

Navigating Digital Transformation in Banking with Cloud Computing Solutions

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Abstract

The banking sector is undergoing a digital revolution that is drastically changing how banks run, interact with clients, and handle internal procedures. But the advent of digital technologies has forced a change in direction toward more adaptable, scalable, and economical solutions. Banks are currently utilizing cloud technologies more and more to accomplish their many goals and to establish an adaptable and agile banking environment that can react rapidly to changing business requirements. The main purpose of this paper is to examine how cloud computing is conceptualized through digital transformation, and how it performs smooth adoption of cloud computing in the banking industry. With the help of previous research studies, models of cloud computing, cloud operating models, best practices, and challenges from the viewpoint of the customer pointed out clearly. First, the review revealed that more easily than not, SaaS can help bank customers complete their regular financial transactions. Second, while public financial clouds are better suited for smaller banks, private clouds are better suited for larger banks. Third, through personalized services, it helps banks to improve efficiency and customer satisfaction while streamlining operations, optimizing resource utilization, ensuring cyber security, reducing operating expenses and adhering to regulatory requirements. The findings suggest that cloud computing is a key driver of the banking sector's digital transformation. However, for this to be implemented successfully, it takes careful planning, constant funding, and a dedication to accepting change in the name of long-term expansion and sustainability.

Keywords

Banking Industry, Cloud Computing Models, Digital Transformation,

1. Introduction

Over the last two decades, world countries have been facing and living advanced technology in their routine activities. Business entities are using and adopting this new and advanced technologies to its activities for enhancing the operational efficiency. In general, such technologies are Robotic Process Automation (RPA), Computing Power, Datafication, Artificial Intelligence (AI) and Machine Learning (ML), Internet of Things (IoT), Cloud Computing, Blockchain, Quantum Computing, Analytics, Software and Full Stack Web Development which is using in various fields. Current banking technology trends, paying particular attention to block Chain, AI/ML, cloud computing, and emerging technologies like IoT and open banking. The majority of digital technologies included in the sample above align with the widely recognized acronym SMACIT (Social, Mobile, Analytics, Cloud, and Internet of Things) (Sebastian et al., 2017). This acronym refers to technologies associated with social media (Li et al., 2017; Oestreicher-Singer and Zalmanson, 2012), mobile (Hanelt et al., 2015; Pousttchi et al., 2015), analytics (Duerr et al., 2017; Günther et al., 2017), cloud (Clohessy et al., 2017; Du et al. 2016), and the internet of things (IoT) (Petrikina et al., 2017; Richter et al., 2017). Additionally, I thought that platforms were a significant category, particularly in research articles (Tan et al., 2015; Tiwana et al., 2010). In contrast, I hardly ever saw other digital technologies such as software (Karimi et al., 2009; Setia et al., 2013), blockchain (Glaser, 2017), or the internet (Lyytinen and Rose, 2003). Nowadays, banks are increasingly adopting cloud computing technologies to fulfill their varied purposes and to create a flexible and agile banking environment that can quickly respond to new business needs.

Some businesses claim that in order to innovate with these technologies at the organizational level, they must create “strategies that embrace the implications of digital transformation and drive better operational performance” (Hess et al., 2016: p. 123). Introduction of new and advanced technology not only increase the efficiency, time saving, reduce fraudulent activities, reduction in cost but also removes the traditional methods. The process of traditional methods changed into a new method is called digitization. In technical terms, digitization is the process of converting analog data into zeros and ones so that computers can process, store, and send it. “Digitization is the process of changing from analog to digital form,” according to Gartner’s IT Glossary. Both Horváth and Szabó (2019) and Hess et al. (2016) see process automation via IT as a form of digitization. Digital technology has the capability to demonstrate the economic growth of a nation. Our economy and society both heavily rely on digital technology (Andersson et al., 2018; Gimpel et al., 2018). It can also help predict changes in businesses like the stock market and banking to meet customer needs. Implementation of such advanced

technologies into various fields needs to do heavy investment and technically skilled persons. The banking sector in India is at a crossroads where new technology presents both formidable challenges and significant opportunities. This study emphasizes how modern technologies, like blockchain, cloud computing, and artificial intelligence (AI), can boost productivity, stop fraud, and personalize user experiences. But in order to guarantee widespread adoption, practical disruptions, skill gaps, and ethical issues surrounding the use of information must all be properly taken into account (Balasaheb Aher, 2022). The adoption of cloud computing has been steadily increasing across the financial services industry because of emerging technology. Banks of all sizes, from global institutions to financial services companies, embrace cloud-based solutions to modernise their operations and enhance customer experiences. According to the Allied Market Research's report, the cloud computing banking market was valued at \$67.9 billion in 2022 and is estimated to reach \$301 billion by 2032, exhibiting a CAGR of 16.3% from 2023 to 2032 (Advapay, 2024). The global cloud banking market's growth is fueled by digital transformation initiatives, regulatory pressures, and changing consumer preferences. Hence, this paper mainly focuses on the role and functioning of cloud computing in banking sector in customer perspective.

2. Digitization, Digitalization and Digital Transformation

The concepts of “digitization,” “digitalization,” and “digital transformation” are completely distinct from one another. Although the aforementioned three terms have different meanings, research has shown that they are frequently used interchangeably (Bloomberg, 2018). Digitization, or “the conversion from analogue to digital,” is referred to as the first stage of transformation by Maltaverne (2017). The second stage, known as digitalization, entails “the process of using digital technology and the impact it has” (digitalization of a process). Unruh and Kiron (2017) have a similar thought and described digitalization as “the innovation of business models and processes that exploit digital opportunities”. The core of digitalization is drastically upending and altering the underlying presumptions of how work is organized and how people live their lives. The society becoming more globalized and more digitalized than ever before due to digitalized. Consequently, it is becoming increasingly important for organizations to quickly, efficiently, and appropriately plan the “digital transformation” to achieve flexibility and to maintain market competitiveness. “Digital transformation,” the most inclusive of the three terms, refers to the third phase and includes the entire organization, not just a single process. In strategic research (Bharadwaj et al., 2013; Piccinini et al., 2015) and for practitioners (Fitzgerald et al., 2014; Westerman et al., 2011), digital transformation (DT) has become a significant phenomenon. According to Agarwal et al. (2010) and Majchrzak et al. (2016), digital transformation (DT) is the broad term used to describe the significant changes that digital technologies are bringing about in industries and society.

