Evaluating Legacy System Refactoring for Cloud-Native Infrastructure Transformation in African Markets

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Abstract- ***This paper explores the transformation of legacy systems into cloud-native infrastructures within the context of African markets. It highlights the limitations of legacy systems, such as inefficiency, high maintenance costs, and lack of scalability, which hinder the growth and competitiveness of businesses. The study discusses the key principles of cloud-native technologies, including microservices, containers, and Kubernetes, and examines their potential to modernize IT systems. Several refactoring approaches—lift and shift, re-platforming, and re-architecting—are explored, providing insights into their benefits and challenges for African enterprises. Additionally, the paper analyzes the tools and technologies used in the migration process, such as cloud migration platforms and APIs, which facilitate the transition to cloud-based solutions. Through case studies from African sectors, such as fintech and telecommunications, the study demonstrates the transformative impact of cloud-native infrastructure on operational efficiency and scalability. Practical recommendations are provided for African businesses considering cloud adoption, including strategies for overcoming infrastructural, financial, and skills-related challenges. Finally, the paper suggests future research directions in the areas of cloud adoption, regional-specific frameworks, and the integration of emerging technologies like AI and IoT in cloud-native systems.***

Indexed Terms- ***Legacy Systems, Cloud-Native Transformation, Refactoring Approaches, Microservices, Cloud Adoption in Africa, Scalability and Flexibility***

I. INTRODUCTION

1.1 Background and Motivation

Legacy systems are older software or hardware systems that continue to function within organizations despite their inefficiency and limitations. In African markets, many businesses still rely on these outdated technologies, often due to financial constraints or a lack of skilled labor to implement newer solutions [1, 2]. Legacy systems, while functional, are typically difficult to maintain and unable to support rapid innovation. In the context of African businesses, these systems limit access to more advanced, scalable solutions and impede growth potential, particularly in an era where digital transformation is essential [3-5]. As a result, businesses may struggle to compete in an increasingly globalized and technologically driven market [6-8].

Furthermore, legacy systems often lack the flexibility needed for modern demands such as scalability, mobile integration, or cloud computing. The ongoing maintenance costs and risk of system failures often outweigh the benefits, making it essential for African enterprises to consider alternative solutions. The motivation for this study lies in understanding the need for refactoring these legacy systems to improve their performance and relevance in today's dynamic business environment [9, 10].

1.2 Cloud-Native Transformation

Cloud-native infrastructure refers to the approach of building and running applications that fully leverage

the advantages of cloud computing [11, 12]. Unlike traditional infrastructure, which relies heavily on physical hardware and on-premise solutions, cloud-native systems are designed to be flexible, scalable, and capable of running in distributed environments [13, 14]. This transformation has become increasingly important for businesses worldwide, and for African markets, it represents a critical step in modernizing IT infrastructure to meet the growing demands of the digital age [15, 16].

The relevance of cloud-native technologies lies in their ability to provide businesses with resources that are not only scalable but also cost-efficient. Through the use of containers, microservices, and serverless computing, businesses can enhance operational efficiency, reduce overhead costs, and innovate more rapidly [17, 18]. For African businesses, cloud-native infrastructure offers a chance to leapfrog outdated systems and embrace the flexibility needed to compete globally, particularly in sectors like e-commerce, healthcare, and finance [19, 20].

Cloud-native transformation can empower African businesses by providing a more adaptable and efficient technology stack. This transition can also help overcome some of the unique infrastructure challenges present in the region, such as unreliable power and connectivity. With cloud solutions, businesses can reduce their reliance on physical infrastructure and focus on developing their core services, thus driving growth and competitiveness [21, 22].

1.3 Research Scope and Objectives

This study focuses on evaluating the process of legacy system refactoring for cloud-native infrastructure transformation within the context of African markets. The primary objective is to understand how legacy systems can be effectively transitioned to cloud-native environments, thereby enabling businesses to reap the benefits of scalability, flexibility, and cost savings. By examining both the challenges and opportunities of such a transformation, the study aims to provide a comprehensive framework that African businesses can adopt for successful digital migration.

