Framework for Decentralized Data Strategies in Virtual Banking: Navigating Scalability, Innovation, and Regulatory Challenges in Thailand

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Abstract: In the rapidly advancing realm of virtual banking, a robust data strategy is crucial for competitiveness and meeting growing customer demands. In 2025, the Bank of Thailand will be issued three virtual banking licenses, marking a pivotal shift in the financial landscape. This paper outlines key components of a virtual banking data strategy, focusing on real-time service delivery, innovative financial products, enhanced customer support, and strong data governance. This research offers strategic insights into the navigation of these complexities and the driving force of successful digital transformation in the banking sector.

1 INTRODUCTION

In 2024, the Bank of Thailand (BOT) took a major step toward advancing the country's financial landscape by stating that BOT will be granting three virtual banking licenses. The BOT has set stringent requirements for virtual banking applicants, including a paid-up registered capital of at least 5 billion baht. By 2025, these virtual banks are expected to start offering a range of dynamic financial solutions, leveraging technology to streamline services like loan approvals and account management while reducing costs associated with traditional banking infrastructure. We already have seen a number of virtual banking operating in Asia (Curtis et al., 2022) (Nguyen and McCahery, 2020) (Analytica, 2020).

A well-structured data strategy is a critical tool in enabling banks to meet these demands, transforming not only the way they deliver services but also how they design financial products, support customers, and ensure compliance with regulatory frameworks (Hadi and Hmood, 2020). These elements are interlinked, collectively enabling banks to respond to the dynamic needs of the digital marketplace while maintaining regulatory compliance and protecting customer trust (Kraiwanit et al., 2024).

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Financial institutions are increasingly relying on real-time data processing and AI-driven automation to deliver such services, enabling them to meet customer expectations of speed and convenience (Oruganti, 2020) (Mori, 2021). Financial data products represent a new frontier in banking innovation. Using customer data in conjunction with external financial indicators, banks can offer customized solutions that meet individual needs, improving customer loyalty and driving revenue growth (Schatt, 2014) (Boshkov, 2019).

The cost structure of virtual and traditional banking also contrasts sharply. Virtual banking typically has lower operational costs due to the lack of physical branches and automation of most services. This cost-efficiency often translates to lower fees for customers, making it an attractive option for those seeking affordable financial solutions (Chaimaa et al., 2021). Traditional banking, on the other hand, incurs higher operational costs due to the need for physical infrastructure and staff. These additional expenses are often passed on to customers in the form of higher fees, making traditional banking more expensive in many cases (Wewege et al., 2020).

In terms of customer interaction and service delivery, virtual banking is heavily based on digital tools such as chatbots, AI, and email support (Windasari et al., 2022). This can offer quick responses

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to straightforward queries but may lack the personal touch that some customers value. Furthermore, regulatory uncertainty and evolving policies, especially in fintech, could create hurdles for new entrepreneurs looking to operate fully virtual banking models (Nian and Chuen, 2024) (Wewege et al., 2020) (Lehmann, 2020). Furthermore, political instability or changes in government policies can lead to changes in regulatory frameworks, increasing uncertainty for virtual banks operating in the country.

This paper aims to explore these critical elements of a virtual banking data strategy, focusing on how they interconnect to drive competitive advantage in a highly regulated and customer-centric industry. Through an examination of industry best practices, case studies, and technological innovations, we will provide two frameworks for how banks can develop and implement comprehensive data strategies that enable fast services, innovative products, exceptional customer support, and strong governance. In Section 2, we discussed the virtual banking landscape, data strategy, and approaches. In Section 3, we presented distributed concepts for virtual banking focused on key components and critical operational linkages and flows. In Section 4, we present the migration and transformation frameworks for moving to virtual banking. We also discussed the difficulties of moving physical banking toward virtual banking. We then present our highlight in the conclusion.

