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A Governance Framework for Digital Transformation in Banking: Unveiling Archetypes through Latent Class Analysis

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Abstract

The banking industry is undergoing a significant transformation driven by digital technologies, evolving customer behaviors, and increasing regulatory pressures. To remain competitive, banks must adopt governance frameworks that integrate digital innovations to enhance operational efficiency and improve environmental, social, and governance (ESG) performance. This study identifies governance framework archetypes essential to digital transformation in banks through a comprehensive research methodology, including a

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literature review of digital governance frameworks, a comparative analysis of 11 leading digital banks worldwide, and latent class analysis to uncover key archetypes. Our findings reveal nine distinct governance archetypes, categorized into three dimensions: structural, including Centralized, Semi-centralized, and Open Innovation-oriented banks; dedicated processes, comprising Continuous Improvement, Vanguard, and Fast Follower banks; and relational mechanisms, featuring Self-empowering, Explorer, and Relationship-oriented banks. This classification advances the understanding of governance approaches that effectively support banks in their digital transformation journeys. The implications of these archetypes are substantial, offering a framework for banks to align their strategies with digital transformation initiatives. By adopting these governance structures, banks can better navigate the complexities of the digital landscape, foster innovation, and ultimately enhance their service offerings while addressing the evolving demands of customers. This research contributes to the growing body of knowledge on digital governance in banking and provides guidance for financial institutions striving to succeed in an increasingly digital world.

Keywords: Digital Transformation, Digital Governance, Digital Banks, Digital Innovations, Latent Class Analysis

Introduction

The banking industry is undergoing a profound transformation, driven by the rapid advancement of digital technologies and shifting customer expectations. As digital banking has emerged as a key strategy for banks to remain competitive, mitigate risks, and foster innovation, the ability to harness digital innovations has become a critical factor in achieving a sustainable competitive advantage. Thus, robust governance of digital innovations is critical, enabling banks to effectively navigate the complexities of digital transformation, minimize risks, and harness the full potential of digital banking.

Governance plays a pivotal role in the digital transformation of banks, involving the setting of overall direction, risk management, and resource allocation to support digital transformation. The literature emphasizes the importance of governance in digital transformation, highlighting the need for a clear strategy, effective risk management, and a culture of innovation (Bharadwaj et al., 2013). Digital transformation necessitates a distinct approach to governance, as it entails experimenting with new technologies, business models, and partnerships. Effective governance is crucial for ensuring that digital transformation aligns with the bank's overall strategy and risk appetite, thereby mitigating potential risks and maximizing opportunities.

A comprehensive review of 1,631 published articles in the field of digital technology in the banking industry from 1967 to 2024 reveals a significant gap in understanding the governance of digital transformation in banking. While previous studies have explored

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various aspects of digital transformation, including its impact on bank efficiency, organizational requirements, strategy, leadership, and governance, as well as its effects on social and environmental performance, operational capabilities, and innovation within banks, a more comprehensive study is needed to understand the concept of digital transformation governance in banking. These research papers not only highlight critical areas for further exploration but also align with ongoing discussions in the literature regarding the evolving nature of governance in the digital banking landscape.

For instance, the paper by Hilary and Serret (2023) emphasizes the importance of governance structures in the context of digital transformation, suggesting that detailed clinical cases can provide fruitful avenues for research. They advocate for a multidisciplinary approach that spans financial, operational, and legal domains to enhance the understanding of governance in the context of digital transformation.

Similarly, Mulyana et al. (2022) in their study titled "IT Governance Mechanisms that Influence Digital Transformation: A Delphi Study in Indonesian Banking and Insurance Industry," identify key governance processes that are critical for successfully navigating digital transformation. Their research highlights essential processes such as establishing clear digital transformation strategies, implementing agile governance frameworks, ensuring effective communication across business units, and continuously monitoring digital initiatives.

Furthermore, the work by Bui et al. (2023) titled "The Impact of Digital Transformation Initiatives on Governance and Public Value Creation" discusses relational mechanisms that facilitate effective governance of digital transformation initiatives. Their findings underscore the necessity of strong collaboration and communication among stakeholders to coordinate efforts across organizational boundaries.

By pursuing these research objectives, future studies can enhance our understanding of how organizations effectively navigate the complexities of digital transformation governance. This exploration is vital for informing practitioners and policymakers about the strategic frameworks necessary for successful digital transformation in the banking sector, ultimately leading to the development of more resilient and adaptive banking institutions. Such insights will empower banks to implement robust governance structures that not only facilitate digital innovations but also drive overall business success in an increasingly competitive landscape.

This study aims to address this gap by exploring the governance archetypes for digital transformation in banks, including the essential elements, processes, capabilities, and governance structures required to support digital innovations. Our research provides valuable insights for banks to develop effective governance frameworks that support digital innovation and drive business success. The research questions are formulated as follows:

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- What is the governance framework for digital transformation in banks?

The secondary research questions include:

- What are the archetypes related to the governance structures of digital transformation in banks?
- What are the archetypes related to the dedicated governance processes of digital transformation in banks?
- What are the archetypes related to the relational mechanisms of digital transformation in banks?

Literature Review

Digital transformation is revolutionizing industries such as social media, mobile, cloud computing, and automation by leveraging advanced technologies. This transformation is particularly crucial in sectors like banking, where customer expectations and technological advancements are rapidly evolving (Fischer et al., 2020; da Rosa and de Almeida, 2018).

Despite the opportunities that digital transformation presents, it poses significant challenges to traditional business models and operational frameworks, necessitating substantial adaptation strategies (van Tonder et al., 2024 and Sánchez Báez et al., 2024).

The need for robust governance structures becomes apparent as organizations navigate through these transformations. Traditional governance frameworks in IT are becoming less effective in coping with the demands of digital transformation, prompting a shift towards more integrated and dynamic digital governance approaches (Kandil et al., 2023; van Tonder et al., 2024). These new governance structures aim to foster alignment between technology and business strategies, ensuring that digital initiatives are consistent with organizational goals and deliver value (Tallon, 2019). For instance, a study by Hanelt et al. (2020) found that digital transformation governance is critical for SMEs to achieve digital maturity, highlighting the need for effective governance structures to support digital transformation.

Leadership plays a critical role in this dynamic environment. Beyond traditional IT governance, which primarily involves CIOs, digital transformation governance requires a collective effort from all organizational leaders, including roles like Chief Digital Officers (CDOs), who specifically guide digital strategies (Sánchez Báez et al., 2024).

The responsibility of these roles spans strategic oversight to operational implementation, reflecting a necessary evolution from IT governance to a more comprehensive digital governance model (Kähkipuro, 2020). Furthermore, research by Raković et al. (2024) emphasizes the importance of leadership in driving digital transformation, highlighting the need for leaders to possess digital literacy and vision to navigate the complexities of digital transformation.

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Digital Transformation in Banks

In the banking sector, digital transformation has ushered in significant changes to how services are delivered and managed. Banks have been compelled to redesign their business models, operational processes, and governance frameworks in response to the evolving digital landscape (Fischer et al., 2020; Zhu and Jin, 2022; Martovoy et al., 2015). The rise of digital platforms has transformed the information technology (IT) industry, prompting traditional industries like banking to adopt similar strategies (Schreieck et al., 2024).

