UNIVERSIDADE ESTADUAL DE CAMPINAS
Faculdade de Engenharia Mecânica

LUIZ ANTONIO BUENO

Exploratory Study of Digital Operational Efficiency for Brazilian Banks

Estudo Exploratório sobre Eficiência Operacional Digital para Bancos Brasileiros

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The work presented to the School of Mechanical Engineering of the University of Campinas in partial fulfillment of the requirements for the degree of Master in Mechanical Engineering, in the area of Materials and Manufacturing Process.

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Orientador: Prof. Dr. Rosley Anholon
Coorientador: Prof. Dr. Tiago Fonseca Albuquerque Cavalcanti Sigahi

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FACULDADE DE ENGENHARIA MECÂNICA

DISSERTAÇÃO DE MESTRADO ACADÊMICO

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Resumo

Este trabalho teve como objetivo desenvolver uma pesquisa exploratória sobre o conceito de Eficiência Operacional Digital para Bancos no Brasil, visando aprimorar a abordagem atual de eficiência operacional dos bancos neste novo contexto da economia digital. O trabalho foi desenvolvido com uma abordagem incremental de análise de pesquisa, em três etapas. A primeira análise considerou desenvolver um Ponto de Vista sobre os Bancos Digitais, iniciando a análise com 4 perspectivas do cliente (conveniência, baixas taxas, segurança aprimorada e serviços personalizados) e 4 perspectivas de negócios (custos mais baixos, agilidade, escalabilidade e perspectiva aprimorada do cliente) das SMEs. Além disso, esta pesquisa considerou benefícios, desafios e evolução de modelos de negócios no Brasil. A segunda análise realizou uma revisão de conteúdo para identificar os principais tópicos de pesquisa, temas e debates em torno da transformação digital e eficácia operacional no setor bancário. Foram analisados 292 artigos e desses, 23 apresentaram uma relação mais próxima com a DOE, mas não uma correspondência completa. Assim, os resultados indicam originalidade do conceito de Eficiência Operacional Digital (*Digital Operational Efficiency* – DOE). A terceira análise realizou uma pesquisa Delphi com especialistas em serviços financeiros, com foco em explorar um possível conceito para DOE, os principais KPIs que deveriam ser considerados para o cálculo da DOE e melhorias para a indústria de serviços financeiros brasileira em relação à DOE. A média de experiência deste grupo é de 21 anos. As posições organizacionais dessas 14 SMEs são: 3 são C-Level (21%); 5 são Diretores (36%); 4 Superintendentes (29%) e 2 Gerentes (14%) das maiores organizações de serviços financeiros/bancários do Brasil. A análise das contribuições das SMEs gerou 8 principais clusters de tópicos de discussão ("Processo, processo digital, operações"; "Investimentos, receitas, custos"; "Soluções digitais"; "Qualidade"; "Trabalho, funcionários, pessoas"; "Experiência do cliente"; "Escalabilidade"; "Planejamento estratégico, alinhamento de negócios, KPIs, OKRs"; "Regulatório"). Considerando esses resultados, este trabalho contribui com a literatura, fornecendo uma nova discussão sobre o conceito de eficiência considerando elementos adicionais presentes nesta era de serviços digitais, como escalabilidade de sistemas, NPS, *agile*, dentre outros. Além disso, também fornece uma agenda de pesquisa relacionada a este tópico, por exemplo: Otimização do portfólio de produtos e serviços oferecidos pelos bancos digitais, Índice de Eficiência Operacional Digital, o que é relevante, dado que a pesquisa inicial apresentou uma originalidade

do tema. Além da academia, a indústria de serviços financeiros pode aproveitar os resultados da pesquisa para aprimorar a abordagem de mensuração da eficiência das operações dos bancos digitais e, em seguida, encontrar novos caminhos para aumentar os serviços ao cliente e, no final, as receitas para os acionistas.

Palavras-chave: Instituições Financeiras; Digitalização; Transformação digital; Brasil; Eficiência.