2 THAILAND VIRTUAL BANKING LANDSCAPE, DATA STRATEGY, AND APPROACHES

The role of data in virtual banking is pivotal, as it underpins nearly every aspect of the service delivery. Unlike traditional banks, which rely heavily on face-to-face interactions and manual processes, digital banks leverage data analytics and AI to personalize customer experiences, detect fraud, and streamline operations. Data enables digital banks to offer tailored financial products, such as personalized loan options or spending insights, based on a customer's transaction history and financial behavior.

2.1 Virtual Banking Approaches

We observed that virtual banking can be constructed through three different approaches: digital native, digital migration, and digital transformation.

1. **The Digital Native Approach** approach refers to banks that are born purely online, with no legacy systems or physical branches. These banks leverage cutting-edge technology, from mobile-first strategies to advanced AI, to provide seamless digital experiences. Examples include fintech companies like Revolut and Monzo, which were designed with internet generation in mind and offer fast, customer-centric services using big data and analytics.
2. **The Digital Migration Approach** involves traditional banks moving their services to digital platforms without completely abandoning their physical operations. This gradual migration helps traditional banks like JPMorgan Chase and HSBC provide digital banking services alongside brick-and-mortar ones, appealing to a broader customer base. These institutions often start by offering mobile banking apps and online portals to extend their services digitally. Research supports this migration as a way to retain long-time customers while attracting tech-savvy users. Migrating to digital platforms requires overcoming legacy system challenges. Still, it allows traditional banks to build on their established trust and brand recognition while slowly transitioning customers to more digital interactions.
3. **The Digital Transformation Approach** involves a holistic revamp of a traditional bank's entire operating model, transitioning from legacy systems to a fully integrated digital framework. This process is more than just digitizing services; it often involves redesigning products, retraining staff, and adopting cloud technologies, AI, and automation. Major players such as BBVA and ING are undertaking digital transformation strategies, which have invested heavily in reshaping their business models around data-driven insights and customer experience. Research indicates that while this approach is more complex and resource-intensive, it allows for the creation of agile, scalable systems that can adapt to changing market dynamics and consumer demands, ensuring long-term competitiveness in the digital banking space

No matter which virtual bank approach is pursued, data strategy is still central to the success of virtual banking, as the entire model depends on the ability to process, analyze, and secure vast amounts of real-time data. Virtual banks operate without physical branches, meaning every transaction, interaction, and customer request must be managed digitally. This requires a well-structured data strategy that ensures efficient data flow, from customer onboarding to transaction processing and service personalization. Virtual banks must prioritize data accessibility, ensuring that all necessary data is available to the right teams at the right time to deliver seamless customer experiences. Additionally, the data strategy must focus heavily on cybersecurity, as digital-first banks are prime targets for cyber threats. Strong encryption, multi-factor authentication, and real-time fraud detection algorithms are key components of a robust virtual banking data strategy.

2.2 Decentralized Data: Components, Linkages, and Flows

Virtual banking operates 24/7 across digital platforms, often processing large volumes of transactions and interactions simultaneously. Since virtual banking relies heavily on AI-driven, real-time analytics for services such as personalized recommendations, fraud detection, and customer support, having a distributed data strategy ensures that these services are not impacted by data silos or delays in accessing critical information. A distributed data strategy like data mesh (Dehghani, 2019) could be an ideal choice for virtual banking due to the decentralized nature of its operations and the need for real-time, scalable data management (Machado et al., 2022).

A data mesh strategy, which decentralizes data ownership to individual domain teams, allows for better scalability and flexibility (Dolhopolov et al., 2024). Instead of relying on a centralized data team, each business unit (such as payments, customer service, or fraud detection) can manage its own data pipeline and infrastructure. This aligns perfectly with virtual banking's need for rapid decision-making, agility in service delivery, and continuous data availability across multiple services. By decentralizing data ownership, virtual banks can ensure each domain has direct access to the data they need to drive improvements without being bottlenecked by a centralized data architecture. We provide key components of a decentralized data platform, such as a data mesh, to illustrate the concept of using it for virtual banking in figure 1.