Across all industries, management is under increasing pressure to prioritize

digital transformation and take advantage of the opportunities presented by emerging digital technology (Christensen, 1997; Horlacher & Hess, 2016; Smolinski et al., 2017; Zavalokina, Dolata, & Schwabe, 2016). The difficulty of digital transformation is accompanied by a number of other difficulties, including shifting consumer behavior, stringent regulations, and declining profit margins (Smolinski et al., 2017). A recent study (Bughin & Van Zeebroeck, 2017) confirmed that only a small minority of companies are successfully undertaking digital transformation consistent with a clearly articulated corporate strategy. In summary, cloud computing is a major force behind the digital transformation of the banking industry, allowing banks to innovate, boost productivity, and improve customer experiences, as stated by Kanchepu (2023). However, effective implementation requires strategic planning, ongoing investment, and a commitment to accepting change in order to achieve long-term growth and sustainability.

Banking and financial sector plays significant role in the development of an economy of the nation. A sound and stable financial system facilitates the economic growth of the nation (Levine, 1997; Paun et al., 2019). Because it distributes money to borrowers who make profitable investments, the banking industry is one of the main engines of most economies. Bank is dealing with credit facilities, storage for cash, investments, and other financial transactions on behalf of the customers and government. A bank collects deposits from customers, collects amount from cross-border transactions, receive inflow through foreign direct investments to various sectors of the country and lend to customers, business people and invest an amount to neighboring countries to strengthening the economy. Strong financial institutions stimulate investment in profitable ventures and capital formation (Habibullah & Eng, 2006; Haini, 2020). Through the mobilization of accumulated capital into productive sectors, the financial sector's development has a major impact on the country's economic growth (Dhungana, 2014a; Paun et al., 2019; Puatwoe & Piabuo, 2017). Economists have generally agreed that financial institutions are essential to economic growth (Alawi et al., 2022; Chinoda & Kapingura, 2023; Dhungana, 2014b; Ustarz & Fanta, 2021). Schumpeter's (1934) analysis states that the financial sector stimulates economic growth by lending money to successful business endeavors. According to the studies of Kuznyetsova et al. (2022), Shawtari et al. (2023), stable economic growth and stability always depends on the financial and banking sector strong foundations.

Digital transformation for banks means just updating recent technology into its operations. According to Klimenko (2023), the banking sector is going through a digital revolution as a result of the quick development of technology and shifting demands from customers. The integration of digital technologies and strategies to optimize operations and improve personalized experiences is known as digital transformation in the banking industry (Finn & Downie, 2024). Digital transformation in the banking sector is being driven by the need to adjust to changing customer expectations, increase operational effectiveness, and manage competitive pressures from fintech startups and traditional financial institutions. Banks

leveraging cloud computing are in a strong position to address financial unpredictability, global interconnected financial networks, and high-expectations clients. Banks can leverage data to refine their methods of dividing customers and to enhance services that are in line with what customers want. The use of cloud computing enables banks to create a flexible and agile banking environment that can quickly respond to new business needs (Patani et al., 2014).

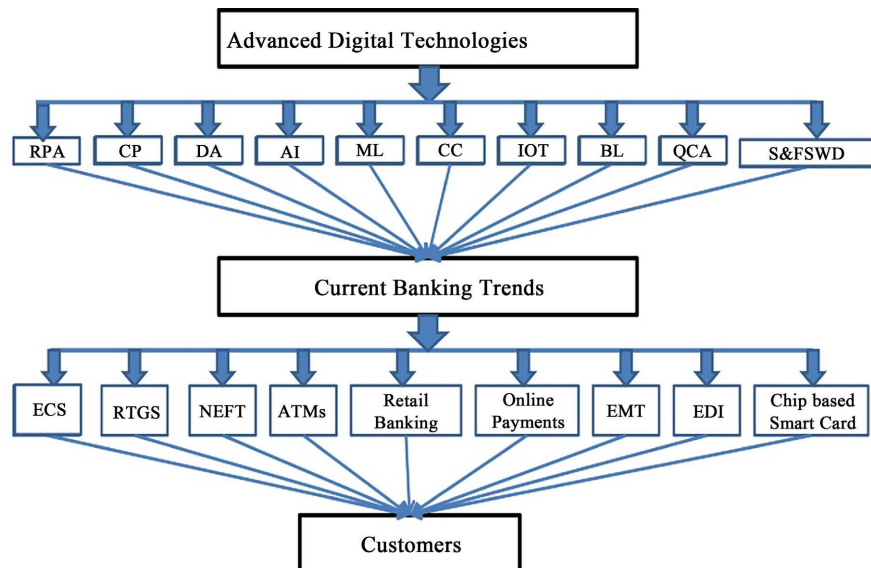


Figure 1. Digital technologies and benefits to customers. Note: Digital technologies and its benefit to customers. Own work.

From **Figure 1**, we could be able to understand digital transformation would have both advantages and disadvantages. The banking and financial services industry is likewise not exempt from this rule. Thus, the purpose of this study is to review earlier research on cloud adoption, optimal and appropriate models, challenges and best practices related to cloud computing in banking operations.

2.1. Complementary Empirical Research: Cloud Computing

Cloud computing is one of the newest service innovations in the IT sector. One of the technologies that is predicted to grow the fastest in the coming years is cloud computing. The term “cloud computing” first surfaced, during a joint project between Google and IBM in the fourth quarter of 2007 (Vouk, 2008; Zhang et al., 2010). In actuality, cloud computing is not a new idea; it was first used by businesses to manage virtual data resources in the 1960s. But it wasn’t until the early 21st century that it became widely known, as evidenced by the introduction of Microsoft’s Azure in 2010, Google’s App Engine in 2008, and Amazon Web Services in 2006. These three cloud service providers currently hold a 65% market share. However, there are additional ones. Sales force, IBM Cloud, Alibaba Cloud, and other clouds add even more variety to the already diverse cloud

landscape. As per the National Institute of Standards and Technology (NIST), cloud computing, is “a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.” (Mell & Grance, 2011).

