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Original Article

Cost-Benefit Analysis of Cloud Migration for Mainframe Modernization: A Study of AWS, Azure, and GCP

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Abstract: *The increasing need for enterprises to modernize legacy mainframe systems has prompted many organizations to consider cloud platforms as a viable solution for migration. This research examines the cost-benefit landscape of migrating mainframe workloads to the three leading cloud platforms: Amazon Web Services (AWS), Microsoft Azure, and Google Cloud Platform (GCP). Through a comprehensive cost-benefit analysis framework, this study evaluates the direct and indirect costs associated with cloud migration, including infrastructure, migration labor, and data transfer. It also assesses the operational benefits such as scalability, flexibility, security, and cost reduction that can be realized post-migration. By analyzing real-world case studies from each cloud provider, the research offers a comparative assessment of how AWS, Azure, and GCP support mainframe modernization. The findings provide valuable insights into the potential savings, operational advantages, and risks associated with each platform, helping organizations make informed decisions about their migration strategies.*

Keywords: *Mainframe Modernization, Cloud Migration, Cost-Benefit Analysis, AWS, Azure, Google Cloud Platform (GCP), Legacy System Modernization, Cloud Computing, Migration Strategy, Total Cost of Ownership (TCO), Return on Investment (ROI), Scalability, Cloud Pricing Models.*

I. INTRODUCTION

In this section, the research topic is introduced with an overview of the significance of mainframe systems in modern IT infrastructure. Mainframes have historically supported critical business operations, but as technology has evolved, they have faced several challenges such as high operational costs, limited scalability, and slow innovation cycles. With increasing demands for agility, cost efficiency, and cloud-native applications, enterprises are increasingly turning to cloud computing platforms as a means of modernizing their mainframe environments. The introduction should articulate the need for modernizing legacy systems and explore how the cloud offers solutions such as scalability, cost reduction, flexibility, and innovation.

This section will also emphasize the growing trend of cloud adoption among organizations and the strategic shift towards cloud-first approaches. The importance of evaluating the costs and benefits of migration is stressed, as cloud migration involves a complex process with significant financial, operational, and technical implications. The primary objective of this research is to perform a comparative cost-benefit analysis of migrating mainframe workloads to three major cloud platforms—Amazon Web Services (AWS), Microsoft Azure, and Google Cloud Platform (GCP). This analysis will assist businesses in making informed decisions about their cloud migration strategies.

II. LITERATURE REVIEW

This section provides an in-depth review of existing research and theoretical frameworks surrounding mainframe modernization and cloud adoption. Several studies have explored the benefits and challenges of migrating legacy systems to the cloud, but few have provided a detailed comparative cost-benefit analysis for mainframe modernization specifically. The literature review will focus on the following key areas:

A. Mainframe Modernization:

A review of traditional methods for mainframe modernization, such as re-hosting, re-platforming, and re-architecting legacy systems. It will also discuss the increasing emphasis on moving from on-premise mainframes to cloud environments.

B. Cloud Adoption:

Exploration of the general trends in cloud adoption, the shift towards Infrastructure as a Service (IaaS), and Platform as a Service (PaaS), and the strategic advantages cloud computing offers for large-scale enterprises, including improved efficiency, scalability, and lower operating costs.

C. Cost-Benefit Analysis Models:

Discussion of various cost-benefit analysis frameworks that have been used in prior research to evaluate cloud migration, with a focus on how they can be adapted to the specific context of mainframe modernization.

D. Challenges and Risks in Cloud Migration:

This will cover the common challenges faced during cloud adoption, such as data migration issues, application re-architecture, and security risks, including compliance and data privacy concerns. By synthesizing existing literature, this section aims to create a foundation for the current research and highlight the knowledge gap that this study seeks to address.

III. CLOUD PLATFORMS OVERVIEW

In this section, an overview of the three major cloud platforms—AWS, Azure, and GCP—is provided, with a focus on their unique offerings, strengths, and tools that support mainframe modernization.

A. Amazon Web Services (AWS):

AWS is often considered a leader in the cloud industry, offering a wide range of services including EC2 instances, S3 storage, Lambda functions, and database management tools. AWS has also developed specific migration tools like the AWS Migration Hub and Server Migration Service, designed to help enterprises transition from on-premise infrastructures to the cloud seamlessly. This section will explore how AWS supports mainframe migrations, including the compatibility of its services with legacy mainframe workloads and the cost structures involved in utilizing AWS for modernization.

