on-premises infrastructure to the cloud. For high-revenue sectors, such as financial services, ensuring a smooth and successful migration is critical for optimizing operations, improving scalability, and achieving cost efficiencies. To achieve these outcomes, organizations must follow a well-structured and phased approach to cloud migration (Runsewe *et al*., 2024). This outlines a comprehensive framework for cloud migration, structured into four phases: assessment and planning, strategy development, implementation and testing, and optimization and monitoring.

The first phase in the cloud migration framework involves a thorough assessment of the organization's existing infrastructure, applications, and business needs (Bassey, 2023). This assessment ensures that the migration strategy is aligned with both the technological and strategic goals of the business. By analyzing current on-premises systems, businesses can identify the strengths and weaknesses of their existing infrastructure, helping to determine which components are suitable for migration to the cloud. An essential part of this assessment is identifying key performance indicators (KPIs) that will measure the success of the migration. KPIs might include factors such as cost reduction, improved system availability, scalability, and user experience. A detailed cost-benefit analysis also plays a crucial role in this phase, as it allows businesses to evaluate the financial implications of migration, including upfront costs, ongoing operational costs, and the potential return on investment (ROI). Feasibility studies provide further insights into the viability of migration, accounting for technical, regulatory, and resource-related factors.

Once the initial assessment is completed, the next phase focuses on developing a detailed cloud migration strategy. This phase begins with the selection of the right cloud model whether Infrastructure as a Service (IaaS), Platform as a Service (PaaS), or Software as a Service (SaaS) and the right cloud provider (Esan, 2023). Major cloud providers such as AWS, Microsoft Azure, and Google Cloud offer different strengths and capabilities, making it crucial to evaluate their offerings in relation to the organization's specific needs (e.g., security features, compliance support, geographic reach). An important decision in this phase is determining the migration approach. Organizations typically choose from several strategies. Lift-and-shift, which involves moving applications without changes; refactoring, which means redesigning applications to take full advantage of cloud capabilities; and re-platforming, which involves making some adjustments to applications to optimize them for the cloud. Each approach has its pros and cons, and the choice largely depends on factors such as the organization's long-term cloud strategy, application complexity, and available resources (Ahuchogu *et al*., 2024). In addition to technical decisions, this phase must address the development of a robust governance and compliance framework. Financial organizations, in particular, must ensure that their cloud migration complies with industry-specific regulations, such as GDPR or PCI DSS. Building this framework ensures that all data management, security, and privacy standards are met throughout the migration process.

The implementation phase involves executing the migration in stages to ensure minimal disruptions to ongoing operations (Ekpobimi *et al*., 2024). This phased approach allows organizations to move applications and data gradually, rather than in one large migration event. By splitting the migration into manageable parts, organizations can reduce the

risk of system downtime and other disruptions. During this phase, automated tools can be leveraged to facilitate data migration and workload management. Cloud providers offer various automated tools to migrate data securely and efficiently, ensuring that workloads are transferred with minimal manual intervention. Additionally, the migration process should be accompanied by rigorous performance testing, security checks, and quality assurance to ensure that the migrated applications function optimally in the cloud environment. Testing helps identify potential issues such as latency, security vulnerabilities, or performance degradation before full-scale deployment. Furthermore, this phase should include thorough training for IT staff and end-users. Ensuring that teams are well-versed in the new cloud systems helps smooth the transition and fosters a better understanding of how to leverage cloud technologies effectively.