The main benefit of cloud computing is that it can be accessed from anywhere at any time, regardless of schedule constraints. Financial institutions can benefit from cost savings, usage-based billing, business continuity, business agility, and green IT, among other benefits. According to Nazoksara et al. (2024), cloud computing provides cost savings, flexibility in handling storage capacities, and support for interactive and portable apps and services. Additionally, cloud computing solutions allow users to choose from a variety of providers based on their needs because they are multi-source (Kumar et al., 2022; Panwar et al., 2022). Furthermore, cloud computing reduces the need for physical space and operations for on-site storage, as well as capital costs and power consumption. Furthermore, cloud computing is “open to every service,” but it only handles the data that is absolutely necessary. Users can access cloud services to enable effective computation (Chang et al., 2022; Sharon et al., 2022). Moving to the cloud is justified for a number of reasons, including reduced time to market, lower cost of ownership, and more flexible infrastructure. As cloud computing adoption increases, financial institutions must consider the advantages and disadvantages of each option before making a choice. Adopt cloud computing and implement the proper oversight and governance to realize business benefits successfully and at a risk that is manageable Sumathy and Anitha Rathna (2018). Users can access IT services through cloud computing without having to understand the technology or own the infrastructure (Singh, 2012). By offering different entry points, cloud computing technology is significantly contributing to the simplification, cost reduction, and ease of transactions for all clients. Indian banks should all quickly implement cloud computing services for everyone. Without a doubt, it will give our banking industries a lively break and contribute to our economic expansion (Kamesh & Linda, 2018).

The biggest market for cloud services spending will be in business applications, where there will be a gradual shift from on-premise to cloud-based services, particularly for common business applications like ERP and CRM (Customer Relationship Management). In their study, Ghane et al. (2016) assess how cloud computing affects the efficiency of E-HRM at EGHTEASAD NOVIN BANK’s Customer Relationship Management system. Furthermore, answer the following question: Can elements of cloud computing impact a CRM system’s effectiveness? As an additional innovation, a model for cloud computing banking and CRM was proposed and implemented. The results of employing questioners indicate that the cloud computing banking approach will be beneficial to banks’ prosperity. Before making the switch to the cloud, banks need to think about the following: data

security, privacy, regulatory compliance, standard interoperability, and service quality. On-demand self-service, wide network access, resource pooling, quick elasticity, and measured service for business are a few of its benefits (Mell & Grance, 2011). The cloud computing system, as defined by Buyya et al. (2009), is a group of virtualized, networked computers that are dynamically provisioned and presented as one or more unified computing resources based on Service-Level Agreement (SLA) negotiated between the service provider and customers. Although there are many definitions of cloud computing, the following are particularly prevalent: 1) self-service interface; 2) elastic capacity and the appearance of infinite resources; 3) pay-per-use (no ongoing utility prices or commitments); and 4) virtualized or abstracted resources (Avram, 2014). A cloud-enabled platform is essential for providing the agility, flexibility, innovation, and productivity required to meet expanding business demands, according to 89% of financial services executives today. The financial services sector is encountering difficulties in keeping up the rate of business growth as a result of macroeconomic instability and other market conditions. Consequently, a lot of businesses are actively embracing digital transformation, and in order to obtain a competitive advantage, they must deploy cloud-enabled solutions (IDC, 2023).

Related Empirical Research: The Use of Cloud Computing in the Banking

In the digital age, cloud computing is a game-changing technology that has completely changed how banks handle, store, and analyze data. With the aid of cloud computing, banks can access a broad range of IT services and software programs to help optimize their operations and spur innovation. Streamline operations, banks able to satisfy the customers' expectations. Banks won't have to spend money on pricey hardware and software infrastructure or maintain sizable on-site data centers. The operational expenses of banks are significantly influenced by their IT infrastructure. At the same time, cloud computing presents the opportunity to transform security practices and improve defenses (Sumathy & Anitha Rathna, 2018). Secure deployment options provided by cloud computing technology could help banks enhance their new customer experiences. It improves IT efficiency while enabling remarkable collaboration and quick time to market. An increasing number of industries, including banking, are showing interest in using cloud computing (Foster et al., 2008; Lee et al., 2014; Marin, 2012). Pay-as-you-go models allow banks to access the computing resources they require, scaling up or down based on demand. Banks can respond more quickly and nimbly to shifting business requirements thanks to cloud computing, which eliminates the upfront expenses and ongoing maintenance requirements of traditional IT infrastructure. Banks can use cloud computing to enhance their operations in the ways listed below. It facilitates the banks' ability to convert capital expenditure into a lower level of continuous operating expenses. Additionally, it saves money because financial institutions only have to pay for the services they use and functional consumption (Patani et al., 2014). Additionally, financial institutions can benefit from

shorter product development cycles due to the flexibility of cloud-based operating models. It offers a quicker and more effective way to address the requirements of bank clients. Moreover, cloud banking has streamlined innovation, efficiency, and customer-centricity in the banking sector in addition to simplifying digitalization. It has completely changed how banks function, accelerating development and providing a flawless banking experience.

On the other hand, Benton (2010) identifies two domains where cloud-based apps can help bank clients/customers. Second, in contrast to traditional client-server technologies that impose significant time, cost, and resource barriers (Li and Li, 2011), cloud-based applications, specifically Software as a Service (SaaS), can assist bank customers in fulfilling their daily financial transactions more easily and without incurring additional costs (Huang et al., 2011). On the other hand, users of cloud-based apps do not need to install software (Marston et al., 2011). Banks can also benefit from increased fault tolerance, disaster recovery, and data protection. Not only does it offer more redundancy and backup than traditional managed solutions, but it also costs less. Through the transfer of their services to a virtual environment, cloud computing lowers energy consumption and its carbon footprint while also increasing computing power utilization efficiency and decreasing idle time. Large banks are very confident about the adoption of cloud technology and others are more careful and wait before jumping into this technology due to security and regulatory challenges. Although a bank may move to the cloud for a variety of reasons, applications will probably be the main driver. A survey on bank customers' interest in 186 banking technologies was carried out in 2010 by Bank Systems Technology and Information Week Analytics. The majority of customers (73%) said that their interest stemmed from cloud services' capacity to scale in the cloud and quickly respond to customer requests. However, it is anticipated that banks will lead the globe in SaaS solution nobility and cloud adoption. At the same time, banks must seek creative ways to satisfy business needs in today's demanding environment due to strict financial constraints, a developed regulation (Apostu et al., 2012).