This transformation is driven by the need to enhance customer experience, manage growth opportunities, and navigate competitive pressures effectively. For instance, open innovation strategies, such as inbound open innovation, can facilitate the adoption of digital technologies and foster innovation in the banking sector (Martovoy et al., 2015). Transformative governance in banks involves not only adapting governance frameworks to manage digital risks but also leveraging digital capabilities to foster innovation and strategic opportunities. Shifts include a greater focus on data governance, cybersecurity, and compliance with increasingly stringent regulations (Zhu and Jin, 2022; Tian et al., 2022). For instance, the integration of technologies such as AI and blockchain in banking processes demands an oversight mechanism that can cover ethical implications, data integrity, and operational risks (Kauffman and Lahiri, 2023).

Moreover, digital platforms are becoming a core component of the banking infrastructure. These platforms facilitate new forms of consumer interaction, offering customized financial products and enabling seamless user experiences. However, the adoption of such platforms also requires banks to reevaluate their governance practices to ensure these platforms are reliable, secure, and beneficial to the organizational values and customer expectations. Furthermore, the use of digital platforms can also enable banks to leverage external sources of innovation, such as fintech companies, to enhance their services and stay competitive in the market (Martovoy et al., 2015).

Digital transformation and governance

Governance within the context of digital transformation (DTG) extends beyond traditional frameworks by integrating strategic direction and policy oversight with tactical operational management (Kähkipuro, 2020). DTG involves not just technological adoption but broad organizational changes, including strategic alignment, culture, and leadership roles. Effective DTG ensures that digital initiatives are in sync with the organization's overall objectives and that they contribute positively to its performance (Jewer and van der Meulen, 2022; Kähkipuro, 2020; and Kim, 2020).

In organizations, digital transformation governance emphasizes the alignment of roles and

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responsibilities with digital strategies. It increasingly necessitates the inclusion of positions such as the Chief Digital Officer (CDO) to oversee and guide digital initiatives, alongside traditional roles like Chief Information Officers (CIOs). This shift signifies a move towards a more integrative governance approach (Kähkipuro, 2020). Such a collaborative governance framework not only facilitates the technological transition but also enhances accountability and transparency, ensuring that digital processes align with the interests and policy objectives of Environmental, Social, and Governance (ESG) criteria.

The introduction of comprehensive governance frameworks suggests a structured way to manage digital transformation by incorporating recognized best practices and standards like COBIT 5. These frameworks provide a basis for aligning IT strategies with broader business processes and strategic imperatives, facilitating a holistic approach to governance (Kähkipuro, 2020).

From IT governance to Digital governance

The evolution from IT governance to digital governance is characterized by a need to support broader digital transformations that affect multiple aspects of the organization. While IT governance primarily focuses on technology and information systems, digital governance extends to incorporate governance of digital innovations, including strategies for digital products, services, and business models (Zhao, 2023).

Key frameworks, like those discussed by Fischer et al. (2020), suggest incorporating flexible and inclusive business process management (BPM) practices as part of the digital transformation strategy. These practices not only support strategic alignment but also foster stakeholder participation and empowerment across the organization. This transition underscores the necessity for governance frameworks to be dynamic and adaptive, aligning with the evolving digital landscape and the inherent complexities of managing digital innovations.

Digital governance thus diversifies the scope of governance by including new roles such as Chief Digital Officers (CDOs), who oversee the strategic implementation of digital technologies and foster a culture receptive to digital innovations (Kähkipuro, 2020). These roles facilitate the fusion of traditional and digital strategies, ensuring that digital transformation initiatives are robust, strategic, and integrated into the core operational frameworks of the organization.

Governing Digital Transformation in Banking Sectors

Today, the banking sector is experiencing significant changes globally, with the development of digital technologies being a key factor. One of the most important changes in this industry, especially after the COVID-19 pandemic, is the shift in customer behavior and demand

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towards non-physical banking and receiving comprehensive digital services. This trend is considered a major driver of the digital transformation paradigm (Jewer and van der Meulen, 2022). In digital transformation, new business opportunities emerge, and companies transform their processes, structures, strategies, and cultures to utilize the capabilities and capacities of the digital environment and the internet. In this transformation journey, governance plays a crucial role; to explain this importance, it is necessary to distinguish between management and governance.

Governance of digital transformation requires an integrated approach that combines technology management with strategic business objectives. Digital innovations—ranging from the development of new digital services and business models to transformative digital platforms—necessitate robust governance frameworks that can ensure these innovations align with organizational goals and provide tangible business value (Kauffman and Lahiri, 2023 and Zhao, 2023).

Frameworks for governing digital transformation often encapsulate structures for roles and responsibilities, processes for strategic and operational management, and relational mechanisms to foster collaboration across and beyond the organization (Fischer et al., 2020). For example, digital innovation in the banking sector requires governance frameworks that address the specific challenges and opportunities posed by digital technologies, balancing the pursuit of transformation with risk management and compliance (Zhu and Jin, 2022).

Moreover, as digital platforms become central to organizational strategies, the governance of these platforms must ensure that they not only support business objectives but also adhere to ethical standards, ensuring data privacy, security, and reliability. This includes managing user data responsibly, addressing regulatory requirements, and fostering an organizational culture that prioritizes ethical considerations in digital initiatives.

Conceptual model of digital transformation governance framework

Following a comprehensive review of the extant literature on digital governance and leadership frameworks in organizations, and considering the research objective and topic of the present study, which centers on the conceptual framework of digital transformation, analogous to innovation in organizations, and taking into account the notion of governance at the organizational level, as well as the comprehensiveness of the framework presented for digital innovation governance, the most suitable framework was selected to examine and develop a conceptual model of the research.

A comparative analysis (see Table 1) was conducted, juxtaposing the dimensions and characteristics of each of the aforementioned studies, to identify the most pertinent framework

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for incorporation into the conceptual model of the research, and subsequently, to subject it to rigorous examination and critical evaluation.

Table 1. Digital Transformation Governance Frameworks

Framework	Dimensions and Components	References
Digital Governance in Corporate Sectors	1. Digital team structure and budget 2. Who defines digital strategy 3. Digital policy monitoring and governance 4. Standards for digital governance, development, and monitoring	Grove and Georg Schaffner, 2018
Digital Transformation Governance Framework	1. Dedicated structures (e.g., digital business units or roles) 2. Dedicated processes (e.g., digital transformation strategy development or project execution) 3. Relationship mechanisms	Wiesböck and Hess, 2020
IT Governance Model	1. Organizational units and decision-making roles in IT 2. Alignment of business and IT decision-making functions (e.g., IT strategy committee) 3. IT governance communication mechanisms (e.g., job rotation, announcements, sponsors, channels, and training activities)	De Haes et al., 2020
Enterprise Governance of IT (EGIT)	5 governance objectives and 35 management objectives	Cobit, 2019
IT Governance Maturity Model (Smith and Hillegersberg)	1. Soft (human aspects) 2. Hard (process aspects) 3. Formal (organizational aspects)	Smits and Hillegersberg, 2017

Following a rigorous comparison and review of the existing frameworks, the Digital Transformation Governance Framework proposed by Wiesböck and Hess (2020) has been selected as the conceptual foundation of this research, owing to its comprehensive and nuanced approach to governing digital innovation in organizations.

