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Chapter 1: Tracing the digital evolution of core banking infrastructure in the face of emerging technologies and changing regulatory frameworks

1.1. Introduction

Our goal is to articulate the transition of the core banking infrastructure from a traditional on-premise existing world into a digital first world, where both the digital and physical branches integrate and complement each other. We describe key areas for successful implementation of this digital evolution - APIs for integration of services across banking and non-banking solution providers, convergence of Digital Banking app with Digital Front-end systems, and embracing of advanced and emerging technologies – a next generation public cloud infrastructure to create new banking business models, data analytics as the operating system to offer more personalized products and services, and blockchain technology to develop a new financial services ecosystem (Brynjolfsson & McAfee, 2014; Iansiti & Lakhani, 2020; Marr, 2020).

We recognize that the incumbent banks have huge investments into their existing core banking systems which do not get amortized overnight. Hence, a successful evolution must start with a clear definition of how the evolving bank will look like, engaging with both customers and employees, and will lay the foundation for a vision based and customer-centric unified strategy involving both flexibility and agility to support customized and innovative deposit and lending products and solutions. Bank's treasury, risk and compliance must be aligned to digital evolution while sustaining focus on customer acquisition, retail and wholesale funding, customer and product profitability, liquidity and asset quality, risk-adjusted return on capital and improving operational efficiency.

Advances in technology have the power to change the core operating model for banks, which if used effectively, may materially benefit from economies of scale and efficiencies from automation. Data-driven insights along the banking value chain can allow for product development tailored to consumer preferences, risk pricing models

which take into account both the likelihood of default as well as loss given default, real time credit decisioning powered by artificial intelligence, and a 360° customer view enabling the cross-selling of banking and non-banking services – mutual funds insurance, pensions which can drive up customer lifetime value (Ross, 2016; Tapscott & Tapscott, 2016).

Fig 1.1: Digital Evolution of Core Banking Infrastructure

1.1.1. Big Data Analytics

Today's world is full of data, mostly unstructured, which needs to be further organized or processed to meet business needs and model predictions. Big data solutions are primarily based on cloud infrastructures and frameworks. These frameworks are built on strong core enabling data collection and pre-processing; extensive exploratory data analysis; state of the art models implementing both traditional models and cutting-edge deep-learning-based learning models; and deployment of models with live monitoring of prediction performance.

Modern IT solutions and banking services need to be based on data-driven decisions and end-user requirements. Customers today have varied behavioral patterns with respect to

transactional frequency, channel usage, financial well-being, and risk appetite. Various demographic aspects of customers have also become some of the defining value generators for banks and financial institutions. A customer-centric approach is expected to be the key factor in determining the future performance of any surviving bank. Banks are aggregating information about their existing customers and analyzing data related to customer behavior through advanced customer segmentation and targeting models. Such statistically driven merchandise and marketing campaigns will help banks churn more returns from their existing customer framework. The analysis of big data also helps banks in improving and enhancing their next-generation banking services through recommendation engines and next-best action tasks defined by predictive models. Cross-selling of services, targeting of advertisements, and marketing efforts can be vastly improved through model outputs. Global banks are also using big data analytics for campaigns, both to bolster customer experience and achieve stickiness through customized offers.

1.2. Historical Overview of Core Banking

The term core banking refers to services offered by a group of networked bank branches addressing areas of work such as deposits, loans, payments, and credit cards. The origin of the core banking concept dates back to the 1980s, with the evolution of the work model of bank automation, which was mostly focused on back-office operations – at the time, almost solely composed of centralized units for final settlement of payment operations initiated at bank branches. Its introduction in banks in developed countries enabled major improvements to be made to their operations, in a context of strong growth of demand for banking services and significant barriers to entry for new competitors. This context led to a period of extreme profitability for banks in developed countries, with significant capital accumulation. Banks then gradually started to decentralize their payment operations to their branches, as these operations became standardized. This stage of bank automation mainly focused on enhancing the technological infrastructure of banks, by introducing computerized batch processing systems, serving a centralized database and replacing the then-paper-based, manual processing systems that were used to handle high volumes of payment operations.