2.3 Key Components

1. Data Domains & Products: Virtual banking operates with decentralized data domains, each responsible for its own data and producing specific data products:
   - Customer Data Domain: Manages personal and account data, producing customer profiles.
   - Transaction Data Domain: Handles transaction records, creating transaction history products.
   - Fraud Detection Data Domain: Monitors fraud, generating fraud alerts.
   - Product Data Domain: Covers banking products like loans, credit cards, and mortgages.
   - Compliance Data Domain: Ensures regulatory adherence (e.g., KYC, AML).
   - Data Consumers: Various services and stakeholders consume data:
2. Customer Service Teams: Access customer profiles and transaction histories.
   - Fraud Monitoring Systems: Use transaction data to detect fraud.
   - Product Teams: Leverage customer and product data for personalized offerings.
3. Infrastructure Layer:
   - Data Platform as a Service: Scalable cloud infrastructure for data management.
   - Data Governance & Security: Ensures data policies, security, and compliance.
   - Decentralized Ownership: Domains manage their data as products with APIs or catalogs.
   - Cross-Domain Collaboration: Insights are generated by combining data across domains (e.g., transaction data with fraud patterns for risk assessments).

2.4 Linkages and Flows

In the decentralized data domain architecture, each data domain operates independently but remains interconnected through a central infrastructure. Let's break down the key linkages and flows within this system:

1. Central Infrastructure: Data Platform as a Service (DPaaS)

   • Role: The core of the system is the central infrastructure labeled "Data Platform as a Service" (DPaaS). It includes aspects like data governance and security and serves as the integration layer for all data domains.

   • Flows: Each data domain (Customer Data, Transaction Data, Fraud Detection Data, Product Data, and Compliance Data) connects to the DPaaS, where data is securely managed, governed, and potentially processed. This central layer ensures that decentralized data remains coherent, adheres to compliance requirements, and is accessible for broader organizational needs.
2. Data Domains and Their Products: Each data domain produces specific outputs (data products) as a result of the data it manages:

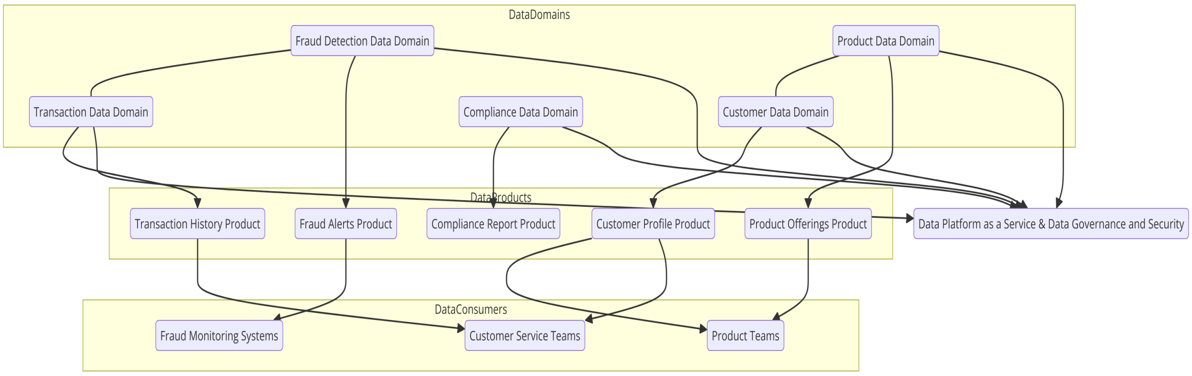

Figure 1: Decentralized.

• Customer Data Domain produces the Customer Profile Product.

• Transaction Data Domain generates Transaction History Product.

• Fraud Detection Data Domain provides Fraud Alerts Product.

• Product Data Domain offers the Product Offerings Product.

• Compliance Data Domain produces the Compliance Report Product.