Digital transformation governance (DTG) is a complex and multifaceted concept that can be understood through three interconnected dimensions (see Fig. 2): processes, structures, and relational mechanisms. The process dimension of DTG encompasses the dynamic and iterative activities involved in governing digital transformation, including strategy development, risk management, and performance monitoring. The structural dimension refers to the organizational arrangements and architectures that enable and support digital transformation, such as defined roles, responsibilities, and decision-making authorities. The relational dimension captures the social and cultural aspects of governance, including the relationships, trust, and communication patterns between various stakeholders, such as leaders, employees, customers, and partners (Wiesböck & Hess, 2020). By examining these three dimensions, organizations can gain a deeper understanding of their digital

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transformation governance capabilities, identify areas for improvement, and ultimately ensure successful digital innovation and sustainable competitiveness

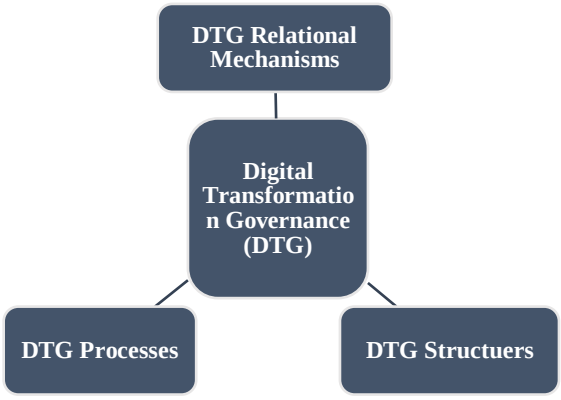


Fig 2. Digital Transformation Governance (Wiesböck and Hess, 2020)

According to a common definition, digital transformation can be understood as a specialized type of business transformation, where information technology plays a commanding role (Uhl and Gollenia, 2016). To prepare for the adoption of digital technologies, managers and governing bodies in organizations must understand, develop, and implement a digital transformation governance (DTG) framework. This framework's successful development and implementation require consideration of three key components: specialized structures (such as management roles or digital business units), Dedicated processes (for example, developing digital transformation strategies or executing digital transformation projects), and specialized relational mechanisms. A literature review and synthesis reveal that the digital transformation governance framework, with its three dimensions, serves as a theoretical basis, as illustrated in Table 3.

Table 3. Components of Digital Transformation Governance

Dimension	Components	References
Governance Structures	Centralized: ▪ Senior Management ▪ Organizational Unit	Wiesböck and Hess, 2020; Horlacher and Hess, 2016 and Matt et al., 2015
	Semi-Centralized: ▪ Steering Committees	Haffke et al., 2017; Westerman et al., 2014 and Chatterjee et al., 2002
	Independent and Specialized: ▪ Innovation Centers ▪ Excellence Centers ▪ Technology Laboratories	Haskamp et al., 2022; Ashwell, 2017; Dery et al., 2017; Sia and Weil, 2016 and Westerman et al., 2014
Dedicated processes	Value Creation Approach: ▪ Edge Experience ▪ Core Business Encounter ▪ Business Model Reinvention	Green and Daniels, 2019; Venkatraman, 2017; and Bharadwaj et al., 2013
	Organizational Attitude Adjustment towards	Badham and Luoma-aho, 2023, and Matt et

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Dimension	Components	References
	Technology: ▪ Pioneer ▪ Follower	al., 2015
	Financial Resource Allocation for Transformation: ▪ Centralized Investment ▪ Local Investment ▪ Partner-Supported Investment	Tian et al., 2022 and Westerman et al., 2014
Relational Mechanisms	Intra-Organizational: ▪ Inter-Unit Collaboration ▪ Cross-Functional Teams ▪ Co-Location of Technology and Business Units	Bala et al., 2017; Chanias, 2017; Islam et al., 2017; Saldanha et al., 2017; Karttunen et al., 2023; Bharadwaj et al., 2013; Berman and Marshall, 2014; Jewer and McKay 2012 and Haes and Van Grembergen, 2009
	Inter-Organizational: ▪ New Forms of Customer Collaboration ▪ New Forms of Partner Collaboration	Gilli and Knappstein, 2023; Nayal et al., 2022; Koch and Bierbamer, 2016; Hadaya and Cassivi, 2009; Wu et al., 2014 and Nyaga et al., 2010

Digital governance structures outline how organizations can adapt their organizational frameworks to align with their digital initiatives. In this governance dimension, banks can explore various options related to structural and institutional mechanisms, considering the trade-offs between centralization and decentralization (Wiesböck & Hess, 2020). To facilitate digital transformation, organizations must develop and implement a comprehensive digital transformation strategy that spans the entire organization, defining all tasks and activities related to digital transformation and encompassing digital innovation initiatives (Bharadwaj et al., 2013; Chanias, 2017; Matt et al., 2015). This strategy enables organizations to align and prioritize their digital innovation efforts with various organizational functions. Moreover, the development and implementation of digital transformation strategies rely heavily on the interplay between centralized (top-down) and decentralized (bottom-up) digital transformation activities within the organization (Chanias, 2017; Chanias et al., 2019; Yeow et al., 2018). Relational mechanisms serve as a crucial complement to the structures and processes of digital transformation governance in organizations. These mechanisms function as a communication interface, facilitating active participation and information exchange among various internal and external stakeholders involved in innovation activities, thereby requiring alignment between IT and business units (Cao et al., 2013; Jewer & McKay, 2012).

Methodology

This study aims to develop practical knowledge of digital transformation governance in banks through a comparative study approach. As applied research, it seeks to provide actionable insights for bank executives, board members, and policymakers. Aligned with the descriptive research paradigm, the primary objective is to describe and analyze the current state of digital transformation governance in banks, focusing on identifying best practices, challenges, and areas for improvement (see Fig. 4).