In parallel to this, banks licensed more complex front-office applications from specialist software vendors, who had developed systems focusing on the fulfillment of specific banking products, such as ATMs, mortgages, loans, bank credit cards, merchandise and utility vouchers, and to a lesser extent on deposits. Management of core processes such as marketing, relationship management, work scheduling and monitoring, negotiations, and decision making was carried out separately by each bank department in disparate, poorly integrated systems, relying on homogeneous databases and data architectures.

These applications evolved over the course of the 1990s as demand products became increasingly commoditized and generic. VRKs and bank account market shares became vital differentiating factors, along with rental fees on electronic distribution networks.

1.2.2. Cloud Computing

Cloud computing can be thought of as the process of shifting the management of computing services from traditional on-premises data centers to a shared, globally distributed computing platform. The explosion in the availability of affordable, globally distributed, shared resources has been a transformational force for modern computing, and the cloud has made modern application development and deployment faster and less expensive than ever. Cloud service providers provide building blocks that allow developers to develop, test, and deploy solutions without worrying about many of the mundane tasks associated with both traditional on-premises data centers and also the initial configuration of the cloud infrastructure.

Cloud computing facilitates easy access to virtually limitless amounts of flexible, pay-as-you-go shared computing resources. There are three main models for utilizing cloud services, which are classified based on who manages the cloud service. Infrastructure as a Service (IaaS) allows developers to access computer instances running on physical servers managed by the cloud service provider. In this case, developers are responsible for applying patches and managing the configuration and security of the application stack. Platform as a Service (PaaS) manages the hardware and the operating systems and provides developers with development frameworks for building applications. While developers are responsible for application security, the underlying components are kept secure and patched by the provider. Software as a Service (SaaS) is completely managed by the cloud provider, which means that application security and management is handled by the provider. The consumer of the service simply accesses the software over the Internet.

1.3. Emerging Technologies in Banking

Emerging technologies will reorganize the agenda of all banks. They will allow them to smoothly integrate new services to their clients, which will need to be offered as platforms accessible inside and outside the banking organization. These capabilities would favor the swift integration of banking services into third parties' products with which clients interact every day and outside the traditional bank interface. This trend will stretch the relevance of banks into extreme niches, like the custody of assets, without guaranteeing profits, as banks today remain critical and necessary for day-to-day operations. Therefore, the banking services chain would migrate from banks to non-

banks. These technological platforms are based on a group of enablers like AI, blockchain, Big Data, Cloud, etc.

AI and Machine Learning would be the most disruptive force affecting banking organizations. It would allow banks to internally reinvent their competitive advantages, like credit risk evaluation, prevention of fraud, anti-money laundering, or trading. Externally, it would allow banks to know what their customers want at each point of their lifecycle. AI is the application of big data, cloud, and computing power enhancement to automation. This means proposing software programs that automate specific tasks which previously required human intelligence. The human-like abilities leveraged by AI include sounding like a person, talking like a person, and seeing like a person. These capabilities allow banks to automate many services performed by their trained personnel. It is worth highlighting that these new developments reduce by much the barriers to entry into the bank's business for non-banks. Today any company is able to build a service close to any bank's service.

Fig 1.2: Emerging Technologies in Banking

1.3.1. Artificial Intelligence and Machine Learning

The use of Artificial Intelligence (AI) in the Banking Sector is not novel. Banks have been using rule-based systems for several decades, such as developing rules to filter email spam or utilizing fuzzy logic to assess loan risks. However, the recent contribution of machine learning, which combines developers' efforts to design algorithms with the availability of vast amounts of data and computational capability, has led to remarkable success in areas such as vision and speech recognition. These successes have spurred the long-predicted development of "smart banks" and "robo-advisors." By the end of 2016, a significant percentage of the wealth of clients with less than one million dollars was managed by banks, but only a portion had been willing to pay for that service. Robo-advisors are already competing with traditional banking for low-end clients.

Currently, machine learning programs are widely used to improve the efficiency and effectiveness of banks' IT processes in several ways. AI algorithms are being employed for robotic process automation to eliminate or reduce repetitive tasks performed by numerous banking employees, such as gathering KYC, Anti-Money Laundering, and customer compliance information. There is a push for the transition from rule-based systems to machine-learning programs in order to improve predictive capabilities in financial applications. These include detecting at an early stage possible defaults by clients and those anticipative models used to recommend banking products that best satisfy clients' needs of a certain profile.