Although the banking industry continues to have reservations about cloud technologies, the most common ones are security, privacy, data location, data integrity and confidentiality, availability, and user trust (Bose et al., 2013; Rani & Gangal, 2012). However, it is anticipated that banks will lead the globe in SaaS solution nobility and cloud adoption. The way banks store, process, and analyse data has changed because of the revolutionary technology known as cloud computing.

Cloud computing offers on-demand access, requires fewer infrastructures, and requires less setup time. Purchasing a lot of new hardware and software is not necessary when using cloud computing. Thanks to cloud computing, the development of new products can continue without requiring a capital investment. It makes it possible for businesses to move non-essential services to the cloud, like software updates, maintenance, and other computer-related issues. Consequently,

banks are able to concentrate more on their financial services business as opposed to IT. It's critical to recognize that the financial industry has stringent regulations pertaining to cloud technology. Financial institutions handling data in the cloud are subject to several guidelines, directives, and standards. Banks can adopt cloud computing solutions at their peripheral businesses before progressively bringing them closer to their core operations. To enhance security and high availability of IT infrastructure and enable on-demand IT infrastructure services, large banks can begin with "private cloud. Based on this, they can progressively experiment with "public cloud" and "hybrid cloud." Small banks have fewer resources than big banks in terms of capital, talent, technology, and other areas. It is also evident that setting up their own data centers is challenging due to the high expense. It would be wiser for small banks to use cloud service providers' public financial cloud services (Yan, 2017). A methodology for evaluating is the security of cloud computing in banks. It addresses every facet of cloud computing security and guarantees the creation of standard evaluation standards. The security requirements, obstacles, and challenges in the cloud for bank business are covered in this paper. After that, help banks find solutions to security-related issues in order to facilitate cloud adoption (Martin et al., 2014).

Researchers Rieger and Schmacher (2013) developed the TOE model to look into the variables influencing German banks' decisions to use cloud computing and to pinpoint the advantages and disadvantages of the technology from a manager's point of view. The biggest determining factors are government regulations, followed by security, data location, and provider. The main justifications for using cloud computing are the alleged financial advantages. Bekele (2014) conducted a study that examines the internal and external factors that impacted the decision of IT executives and experts regarding the adoption of cloud computing in the banking sector of Ethiopia. PCA analysis was used in the research process to analyze data from both quantitative (survey) and qualitative (interview) sources. The TOE model was intended. The findings suggest that the following internal and external factors impacted the decisions made by IT executives and experts: employee skills, external pressure, cost, and cloud consistency; complexity, compatibility, and risk of failure.

Jiang and Yang (2011) explain the fundamentals, traits, and uses of cloud computing. They also examine the drawbacks of bank information systems and identify novel uses for cloud computing. They think that with the help of cloud technology, commercial banks will have enormous development potential. Researcher Modak and Walke (2013) talked about problems that banks have that need to be resolved before going cloud-based. Additionally, this paper highlights a few unresolved issues with cloud platforms, such as mobility, elasticity, and deployment. A few solution techniques are provided in the paper, including firewalls, honey pots, and intrusion detection systems (IDS). Awn and Ghilan (2021) carried out a survey on the adoption of cloud computing in the banking industry. It discusses the various adoption models for cloud technology, security, and privacy in

banks, and it chooses the best model for cloud adoption in banks. [Asadi and Yadegaridehkordi \(2016\)](#) in their study conclude that perceived usefulness, perceived ease of use, cost, attitudes toward cloud and trust significantly influence users' behavioral intention to adopt cloud computing. The study concludes that the banks enable to focus more on customer perspectives on cloud-based applications and identify their attitude towards their adoption. In their research, [Alexandru et al. \(2013\)](#) examine and contrast a number of the most widely used online banking platforms while also analyzing the Romanian online banking industry. Include conclusions about this cloud computing market as well. Analysis results indicate that Internet banking needs to be redesigned to be more flexible and efficient in meeting customer needs. They noticed that cloud services are the answer to organization demand. [Tesema \(2020\)](#) seeks to determine the difficulties and concerns related to security, privacy, and availability of cloud computing in Ethiopia's Commercial Bank. Using case studies of major banks, the researchers employed a descriptive methodology to investigate and evaluate the role of cloud computing in Ethiopia's commercial banks that generate robust and economical solutions to the present issue. Major factors like cost-effectiveness, security and compliance, reliability, interoperability, and regulation have an impact on cloud adoption in CBE. After stating that the global economic crisis has affected Russia's banking system, [Bataev \(2017\)](#) addresses the use of cloud technologies by Russian banks. The essay also examined the fundamentals of cloud computing and examined the variables influencing cloud adoption in Russian banking. The results of this study show that over 52% of Russian banks do not use cloud services, and that the country's banking sector is implementing cloud technology rather slowly. In the study, [Beju \(2014\)](#) provided an overview of cloud computing and suggested a business plan to lessen the constraints of cloud-based technologies. Examine the shortcomings of the current banking system as well as the creative ways that cloud computing is being used in banks. The difficulties in adopting cloud computing, including those related to security, regulatory compliance, data segregation and privileged user access, long-term viability, and recovery, were also covered in the paper. A survey on cloud computing adoption in the banking sector was conducted by [Awn and Ghilan \(2021\)](#). It addresses the different models of cloud technology, security, and privacy adoption in banks and selects the most effective model. Furthermore, our paper explores challenges and optimal methodologies associated with cloud computing adoption in the banking sector. The study's conclusion is that the TOE model was identified as the common model across studies that had an impact on banks' adoption of cloud computing.