The research will assess various refactoring approaches, including lift-and-shift, re-platforming, and re-architecting, to determine which methods are best suited to the unique conditions found in African markets. Additionally, it will explore the tools and technologies that facilitate this transformation, ensuring the recommendations align with the specific needs and constraints of the region. By providing evidence-based insights, the paper seeks to assist business leaders, IT professionals, and policymakers in making informed decisions regarding IT modernization strategies. Ultimately, this study aims to highlight the potential for cloud-native infrastructure to foster growth and innovation in African businesses. By identifying practical solutions and real-world examples, it will contribute to the broader discourse on digital transformation in emerging economies and position Africa as a significant player in the global digital economy.

II. UNDERSTANDING LEGACY SYSTEMS AND THEIR LIMITATIONS

2.1 Overview of Legacy Systems

Legacy systems are often defined by their outdated technology and long-standing presence within organizations. These systems were typically built on older programming languages, monolithic architectures, and rigid infrastructures, making them difficult to modify or integrate with modern technologies [23]. Despite their age, many African businesses still rely on these systems due to the high cost and complexity of replacing or updating them. One of the key characteristics of legacy systems is their reliance on on-premises hardware and software, which limits scalability and flexibility [12].

The costs associated with maintaining legacy systems are significant. Organizations must allocate resources for regular maintenance, system upgrades, and troubleshooting, which are often costly and time-consuming [2, 24]. Additionally, these systems typically lack the agility required to meet the demands of modern business environments. Performance limitations, such as slow processing speeds, inefficient data handling, and limited interoperability with newer technologies, further hinder the potential for innovation and competitive advantage [25, 26].

In African markets, legacy systems are particularly problematic as businesses struggle to keep up with the demands of the global digital economy [27-29]. The inability of these systems to integrate with emerging technologies such as cloud computing, artificial intelligence, and mobile platforms further isolates businesses, making them less adaptable to changing market conditions [30, 31].

2.2 Challenges in African Markets

African businesses face unique challenges when managing legacy systems, largely due to infrastructural, financial, and human resource constraints [32, 33]. One of the primary challenges is the inadequate infrastructure in many regions, where unreliable power supplies, limited internet connectivity, and poor network coverage can severely disrupt the functioning of legacy systems. These systems, often designed without regard for modern cloud-based solutions, are vulnerable to these infrastructural weaknesses, making them even less reliable in African contexts [34-36].

In addition, there is a significant skills gap in many African markets, where the workforce lacks the necessary expertise to manage, update, or replace legacy systems. This skills shortage means that businesses may not have the in-house talent required to migrate to more modern, cloud-native solutions, leading to increased dependence on external consultants and high costs [37]. Furthermore, the limited availability of training and professional development opportunities exacerbates this issue, making it difficult for businesses to build sustainable IT capabilities in-house [38].

Finally, financial constraints often prevent African businesses from investing in the refactoring or replacement of legacy systems [39]. While cloud-native solutions can ultimately be more cost-effective, the initial investment required for training, platform migration, and system upgrades can be prohibitive. This creates a situation where businesses are stuck with outdated systems, which can hinder their ability to compete effectively in a rapidly changing business landscape. [16]

2.3 Impact on Business Innovation

Legacy systems can significantly hinder innovation and growth, as they are inherently inflexible and resistant to change. These systems often operate in silos, unable to integrate with newer technologies or adapt to evolving business needs. As a result, businesses are limited in their ability to innovate, particularly in sectors where agility and scalability are critical. In African markets, this lack of flexibility is particularly detrimental, as businesses miss opportunities to leverage emerging technologies like big data analytics, cloud computing, and e-commerce solutions [40-42].

For example, in the African banking sector, many institutions still rely on legacy core banking systems that were designed decades ago. These systems struggle to keep pace with the rapid growth of mobile banking and digital payment platforms, limiting their ability to offer competitive services [43, 44]. As a result, younger, more agile fintech startups have emerged, filling the gap by offering innovative, mobile-first financial solutions that legacy banks cannot match. This demonstrates how reliance on legacy systems can result in missed business opportunities and hinder market expansion [45-47].