1.3.2. Blockchain Technology

In October 2008, an anonymous person, or possibly a group, under the pseudonym introduced blockchain technology. Blockchain was introduced as a trustless and decentralized infrastructure to stop the double-spending solution for the cryptocurrency. Since then, several notable cryptocurrencies have been launched on this blockchain. Bitcoin blockchain technology is a "public permissionless" blockchain. This means that this blockchain is a distributed system with no central trusted authority managing it. In addition, anybody can submit transactions to this blockchain to be recorded. Transactions are centrally managed and are tamper-proof once added to the blockchain.

In 2013, a paper was published describing the key important features of the Bitcoin blockchain. In addition, the term "blockchain" was introduced to describe the underlying technology for Bitcoin. Blockchain is a distributed database that is shared among the nodes of a computer network. Transactions stored in a blockchain on the network are approved and verified by each participating node. Group transactions are secured and bound into the block using a cryptographic hash function. Each block contains a unique hash of the previous block, timestamps, and transaction data. These blocks are then

linked together to form a chain-like structure. New blocks are added through a consensus mechanism to ensure integrity and security. These new blocks are immutable as only the authorized nodes can modify or delete them.

1.4. Regulatory Frameworks Impacting Core Banking

The banking sector's transformation from an analog system run on paper sheets to a futuristic digital system was necessitated by the changing banking environment at the global level. The banking sector was hit hard in the aftermath of the worldwide financial crisis, due to the overly lax banking regulations that had developed over the years. Post-crisis, decisions were taken to reform the structure of regulation and increase the capital base as well as the level of capital adequacy of the global banking system. Therefore, the global regulatory framework to which all banking systems have adhered was enhanced. Banks, whether building conventional infrastructure or digital, need to ensure regulatory compliance at all levels of their operation.

The framework provides a comprehensive set of reform measures to improve the resiliency of banks and the banking system. It sets out stricter capital requirements in terms of quantity, quality, and composition of capital in the banking system and aims at promoting the use of risk-weighted capital. Regulatory bodies across the globe have emphasized that banks adopt the latest technological innovations in risk mitigation practices. Digital technology will not only allow banks to replicate existing best practices but at the same time enable them to promote the smarter use of risk solutions. Banks can use digital means to promote high-risk factors and reduce monitoring and management costs while leveraging machine learning to do real-time risk factor pricing. Cybersecurity is of utmost importance in a digital world. Banks can use technology to develop protection against external cyber threats to the digital base of their operations. However, cybersecurity is all for nothing if banks do not develop a risk culture and if employees do not feel generally responsible.

1.4.1. Basel III and Its Implications

The banking risk management and reporting framework was developed as a result of the financial crisis that evolved between 2008 and 2011, wherein several financial institutions became insolvent, and banks and governments incurred huge losses in order to save financial institutions and the economy. became ineffective as a result of the crisis, which is why it was developed as a more stringent framework for banks around the world; it will replace , and its implementation will take effect in 2018 to 2022. was amended by and . Within the framework of , banks are obliged to keep enough liquidity on their balance sheet in order to be able to survive serious liquidity funding difficulties;

hence, liquidity risk has to be monitored. In addition to liquidity risk, which has not been part of Pillar 2 of , capital is also required in order to cover other losses in excess of capital under Pillar 1, such as those related to all banking risk types, including credit risk, counterparty credit risk, operational risk, market risk, and concentration risk, among others. The preceding capital requirements are more stringent than and have been introduced in order to prevent contagious shocks within and effects on the economy in excessive amounts; excessive amounts are only allowed for banks that are considered systemically important because they are regulators.

1.4.2. GDPR Compliance in Banking

The General Data Protection Regulation has ushered in a new phase of regulations regarding the use of data, particularly related to financial services that vastly impacts core banking infrastructure. GDPR encompasses four pillars: Principle of Explicability, Principle of Minimization, Right to Rectification, Right of Erasure, Principle of Security, and Right to Data Portability. Financial institutions have to ensure compliance on numerous functions of the infrastructure, address the needs of data confidentiality and security, and allow customers to simply and quickly request and obtain personal data deletion. Banks will also have to make provisions to modify transaction details, such as the address or phone number connected with a transaction.