[Nedelcu Bogdan et al. \(2015\)](#) highlight the current status of the cloud computing infrastructure. Answer the question, "Is cloud computing safe?" by weighing the benefits and drawbacks of the security system. Highlight the advantages of cloud computing security. Discuss the many cloud service models, cloud computing security issues, and complex data security issues in the cloud. Discover ways to protect data in the cloud and its advantages, disadvantages, and possibilities.

From the above previous empirical investigations of various studies, we could able to understand the use and adoption of cloud computing in the banking sector. This technology more useful to the banks to full the requirements of customer expectation, as a result of technological advancement. The above studies are proved that the benefits and challenges of cloud computing technology adoption in the banking sectors. Some studies address the different models of cloud technology which is more effective models. Studies identified major factors that have an impact on cloud technology adoption in banking sector.

3. Model of Cloud Computing

To put it simply, the cloud is an international network of distant servers that store resources data, and applications. Through the internet, businesses can easily and instantaneously access computing resources, eliminating the need for physical infrastructure. This removes the requirement for large hardware investments and on-site data centers. Financial institutions can switch from a capital-intensive strategy to a more adaptable business model with lower operating costs through cloud service models. The best cloud services model for the business is the key to success. **Figure 2** shows that various cloud computing such as service models, deployment and operations. In their study, [Elzamly et al. \(2019\)](#) developed a model for cloud computing adoption in the management of electronic banking systems. The adoption of the cloud computing model for managing electronic banking systems can be divided into four stages: technological, organizational, environmental, and operational (TOE + operational). The likelihood that cloud e-banking will succeed in banking organizations will increase significantly with the effective adoption of the cloud computing model for managing E-banking systems. [Islam et al. \(2015\)](#) suggest a modular banking system with a straightforward, effective load allocation algorithm as well as private cloud architecture for the banking industry. Upon conducting a comparative analysis of the proposed model, the findings indicate that private cloud computing guarantees data confidentiality, lower costs, central data processing and scalability, enhanced data integrity and reliability with minimal overhead, effective resource utilization, and accessibility to low-income customers. Below **Figure 2** shows the model of cloud computing.

3.1. Cloud Service Delivery Models

According to [Sunami \(2017\)](#), weigh the advantages and disadvantages of the current core banking systems and compare the design architecture of the cloud-based core banking system with bank architectures currently in place. Additionally, the researchers proposed architecture for a cloud-based core banking system that can be used to automate a range of cloud-based banking services. The study's findings indicate that critical systems' security issues may need to be discussed with vendors, which may limit some applications to the IaaS or PaaS models.

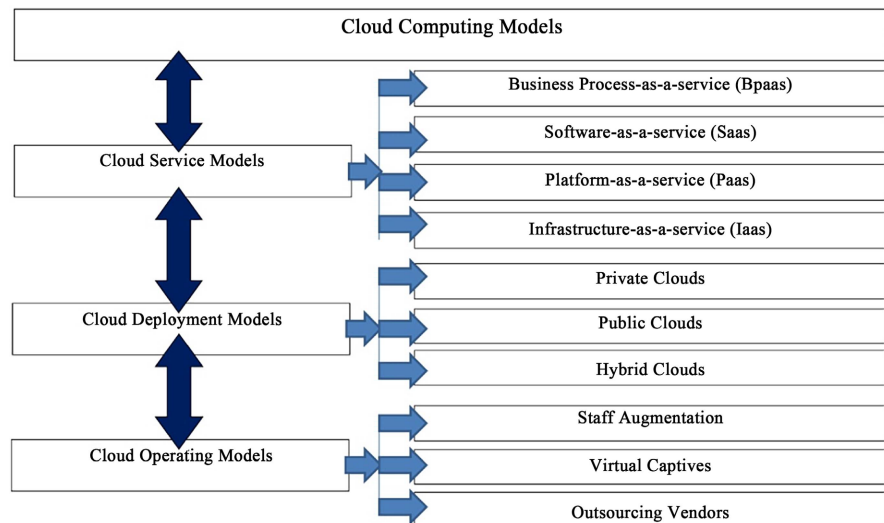


Figure 2. Model of cloud computing. Source: Capgemini analysis 2011. Own work.

However, there are certain drawbacks to cloud computing, like expense and security. **Figure 3** depicts that the cloud service delivery models used to four path.

First model, Business Process-as-a-Service (BPaaS): According to Lara Greden, research director at Platform as a Service at IDC, “the fundamentals of cloud technologies and public cloud PaaS providers as strategic partners to enterprises and companies of all sizes are evident as AI pervasiveness strengthens.” Billing, payroll, and human resources are all common business processes that are carried out in the cloud. All of the other service models are combined with process expertise in BPaaS. With the help of second model **Software-as-a-Service (SaaS)**, users can access the business software and data through their web browsers, which are hosted by a cloud service provider. Accounting, customer relationship management, enterprise resource planning, invoicing, human resource management, content management, and service desk management are examples of software that can be delivered this way. Third model named as **Platform-as-a-Service (PaaS)**, a complete platform for application, interface, and database development, storage, and testing is provided by a cloud service provider. By streamlining the development, upkeep, and support of custom applications, businesses can cut down on IT expenses and use less hardware, software, and hosting environments and from the fourth model **Infrastructure-as-a-Service (IaaS)**, lets businesses buy resources like servers, software, data center space, and network equipment as a fully outsourced service instead of buying them themselves.

3.2. Cloud Deployment Models

From the below **Figure 4**, we could be able to understand that there are three ways service providers most commonly deploy clouds:

3.2.1. Public Cloud

It’s an internet-based cloud infrastructure shared by several organizations under

	IaaS	PaaS	SaaS	BPaaS		Owner	Operator	Operating Model
LOW	PUBLIC CLOUDS					Service Provider	Service Provider	Outsourcing Vendor
Level of Control	HYBRID CLOUDS					Bank	Service Provider	Virtual Captive
HIGH	PRIVATE CLOUDS					Bank	Bank	Self - Augmentation
	Cost Driven	Business Driver		Value Driven				

Figure 3. Cloud service delivery models: How much control? Source: Capgemini analysis 2011. Own work.