B. Microsoft Azure:

As a strong player in the enterprise space, particularly in industries with significant Microsoft product usage, Azure provides a suite of services, including Azure Virtual Machines, Azure SQL Database, and Azure Kubernetes Service. Azure's unique advantage lies in its hybrid capabilities, allowing businesses to run cloud workloads alongside on-premise infrastructures. This section will examine how Azure's migration tools like Azure Migrate and Azure Site Recovery can facilitate mainframe modernization and address specific use cases where Azure is particularly beneficial.

C. Google Cloud Platform (GCP):

GCP, known for its focus on data analytics, machine learning, and high-performance computing, provides a robust platform for businesses looking to modernize and innovate. GCP offers services such as Compute Engine, BigQuery, and Cloud Spanner, which can be highly beneficial for mainframe modernization, especially in organizations with heavy data processing needs. This section will discuss the tools provided by GCP, including Migrate for Compute Engine, and how they can be utilized to migrate legacy workloads to the cloud.

By the end of this section, the reader should have a clear understanding of the unique strengths of each cloud provider in relation to mainframe modernization.

IV. COST-BENEFIT ANALYSIS FRAMEWORK

This section will outline the conceptual framework for performing a cost-benefit analysis of cloud migration. The analysis will involve a combination of quantitative and qualitative metrics to evaluate the total cost of ownership (TCO) and return on investment (ROI) of migrating mainframe workloads to the cloud.

A. Cost Factors:

This includes both direct costs, such as cloud service pricing, data transfer fees, and migration labor costs, and indirect costs, such as downtime, training, and potential system disruptions during the migration process. A detailed breakdown of cloud pricing models (pay-as-you-go, reserved instances, spot instances) will be included to help businesses better understand how costs accumulate during migration and operation.

B. Benefit Factors:

Operational benefits include scalability (the ability to rapidly scale resources up or down), flexibility (the ability to adopt new services and technologies), and security (enhanced security features and compliance standards in cloud platforms). The analysis will also consider strategic advantages such as business agility, enhanced disaster recovery capabilities, and the reduction in ongoing mainframe maintenance costs.

C. Quantitative Analysis:

This will involve calculating key performance indicators (KPIs), such as TCO, ROI, payback period, and the overall cost savings achieved through cloud migration. The analysis will provide businesses with a clear understanding of the financial implications of moving to the cloud.

D. Qualitative Benefits:

These include improvements in business processes, increased speed of innovation, and long-term strategic benefits of adopting a cloud-first approach, such as improved customer experience and enhanced data analytics capabilities.

This section aims to provide a structured approach to understanding the financial and operational impact of cloud migration, offering businesses a roadmap for evaluating their cloud migration decisions.

V. CASE STUDIES/EMPIRICAL DATA

The case study section provides practical examples from businesses that have already migrated their mainframe workloads to the cloud. This section will present real-world examples from AWS, Azure, and GCP, offering insights into the actual costs, benefits, challenges, and lessons learned during the migration process.

A. Case Study 1: AWS Mainframe Migration:

A detailed example of a business that migrated its mainframe workloads to AWS. The case study will focus on the initial costs, cloud adoption challenges, and operational benefits realized post-migration, with emphasis on the specific tools and services utilized by AWS.

B. Case Study 2: Azure Mainframe Modernization:

An example of a company in a Microsoft-centric environment that migrated from a mainframe to Azure. This case study will highlight the integration with existing Microsoft systems, the hybrid cloud model, and the unique benefits of using Azure for mainframe workloads.

C. Case Study 3: GCP Mainframe Migration:

A case study of a company with a heavy reliance on data analytics and machine learning that migrated its mainframe to GCP. The case study will focus on the performance improvements, scalability, and cost reduction achieved using GCP's advanced data processing capabilities.

Each case study will be followed by a comparative analysis, showing how each platform supports mainframe modernization in different ways. This section will also highlight the specific challenges faced by each company and the overall success of the migration.

VI. CHALLENGES AND RISKS

While cloud migration offers several benefits, it is not without its challenges. This section outlines the common hurdles organizations face during the migration process, including:

A. Data Migration:

Transferring large volumes of data from legacy mainframes to the cloud can be time-consuming, costly, and prone to errors. The complexities involved in ensuring data integrity and minimizing downtime during the transfer process are discussed.