Decentralized identity systems are gaining traction and will allow institutions and customers to have seamless storage and transfer of personal data. An overextended identity model allows financial institutions the option to outsource data storage and gives customers an option to retract consent at any time. The proposed solution postulates that a user has a universal decentralized identity that is connected with hyper-sharded personal data stored privately and securely, relying on Quantum-Resistant Homomorphic encryption and a decentralized storage platform. Such entities can effectively allow banks and their customers to create a trusted partnership since they are more aware of the data mined or stored by institutions. The performance of financial institutions in implementing the stated pillars must be reflected within their core infrastructure.

1.5. Digital Transformation Strategies

Digital transformation is changing the way organizations do business. Enabling technologies such as cloud computing, big data and analytics, machine learning and artificial intelligence are the driving forces of this transformation. All industries are under digital transformation pressure to be more agile, customer friendly, and efficient, and the banking industry is no exception. The pandemic accelerated the digital economy

and made all customers digitally savvy. Disruptors such as Fintech companies, whose core business models are based on higher customer satisfaction and cost efficiency, are threatening the traditional banks. Traditional banks are no longer the sole players in their game and are losing market share where it counts most — customer acquisition and retention.

The banking industry responded to the digital transformation challenge by investing heavily in technology. Banks and financial institutions worldwide spent about 500 billion U.S. dollars on technology in 2021, including cybersecurity. Many American banks, such as Citibank and Bank of America with the largest technology budgets, doubled down on their technology investments on digital banking experience and cybersecurity. The large technology budgets sound impressive and indicate the banks sensitivity to their digital vulnerability; however, investing on technology without the appropriate vision, strategy or discipline is not a solution — a technology-enabled vision and strategy for digital transformation is.

1.5.1. Agile Methodologies in Banking

Financial institutions are investors and developers of crucial economic and social infrastructures, including the core services and regulations that determine the level of a country's development.

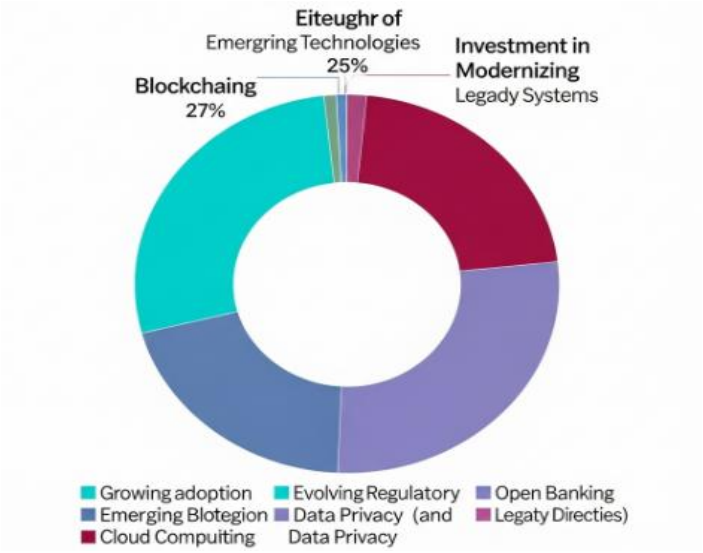

Fig : Emerging Technologies and Changing Regulatory Frameworks

Due to historical and legal limitations, banks have established and maintained massive infrastructures based on core legacy systems to guide and strengthen specialization and

centralization after the crisis of 1929. With the advent of information technology, such as electronic systems, banking has undergone changes in the service and channel systems, thus enhancing the core services that keep back office systems under complete control. However, the basic tenets of specialization and centralization remain; that is, banks take deposits and provide financing through a central banking system. Nevertheless, considering the rapid change in the financial environment caused by globalization, digital technology, and multidimensional financial needs of individuals, the time has come to reevaluate the core infrastructures of banks. This reassessment is required not only for the developing but also for the developed and ultra-developed nations.