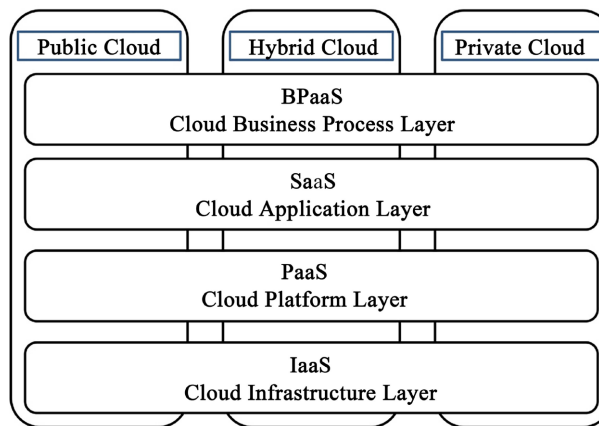


Figure 4. Cloud service and deployment models. Source: Capgemini analysis 2011. Own work.

the management of outside cloud service providers. All hardware and software are owned and managed by the cloud provider, and subscriptions are used to gain access to this space.

3.2.2. Hybrid Cloud

In this scenario, banks have access to both private and public cloud infrastructures, enabling data and applications to move back and forth between them. Less important data is kept in a public cloud area, whereas sensitive data is kept in a private one. At the moment, 78% of business used a hybrid cloud strategy because they understand that the particular requirements of financial institutions cannot be satisfied by depending only on a private or public cloud. A hybrid cloud combines the control and security of a private cloud with the scalability and flexibility of a public cloud (Twarogal, 2024).

3.2.3. Private Cloud

Managed within a private network, a private cloud is built specifically for a single

financial institution. It may be hosted by a third party or kept in the bank's own data center. Private clouds are generally advised for banks due to their increased control over security and data.

3.2.4. Public Cloud Services: Worldwide Revenue

The first half of 2023 (1H23) saw \$315.5 billion in worldwide revenue for the public cloud services market, up 19.1% from the same period in 2022, according to new data from the International Data Corporation (IDC) Worldwide Semiannual Public Cloud Services Tracker.

From the below **Table 1**, we could be able to understand clearly Software as a Service (SaaS) applications, which accounted for almost 45% of all revenue from public cloud services in 1H23, remained the main source of income. The second-biggest revenue category was Infrastructure as a Service (IaaS), accounting for 20.4% of the total. Platform as a Service (PaaS) and Software as a Service-System Infrastructure Software (SaaS-SIS) contributed 18.0% and 16.9% of the total revenue, respectively. The categories with the fastest revenue growth year over year were PaaS and SaaS-SIS.

Table 1. Worldwide public cloud services revenue and year-over-year growth, 1H 2023 (Revenues in US\$ billions).

Deployment Category	1H23	1H23	1H22	1H22	1H23/1H22
	Revenue (\$)	Market Share (%)	Revenue (\$)	Market Share (%)	Growth (%)
IaaS	64.4	20.4%	55.1	20.8%	16.9%
PaaS	56.8	18.0%	44.5	16.8%	27.7%
SaaS—Applications	141.2	44.7%	121.9	46.0%	15.8%
SaaS—Sys. Infra. Software	53.2	16.9%	43.3	16.4%	22.7%
Total	315.5	100%	\$264.8	100%	19.1%

Source: IDC worldwide semi-annual public cloud services tracker, 1H2023, November 30, 2023.

With 41% of global revenue coming from the top 5 public cloud service providers (Microsoft, Amazon, Web Services, Google, Sales force Inc., and Oracle), the top providers of public cloud services held onto their positions in 1H23. This revenue growth was largely consistent year over year. Microsoft maintained its leading position in the public cloud services market in 1H23 with 17.1% share, followed by Amazon Web Services with 12.6% share, both of which had offerings in all four deployment categories.

Global revenue from public cloud services is expected to reach \$663 billion in 2023, up 20.0% from 2022, according to IDC forecasts. A comparable increase is anticipated in 2024. It is anticipated that the market will grow at a five-year compound annual growth rate (CAGR) of 19.4%, with global revenues expected to reach \$1.34 trillion in 2027, despite a slight slowdown in growth over the forecast period.

3.3. Cloud Operating Models

The third aspect of choosing the right cloud services delivery model is determining

the appropriate operating model for the required mix of resources and assets. From the above **Figure 2**, we could be able to identify clearly three operating models for cloud services.

3.3.1. Staff Augmentation

Financial firms can gain cloud expertise by hiring people with the right skill sets from service vendors. The additional staff can be housed in the firm's existing offshore captive center. This operating model allows for flexibility and lets firms choose the best resource for each specific requirement.

3.3.2. Virtual Captives

Virtual captives have a dedicated pool of resources or centers to help with cloud operations and meet demand. This operating model is a good alternative to a complete outsourcing approach.

3.3.3. Outsourcing Vendors

This approach uses offshore centers, facilities, and people from a third-party vendor to handle cloud operations. The model combines resources and investments to cater to cloud services for multiple banks.

4. Cloud Computing: Best Practices

According to a poll by O' Reilly, cloud computing is rapidly permeating every industry and is already used by 90% of organization. By 2025, it's predicted that the total amount invested globally in cloud-based services will exceed 1.12 trillion euros (Twarogal, 2024). Scaling, maintaining compliance, and managing an agile business are all made simpler by operating in the cloud. Businesses in all industries are gravitating toward cloud-based systems due to their recognition of the enormous opportunities; the banking sector is no exception. However, there are more moving parts involved in a cloud environment than first meets the eye. It should come as no surprise that banks proceed cautiously and take their time figuring out this complex process. This is especially helpful for recently established digital banks and fintech companies to develop their business plans and catering technology to its customers (Schou-Zibell, 2023). Moreover, the benefits of cloud computing for banking, as well as the challenges in adopting cloud computing and providing a solution for it, since security and privacy become the primary concerns in cloud computing for banking applications.