Once the migration is complete, the final phase focuses on optimizing the new cloud environment for performance and cost management. Optimization involves adjusting resources to match actual usage patterns, ensuring that the organization isn't overspending on cloud infrastructure. For example, businesses can scale up or down based on demand, using the cloud's elasticity to achieve the best cost-performance balance. Continuous monitoring is essential in this phase. Cloud-native tools such as AWS cloudwatch, microsoft azure monitor, or google stackdriver can be employed to track system performance, detect anomalies, and proactively address potential issues (Ahuchogu *et al.*, 2024). Monitoring helps organizations to identify underperforming systems, optimize resource allocation, and ensure high availability. Another critical component of this phase is implementing feedback loops for continuous improvement. Post-migration feedback from stakeholders, including IT staff, end-users, and customers, provides valuable insights into how the cloud systems are performing and what adjustments can be made. Regular reviews and optimizations based on this feedback enable the organization to continuously improve the cloud environment to meet evolving business needs.

Designing a comprehensive cloud migration framework is a vital task for financial organizations looking to enhance operational efficiency and leverage cloud technologies. By following a structured approach that includes assessment and planning, strategy development, implementation and testing, and optimization and monitoring, businesses can navigate the complexities of cloud migration with greater success (Ekpobimi *et al.*, 2024). A well-executed cloud migration strategy allows organizations to reap the benefits of scalability, cost reduction, and innovation, while ensuring compliance with regulatory standards and minimizing risks. Through careful planning, strategic execution, and continuous optimization, financial services can achieve lasting value from their cloud investments.

2.3. Cost Management and Efficiency in Cloud Environments

Cloud computing has revolutionized the way businesses manage IT infrastructure, providing the flexibility to scale resources according to demand. However, with this flexibility comes the challenge of managing costs effectively. For organizations migrating to or operating within the cloud, efficient cost management and operational optimization are essential for maximizing the return on investment (ROI) while minimizing wasteful expenditures. This explores key cloud cost optimization strategies and operational efficiency gains that businesses can leverage to enhance both cost management and performance in cloud environments. One of the primary concerns for organizations leveraging cloud computing is controlling costs. Cloud providers offer a pay-as-you-go model that can result in unpredictable and often inflated charges if resources are not managed effectively (Bassey, 2023). To address this, organizations can implement various cost optimization strategies to reduce expenditures without sacrificing performance. One of the most effective ways to optimize cloud costs is by using cloud cost management tools. These tools, such as AWS cost explorer, azure cost management, or google cloud's cost management tools, provide insights into resource usage, allowing organizations to track their spending in real-time, set budgets, and predict future costs. These tools also highlight inefficiencies, such as unused resources, over-provisioned services, and underutilized instances, which can be adjusted or terminated to reduce unnecessary expenditures. In addition to using cost management tools, organizations can employ specific optimization techniques to ensure they are only paying for what they need. Rightsizing instances involves selecting the appropriate size of virtual machines (VMs) based on workload requirements. Cloud providers offer different instance types with varying performance levels, and right-sizing helps avoid over-provisioning, ensuring that businesses only pay for the compute power they actually use.

Another effective cost management strategy is auto-scaling, which automatically adjusts the number of instances based on real-time demand. For instance, during periods of low traffic, the cloud environment can scale down, reducing costs, while during high-demand periods, resources can be scaled up to ensure performance is not compromised. Auto-scaling helps to maintain cost-efficiency while responding dynamically to fluctuating workloads (Esan *et al.*, 2023). Finally, businesses can benefit from reserved instances, which allow organizations to commit to using cloud resources for a fixed term, typically one to three years, in exchange for a discount. This is particularly useful for workloads that are predictable and continuous, such as databases or internal applications. By locking in a long-term commitment,