• Flows: Each of these products flows out of the respective data domains, representing processed and refined data outputs. External teams or systems then consume these.

3. Data Consumers

• The Customer Service Teams are linked to the Customer Data Domain and Transaction Data Domain, consuming the Customer Profile Product and Transaction History Product to improve customer interactions and insights.

• Fraud Monitoring Systems connect to the Fraud Detection Data Domain to consume Fraud Alerts Product for real-time fraud detection and prevention.

• Product Teams link with both the Customer Data Domain and the Product Data Domain, consuming the Customer Profile Product and Product Offerings Product to tailor product development and offerings.

4. Cross-Domain Collaboration

• Dotted or dashed arrows between data domains indicate collaboration:

• Transaction Data Domain and Fraud Detection Data Domain are interconnected, sharing data for fraud prevention. Transaction history feeds into fraud detection mechanisms, allowing for the identification of suspicious patterns.

• The Product Data Domain and the Customer Data Domain share insights to improve product offerings based on customer profiles and behaviors. This enables better product personalization and market targeting.

5. Decentralization but with Centralized Coordination

• While each domain is decentralized and responsible for its data, all domains are connected to the central DPaaS. This ensures coordination without centralizing the data itself. Each domain can operate autonomously, but the shared platform allows for consistent governance, security, and cross-domain data sharing when necessary.

Summary of Data Flows:

• Domain to DPaaS: All data flows into the central platform for governance, processing, and accessibility.

• Domain to Products: Each data domain produces specialized data products that are consumed by various teams.

• Cross-Domain Collaboration: Domains share data (e.g., transaction and fraud detection) to enhance functionality, such as fraud prevention or personalized product offerings.

Virtual banking operates in a 24/7 digital environment, requiring a robust and scalable data strategy to handle the high volume of transactions and interactions. The distributed data approach, such as data mesh, aligns well with the decentralized needs of virtual banking. By decentralizing data ownership to individual domain teams, a data mesh provides scalability, flexibility, and real-time analytics essential for virtual banking operations, from fraud detection to personalized services. Each domain, such as customer data or transaction data, produces specific data products, which are shared across the organization to ensure collaboration and functionality without compromising autonomy. As we move forward, exploring the framework for migration and transformation, it becomes essential to understand how these decentralized structures can transition from traditional to virtual banking.

3 MIGRATION AND TRANSFORMATION FRAMEWORKS

Migration from a centralized to a decentralized data platform is a more incremental and controlled process compared to transformation, which involves a fundamental overhaul of the banking infrastructure and operations. Migration typically follows a phased approach where traditional banking systems continue to operate while specific components are gradually transitioned to a decentralized platform. This approach is focused on minimizing disruptions by allowing for coexistence between old and new systems, ensuring operational stability during the transition.

A major advantage of migration is that it allows organizations to leverage existing investments in legacy systems while gradually adopting new technologies, such as data mesh or cloud-native architectures. Additionally, migration focuses heavily on integration with hybrid infrastructures that bridge centralized and decentralized environments, making it easier to manage regulatory compliance, data governance, and customer expectations. However, the gradual nature of migration can lead to longer timelines, often requiring more complex management to avoid friction between legacy systems and the emerging decentralized infrastructure.

In contrast, transformation entails a complete reimagining of the banking architecture, where decentralized data platforms are integrated as the core backbone of operations right from the onset. Unlike migration, transformation is not about coexistence but about a comprehensive shift towards a digital-first, data-centric operational model. Transformation is often driven by a visionary approach that seeks to enable agility, real-time decision-making, and deep customer personalization, which traditional centralized systems often struggle to deliver. The transformation framework embraces cutting-edge technologies such as cloud-native applications, microservices, blockchain, and AI to support decentralized data governance and domain autonomy fully.

However, transformation also comes with significant challenges. It requires leadership commitment, a cultural shift within the organization, and substantial investments in talent, technology, and change management. The risks are higher, as it involves more rapid change, which can lead to operational disruptions if not managed carefully. Ultimately, while migration focuses on minimizing disruption and modernizing gradually, transformation aims for rapid, revolutionary change that positions the bank for long-term digital dominance.