Furthermore, legacy systems can impede internal innovation by consuming too many resources on maintenance and troubleshooting. Employees may spend a significant portion of their time addressing issues with outdated technology, leaving little room for creative problem-solving or strategic initiatives [48]. In industries such as healthcare, education, and logistics, where technological innovation can significantly enhance service delivery, the inefficiency of legacy systems results in suboptimal outcomes and diminished growth prospects [49].

III. CLOUD-NATIVE INFRASTRUCTURE TRANSFORMATION

3.1 Concept of Cloud-Native Architecture

Cloud-native architecture is a design methodology that enables the creation of scalable, resilient, and flexible applications built to run on cloud infrastructure. At its core, cloud-native development embraces key technologies such as microservices, containers, and Kubernetes to support the dynamic needs of modern

businesses [16]. Microservices break down applications into smaller, independent services that can be deployed, updated, and scaled individually, enhancing flexibility and reducing development time. Containers provide a lightweight, portable environment for running applications, allowing them to run consistently across different cloud platforms, making the deployment process simpler and more efficient [15, 50, 51].

Kubernetes, an open-source container orchestration tool, is a cornerstone of cloud-native systems. It automates the deployment, scaling, and management of containerized applications, making it easier for organizations to manage complex application environments [52, 53]. By using these technologies, businesses can ensure that their applications are more resilient, scalable, and adaptable to changing needs. Cloud-native architecture also promotes DevOps practices, enabling faster development cycles, continuous integration, and better collaboration between teams. This approach fosters innovation and ensures applications are always up to date with the latest features and security enhancements [54-56].

For African businesses, adopting a cloud-native approach is particularly valuable, as it allows them to access enterprise-level technologies without needing large investments in physical infrastructure. Cloud-native systems support efficient resource management and enable businesses to scale their operations quickly, which is essential for growth in an ever-evolving market [57-59].

3.2 Benefits of Cloud-Native Infrastructure

Cloud-native infrastructure offers several key advantages that can transform the operational capabilities of businesses, especially in emerging markets like Africa. One of the primary benefits is scalability. Cloud-native applications are designed to scale horizontally, meaning businesses can increase their computing resources as needed to meet growing demands [60, 61]. This is particularly valuable for African businesses that may experience unpredictable growth or fluctuating traffic, such as those in e-commerce or financial services. With cloud-native technologies, businesses can easily scale up or down without significant upfront costs or long-term commitments [62-64].

Cost-efficiency is another critical advantage. By migrating to the cloud, businesses eliminate the need for expensive on-premise hardware and the maintenance costs associated with legacy systems. Cloud-native applications run in virtualized environments, allowing for more efficient use of computing resources and reducing wastage [65]. This pay-as-you-go model ensures that businesses only pay for the resources they use, making it a more affordable solution, particularly for small and medium-sized enterprises (SMEs) in Africa. Cloud-native infrastructure also allows for rapid innovation and faster deployment of new features, which enhances a business's ability to respond to market changes and customer needs [66-68].

Additionally, cloud-native systems provide greater flexibility by supporting multi-cloud and hybrid cloud environments. This flexibility enables businesses to choose the best cloud services based on their unique requirements, whether they need high-performance computing, data storage, or advanced analytics. For African businesses, which may face region-specific challenges such as power outages or data sovereignty concerns, cloud-native solutions provide the agility to select cloud providers that meet their specific needs and ensure business continuity [69-71].

3.3 Cloud Adoption in African Markets

Cloud adoption in African markets has been steadily increasing as businesses recognize the transformative potential of cloud technologies. Several factors, including the rising cost of maintaining legacy systems, the need for more agile and scalable solutions, and the availability of affordable internet services, have accelerated the shift toward cloud computing [72, 73]. In countries like Kenya, Nigeria, and South Africa, cloud adoption has been driven by the growing demand for digital services in sectors such as fintech, e-commerce, and education. Additionally, cloud platforms have become more accessible due to the proliferation of local data centers, reducing latency and improving service reliability [74-76].

However, despite the growing interest in cloud technologies, challenges remain. One of the primary hurdles is the lack of skilled professionals to manage and implement cloud-native systems. Many African businesses still struggle to find employees with the necessary expertise in cloud computing, microservices, and containerization [77, 78]. Additionally, concerns regarding data privacy, security, and regulatory compliance can slow the adoption of cloud services, especially in industries like healthcare and banking. These concerns have led some businesses to prefer on-premises solutions or to delay their cloud adoption strategies [79, 80].