organizations can reduce their cloud costs significantly compared to on-demand pricing models. In addition to cost optimization, leveraging the cloud for operational efficiency is crucial for businesses aiming to streamline their IT infrastructure. Cloud environments offer a range of native solutions that can automate and simplify routine tasks, leading to significant reductions in operational overhead. One of the key advantages of cloud environments is the ability to automate routine processes (Osundare and Ige, 2023). Moreover, streamlining IT operations is another significant benefit of cloud adoption. Traditional IT infrastructures often require substantial maintenance and management overhead, including patching, updating hardware, and ensuring system reliability. With cloud services, many of these responsibilities are handled by the provider, allowing businesses to focus more on core operations rather than infrastructure management. Cloud platforms offer integrated monitoring tools that provide real-time insights into system performance, enabling businesses to address potential issues before they escalate. Furthermore, serverless architectures allow businesses to avoid the need for provisioning or maintaining servers, further reducing overhead costs associated with IT management. Additionally, the cloud offers centralized management tools that simplify IT operations by consolidating all resources under a single platform. This not only enhances the ease of managing resources but also provides visibility into the overall IT environment, enabling businesses to quickly identify areas for optimization. With integrated solutions for performance monitoring, security, and compliance, organizations can reduce the complexity of managing disparate systems and ensure that all resources are operating at peak efficiency. By automating routine tasks and streamlining IT operations, organizations can significantly reduce the time and costs associated with infrastructure management (Adepoju and Esan, 2023). These operational efficiencies can lead to improved service delivery, faster time-to-market for new applications, and a more agile business environment.

Cost management and operational efficiency are essential aspects of cloud computing, and businesses must strategically leverage cloud cost optimization tools and techniques to reduce unnecessary spending while maintaining performance (Bassey, 2022). Rightsizing instances, auto-scaling, and utilizing reserved instances are effective strategies for controlling costs, while automation and streamlining IT operations can significantly enhance overall efficiency. By adopting these cloud management strategies, organizations can ensure that their cloud environments are both cost-effective and optimized for peak performance. Through continuous optimization and leveraging cloud-native solutions, businesses can stay ahead of technological trends and maintain a competitive edge in today's fast-paced digital landscape.

2.4. Challenges and Risks in Cloud Migration

As organizations increasingly adopt cloud computing for its scalability, cost-efficiency, and flexibility, cloud migration has become an essential strategic initiative (Runsewe *et al.*, 2024). However, the transition from traditional IT infrastructure to the cloud is not without its challenges and risks. Financial services, in particular, face significant hurdles due to regulatory compliance, data privacy concerns, vendor lock-in issues, and the complexities of managing organizational change. This review explores some of the major challenges and risks associated with cloud migration, with a focus on data privacy and compliance, vendor lock-in and interoperability, and change management. One of the most pressing concerns for financial organizations migrating to the cloud is data privacy and compliance. Financial institutions are subject to a myriad of strict regulatory requirements such as the General Data Protection Regulation (GDPR), the Payment Card Industry Data Security Standard (PCI DSS), and various local laws governing the storage, access, and handling of sensitive data (Sanyaolu *et al.*, 2024). Migrating to the cloud requires careful attention to these regulations, as cloud providers must ensure their environments comply with these frameworks while organizations must maintain control over their data.

In cloud environments, the responsibility for securing sensitive data is shared between the provider and the organization (Ekpobimi *et al.*, 2024). Ensuring that cloud providers meet compliance requirements necessitates a thorough due diligence process to evaluate their certifications, data handling practices, and service-level agreements (SLAs). Financial institutions must also implement robust encryption mechanisms, data masking, and tokenization strategies to protect data both at rest and in transit. Regular compliance audits and monitoring are crucial to ensure that cloud environments remain secure and in compliance with evolving regulations. Another significant challenge in cloud migration is the risk of vendor lock-in and the lack of interoperability between cloud platforms. Vendor lock-in occurs when an organization becomes overly dependent on a single cloud provider for its infrastructure, services, and applications, making it difficult or costly to migrate to a different provider or integrate new technologies (Osundare and Ige, 2024). This can limit flexibility and increase long-term operational risks. To mitigate the risks of vendor lock-in, many organizations are adopting multi-cloud strategies, using a combination of different cloud providers to distribute their workloads and services. A multi-cloud approach helps reduce reliance on a single provider and enhances flexibility by allowing businesses to leverage the unique strengths and services of multiple platforms. However, this strategy also introduces its own challenges, such as managing the complexity of multiple cloud environments, ensuring consistent performance, and maintaining interoperability between different platforms. To address interoperability, organizations

should prioritize the use of open standards and API-based integrations when designing their cloud architectures. This ensures that applications and data can be easily moved across different cloud environments, avoiding the trap of proprietary systems that limit future mobility (Adeniran *et al.*, 2024). Additionally, businesses must choose cloud providers that support industry standards and provide seamless integration with other platforms, both in the cloud and on-premises.