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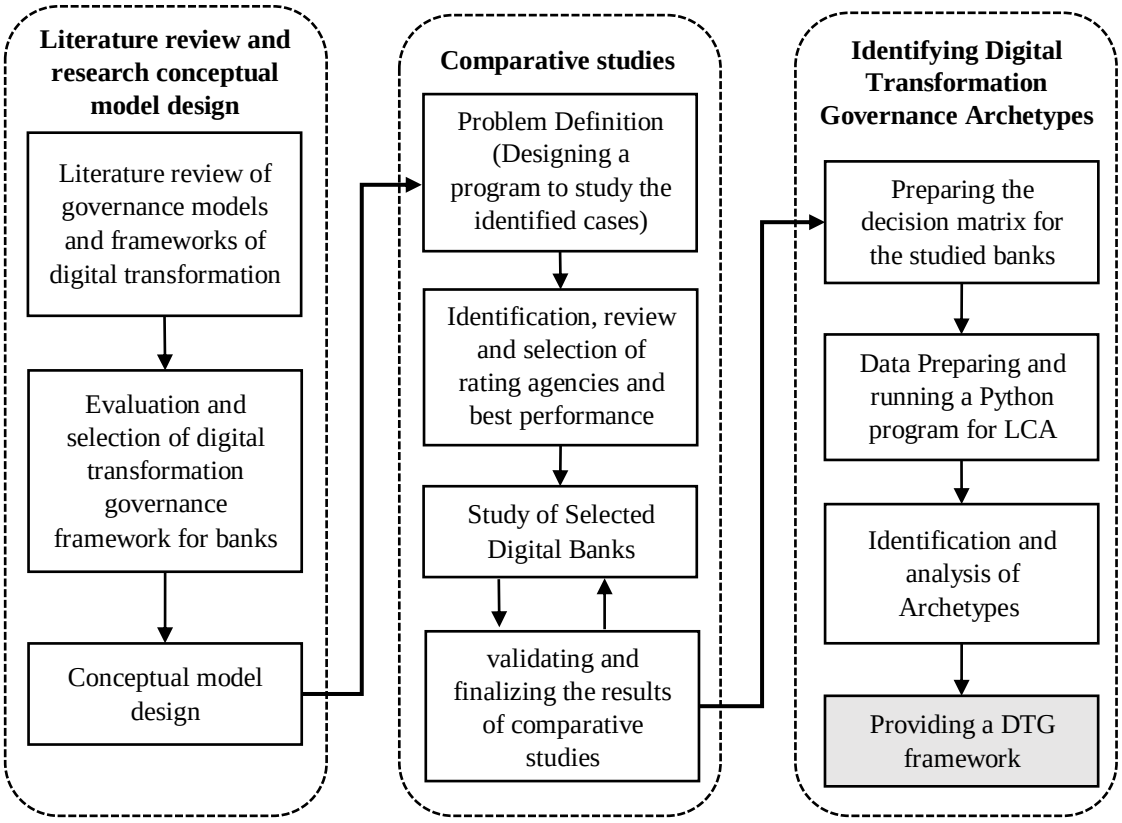


Fig 4. The main stages of research

1. **Literature Review and Research Conceptual Model Design:** This stage involves a comprehensive examination of existing literature to establish a robust theoretical framework that emphasizes the significance of digital transformation governance in banks. It critically reviews relevant literature on governance models, elucidating key concepts, frameworks, and theories that underpin the study. A rigorous selection process is employed to identify the most pertinent framework that aligns with the primary research question, drawing on notable references such as Kraus et al. (2022), which maps the thematic evolution of digital transformation in business and management, and the systematic review by Ziboud and Vanthienen (2023), which highlights best practices for digital transformation. The selection is further informed by a deliberative approach involving consultative sessions with the research team, ensuring that the chosen framework is optimally suited to address the research question and enhance the study's relevance in the context of digital transformation governance in banking.
2. **Comparative studies:** This stage employs a qualitative approach to gather in-depth insights from multiple banks, drawing on the framework established by Shanti et al. (2023), which examines the impact of digital transformation on business models in banks, providing a relevant context for analyzing governance structures. The comparative studies design allows for a nuanced understanding of how different banks navigate the

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complexities of digital transformation, enabling the research team to uncover best practices, challenges, and areas for improvement in digital transformation governance. The case selection process is guided by a set of predefined criteria, ensuring a diverse sample that captures the heterogeneity of banking institutions. The research design has been systematically structured into four primary stages as outlined below:

- *Stage 1: Problem Definition* - This stage involved a collaborative effort by the research team to delineate the research problem, drawing on the triple helix framework of digital transformation governance proposed by Weisbek and Hesse (2020). This framework, informed by the literature review presented in the preceding section, was adapted to extract the primary components of digital transformation governance, which were then applied to this study. The objective was to investigate the selective behavior of each bank and categorize them into distinct classes, thereby identifying archetypes of digital transformation governance.
- *Stage 2: Identification of Bank Ranking Institutions* - The purpose of this stage was to identify reputable institutions that confer prestigious awards in the realm of digital banking and digital transformation, based on a set of criteria including maximum geographic coverage, evaluation of thematic indices, level of institutional credibility, and diversity of bank evaluation aspects.
- *Stage 3: Identification of Selected Digital Banks* - The purpose of this stage was to compile a list of top-performing digital banks, with a focus on digital banking and digital transformation themes, across diverse geographic regions.
- *Stage 4: Investigating the Triple Helix Dimensions of Digital Transformation Governance* - Data about each bank was extracted and analyzed through a combination of observational studies, website reviews, and social media platform analyses (including LinkedIn), as well as official reports and analytical reports from international consulting firms. In this stage, the research team, in collaboration with expert opinions, employed a binary (0 and 1) approach to evaluate the components related to the triple helix dimensions of digital transformation governance.

Identifying Digital Transformation Governance Archetypes: In this section, Latent Class Analysis (LCA) is employed to uncover unobserved subgroups within the population of banks based on observed variables (Hagenaars & McCutcheon, 2002). The use of LCA is particularly justified as it facilitates the identification of latent classes that exhibit similar response patterns to the observed variables, thereby enriching our understanding of governance archetypes in banks. This method is well-suited for categorizing the 11 banks into distinct governance archetypes based on 19 binary variables related to digital transformation governance. The LCA process involves several key steps (Fig. 5):

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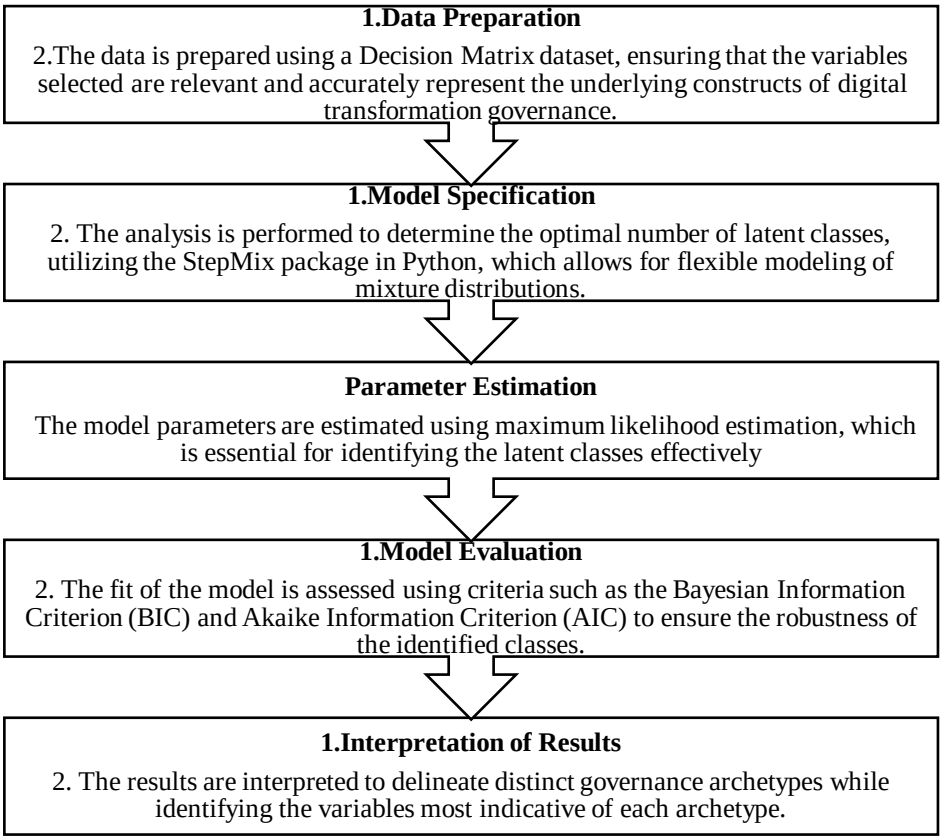


Fig 5. Steps of LCA methodology

The application of LCA has been effectively demonstrated in prior studies, such as those by Bui et al. (2023), which explore the implications of digital initiatives on governance and public value creation across various sectors, thereby underscoring the relevance and applicability of this analytical technique in the context of digital transformation governance in banking.