That said, there have been notable success stories. For example, African fintech companies like M-Pesa have leveraged cloud-native infrastructure to scale their operations and provide financial services to underserved populations [81]. Additionally, major international cloud providers such as Microsoft and Amazon have expanded their services in Africa, further encouraging local businesses to embrace the cloud. The growing adoption of cloud technologies in African markets signals a promising future for digital transformation, with cloud-native infrastructure playing a pivotal role in enabling businesses to innovate, scale, and thrive in the global economy [82].

IV. REFACTORING LEGACY SYSTEMS FOR CLOUD-NATIVE INFRASTRUCTURE

4.1 Approaches to Refactoring

Refactoring legacy systems involves transforming outdated technologies to fit modern cloud-native architectures, enabling greater scalability, efficiency, and innovation. Several approaches can be used depending on the organization's goals, budget, and technological readiness. The most common strategies include lift-and-shift, re-platforming, and re-architecting [83, 84].

Lift and shift is the simplest approach, where legacy systems are moved from on-premises infrastructure to cloud environments without significant modification. This method is typically used when a quick migration is necessary and businesses wish to avoid the complexity of system redesign. While this approach provides immediate cost savings, it does not fully leverage the advantages of cloud-native features such as scalability or microservices [83].

Re-platforming involves moving legacy systems to a cloud platform but with some modifications to improve performance and take advantage of cloud capabilities. This may involve changing certain components of the system to be more cloud-friendly, such as converting databases to cloud-based alternatives [85]. While it requires more effort than lift and shift, re-platforming allows businesses to gain some benefits of the cloud, like cost efficiency and improved flexibility, without overhauling the entire system [16].

Re-architecting is the most comprehensive and complex approach, involving a complete redesign of legacy systems into cloud-native architectures. This method takes full advantage of cloud-native principles, such as microservices, containers, and Kubernetes, to create a more agile and scalable solution [85]. Though it requires significant time, resources, and expertise, re-architecting ensures that businesses fully benefit from cloud-native capabilities. This approach is particularly beneficial for organizations aiming for long-term transformation and innovation [86].

4.2 Tools and Technologies

The refactoring process for legacy systems relies on a wide array of tools and technologies that streamline migration, integration, and management in cloud environments [39]. Cloud migration platforms, such as AWS Migration Hub, Azure Migrate, and Google Cloud Migration Tools, play a critical role in simplifying the transition to cloud-based infrastructure. These platforms offer a range of services, including assessment tools to evaluate the suitability of legacy systems for migration, as well as step-by-step guides for moving applications, data, and workloads to the cloud [87].

Application Programming Interfaces (APIs) are essential for enabling legacy systems to interact with modern cloud-based applications and services [16]. APIs facilitate the communication between old and new technologies, ensuring seamless integration and data exchange. Many organizations use API

management platforms like Apigee or AWS API Gateway to help secure and manage APIs, making it easier to modernize legacy applications incrementally without disrupting core functionalities [87, 88].

Additionally, containerization tools such as Docker and Kubernetes are central to the cloud-native refactoring process. Docker allows developers to package legacy applications into containers, making them portable and consistent across different cloud environments [89]. Kubernetes, an orchestration tool, automates the deployment, scaling, and management of containerized applications, enabling businesses to operate at scale with greater reliability and efficiency. These tools empower organizations to gradually transition to cloud-native architectures, ensuring that legacy systems can operate in hybrid environments while new features are introduced [89-91].

4.3 Case Studies in Africa

In Africa, there are several examples of legacy system refactoring initiatives that highlight the potential for cloud-native transformation. One notable case is M-Pesa, a mobile money service in Kenya. Initially, M-Pesa operated on a legacy infrastructure that limited its ability to scale as demand increased [92]. The company adopted cloud-native principles by migrating to a more scalable cloud infrastructure that supported the growth of its services. By leveraging cloud-based technologies such as microservices and containers, M-Pesa was able to enhance its platform's resilience, security, and ability to handle millions of transactions daily, leading to its expansion across multiple African countries[93, 94].