B. Application Refactoring:

Mainframe applications often require significant refactoring or re-architecting to run efficiently on cloud platforms. This can involve substantial development time and additional costs, particularly if the applications are not cloud-native.

C. Security and Compliance:

Organizations must ensure that their cloud migration adheres to relevant data privacy regulations (e.g., GDPR, HIPAA) and security standards. This section will address the risks associated with ensuring security during migration and post-migration, as well as strategies for mitigating these risks.

D. Vendor Lock-In:

Migrating to a single cloud provider can result in vendor lock-in, making it difficult for businesses to switch providers in the future. This section will discuss the implications of vendor lock-in and how businesses can mitigate this risk through multi-cloud strategies.

VII. RESULTS AND FINDINGS

This section presents the key findings from the research, including the comparative cost and benefit analysis of cloud migration for mainframe modernization. Key insights from the case studies will be summarized, with a focus on the platforms that provided the most significant operational and financial benefits.

A. Cost Comparison:

A detailed analysis of the direct and indirect costs associated with each cloud platform, along with recommendations for optimizing costs based on business needs.

B. Benefit Comparison:

The operational benefits of each cloud platform, including scalability, security, and innovation, are compared. The section concludes with a discussion of which platform—AWS, Azure, or GCP—emerged as the most favorable choice for mainframe modernization based on the criteria of cost, scalability, and business needs.

VIII. CONCLUSION

The conclusion provides a summary of the key findings and insights from the research. It reflects on the importance of considering both quantitative and qualitative factors in the decision-making process for mainframe migration. The section also provides practical recommendations for businesses looking to migrate from mainframe systems to the cloud, including:

A. Choosing the Right Cloud Platform:

Which platform is best suited for various business needs.

B. Best Practices for Migration:

Recommendations for minimizing risks, controlling costs, and ensuring a smooth migration process.

C. Future Research:

A look at the future of cloud migration, with potential research areas including advances in hybrid cloud solutions and the role of artificial intelligence and automation in simplifying the migration process.

IX. REFERENCE

[1] Marinescu, D. C. (2017). *Cloud Computing: Theory and Practice*. Morgan Kaufmann Publishers.

[2] Vasanthi Govindaraj, "Modernizing agricultural workflows using artificial intelligence and deep learning: Enhancing plant species identification," World Journal of Advanced Research and Reviews, vol. 23, no. 03, pp. 3127–3136, 2024. Crossref, https://doi.org/10.30574/wjarr.2024.23.3.3074

[3] Sanjay Moolchandani, "Factor Analysis Framework for Credit, Operational, and Market Risk Modeling", International Journal of Science and Research (IJSR), Volume 13 Issue 4, April 2024, pp. 1987-1993, https://www.ijsr.net/getabstract.php?paperid=SR24417094840, DOI: https://www.doi.org/10.21275/SR24417094840

[4] Gartner, Inc. (2023). *Magic Quadrant for Cloud Infrastructure and Platform Services*.

[5] Govindaraj Vasanthi, Vellathur Jaganathan Humashankar, Periyasamy Prakash. "Explainable transformers in financial forecasting," World Journal of Advanced Research and Reviews, vol. 20, no. 02, pp. 1434–1441, 2023. Crossref, https://doi.org/10.30574/wjarr.2023.20.2.1956

[6] Sanjay Moolchandani, "Advanced Credit Risk Assessment Using Markov Chain Monte Carlo Techniques", International Journal of Science and Research (IJSR), Volume 12 Issue 12, December 2023, pp. 2160-2163, https://www.ijsr.net/getabstract.php?paperid=SR23127095329, DOI: https://www.doi.org/10.21275/SR23127095329

[7] Krebs, R. S., & Harris, S. (2019). *Mainframe Modernization: A Practical Approach to Transformation*. Springer.

[8] Govindaraj, Vasanthi. "Cloud Migration Strategies for Mainframe Modernization: A Comparative Study of AWS, Azure, and GCP," International Journal of Computer Trends and Technology, vol. 72, no. 10, pp. 57-65, 2024. Crossref, https://doi.org/10.14445/22312803/IJCTT-V72I10P110

[9] Chintala, Suman. (2024). Emotion AI in Business Intelligence: Understanding Customer Sentiments and Behaviors. INTERNATIONAL JOURNAL OF COMPUTER SCIENCE AND MATHEMATICAL THEORY E-ISSN. 06. 8.