The banking industry has been comparatively slow to adopt cloud-based services, in contrast to other industries that have done so quickly. While most banks are just getting started, some are making headway on their cloud journey. In any case, to stay competitive, promote innovation, and streamline operations, financial institutions need to embrace new technologies. Not surprisingly, eighty percent of senior bank executives worry that their company's survival may be in jeopardy if these changes are not implemented. Banks move forward the cloud in a methodical but steady manner. 72% of global banks think it will enable them to meet their objectives. But only 13% of financial services industry leaders have

moved their data to the cloud. Theoretically, bank customers can benefit from a variety of opportunities when they adopt cloud-based applications (Huang et al., 2011). In practice, most bank customers still have cold feet towards the adoption of banks' cloud-based applications as they still prefer to use the existing client/servers' solutions offered by these banks (Benton, 2010).

4.1. Lower Infrastructure Cost

Using cloud computing in banking removes the need for spending on infrastructure, security, and storage maintenance. Consequently, there's no need for a special team to handle these tasks, freeing up resources for other pressing business priorities. According to the Economist Intelligence Unit report, cost reduction is the biggest driver of cloud adoption, with 42% of respondents citing this as a key factor.

4.1.1. Improved Agility

Bank operations are revolutionized by cloud computing. By simplifying procedures and giving users immediate access to software updates, it increases their agility and responsiveness to changes in the market. According to a Capgemini survey, 78% of banking executives believe that implementing cloud computing can improve the flexibility and productivity of their companies.

4.1.2. Efficient Processing

One of the main advantages of cloud-based hosting is its effortless resource scaling. A company that builds out its cloud infrastructure also inevitably grows its applications and services while catering to its current clientele. The cloud system in this case needs to be scalable to meet these changing requirements. By automatically adjusting resource allocation to changing workloads, auto-scaling further streamlines this process and ensures optimal performance without the need for manual intervention.

4.1.3. Operational Efficiency

By automating routine tasks like backups and updates, cloud technology reduces human error and manual labor while increasing operational efficiency.

4.1.4. High Availability for Improved Customer Service

Banks can now provide their clients with convenient, anytime, anywhere access to banking services through mobile or web applications thanks to the cloud. High Availability (HA) techniques make sure that these services keep running even in the event that some of their components malfunction. After all, accessibility is paramount in the modern digital world.

4.1.5. Serverless Services

Banks can take advantage of cloud-based server less services, which provide easily scalable, affordable, and on-demand solutions. Developers can relax about infrastructure with server less computing, since the cloud service provider takes care of resource management, scalability, capacity, and patching.

4.1.6. Flexibility and Scalability

Cloud banking makes it possible to allocate computer resources quickly, allowing for prompt responses to demand spikes. Cloud infrastructure has the flexibility to grow services or storage without being limited by a lack of physical resources, allowing it to scale elastically to accommodate varying workloads. Additionally, banks are able to reduce resources when not required, which optimizes expenses and allows for a degree of agility that is challenging to achieve with on-premises systems.

4.1.7. Enhanced Safety

Prominent cloud providers, in contrast to popular belief about cloud vulnerability, employ sophisticated security procedures that are outside the purview of individual businesses. Strong access controls, data encryption, network security, controls at the application level, and sophisticated threat detection are a few of these. Additionally, cloud providers conduct thorough penetration tests and compliance audits. Banks can take advantage of cutting-edge security while lessening their internal security burden by utilizing the cloud.

4.1.8. Competitiveness and Innovation

For banks, cloud computing scalability and flexibility are essential tools for fostering a culture of ongoing innovation. Banks can allocate resources dynamically to create and introduce new digital banking products by utilizing cloud services. Because of their agility, banks are able to quickly prototype and test proofs-of-concept and improve their services in response to real-time customer feedback. The cloud facilitates this iterative approach to product development, which speeds up the rollout of improved services.

4.1.9. Business Uninterruptedness

Cloud computing spreads data across several geographically dispersed data centers, improving a bank's business continuity and disaster recovery capabilities. By doing this, operations are guaranteed not to be disrupted by nearby events, ensuring continuous service availability. In order to reduce downtime, cloud providers also include built-in redundancy for crucial systems. Banks can strengthen their reputation for stability by offering dependable access to banking services through the use of the cloud.

4.2. Cloud Computing: Challenges

The banking industry is still quite concerned about cloud technologies. The most important of these concerns are security, privacy, data location, data integrity, confidentiality, availability, and user trust (Bose et al., 2013; Rani & Gangal, 2012). According to Catteddu and Hogben (2009), barriers such as data privacy and data security are the major hindrance of SaaS adoption. Banks are categorized as a very high-risk level and sensitive organizations (Jain & Bhardwaj, 2010). Because cloud computing denies users direct control over the systems handling their data, cloud-

related anxieties may surface (Shekhawat & Sharma, 2011). Naturally, banks want to store more data on “the cloud” in order to reduce resource consumption and increase revenue. However, more data means more potential for misuse when it comes to “cloud” storage. Many banks will be hesitant to decide because of this predicament. Data security is of utmost importance in banking; moving workloads to a shared architecture will undoubtedly raise the risk of unauthorized access and data leaks. In addition, many financial executives have doubts and concerns because of the cloud computing concept that emphasizes “users do not need to worry about the physical location of the data but only to care about how to use” (Zhang, 2010). It is challenging to win banks’ confidence in cloud computing if the “security” barrier is not overcome as quickly as feasible.

Public cloud providers are aware of their clients’ worries about accessibility and security. In certain jurisdictions, regulatory requirements dictate the location of data storage, so adhering to these requirements may limit the selection of cloud providers capable of fulfilling these requirements.

4.2.1. The risk of Budget Overruns Benefit

It’s common for the expenses associated with implementing and sustaining cloud services to be unforeseen and underestimated. Moreover, at least half of the banks encountered cost overruns in comparison to their original estimates in crucial areas like legislation, departmental support, re-architecting, and external contractors. This demonstrates the difficulty financial institutions have in precisely calculating and controlling the expenses related to cloud adoption.