Results

Comparative studies of Top Banks in Digital Banking

To investigate digital transformation governance mechanisms in successful banks worldwide, rating institutions were selected based on their maximum geographic coverage, thematic indices, and credibility level. Following consultation with the research team, four reputable bank rating institutions and awards - Global Finance Magazine1, Asian Banker2, Digital Banker3, and Banker4 - were chosen to extract the list of top digital banks globally. An initial

[1] The World's Best Digital Banks: https://gfmag.com/award/winner-announcements/press-release-worlds-best-digital-bank-awards-2023-regional-and-global-honorees/
[2] Global Top 100 Digital Banks: https://www.theasianbanker.com/updates-and-articles/the-asian-banker-releases-the-global-top-100-digital-only-banks-ranking
[3] Top 50 Digital Banks: https://thedigitalbanker.com/top-50-digital-banks/

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list of 19 top banks was compiled from a digital banking perspective, considering geographic distribution and digital transformation themes. In the next step, neo-banks (new banks) and digital banks, as well as banks with fewer than 5 million customers, were excluded from the list. Ultimately, 11 banks were selected for final analysis (see Table 6).

Table 6. Final List of Selected Digital Banks

Rank	Financial Institution	Country of Origin	Number of Customers (Millions)
1	CITI Bank	USA	200
2	TD Bank	Canada	27
3	BBVA	Spain	89
4	Ally Bank	USA	11
5	CTBC Bank	Taiwan	6
6	DBS	Singapore	5
7	ING	Netherlands	37
8	Alfa Bank	Ukraine	22
9	Boubyan	Kuwait	196.5
10	Nedbank	South Africa	7.3
11	Banco Bradesco	Brazil	76

After identifying the banks, each bank was studied through observations and reviews of their official websites, social media networks (such as LinkedIn), official reports, and analytical reports from international consulting firms. Subsequently, each bank's behavior was categorized using symbols. Notably, to ensure the credibility of the observations and evaluations, advisory sessions were conducted with academic experts, banking industry professionals, and regulatory bodies. These sessions aimed to validate of the observation into linguistic variables (0 or 1) the comparative studies (see Appendix 1).

Latent class analysis

Considering that the data collected for the 11 observed banks is limited and the type of data is binary (0 and 1), a classification analysis or LCA was employed. This approach enabled the identification of underlying archetypes and relationships within the data, which would have been difficult to discern through traditional analytical methods. By applying this technique, the research was able to uncover meaningful insights into the digital transformation governance practices of the selected banks, despite the limitations of the dataset. The following section presents analyses related to the identification of classes using the LCA method (StepMix package in Python5), illustrated through two distinct scenarios:

[4] Innovation in Digital Banking Awards: https://www.thebanker.com/Awards/Innovation-in-Digital-Banking-Awards

[5] https://github.com/khosropourh/LCA-Retail-Banks.git

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Scenario A) Examining the classification of banks based on all variables

Using the LCA model implemented in Python software, the classification results yielded three distinct classes, with the corresponding probabilities for each class being as follows:

Table 7. Classification of banks based on all variables

Class	Probabilities	Bank	characteres
1	0.35	▪ BBVA ▪ CTBC bank ▪ ING Bank	Class 1 banks are characterized by a high likelihood of having a Chief Digital Officer and a dedicated digital unit, which suggests a structural approach that prioritizes digital transformation management and governance within the bank.
2	0.40	▪ Boubyan Bank ▪ NedBank ▪ Alfa ank ▪ DBS ank	Class 2 banks are likely to have governance committees and innovation centers, adopting a decentralized approach to execute projects both within and outside the bank.
3	0.25	▪ Citi Bank ▪ Allya Bank ▪ Banco Bradesco ▪ TD Bank	Class 3 banks are distinguished by a strong focus on collaboration and partnerships with fintech and innovative companies.

The LCA of 19 variables from 11 banks has yielded three distinct classes (categories). The probabilities and characteristic features of each class are presented in Table 7. The classification results show that Class 1 comprises 3 banks, Class 2 consists of 4 banks, and Class 3 includes 4 banks. Based on the analysis results and the distinctive features of each class, the classes can be categorized as follows:

- **First Class (Centralized Banks):** These banks, such as BBVA, CTBC Bank, and ING Bank, are highly likely to have a chief digital officer and a dedicated digital unit. This indicates a structural approach that focuses on digital transformation management and governance within the bank.

- **Second Class (Semi-Centralized and Decentralized Banks):** These banks, including Boubyan Bank, NedBank, Alfa Bank, and DBS Bank, are highly likely to have governance committees and innovation centers. They adopt a decentralized approach to execute projects both within and outside the bank.

- **Third Class (Open Innovation-Oriented Banks):** These banks, such as Citi Bank, Allya Bank, Banco Bradesco, and TD Bank, are highly likely to focus on collaboration and partnerships with fintech and innovative companies.

The log-likelihood measures how well a statistical model explains the observed data. A higher log-likelihood value indicates a better fit of the model to the data. The Akaike information criterion (AIC) is a measure of the relative quality of a statistical model for a given set of data. It balances the goodness of fit, measured by the log-likelihood, with the

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complexity of the model, measured by the number of parameters. A lower AIC value indicates a better model fit. AIC is more focused on prediction quality, so it prefers models that are more complex but have better predictive power.The Bayesian information criterion (BIC) is another measure of model quality that, like AIC, balances goodness of fit with model complexity. However, BIC is more focused on model simplicity and is often used when the goal is to find the true underlying model. A lower BIC value indicates a better model fit. BIC is more conservative than AIC and prefers simpler models. AIC focuses more on prediction accuracy, while BIC focuses more on model simplicity. A lower value of these indices indicates a better fit of the model with the data. The provided log-likelihood, AIC, and BIC values indicate the goodness of fit for a statistical model (see Table 8). Here's a breakdown of each value:

Table 8. Statistical Model

Index	Value
Log-likelihood	-9.987927788619068
AIC	25.975855577238136
BIC	33.169541395633246

Scenario b) Examining the classification of banks according to the governance variables of digital transformation

A) The implementation of the CLA model in the dimension of governance structures of digital transformation yields the following results and possibilities for each class:

Table 9. Classification of governance structures of digital transformation

Class	Probabilities	Bank	characteres
1	0.45	▪ Boubyan Bank ▪ Allya Bank ▪ CTBC bank ▪ NedBank ▪ Banco Bradesco ▪ DBS Bank	Banks associated with this class are likely to have a chief digital officer and a dedicated digital unit, and they employ a centralized approach to manage and lead digital transformation within the bank.
2	0.45	▪ Citi Bank ▪ BBVA ▪ Alfa Bank	Banks belonging to this class will most likely establish a steering committee for digital transformation within the bank, adopting a decentralized approach. Additionally, they will create innovation centers alongside the bank's structure, leveraging mechanisms that parallel the bank's existing framework.
3	0.1	▪ TD Bank	Banks in this class are most likely to seek maximum utilization of innovations and creative ideas within the financial technology ecosystem, leveraging their venture capital arm. Their approach is characterized by open innovation.