In conclusion, migration and transformation offer two distinct pathways for transitioning from centralized to decentralized data platforms in banking. Migration is more incremental and risk-averse, focusing on minimizing operational disruption. At the same time, transformation is a complete, visionary overhaul that seeks to rebuild the organization's data infrastructure for future growth and competitiveness. The choice between these approaches depends on the bank's risk appetite, leadership vision, and the urgency of digital adoption in the competitive landscape.

3.1 Migration Framework

This framework, illustrated in figure 3, focuses on incremental migration from a traditional, centralized data platform to a decentralized platform, ensuring minimal disruption to existing operations while gradually adopting new data paradigms.

1. Phase 1: Assessment and Strategic Planning
   - Data Architecture Audit: Assess the current state of centralized data architecture (data warehouses, monolithic systems). Identify critical data silos, bottlenecks, and inefficiencies in the centralized system.
   - Define Data Domains: Identify key business domains (e.g., Customer, Transaction, Fraud Detection, Product) to map decentralized data ownership. Assign ownership of data domains to respective business units (following data mesh principles).
   - Roadmap for Data Mesh Implementation: Create a migration roadmap for transitioning each domain from centralized data warehouses to decentralized data products. Prioritize domains based on business criticality and ease of migration.
2. Phase 2: Data Platform Modernization
   - Introduce Domain-Oriented Data Products: Start with key domains (e.g., Customer and Transaction) and develop decentralized data products. Data products must have well-defined APIs for easy consumption by other services.

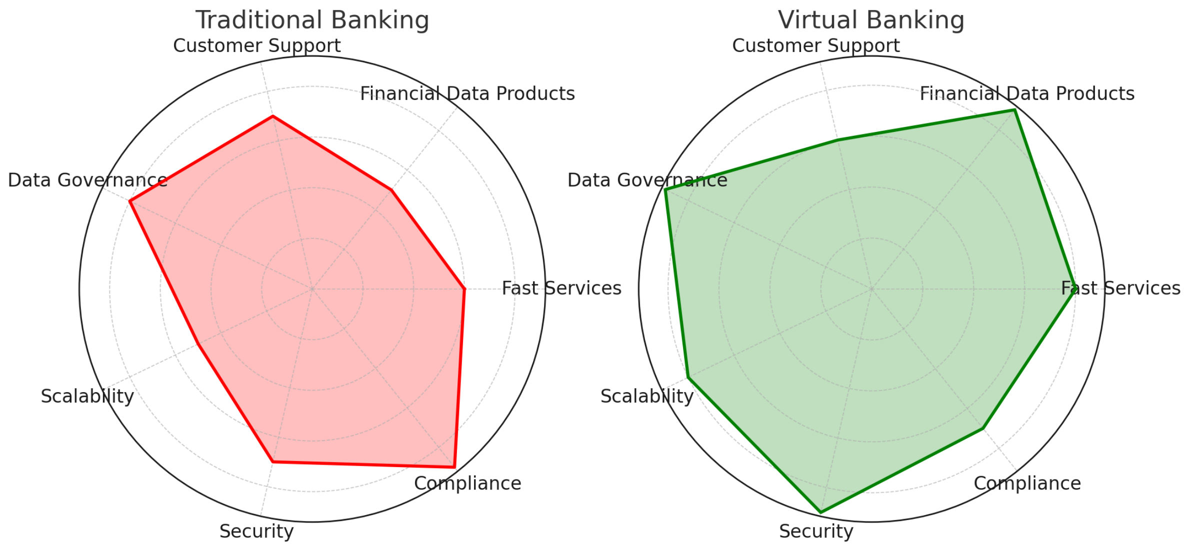

Figure 2: Traditional Banking vs Virtual Banking.