The digital technology hype has led to a frantic rush of incumbents and new market entrants flooding the banking industry. Most, if not all, can agree that this is just the beginning of something big; yet no one knows how this development, and much more importantly, the disruption of the industry will actually play out. Banking will go through some deep changes, and incumbents will have to transform into something different. It does not have to be actually a metamorphose, just something that implements more agility. While it is unsurprising to hear from managers that banks have been using Agile methodologies for projects for years alone, everybody acknowledges that it is not sufficient to become agile. Implementing Agile projects has not helped banking to mitigate the time-to-market issue.

1.5.2. Customer-Centric Approaches

In order to remain relevant in a world increasingly marked by emerging technologies, financial service institutions today need to be more customer-centric through the use of their vast repositories of consumer data. Digital transformation in banking is thus on its way to a much deeper level, moving from a pure push of innovation on the side of the banks to the need for shaping different customer experiences according to segment and needs; from the capacity to respond to regulatory needs to a much richer perspective in an ecosystem of more diverse stakeholders, including non-financial service firms; and from capitalizing on often inherently inefficient banking processes that have enabled them to be less customer-oriented to a reinvention of the bank's role in the origin-transform-distribute value chain. Moving along this multifaceted transformational journey, the organization remains the emerging bank's additional unseen corner stone. Most banks are still organized along product lines, such as retail; corporate; wholesale; treasury and cash management; cards and processing; and other product and service niches. The organizational structure, along with the group accountability model, usually adds multiple layers between the customer and the executive responsible for the institution's strategy and the pioneers of the retail banking revolution to the C-level.

Without redesigning the product silo mentality that continues to dominate the bank's organization, it will be all too easy to overlook the truly customer-centric priorities, which can vary from market to market and need to be made clear to each employee. And only in those institutions where that customer-centric manifestation is present at all levels will the use of cloud, mobile, biometric, social media, and big data help to create the underlying technology-enabling innovation that consumers have also come to expect from both their bank and the broader industry.

1.6. Conclusion

The banking sector's digital evolution has picked up pace in the recent past and is expected to witness more frenetic activity in the years ahead. Cloud computing, open banking and banking-as-a-service will be key components of the industry transition to digital Capex models driven more by revenue subscriptions rather than lump-sum investments. The pandemic has hastened a number of banks' digital journeys and helped awaken risk-taking spirits within banks that had previously been averse to pursuing a tech-forward, cost-efficacy agenda. In many countries, banks are now among the industry leaders in regards to digital capabilities. However, the newfound tech strength is not simply a matter of IT building digital frontends, but also involves banks' tooling for the digital economy at the Core with API-enabled connections to third-party providers, as well as interconnections between different Lines of Business. These ambitious investments at the Core are transforming Banks to Evolutionary Digital Enterprises; more business units energized by data and backed by the digital tools that will benefit from improved cash management processes, enhanced risk visibility, and more robust product services.

1.6.1. Future Trends

As the financial services industry continues to innovate and undergo disruption, the future landscape of change will advance the digital evolution of banking core infrastructure in significant ways. Examples of what is ahead include the following:

With demand for faster payments on the rise, payments infrastructure and core banking technology infrastructure are converging. Real Time Payments schemes in retail and commercial banking are growing rapidly in terms of transaction volume. The trend toward embedded banking for businesses and consumers is increasingly blurring the lines between banks and non-banks. Bank and fintech partnerships are getting more sophisticated and moving more upstream in depth in what they offer customers. With rapid change comes greater risk, and next generation banking core platforms are enabling bi-modal banking as banks look to modernize experiences while maintaining legacy

systems to meet risk and compliance needs. Use of real-time data and analytics will take center stage as banks look to innovate rapidly and meet the expectations of the next generation of bank customers. Consumer banking continues to soften, guiding more banks to focus on commercial banking. Technology enablement will be a critical factor in the ability of banks to differentiate customer experiences.

The pressures of the 2020s are placing increasing pressure on banks to place acute focus on strategy and change. The burden of regulation; the need for more efficient operations; the demand for new levels of superior customer service experiences – which are no longer benchmarks but minimums provided by companies – have resulted in a "call to arms" designed to define the bank of the future, one which must be a master of modern technology and digital change, and deliver on the promise of customer experience, capability, and relationship. The reward for those banks who successfully navigate this journey will be significant.

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