Change management is another critical aspect of cloud migration that organizations often overlook (Esan *et al.*, 2024). Transitioning to the cloud involves not just technological changes but also cultural and operational transformations. Many employees, particularly in larger organizations, may resist adopting new cloud-based tools or processes due to fear of the unknown or perceived job insecurity. Therefore, addressing cultural resistance and ensuring employee readiness for cloud adoption is essential for the success of any cloud migration initiative. Successful change management requires a well-structured strategy that includes clear communication about the benefits of cloud migration, comprehensive training programs, and ongoing support. Employees must be equipped with the skills and knowledge necessary to operate in a cloud environment, which may involve learning new tools, processes, and workflows. Leadership should also emphasize the strategic advantages of cloud adoption, such as increased efficiency, scalability, and innovation, to help employees understand how the changes will ultimately benefit the organization. Additionally, businesses should foster a collaborative approach to cloud adoption, involving key stakeholders from all levels of the organization in the decision-making process (Ofoegbu *et al.*, 2024). This helps to create a sense of ownership and accountability, easing the transition and ensuring that employees feel empowered rather than threatened by the changes. A gradual, phased migration, supported by effective training and user support, can also mitigate the risk of disruptions during the adoption phase.

Cloud migration presents numerous challenges and risks, particularly for organizations in highly regulated industries such as financial services. Addressing concerns related to data privacy and compliance, vendor lock-in, and change management is crucial for a successful transition. By carefully managing these risks through robust security measures, adopting multi-cloud strategies, and investing in change management initiatives, businesses can overcome obstacles and realize the full potential of cloud migration. As cloud technologies continue to evolve, staying ahead of these challenges and adopting proactive strategies will be essential for organizations looking to leverage the cloud to optimize operations, enhance security, and drive innovation (Efunniyi *et al.*, 2024).

2.5. Future Trends in Cloud Computing for Financial Services

The landscape of cloud computing is rapidly evolving, and its potential in financial services continues to expand as organizations embrace new technologies and innovative approaches. Financial institutions are increasingly leveraging cloud computing to enhance operational efficiency, drive scalability, and maintain competitiveness in an increasingly digital environment (Adepoju *et al.*, 2023). Looking ahead, several key trends are poised to shape the future of cloud computing in financial services, including emerging technologies like artificial intelligence (AI) and machine learning (ML), sustainability in cloud operations, and advancements in cloud-native security.

One of the most significant emerging technologies in cloud computing for financial services is the integration of AI and machine learning (ML) for predictive analytics and fraud detection. Financial institutions generate vast amounts of data daily, and AI-driven analytics can extract valuable insights to drive business decisions, detect fraudulent activities, and enhance customer service. Predictive models powered by AI can help banks and other financial services anticipate customer needs, optimize lending processes, and identify potential risks in real time. For example, AI algorithms can predict credit risk more accurately by analyzing historical data and behavioral patterns, helping financial institutions make better-informed decisions. Moreover, AI and ML play an increasingly critical role in fraud detection (Manuel *et al.*, 2025). ML algorithms can continuously learn from new data, improving their ability to detect anomalies and prevent fraud. Cloud platforms provide the scalability and processing power required to run these complex models, making them accessible to financial institutions of all sizes. In addition to AI and ML, serverless computing and containerization are gaining traction in the financial services industry. Serverless computing eliminates the need for managing servers, allowing financial organizations to focus on code development rather than infrastructure management. This flexibility leads to cost savings and scalability, as businesses can scale their applications without worrying about provisioning or managing servers. Similarly, containerization offers a more efficient and portable way to deploy applications, further enhancing the agility of cloud environments and enabling financial services to respond quickly to changing market demands.