[10] Amazon Web Services (2020). *Cloud Adoption Framework for Mainframe Migration*. Amazon Web Services.

[11] Microsoft Azure (2022). *Azure Cloud Migration: Mainframe Modernization*.

[12] Choudhary, V., & Rattan, P. (2018). A survey on mainframe to cloud migration. *International Journal of Cloud Computing and Services Science, 7*(4), 248-260.

[13] Suman Chintala, "Strategic Forecasting: AI-Powered BI Techniques", International Journal of Science and Research (IJSR), Volume 13 Issue 8, August 2024, pp. 557-563, https://www.ijsr.net/getabstract.php?paperid=SR24803092145, DOI: https://www.doi.org/10.21275/SR24803092145

[14] Google Cloud (2021). *Modernizing Mainframe Applications on Google Cloud*. Google Cloud Platform.

[15] Suman Chintala, "Harnessing AI and BI for Smart Cities: Transforming Urban Life with Data Driven Solutions", International Journal of Science and Research (IJSR), Volume 13 Issue 9, September 2024, pp. 337-342, https://www.ijsr.net/getabstract.php?paperid=SR24902235715, DOI: https://www.doi.org/10.21275/SR24902235715

[16] Hofmann, P., & Chavez, J. (2020). Cost-benefit analysis in cloud computing: A practical approach to cloud service selection. *International Journal of Information Technology and Management, 19*(2), 135-150.

[17] Suvvari, S. K. (2024). Ensuring security and compliance in agile cloud infrastructure projects. International Journal of Computing and Engineering, 6(4), 54–73. https://doi.org/10.47941/ijce.2222

[18] IDC (2021). *Worldwide Public Cloud Services Spending Guide*.

[19] S. K. Suvvari and V. D. Saxena, "Stakeholder management in projects: Strategies for effective communication," Innov. Res. Thoughts, vol. 9, no. 5, pp. 188–201, 2023.

[20] Forrester Research (2020). *The Total Economic Impact™ of AWS Mainframe Modernization*. Forrester Consulting.

[21] S. K. Suvvari, "Managing project scope creep: Strategies for containing changes," Innov. Res. Thoughts, vol. 8, no. 4, pp. 360–371, 2022.

[22] Sudheer Amgothu, Giridhar Kankanala, 2024. *Adoption of Source Control Systems in the Software Industry,* ESP Journal of Engineering & Technology Advancements 4(1): 122-125.

[23] Kanagarla Krishna Prasanth Brahmaji, (2024). Integrating AI-Driven Healthcare Solutions: Bridging Technical Advancement and Ethical Governance in Modern Medicine. International Journal of Research in Computer Applications and Information Technology, 7(2), 890–900. https://iaeme.com/MasterAdmin/Journal_uploads/IJRCAIT/VOLUME_7_ISSUE_2/IJRCAIT_07_02_070.pdf

[24] Sudheer Amgothu, Giridhar Kankanala, "SAP Cloud Installation CLI vs GUI: Comparative Study", International Journal of Science and Research (IJSR), Volume 11 Issue 12, December 2022, pp. 1395-1395, https://www.ijsr.net/getabstract.php?paperid=SR22128121553, DOI: https://www.doi.org/10.21275/SR22128121553

[25] Integrating Social Determinants of Health into Predictive Models: Assessing How Dremio Can Aggregate Diverse Data Sources to Enhance Predictive Modeling in Healthcare - Saurabh Gupta - IJFMR Volume 6, Issue 3, May-June 2024. DOI 10.36948/ijfmr.2024.v06i03.29755.

[26] Rajarao Tadimety Akbar Doctor, Sambiah Gunkala, 2016." *A Method and System For Automated Light Intensity Testing Of Building Management,* patent Office IN, Patent number 201641001890, Application number 201641001890, [LINK].

[27] Dixit, A.S., Patwardhan, A.V. and Pandit, A.B., 2021. PARAMETER OPTIMIZATION OF PRODIGIOSIN BASEDDYE-SENSITIZED SOLAR CELL. *International Journal of Pharmaceutical, Chemical & Biological Sciences*, *11*(1), pp.19-29.