Abstract

This work aimed to develop exploratory research about the concept of Digital Operational Efficiency for Banks in Brazil to enhance the current bank's operational efficiency approach in this new digital economy context. This work was developed considering an incremental research analysis approach, in three steps. The first analysis considered to develop a Viewpoint about the Digital Banks, initiating the analysis with 4 customer perspectives (convenience, low fees, enhance security and personalized services) and 4 business perspectives (lower costs, agile, scalability and enhanced customer perspective) from the SMEs. Besides this, this research considered benefits, challenges, and business models evolution in Brazil. The second analysis performed a content review to identify the main research topics, themes, and debates surrounding digital transformation and operational efficacy within the banking sector. There were analyzed 292 articles and of those 23 presented a closer relationship with the DOE, but not a complete match. Thus, the results indicate originality of the Digital Operational Efficiency (DOE) concept. The third analysis performed Delphi research with financial services experts, focusing to explore a possible concept for DOE, the main KPIs that should be considered for DOE calculation and enhancements for the Brazilian financial services industry regarding DOE. The experience average of this group is 21 years. The organizational positions of those 14 SMEs are: 3 are C-Level (21%); 5 are Directors (36%); 4 Superintendent (29%) and 2 are Manager (14%) from the largest financial services/banking organizations in Brazil. The analysis of SMEs contributions generated 8 main discussing topics clusters ("Process, digital process, operations"; "Investments, revenues, costs"; "Digital solutions"; "Quality"; "Labor, employees, people"; "Customer experience"; "Scalability"; "Strategic planning, business alignment, KPIs, OKRs"; "Regulatory"). Considering those results, this work can support the academia, proving a new efficiency concept discussion considering additional elements present in this digital services age, such as system scalability, NPS, agile, and others. Besides this, it also provides a research agenda related to this topic, for instance: Optimization of the product and service portfolio offered by digital banks, Digital Operational Efficiency Index, which is relevant as the initial research presented an originality of the topic. Beyond academia, the financial services industry can leverage the results of the research to enhance the approach to measure the digital banks operations efficiency and then find new avenues to increase the customer services and at the end, the revenues for the stakeholders.

Keywords: Financial institutions; Digitization; Digital transformation; Brazil; Efficiency.

Sumário

1 INTRODUCTION

1.1 Context

In the dawn of the 21st century, society is witnessing an unprecedented wave of digital transformations that are reshaping the very fabric of our existence. From the way people communicate and consume information to the way people conduct business, the pervasive influence of digital technologies is undeniable. During the recent year, the COVID-19 Pandemic demanded/forced an acceleration in this digital transformation process, as the isolation/quarantine requirement was stated for the society.

The advent of digital transformation has brought about a paradigm shift in the banking industry, altering the landscape of traditional banking operations and reshaping the manner in which financial institutions interact with their clients (Al-Dmour *et al*., 2022). This technological evolution has not only streamlined internal processes but has also revolutionized customer engagement through innovative digital channels (Bueno, Sigahi e Anholon, 2023; Pio *et al.*, 2023).

To fulfill the digital transformation, the financial services industry developed some different approaches, such as, developed a new digital bank area inside the traditional bank, investing in FinTech's partnerships and/or change its own traditional organization to digital model. According to (Chhaidar, Abdelhedi e Abdelkafi, 2022), the investment in the FinTech is a possible channel through which banks improve their performance, particularly when the bank size is considered large.

On the other hand, digital native banks, develop its business and digital model since the beginning. In this sense, customers can expect (Bueno *et al.*, 2023):

- Convenience: customers can access banking services anytime and anywhere through their smartphones or computers without having to visit a physical bank branch;
- Lower fees: digital banks often have lower overhead costs compared to traditional banks, allowing them to offer lower fees and better rates on deposits and loans;

- Enhanced security: digital banks often use advanced security measures to protect customer data and prevent fraud, such as two-factor authentication and biometric authentication;
- Personalized services: digital banks can use customer data and artificial intelligence to provide personalized financial advice and tailored banking services.

From a business perspective, digital banks can offer several advantages such as:

- Lower costs: Digital banks can operate with lower overhead costs than traditional banks, allowing them to offer competitive pricing on products and services;
- Agile operations: Digital banks can quickly adapt to changes in the market and customer needs by leveraging technology and data analytics;
- Scalability: Digital banks can expand their customer base quickly and efficiently by leveraging digital channels;
- Enhanced customer experience: Digital banks can offer a seamless and personalized customer experience by leveraging technology and data analytics.