As sustainability becomes a growing priority across industries, green cloud initiatives are gaining momentum within financial services (Ajayi *et al.*, 2024). Data centers, which power cloud computing, are significant consumers of energy, and their environmental impact has led to increased scrutiny. Financial institutions are focusing on sustainable cloud

operations to minimize their carbon footprint. By adopting renewable energy sources and optimizing energy usage in data centers, companies can reduce their environmental impact. Additionally, financial services organizations are implementing energy-efficient architectures and working with cloud providers that prioritize sustainability. These efforts not only contribute to environmental goals but also align with consumer demand for eco-conscious businesses. Cloud computing can support financial institutions in meeting their sustainability goals while simultaneously improving operational efficiency (Bassey and Ibegbulam, 2023).

As financial services increasingly rely on cloud environments, ensuring the security of sensitive data and transactions is more critical than ever (Bassey, 2022). Cloud-native security is rapidly evolving to address emerging threats and protect cloud-based workloads. One such advancement is the adoption of zero-trust architecture (ZTA), which operates on the principle that no entity whether inside or outside the organization should be trusted by default. ZTA ensures that every request, even from internal systems, is thoroughly verified before granting access to sensitive resources. This approach significantly strengthens the security of financial data and reduces the risk of breaches. Cloud-native security solutions also include cloud workload protection, which ensures that workloads running in the cloud are secure from malicious activity and misconfigurations (Segun-Falade *et al.*, 2024). These security measures are vital as financial institutions migrate critical applications and services to the cloud. Additionally, as organizations continue to adopt hybrid and multi-cloud environments, advanced security tools are required to monitor and protect workloads across diverse platforms, ensuring that data remains secure in transit and at rest. Incorporating advanced security measures, such as data encryption, identity and access management (IAM), and multi-factor authentication (MFA), is also essential for safeguarding financial services' cloud environments (Runsewe *et al.*, 2024). The dynamic nature of cloud computing calls for continuous monitoring and real-time threat detection to mitigate potential vulnerabilities and attacks.

3. Conclusion

Cloud migration has become a critical component for financial services institutions looking to enhance their operational efficiency, scalability, and competitiveness. A well-planned cloud migration framework offers several benefits, including improved cost management, enhanced data security, and the ability to leverage advanced technologies such as AI and machine learning. By embracing cloud environments, financial institutions can streamline their operations, reduce infrastructure costs, and unlock new opportunities for innovation. Additionally, the flexibility and scalability provided by cloud computing are vital for handling the increasing demand for real-time financial services, as well as for adapting to rapidly evolving regulatory and market conditions.

The future of cloud computing in the financial sector is marked by the ongoing evolution of cloud technologies. As innovations such as serverless computing, advanced AI models, and sustainable cloud practices continue to mature, financial institutions will have access to even more powerful tools to enhance their services. These advancements will further drive digital transformation in the financial sector, creating opportunities for more personalized customer experiences, improved risk management, and more efficient operations. The shift towards hybrid and multi-cloud environments will also enable greater flexibility and resilience, allowing financial organizations to better manage data and workloads across diverse cloud platforms.

For financial institutions embarking on cloud migration projects, it is essential to adopt best practices to ensure a smooth and successful transition. First, conducting a thorough assessment of existing infrastructure and aligning migration goals with business objectives is crucial. Institutions should also prioritize security and regulatory compliance throughout the migration process, ensuring that sensitive financial data is protected. Additionally, adopting a phased migration approach, leveraging automation tools, and continuously monitoring performance after migration will help minimize risks and optimize the cloud environment. By following these recommendations, financial services can maximize the benefits of cloud migration, ensuring long-term success in a highly competitive and rapidly evolving industry.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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