4.2.2. Control and Governing

It can be difficult to maintain governance and control over IT resources in a cloud environment. To manage cloud resources, guarantee appropriate oversight, and uphold compliance with internal and external policies, banks need to set up explicit policies and procedures. Banks should use DevSecOps tool chains and cloud management platforms to further improve governance by offering continuous compliance, centralized control, and automation across hybrid cloud environments.

4.2.3. Data Migration Complexity

A significant amount of data is generated by banks. It can be difficult and time-consuming to move everything to the cloud and guarantee its portability across various cloud service providers. Nine out of ten companies are thought to struggle with cloud migration. Although it can take up to 15 months on average, larger banks should anticipate much longer wait times.

4.2.4. Integration with Legacy Systems

It can be difficult for banks to smoothly integrate their legacy systems with cloud solutions. It can be challenging to ensure compatibility between the new cloud environment and the antiquated system. Legacy systems frequently use antiquated operating systems, programming languages, and technologies that may not be

compatible with cloud infrastructure. It is very difficult to achieve this integration without any problems.

4.2.5. Customer Service Disruptions

On the other hand, the unrelenting pursuit of high availability might present unique difficulties. Relying only on a vendor for redundancy assurance could result in problems like service disruptions, downtime, and disagreements over contracts. This may have an effect on the smooth provision of services to clients and jeopardize the advancements in client care.

4.2.6. Risk of Non-Compliance

Because these services are public and multi-tenant, they may not be appropriate for critical banking applications, despite their power. Banking executives are concerned because navigating the complex regulations governing the finance industry becomes even more difficult in the cloud. If cloud migration isn't approved by regulators, there could be penalties and harm to one's reputation. Additionally, with programs like the General Data Protection Regulation (GDPR), open banking, Know Your Customer (KYC), and anti-money laundering, international regulators are adopting a more proactive stance.

4.2.7. Threat Landscape for Cyber-Security

The dynamic nature of the cloud and its widespread accessibility can introduce new vulnerabilities and potential attack vectors, even though cloud providers generally offer strong security features. To safeguard consumer data and uphold the integrity of their financial services, banks must constantly update their security procedures and remain alert to new cyber-security threats. Furthermore, banks can proactively fortify their defenses throughout their cloud ecosystem by implementing a zero-trust strategy that is strengthened by analytics-driven threat detection and automated response capabilities.

4.2.8. Problems with Latency and Performance

Latency problems can impact the performance of cloud-based applications, especially if cloud data centers are situated distantly from end users. Banks must make sure that the cloud architecture they have chosen minimizes latency for vital applications, particularly transaction systems that demand real-time processing. Low latency and consistent performance can be achieved by combining edge computing, distributed caching, predictive scaling, and sophisticated traffic monitoring tools for traffic management.

From the above discussion, how it performs best practices of cloud computing adoption in the banking industry. It concludes that the banking sector enjoys cost, enhanced agility, operational efficiency, improved customer satisfaction, safety and innovation. Even though, banking sector facing challenges such as complexity in data migration, cyber security issues, disruption in the customer service and non-compliance issues when it adopts cloud computing.

5. Conclusion

Financial institutions that embrace this shift will be more equipped to use new technologies, adjust to shifting market conditions, and add value for customers and stakeholders. Cloud computing has revolutionized the banking industry by enabling flexibility, efficiency, and innovation in a rapidly evolving digital landscape. Without the use of cloud-based services, financial solutions for individuals and businesses are unlikely to see prosperity and upward mobility. Cloud computing increases operational efficiency and scalability, enhancing digital capabilities and providing more affordable and easily accessible financial services. The purpose of this paper is to conduct a framework survey of previous studies on cloud adoption in the banking sector. The primary subjects of this study are also the adoption of cloud computing, security, and privacy in connection to cloud adoption in banks. Our study also looks into cloud computing models in addition to issues and best practices surrounding cloud computing adoption in the banking sector. Because of previous framework research results, banks are now using shared computing and data storage resources, hosted and run on remote servers in the cloud, to increase flexibility rather than investing in their own on-premise servers. Software as a Service (SaaS) providers typically handle security, updates, and maintenance, which reduces upfront and recurring costs. Axis Bank, Kotak Mahindra Bank, TymeBank in South Africa, Cantilan Bank in the Philippines, and ICICI Banks in India are among the banks that operate exclusively on a secure cloud-based infrastructure network, which lowers costs and boosts customer satisfaction. Banks are expected to adopt private clouds as their cloud service deployment model because they give them complete ownership and control over their cloud systems.

Cloud computing makes it easier to report and allows for more efficient use of staff resources. Customers who live in remote areas may find additional solutions from cloud-based services. These solutions also help to create more seamless experiences by lowering entry barriers. Improved data security, reduced infrastructure costs, effective processing, enhanced agility, better customer service, serverless service, flexibility and scalability, increased safety, increased operational efficiency, competitiveness and innovation, and simple access to software applications are just a few of the advantages that cloud technology brings to financial institutions. Furthermore, cloud computing offers users' online access to servers, storage, networks, software, analytics, and an elastic, scalable, and on-demand service.

However, there are also unique challenges that banks must carefully consider and address, such as latency, data residency, resilience, IT infrastructure faculties leads to security risks, inefficiencies, and inflexibilities when it adapts to the changing needs of customers. Notwithstanding these benefits, there are drawbacks to cloud computing adoption in the banking industry, including issues with data privacy, regulatory compliance, and legacy system integration.

Banks should select service and delivery models that best meet their needs for

cost savings, operational flexibility, and pay-as-you-use when organizing cloud computing projects. To ensure a successful cloud computing migration, banks need to develop implementation strategies tailored to each of these variables. Such a strategy depends on the unique regulatory environment, security considerations, and legacy system integration. When it comes to cloud computing services, banks should take a step-by-step evolutionary approach, assessing each project according to the kind of application and data involved. The implementation of cloud computing would be more beneficial to banks and their clients, enabling them to carry out their streamlined operations in a successful manner.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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