But it also could be observed, usually, Digital Banks, often are "digital outside, providing a more user-friendly and digital experience to the customers, and also traditional inside, requiring intensive labor work to process its transactions". This scenario occurs, mainly because, Digital Banks focus the investments to acquire new customers to growth their customers base though Apps, websites, i.e., a digital approach. But the operational area remains in the traditional model (labor force oriented), because it is easier and cheaper to perform the initial number of transactions with a low number of employees. Once those banks reach a certain number of customers, their operational area became very expensive to escalate, the transactions processing lead time became very high, then it became required/feasible to automate/digitalize this area. Another recent fact, the COVID-19 Pandemic, influenced the global Banking Financial Services and Insurance landscape. The social isolation requirement forced the increase of financial digital transactions, also the home office working model. All of those changes lead to the adoption of the digital transformation in financial operations to process the high transactions volumes (Maiti *et al*., 2022).

This focus on the digital transformation, aims to keep/enhance the competitiveness, results, relevance to customer's life, i.e. bank's efficiency.

The measurement of the overall efficiency for Banks, usually relies on many KPIs, such as ROE, ROA, Operational Efficiency Index (OEI), Man Day Training (MDT) etc. Each of those KPIs focuses on specific aspects of the business/organization, for instance, financial return (ROE, ROA), operations (OEI). It is a common sense in the Banking Industry that OEI is the traditional KPI to measure the operational efficiency, as presented below:

$$OEI = \frac{Operational\ Costs}{Revenues} \quad \text{(Eq. 1)}$$

As a new digital era has been stablished, identify/use a proper KPI to measure how is the contribution of the new technologies in the operational efficiency is crucial. There were a few researches about the digitalization impact on the financial services sector. (Deb e Maity, 2022) developed the DDI (Digital Density Index) which measures the impact of digital channels adoption for customers (transactions performed by digital channels) in India and its Cost efficiency results. But until now, the KPI which could measure the Digital Operational Efficiency (DOE), in a broader perspective, i.e., considering, for instance NPS, regulatory requirements, systems scalability, and the traditional cost and revenues approach, has not been identified, nor defined.

Given the importance and novelty of the subject, several research groups have been investigating issues related to digital transformation in the banking sector across various contexts. As the primary motivation for this study, we build upon a comprehensive research project conducted in Brazil in which the authors are actively engaged. Preliminary analyses within the scope of this project have unveiled significant impacts on the banking sector of this country, presenting numerous research opportunities. A notable gap identified is the need for a better understanding of how DOE will be cultivated within the financial sector.

Based on this scenario, we developed a Viewpoint about Brazilian Digital Banks to explore the current state and design the beginning of a broader study focused on DOE. It was observed that, considering the OEI, Digital Banks, which was expected to be more efficient, presented a higher OEI. In this case, the higher is the value, the lower is the operation efficiency, because it means that costs represent a higher percentage of the revenues (Bueno *et al.*, 2023).

Figure 1 provides a juxtaposition of the OEI values of key traditional and digital banks in Brazil over recent years. Notably, the digital banks under consideration – namely Original,

Nubank, and C6 – have not presented explicit OEI values. Instead, these values have been derived from publicly available information, thoughtfully considering the most pertinent revenue and expense components. This comparison offers a comprehensive insight into the divergent trajectories of these banks, thereby illuminating the distinctive financial landscapes that emerge from the integration of digital and traditional banking practices.