The output of the CLA for 6 variables from 11 banks has identified three distinct classes (categories). The probabilities and features of each class are shown in Table 9. The first class comprises 6 banks, the second class consists of 3 banks, and the third class includes 1 bank.

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Based on the results of this analysis and the features of each class, the classes can be categorized as follows:

- **First Class (Centralized Banks):** These 6 banks are highly likely to have a centralized approach to digital transformation, with a focus on structural management and governance within the bank.
- **Second Class (Semi-Centralized and Decentralized Banks):** These 3 banks are highly likely to have a semi-centralized and independent approach to digital transformation, with a focus on governance committees and innovation centers.
- **Third Class (open Innovation-Oriented Banks):** This 1 bank is highly likely to focus on collaboration and partnerships with fintech and innovative companies, adopting an open innovation approach.

The provided log-likelihood, AIC, and BIC values indicate the goodness of fit for a statistical model (see Table 10). Here is a breakdown of each value:

Table 10. statistical model

Index	Value
Log-likelihood	-2.480445577293391
AIC	10.960891154586783
BIC	18.154576972981893

B) Based on the implementation of the CLA model following the Dedicated processes of digital transformation, the results and possibilities of each class are as follows:

Table 11. Classification of governance Dedicated processes of digital transformation

Class	Probabilities	Bank	characteres
1	0.27	▪ NedBank ▪ ING Bank ▪ DBS Bank	Most likely, banks in this class prioritize upgrading and improving banking products and services based on digital technologies.
2	0.36	▪ Citi Bank ▪ Allya Bank ▪ Banco Bradesco ▪ TD Bank	Banks in this class likely prioritize transforming the traditional banking business model, with the goal of becoming a leader in global markets and providing innovative banking products and services.
3	0.36	▪ BBVA ▪ Boubyan Bank ▪ CTBC Bank ▪ Alfa Bank	Banks in this class likely prioritize risk reduction by keeping pace with and closing the gap with competitors and leaders in the global banking market.

The output of the CLA for 8 variables from 11 banks has identified three distinct classes (categories). The probabilities and features of each class are shown in Table 11. The first class comprises 3 banks, the second class consists of 4 banks, and the third class includes 4 banks. Based on the results of this analysis and the features of each class, the classes can be categorized as follows:

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- **First Class (Continuous Improvement Banks):** These 3 banks are highly likely to have a continuous improvement approach to digital transformation, with a focus on structural management and governance within the bank.
- **Second Class (Vanguard Banks):** These 4 banks are highly likely to have a Vanguard approach to digital transformation, with a focus on governance committees and innovation centers.
- **Third Class (Fast Follower Banks):** These 4 banks are highly likely to focus on collaboration and partnerships with fintech and innovative companies, adopting an open innovation approach.

The provided log-likelihood, AIC, and BIC values indicate the goodness of fit for a statistical model (see Table 12). Here is a breakdown of each value:

Table 12. statistical model

Index	Value
Log-likelihood	-3.6954912493639696
AIC	13.39098249872794
BIC	20.584668317123054

C) Based on the implementation of the CLA model in the dimension of digital transformation mechanisms, the results and possibilities of each class are as follows:

Table 13. Classification of the reational mechanism of DTG

Class	Probabilities	Bank	characteres
1	0.09	▪ DBS Bank	In this class, most likely, banks pursue coordination through the creation of cooperation mechanisms between units and the formation of multitasking teams.
2	0.36	▪ BBVA ▪ Boubyan Bank ▪ NedBank ▪ Alfa Bank	In this class, most likely, banks follow a coordination and development approach, creating relationships with customers through joint creation or co-location of business and technical units.
3	0.54	▪ Citi Bank ▪ Allya Bank ▪ CTBC Bank ▪ Banco Bradesco ▪ ING Bank ▪ TD Bank	In this class, banks probably prioritize communication and cooperation with technological and innovative companies.

The output of the LCA for 5 variables from 11 banks has identified three classes (categories). The probabilities and features of each class are shown in Table 13. The first class includes 1 bank, the second class includes 4 banks, and the third class includes 6 banks. Based on the results of this analysis and the features of each class, the classes can be categorized as follows:

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- **First Class (Self-Empowering Banks):** This 1 bank is highly likely to have a self-empowering approach to digital transformation, with a focus on structural management and governance within the bank.
- **Second Class (Relationship-Oriented Banks):** These 4 banks are highly likely to have a relationship-oriented approach to digital transformation, with a focus on governance committees and innovation centers.
- **Third Class (Explorer Banks):** These 6 banks are highly likely to focus on collaboration and partnerships with fintech and innovative companies, adopting an open innovation approach.

The provided log-likelihood, AIC, and BIC values indicate the goodness of fit for a statistical model (see Table 14). Here is a breakdown of each value:

Table 14. statistical model

Index	Value
Log-likelihood	-1.499030672979012
AIC	8.998061345958025
BIC	16.19174716435314

Discussion

This study identifies 9 governance archetypes of digital transformation across 11 digital banks, categorized into structure, process, and relational mechanisms (see Fig. 15). Three archetypes emerge in each dimension, including centralized, semi-centralized, and open innovation-oriented approaches. The process mechanisms reveal continuous improvement, vanguard, and fast follower approaches. Relational mechanisms display self-empowering, relationship-oriented, and explorer approaches. These findings provide a comprehensive understanding of the diverse governance approaches adopted by digital banks in their digital transformation journeys, highlighting the complexity and variability of governance archetypes in the digital banking sector.

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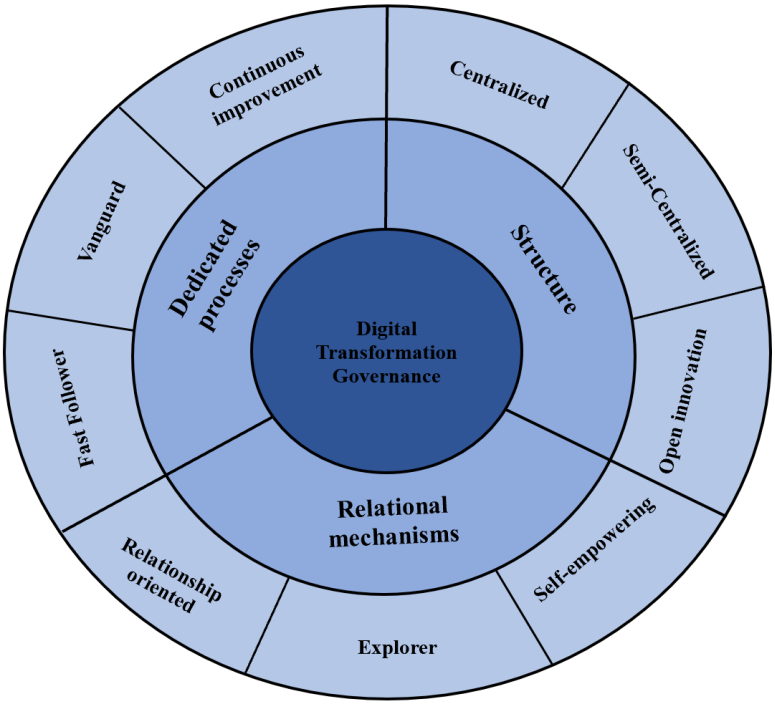