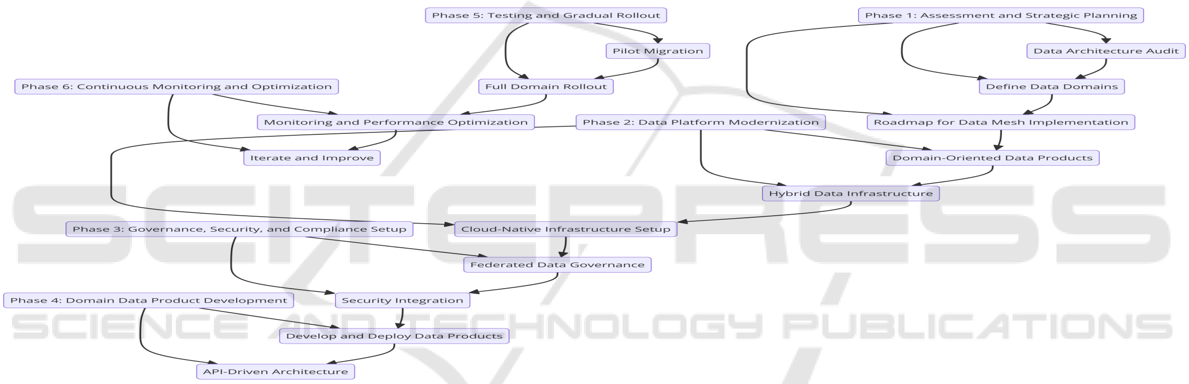

Figure 3: Migration Framework.

- Hybrid Data Infrastructure: Initially, a hybrid infrastructure should be set up to support both centralized (legacy) and decentralized platforms (cloud—or microservices-based). Use data replication and sync mechanisms to ensure data consistency across systems during migration.
- Cloud-Native Infrastructure Setup: Migrate the existing centralized data platform (data lakes, warehouses) to cloud-based storage, introducing decentralized storage solutions (e.g., S3, data buckets). Set up a scalable cloud environment to host domain-specific data products.

3. Phase 3: Governance, Security, and Compliance Setup
   - Implement Federated Data Governance: Establish a federated governance model in which each domain is responsible for ensuring data quality, security, and compliance (e.g., GDPR, KYC/AML, and PDPA). Create global data policies for privacy, access control, and encryption and ensure they are enforced across all domains.
   - Security Integration: Deploy security protocols such as encryption, access control, and logging for each data domain. Ensure decentralized platforms comply with banking security standards and data protection laws.
4. Phase 4: Domain Data Product Development
   - Develop and Deploy Data Products: Develop customer-facing data products (e.g., customer profiles and transaction histories) that can be consumed via APIs by virtual banking services. Deploy data mesh infrastructure (e.g., domain-oriented microservices) that allows seamless access to decentralized data.
   - API-Driven Architecture: Introduce API gateways to allow seamless interaction between de-

centralized data products and virtual banking systems. Enable interoperability between decentralized data domains and third-party services (e.g., payment gateways, fintechs).

5. Phase 5: Testing and Gradual Rollout
   - Pilot Migration: Perform pilot migrations for individual data domains, starting with non-critical services to validate the decentralized approach. Monitor data integrity, access speed, and reliability before expanding the migration process.
   - Full Domain Rollout: Gradually roll out decentralized data products to all business domains, ensuring full decoupling from the centralized data platform.
6. Phase 6: Continuous Monitoring and Optimization
   - Monitoring and Performance Optimization: Set up real-time monitoring for each data domain's performance, ensuring scalability, latency, and fault tolerance. Continuously optimize the data platform for improved virtual banking operations and customer experience.
   - Iterate and Improve: Gather feedback from domain owners and data consumers to refine data products and governance policies. As the system matures, retire the centralized data platform, leaving a fully decentralized structure.

3.2 Transformation Framework

This framework focuses on radical transformation from a traditional, centralized platform to a fully decentralized data platform.