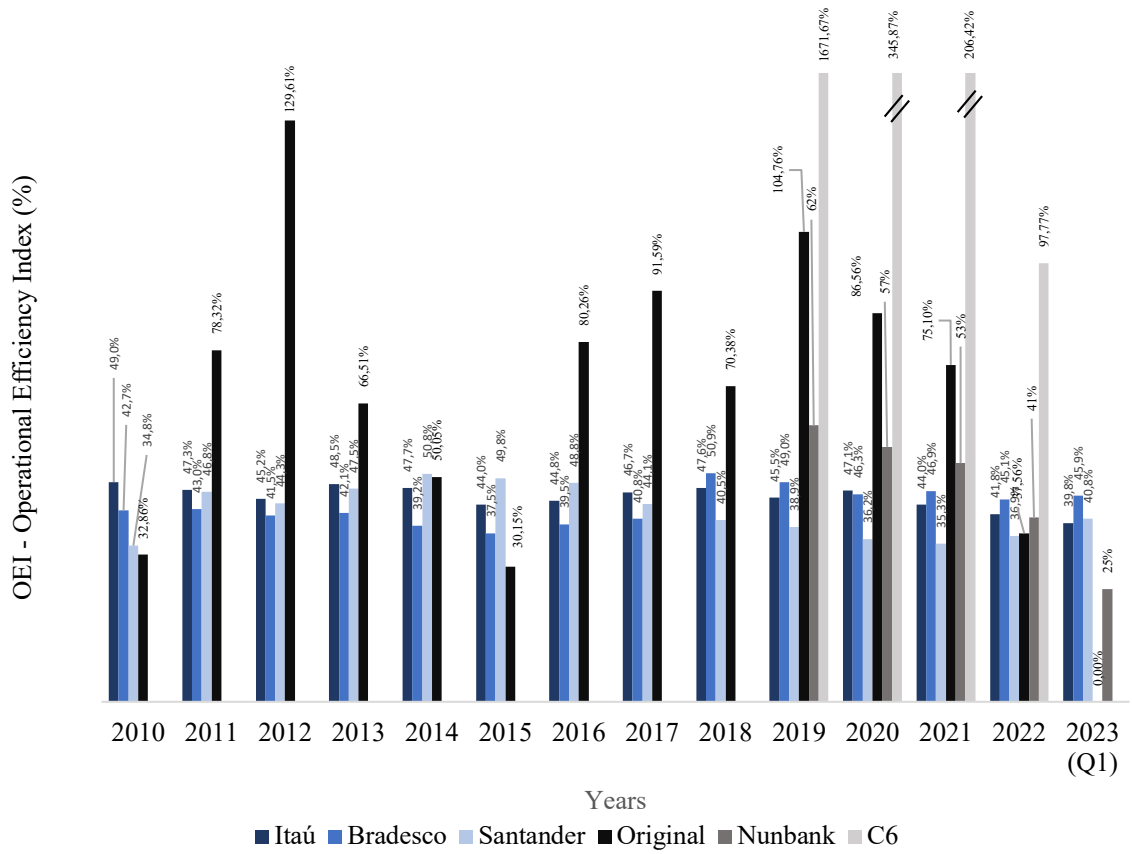

Figure 1. OEI comparison between the main traditional and digital banks in Brazil.
Source: Compiled data from Bank's IR websites (from 2010 to 2023).

A deeper analysis of the data and the Digital Bank's trajectory revels that, usually those institutions are "digital outside and traditional inside". It means that to start the business they offer a digital experience to the customers but has a traditional operation area inside until they reach the proper market size to digitalize/automate their operation area.

In summary, the DOE index concept for Bank's industry presents relevance in academic and practical perspectives and will be discussed during this mastering thesis.

1.2 Research questions

This work has two main research questions:

1) How can the DOE be defined for financial services industry, and which are the main KPIs that should be considered for this evaluation?
2) Considering Brazilian financial services industry, which are the enhancement opportunities related to DOE?

1.2.1 General objective

This thesis focuses to consolidate an overview of the DOE concept considering the subject matter specialists (SMEs) from the Brazilian Banking sector and then analyzing how DOE could be measured.

1.2.2 Specific objectives

As this is exploratory research about DOE, there are 2 main specifics objectives:

1) Perform broad literature research to analyze how the digital efficiency behavior and evolution trough the 2000s;
2) Develop a preliminary research database about the topics to support research and SMEs in the DOE discussions and concept evolution.

1.2.3 Alternative methodology approach

This thesis is presented in an alternative approach have been developed based on three scientific articles according to INFORMAÇÃO CCPG/UNICAMP No 002/2018, Art. 2a. Besides Chapter 1 - Introduction, this thesis structure contains three other chapters. Chapter 2 - Articles compilation, presents the articles developed for this research. Chapter 3 - Discussions, presents the discussions considering the connections among the articles, research results and Bank's Industry analysis. Chapter 4 – Conclusions, presents the final considerations related to the DOE concept development and future research agendas. The references used, authorizations from the Research Ethics

Committee and authorizations from the publishers for the use of published works are listed at the end.