Another example is MTN Group, a telecommunications giant operating across Africa. MTN faced challenges with legacy billing systems that were slow and inefficient, limiting the company's ability to offer flexible pricing models and real-time services to its customers [95]. MTN undertook a cloud-native transformation by refactoring its billing system to run on cloud-based platforms using a microservices architecture. This migration enabled MTN to offer more dynamic pricing, enhance customer experience, and improve operational efficiency [96].

In South Africa, Standard Bank embarked on a similar journey by migrating its legacy core banking system to the cloud. The bank adopted a re-platforming approach, gradually moving applications to the cloud while minimizing disruption to its operations [97]. By leveraging cloud platforms, Standard Bank improved its agility, reducing infrastructure costs and gaining the flexibility needed to roll out new financial products more quickly [16]. These case studies demonstrate that while the refactoring of legacy systems presents challenges, it also offers immense potential for growth, scalability, and competitive advantage [98]. The success stories in Africa show that businesses, regardless of size or sector, can benefit from embracing cloud-native transformation to stay relevant in an increasingly digital economy [99, 100].

CONCLUSION

This study has explored the process of refactoring legacy systems for cloud-native infrastructure transformation in African markets, highlighting the key principles, challenges, and potential benefits of adopting cloud-native technologies. The findings emphasize that legacy systems, though still prevalent in many African businesses, present significant limitations, including inefficiency, high maintenance costs, and a lack of scalability. Cloud-native architectures, which leverage technologies such as microservices, containers, and Kubernetes, offer a promising solution for overcoming these challenges by providing scalable, flexible, and cost-efficient systems that can support the dynamic needs of modern businesses.

Additionally, the research identifies that African businesses face unique barriers to cloud adoption, including infrastructural limitations, skills shortages, and financial constraints. However, successful case studies from sectors like fintech and telecommunications demonstrate that cloud-native transformation can drive significant improvements in operational efficiency, customer satisfaction, and market competitiveness. The study also highlights the importance of choosing the right refactoring approach—whether lift and shift, re-platforming, or re-architecting—based on the specific needs and goals of the organization.

For African businesses considering cloud-native transformation, several practical recommendations emerge from this study. First, businesses should start by conducting a thorough assessment of their existing legacy systems to determine the most suitable approach for migration. Smaller businesses may benefit from the lift-and-shift approach to quickly reduce infrastructure costs, while larger enterprises might consider re-architecting their systems for long-term scalability and innovation.

Second, investing in employee training and building internal expertise in cloud technologies is crucial. Given the skills gap in many African markets, businesses should prioritize upskilling their workforce to manage and optimize cloud-native systems. Partnering with cloud service providers to access training resources or working with external consultants could also help businesses navigate the complexities of cloud adoption. Lastly, African businesses should focus on selecting cloud platforms that meet their specific needs in terms of security, compliance, and cost. Given the concerns around data privacy and regulatory requirements, especially in sectors like healthcare and finance, choosing cloud providers with local data centers or those that adhere to regional regulations can mitigate risks and ensure business continuity.

While this study provides valuable insights into the cloud-native transformation process, there are several avenues for future research. One potential direction is to explore the long-term impact of cloud-native transformations on African businesses, particularly in terms of operational efficiency, market competitiveness, and innovation. Future studies could assess how different sectors, such as healthcare, education, or agriculture, benefit from cloud-native infrastructure and whether certain industries face unique challenges or opportunities in adopting cloud technologies.

Another area for further research is the development of region-specific frameworks and best practices for cloud migration. As African businesses face distinct infrastructural, financial, and regulatory challenges, research could focus on creating tailored solutions that address these specific concerns. Additionally, investigating the role of government policies and incentives in promoting cloud adoption could provide valuable insights into how public-private partnerships can support digital transformation in Africa. Lastly, future studies could delve into the impact of emerging technologies, such as artificial intelligence, big data, and the Internet of Things (IoT), on cloud-native infrastructure. Understanding how these technologies integrate with cloud-native systems could provide businesses with even greater opportunities for innovation and growth in the African context.

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