1. Phase 1: Executive Leadership and Cultural Shift
   - Leadership Commitment: Obtain leadership commitment to transform data architecture to a decentralized platform as part of a larger virtual banking transformation.
   - Cultural Shift to Data-Driven Decision Making: Encourage every department to see themselves as data producers and consumers.
2. Phase 2: Redesign Data Architecture for Decentralization
   - Domain-Oriented Data Ownership: Restructure the organization into domain-driven teams responsible for their respective data products (Customer, Transaction, Product, etc.)
   - Move to Cloud-Native and Distributed Systems: Rebuild the infrastructure to be fully cloud-native, leveraging distributed systems like Kubernetes, serverless computing, and microservices.
3. Phase 3: Building a Decentralized Data Platform
   - Full Adoption of Data Mesh Principles: Design the entire data platform around data mesh principles, focusing on domain autonomy, data as a product, and decentralized governance.
   - Data Product Development: Each domain develops, manages, and publishes its data products (e.g., real-time transaction analytics and fraud detection insights) with full operational responsibility.
4. Phase 4: Advanced Data Governance and Compliance
   - Decentralized Governance and Security: Establish federated data governance, where each domain adheres to global standards but retains control over local security, access, and compliance mechanisms.
   - Regulatory Compliance: Using automated governance workflows, ensure that each domain maintains compliance with data regulations (GDPR, PDPA, KYC, AML).
5. Phase 5: Implementation of Virtual Banking Services
   - Integration with Virtual Banking Systems: Virtual banking services such as online accounts, digital loans, and payments are built on top of decentralized data products.
   - API-First Strategy: Adopt an API-first strategy where every virtual banking service is powered by APIs exposed by the decentralized data platform.
6. Phase 6: Advanced Analytics and AI Integration
   - Data Democratization for AI and Analytics: Empower data scientists and analysts to access decentralized data products for real-time analytics, machine learning, and artificial intelligence.
   - Real-Time Decision-Making: Implement AI-driven predictive analytics across decentralized data products to enable real-time decision-making, such as dynamic loan pricing and personalized financial products.
7. Phase 7: Full Transformation and Continuous Innovation
   - Monitoring, Automation, and Scaling: Continuously monitor data platform performance and automate operations, scaling decentralized systems based on demand.

- Virtual Banking as a Fully Decentralized Ecosystem: Transform into a fully decentralized virtual banking ecosystem where customers experience seamless, data-driven services without reliance on centralized infrastructure.

3.3 Implement Difficulties

In the migration framework, the organization would be in a state that is close to the opposite of the native framework. Its key obstacles would be highly controlled legacy legal contracts and conservative control processes, which highly introduce time and resources to the data-sharing process. Also, the data model might not be ready for data sharing. The key strong advantage of this would also be a large amount of data, in terms of the number of customers and richness of customer behavior to the organization. The key focus on driving open data for migration organizations should be on bringing high-impact use cases, especially on data sharing with other big players from other industries. This would drive the usage and migration to be faster, especially from business impact.

In the transformation approach, which focuses on the transformation of the organization in parallel with the revamping data model and stack, the key advantage would be that the early adopters in organizations are graving for the new business impact, which also includes an open data use case. The key principles that would help drive this would be focusing on Nobel solutions and use cases by drawing the advantage of a huge legacy number of customers. The concerns that organizations should be aware of the matrix process in evaluating cases

4 CONCLUSION

We have highlighted the critical role of data strategy in the successful implementation and operation of virtual banking. As virtual banks operate entirely online, they require a robust data infrastructure capable of handling real-time transactions, customer data, and service requests around the clock. A well-structured data strategy focusing on scalability, real-time analytics, and customer-centricity is essential to meet the growing demand for instant and personalized financial services. By leveraging cutting-edge technologies like AI and big data analytics, virtual banks can offer tailored financial products, enhance fraud detection, and improve operational efficiency compared to their traditional banking counterparts.

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