1.2.4 Research classification

In the realm of academic research, the classification holds paramount significance as it serves as a pivotal component in structuring and organizing the existing body of knowledge within a particular field. This section plays a crucial role in delineating the landscape of relevant literature, offering a comprehensive overview of the various research approaches, methodologies, and theoretical frameworks that have shaped the domain. In this sense the research classification presented is based on Ruy (2002), Martins (1999), Silva e Menezes (2003) and Gil (2010).

Table I. Research Classification Analysis

Classification Criteria	**Thesis Approach**	**Rational**
Broad Methods	Inductive	Based on the empirical facts observed in the bank industry, for instance, digital banks are digital outside and traditional inside; conceptual gap about how digital enhance operational efficiency, the inductive method was applied to build a broader view about DOE
Technical Procedures	Bibliographic research and Survey	Two of the three papers developed bibliographic research to stablish the current stage of the discussion. The last article developed a survey, using Delphi, with banking industry SMEs to collect their perception about DOE
Research Approach	Combined (mixed)	During the research process, the data acquired have both qualitative (insights, discussions, SMEs perspectives) and quantitative (volume of publications, financial KPIs from Banks) aspects
Nature	Applied	This research aims to develop the DOE concept and understanding in between academy and industry

Time	Transversal	In a period of 3 months and 2 rounds of discussions, the SMEs for Banking answered a set of 3 questions related to DOE
Objective	Exploratory	This research is an exploratory study aiming to build a database to support the researchers in the develop the concept of DOE
Technic in Use	Panel	The 3rd article focused on a panel, using Delphi technic to collect and align the SMEs for banking industry about DOE

Source: Author (2024).

1.3 Methodological approach

This work was designed with tree major steps, which specific objectives presented on figure 2 and also described in the sequence:

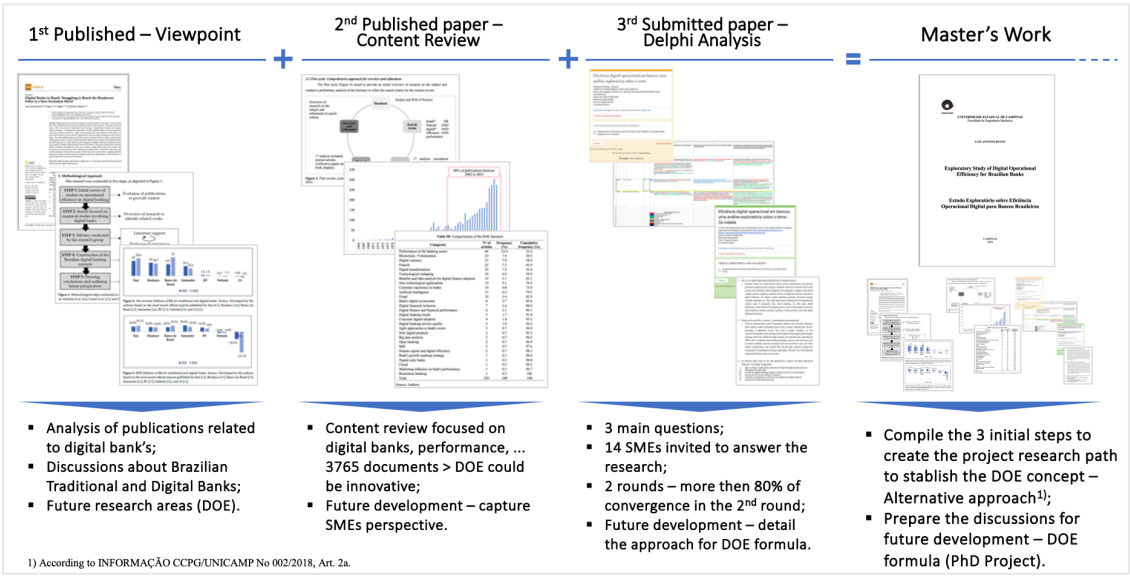

Figure 2. Research steps and accomplishments highlights.