[28] Aparna Bhat, Rajeshwari Hegde, "Comprehensive Study of Renewable Energy Resources and Present Scenario in India," 2015 IEEE International Conference on Engineering and Technology (ICETECH), Coimbatore, TN, India, 2015. [Link]

[29] Apurva Kumar, Shilpa Priyadarshini, "*Adaptive AI Infrastructure: A Containerized Approach For Scalable Model Deployment*", International Research Journal of Modernization in Engineering Technology and Science, Volume:06/Issue:11/November-2024, https://www.doi.org/10.56726/IRJMETS64700

[30] Chandrakanth Lekkala, "*Utilizing Cloud – Based Data Warehouses for Advanced Analytics: A Comparative Study*", International Journal of Science and Research (IJSR), Volume 11 Issue 1, January 2022, pp. 1639-1643, https://www.ijsr.net/getabstract.php?paperid=SR24628182046

[31] Rao, Deepak, and Sourabh Sharma. "Secure and Ethical Innovations: Patenting Ai Models for Precision Medicine, Personalized Treatment, and Drug Discovery in Healthcare." International Journal of Business Management and Visuals, ISSN: 3006-2705 6.2 (2023): 1-8.

[32] Dhameliya, N. (2022). Power Electronics Innovations: Improving Efficiency and Sustainability in Energy Systems. Asia Pacific Journal of Energy and Environment, 9(2), 71-80. [Link]

[33] Vasanthi Govindaraj, "Cloud Migration Strategies for Mainframe Modernization: A Comparative Study of AWS, Azure, and GCP," International Journal of Computer Trends and Technology, vol. 72, no. 10, pp. 57-65, 2024. Crossref, https://doi.org/10.14445/22312803/IJCTT-V72I10P110

[34] Git branching and release strategies - Priyanka Gowda Ashwath Narayana Gowda - IJIRMPS Volume 10, Issue 5, September-October 2022. DOI 10.5281/zenodo.14221771

[35] Priyanka Gowda Ashwath Narayana Gowda, "*Migrating Banking Applications to the Cloud: Strategies and Best Practices*", Journal of Scientific and Engineering Research, 2021, 8(12): 144-151.

[36] Chintale, P., Korada, L., Ranjan, P., & Malviya, R. K. (2019). Adopting Infrastructure as Code (IaC) for Efficient Financial Cloud Management. ISSN: 2096-3246, 51(04).

[37] Chintale, P., Korada, L., Ranjan, P., Malviya, R. K., & Perumal, A. P. (2021). The Impact of Covid-19 on Cloud Service Demand and Pricing in the Fintech Industry. Journal of Harbin Engineering University, 42(7).

[38] Karthik Hosavaranchi Puttaraju, "A Roadmap for Business Model and Capability Transformation in the Digital Age: Strategies for Success", International Journal of Business Quantitative Economics and Applied Management Research, Volume-7, Issue-7, 2023.

[39] Karthik Hosavaranchi Puttaraju, "Harnessing Disruptive Technologies: Strategic Approach to Retail Product Innovation", International Journal of Scientific Research in Engineering and Management (IJSREM), VOLUME: 08 ISSUE: 01 | JAN - 2024.

[40] Karthik Hosavaranchi Puttaraju, "Accelerating Innovation Through Data-Enabled Agile Stage-Gate Processes: Implications For Business Strategy And Execution", International Journal of Core Engineering & Management, Volume-7, Issue-11, 2024.

[41] Chandrakanth Lekkala (2023) Deploying and Managing Containerized Data Workloads on Amazon EKS. Journal of Artificial Intelligence & Cloud Computing. SRC/JAICC-342. DOI: doi.org/10.47363/JAICC/2023 (2)324.

[42] Implementing Low-Latency Data Streaming from SQL Server to BigQuery: A Kafka-Based Approach in Google Cloud Platform - Sainath Muvva - IJFMR Volume 4, Issue 4, July-August 2022.

[43] Karthik Chowdary Tsaliki, "*Revolutionizing Identity Management with AI: Enhancing Cyber Security and Preventing ATO*", International Research Journal of Modernization in Engineering Technology and Science, volume: 6/Issue: 04/April-2024.

[44] Palakurti, N. R. (2024). Challenges and Future Directions in Anomaly Detection. In Practical Applications of Data Processing, Algorithms, and Modeling (pp. 269-284). IGI Global.