Fig 15. Governance Framework for Digital Transformation in Banks

Digital Transformation Governance Structures

This study reveals three distinct archetypes in digital transformation governance structures among banks: Centralized Banks, Semi-Centralized Banks, and Open Innovation-Oriented Banks. The findings underscore the crucial role of leadership in managing digital transformation, as emphasized by Raković et al. (2024), who highlight the necessity for a well-defined governance structure that fosters innovation and adaptability. This aligns with existing research, which has identified similar archetypes, suggesting that governance structures significantly influence the effectiveness of digital transformation initiatives. Furthermore, the integration of digital strategies is critical for banks to navigate the complexities of the digital landscape, as noted by Tran et al. (2023), who assert that digital banking enhances customer interactions and operational performance. Overall, these insights contribute to a deeper understanding of how different governance frameworks can shape the trajectory of digital transformation in the banking sector.

- The Centralized Banks archetype, observed in six banks, indicates that digital transformation is primarily driven by top-down decisions, emphasizing structural management and governance. This centralized approach is particularly advantageous for banks with a strong hierarchical culture, as it facilitates swift decision-making and effective implementation of digital strategies. According to Siti Nurjanah et al. (2022), digital transformation presents both challenges and opportunities, requiring banks to adapt to new technologies while managing the transition from traditional systems. Overall, a well-defined governance structure can significantly influence the success of digital

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transformation initiatives in the banking sector, as highlighted by the need for comprehensive strategies to address implementation barriers (ProQuest, 2023).

- In contrast, the Semi-Centralized or Decentralized Banks archetype, observed in three banks, suggests that digital transformation is driven by governance committees and innovation centers. The semi-centralized approach may be beneficial for banks that aim to strike a balance between centralized control and decentralized innovation. According to Hess et al. (2016), firms undergoing digital transformation often reorganize to implement new strategies, highlighting the importance of finding the right balance between centralization and decentralization.
- The Open Innovation-Oriented Banks archetype, observed in one bank, represents a significant finding in our study, suggesting that digital transformation is driven by collaboration and partnerships with fintech and innovative companies, adopting an open innovation approach. This aligns with the emerging trend of open banking, where financial institutions leverage external partnerships to enhance their service offerings and improve customer experiences (Tink, 2024). Additionally, the concept of "invisible banks" discussed by Sarker et al. (2022) is relevant to our findings, highlighting the potential for banks to become less visible in the digital landscape as their services are integrated into everyday activities through technologies such as AI and IoT. Overall, our results suggest that open innovation-oriented banks may be well-positioned to drive digital transformation, but further research is needed to fully understand the implications of this approach in the context of evolving banking ecosystems.

Digital Transformation Governance: Dedicated processes

This study reveals three distinct archetypes in digital transformation governance processes among banks: Banks with Continuous Improvement, Banks with Vanguard, and Banks with Fast Follower. These findings are consistent with existing research, which has identified similar archetypes in the banking sector. For instance, a report by Rao (2024) outlines eight new digital banking archetypes that emphasize the importance of adapting to a rapidly changing digital ecosystem, highlighting the need for banks to innovate continuously to remain competitive. Furthermore, the study by Tran et al. (2023) emphasizes that digital transformation significantly enhances customer interactions and operational performance in banks, supporting the notion that different governance structures can influence the effectiveness of digital initiatives. Overall, these archetypes provide a framework for understanding how banks can strategically navigate their digital transformation journeys:

- The Banks with Continuous Improvement archetype, observed in three banks, suggests that digital transformation is driven by a continuous improvement approach, focusing on incremental innovation. Research by Zhu and Jin (2023) indicates that digital transformation enhances operational efficiency, which is often a result of continuous

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improvement practices. This suggests that banks that focus on incremental innovations can achieve better efficiency and effectiveness in their operations. The continuous improvement approach may be beneficial for banks that aim to achieve steady and sustainable digital transformation (Weill & Ross, 2004).

- In contrast, the Banks with Vanguard (First Mover) archetype, observed in four banks, indicate that digital transformation is primarily driven by a Vanguard approach, which seeks to achieve radical innovation. This approach may confer significant advantages for banks aiming to realize substantial digital transformation outcomes. The literature supports the notion that first-mover advantages are critical in the banking sector, particularly in the context of rapid technological advancements and shifting consumer expectations. Research by Backbase (n.d.) underscores that genuine digital transformation necessitates a comprehensive overhaul of banking operations, often initiated by early adopters of innovative technologies. These banks not only set industry standards but also cultivate competitive advantages through radical innovation and agility in responding to market dynamics. Furthermore, studies suggest that banks employing a Vanguard strategy can effectively leverage emerging technologies to enhance customer experiences and operational efficiencies. Mad Devs (n.d.) notes that the integration of mobile banking and other digital solutions has become essential for banks to meet evolving customer demands and maintain competitiveness in an increasingly digital landscape. Moreover, Lubauram (n.d.) highlights that organizations adopting a product-driven approach—often aligned with the Vanguard strategy—can achieve faster time-to-market and improved product quality. This reinforces the benefits of being a first mover in the digital transformation journey, enabling banks to respond swiftly to market changes and capitalize on new opportunities.

- Notably, the Banks with the Fast Follower archetype, observed in four banks, suggest that digital transformation is driven by a fast follower approach, which focuses on emulating the innovation strategies of other banks. This finding diverges from existing research, which has not identified a similar archetype within the banking sector. The fast follower strategy allows organizations to capitalize on the successes and failures of first movers, enabling them to refine their offerings based on established market trends (BIE Executive, 2022). This approach is particularly advantageous in the rapidly evolving banking landscape, where customer expectations and technological advancements are continuously shifting. By adopting a fast follower strategy, banks can mitigate risks associated with pioneering innovations and enhance their competitive positioning through informed decision-making (Lark, 2023). Research indicates that fast followers can effectively leverage existing innovations to improve customer experiences and operational efficiencies. For example, the Commonwealth Bank of Australia has successfully integrated advanced technologies such as artificial intelligence and blockchain to enhance

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service delivery and streamline operations (Mad Devs, n.d.). This demonstrates how fast followers can adopt and adapt successful strategies from first movers while avoiding the pitfalls associated with untested innovations. Moreover, the fast follower approach aligns with the concept of digital agility, which emphasizes the importance of quickly responding to market changes and customer needs (Lubauram, n.d.). By observing the outcomes of early adopters, banks that embrace the fast follower archetype can implement proven practices and innovations, thereby accelerating their digital transformation efforts.

Digital Transformation Relational Mechanisms

This study reveals three distinct archetypes in digital transformation relational mechanisms among banks: Self-Empowering Banks, Relationship-Oriented Banks, and Explorer Banks. These findings are consistent with existing research, which has identified similar archetypes:

- The Self-Empowering Banks archetype, observed in one bank, suggests that digital transformation is driven by a self-empowering approach, focusing on internal innovation capabilities and leveraging internal resources and expertise to drive digital innovation. The self-empowering approach may be beneficial for banks that aim to develop innovative solutions independently and maintain control over their digital transformation journey. Additionally, Mad Devs (n.d.) highlights the importance of agility, enabling banks to swiftly adapt to market changes by leveraging their internal capabilities. While the self-empowering approach offers significant benefits, such as enhanced control and responsiveness, it may also introduce challenges, including the potential for siloed thinking.

- In contrast, the Relationship-Oriented Banks archetype, observed in four banks, suggests that digital transformation is driven by a relationship-oriented approach, focusing on partnerships with fintech companies to leverage external expertise and resources. The relationship-oriented approach may be beneficial for banks that aim to accelerate their digital transformation by leveraging the expertise and resources of fintech companies. Existing literature supports the notion that successful digital transformation in banking often requires a combination of internal innovation and external collaboration, as highlighted by Backbase (n.d.), which emphasizes the need for flexible strategies that can adapt to the shifting landscape through iterative development methods and consistent incorporation of customer input. As the industry continues to evolve, understanding and adapting to the characteristics of the Relationship-Oriented Banks archetype may provide banks with a viable pathway to achieve sustainable growth and competitive advantage through strategic partnerships with fintech companies.

- Notably, the Explorer Banks archetype, observed in six banks, suggests that digital transformation is driven by an explorer approach, focusing on collaboration with

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innovative companies to drive digital innovation. This finding diverges from existing research, which has not identified a similar archetype. By embracing the Explorer Banks archetype, banks can position themselves to not only innovate more effectively but also enhance their competitive advantage in an increasingly digital landscape.

Conclusion

This study provides a comprehensive understanding of the governance archetypes for digital transformation in banks. Identifies 9 governance archetypes of digital transformation across 11 digital banks, categorized into structure, process, and relational mechanisms. Three archetypes emerge in each dimension, including centralized, semi-centralized, and open innovation-oriented approaches. The process mechanisms reveal continuous improvement, vanguard, and fast follower approaches. Relational mechanisms display self-empowering, relationship-oriented, and exploratory approaches.

These findings provide a comprehensive understanding of the diverse governance approaches adopted by digital banks in their digital transformation journeys, highlighting the complexity and variability of governance archetypes in the digital banking sector. Our contributions build upon existing literature by emphasizing the critical role of effective governance in achieving sustainable competitive advantage within the banking industry. Notable works that inform this study include the research by Kraus et al. (2022), which explores the thematic evolution of digital transformation in business and management, and Ziboud and Vanthienen (2023), who identify best practices for digital transformation governance.

Additionally, the framework established by Shanti et al. (2023) on the impact of digital transformation on banking business models provides a relevant context for our analysis. By integrating these perspectives, our study enhances the discourse on digital transformation governance in banking, offering actionable insights for practitioners and policymakers seeking to navigate the complexities of digital innovation.

The study's results have significant implications for banks, as they can inform the development of tailored governance strategies that align with the bank's overall strategy and risk appetite. By adopting a more effective governance approach, banks can foster a culture of innovation, improve their operational capabilities, and enhance their social and environmental performance.

Our research provides valuable insights for banks to develop effective governance frameworks that support digital innovation and drive business success. By identifying the governance archetypes for digital transformation in banks, our study offers a comprehensive understanding of the essential elements, processes, capabilities, and governance structures

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required to support digital innovations. This knowledge can inform the development of tailored governance frameworks that align with the bank's overall strategy and risk appetite, thereby mitigating potential risks and maximizing opportunities. Ultimately, our research contributes to the development of more effective governance practices in banking, enabling banks to stay competitive in the digital era.

The practical implications of our research are far-reaching, as banks can leverage our findings to optimize their governance structures, processes, and relational mechanisms to support digital transformation. By adopting a more effective governance approach, banks can foster a culture of innovation, improve their operational capabilities, and enhance their social and environmental performance. Our research provides a roadmap for banks to navigate the complexities of digital transformation, ensuring that they remain competitive, mitigate risks, and unlock the full potential of digital banking.

Limitations and Furture Research

The present study has two main limitations. Firstly, the sample size is limited, which may affect the generalizability of the findings to all top-performing banks worldwide. Future research should prioritize investigating a larger sample of banks to address this limitation. This study aims to investigate digital transformation governance archetypes in a larger sample of top-performing banks worldwide, addressing the limitation of sample size in the current study. The study will explore the diversity of governance archetypes, identify best practices, and examine the relationship between governance archetypes and bank performance.

Secondly, accessing resources and experts from each bank was a challenge, particularly in terms of language and secondary resources. To overcome this limitation, future research should validate the findings using field study methods and expert opinions from the studied banks. This study aims to validate the findings of the current study using field study methods and expert opinions, addressing the limitation of accessing resources and experts from each bank. The study will explore the use of field study methods, such as observational studies and comparative studies, to gather data and validate the governance archetypes identified in the current study.

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Conflict of interest

This research has no conflicts of interest to declare.

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Appendix 1. Decision Matrix of Comparative Studies

Dimension / Banks	Structures						Dedicated Processes								Relational Mechanisms				
	Chief Digital Officer	Digital Unit	Steering Committee	Innovation Center	Innovation Labs	Venture Capital (VC)	Evaluation and Improvement	Digital Product	Changing Business Model	Pioneer in Global Market	Following Others	Central Investment	Local Investment	Co-Investments with Partners	Inter-Unit Collaboration	Multi-Function Teams	Collocating Business and Technical Units	Co-Creation with Customers	Partnerships with Technological Companies
Citi Bank	1	0	1	0	1	1	1	1	1	0	1	1	0	1	0	1	0	1	1
BBVA	0	1	0	0	0	1	1	1	0	1	0	0	1	1	1	0	0	0	1
Boubyan Bank	1	0	1	1	0	0	0	1	0	1	0	0	0	1	1	0	0	0	1
Allya Bank	1	0	0	1	0	0	1	1	0	0	1	1	0	0	0	1	0	1	1
CTBC bank	1	0	1	1	1	0	1	1	0	0	1	0	1	0	0	1	0	0	1
NedBank	1	0	0	0	0	0	1	0	0	1	0	1	0	0	1	0	0	0	1
Banco Bradesco	1	0	0	0	1	1	1	1	0	0	1	1	0	0	0	1	0	0	1
ING Bank	1	0	0	0	1	1	1	0	0	1	0	1	1	0	0	1	0	0	1
TD Bank	1	1	0	1	1	0	1	1	0	0	1	1	0	1	0	2	0	1	1
Alfa Bank	1	1	0	0	0	1	0	0	0	1	1	0	1	0	1	0	0	0	0
DBS Bank	1	0	0	1	0	0	0	1	1	1	0	1	0	0	1	1	1	0	1

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