1. Viewpoint: in academic context, a viewpoint can be defined as a perspective, stance, or position taken by an individual, group, or scholarly community regarding a particular subject. These perspectives are often informed by diverse factor, including theoretical frameworks, methodological approaches, cultural

context, and individual experiences. As an integral element of academic discourse, viewpoints contribute to the richness and complexity of scholarly conversations, reflecting the diversity of thought and fostering critical engagement with the subject matter.

The first article was published in FinTech - *Digital banks in Brazil: struggling to reach the breakeven point or a new evolution wave?* – the main objective of this study is to present the Brazilian scenario related to digital banks from the analytical perspective of the research group, considering:

a. Analysis of the publications related to Digital Banks;
b. Discussions about Brazilian Traditional and Digital Banks;
c. Proposal for future research agenda, for instance Digital Operational Efficiency (DOE).

2. Content review: in academia, a content review is a systematic and comprehensive evaluation of the substantive material, information or subject matter contained within a particular document, publication, research study. The purpose of a content review is to critically access the accuracy of, relevance, depth, and coherence of the information presented, ensuring that it aligns with the indented objectives of the work and meets established standards of quality within the relevant academic discipline. Content reviews involve a thorough examination of the conceptual framework, methodologies, findings, and interpretations presented in the work, with an emphasis on identifying strengths, weaknesses, and areas for improvement.

   The second submitted article – *Digital operational efficiency in the banking sector: A comprehensive exploration and research agenda proposal using content-centric review)* – the purpose of this article is twofold:

   a. Conduct a content-centric literature review of the literature relating digital transformation and operational performance in the banking sector, identifying the main thematic categories and research topics. The Prisma methodology was partially applied to identify the most relevant articles, considering, mainly the abstract, age of the publication,

alignment with the topic (DOE). After this an inductive process was conducted to generate the topics cluster and analysis;

b. Develop a research agenda to guide future research endeavors to advance knowledge in this area.

3. Delphi results and analysis: according (Beiderbeck *et al.* 2021) Delphi is a scientific method to organize and structure an expert discussion aiming to generate insights on controversial topics with limited information.

   The third article under development – *Digital operational efficiency for Banks in Brazil: A SME (Subject Matter Experts) discussion* – focus on evaluate the perception of the senior management at banking industry in Brazil considering:

   a. The lack of publications related to the topics. This gap was identified was identified during an analysis performed with VOSviewer software;
   b. The limited access to the senior management of the Banking Industry derived the study to be performed with a selected SMEs group – sampling group by judgment, considering at least 10 respondents. This sampling group was composed by 14 SMEs: 3 are C-Level (21%) / 27 years of professional experience; 5 are Directors (36%) / 23 years of professional experience; 4 Superintendent (29%) / 22 years of professional experience and 2 are Manager (14%) / 24 years of professional experience from the largest financial services/banking organizations in Brazil: 7 working for Whole Sale Banks (50%); 6 working for Corporate Banks (43%) and 1 working for Acquire (7%) . This number of respondents is compliant with the DELPHI methodology recommendations – 10 respondents at least.

   The main discussions in this article are related to:

   a. Leveraging the concept of DOE;
   b. Identify the main possible components to be used to calculate the DOE;
   c. Identify areas with enhancement opportunities.

2 ARTICLES COMPILATION

This chapter presents the articles that compose this thesis.

The first article was published in FinTech - *Digital banks in Brazil: struggling to reach the breakeven point or a new evolution wave?* – the main objective of this study is to present the Brazilian scenario related to digital banks from the analytical perspective of the research group.

The second was published in International Journal of Management Data Insights – *Impacts of digitization on operational efficiency in the banking sector: Thematic analysis and research agenda proposal* – the purpose of this article is twofold a content-centric review, identifying the most relevant publications related to the topic and design the categories of the discussions.

The third was submitted – *Digital banking operational efficiency: an analysis considering the Brazilian context using the Delphi process* – focus on evaluate the perception of the senior management at banking industry in Brazil in the International Journal of Logistics Management.

In the Chapter 3 the connections among the articles will be discussed.

FinTech

MDPI

Viewpoint

Digital Banks in Brazil: Struggling to Reach the Breakeven Point or a New Evolution Wave?

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Abstract: Digital banks have profoundly changed the financial industry's operations. In this scenario, the study of digital banks has gained increasing attention in the academic community. However, there is still a lot of room to understand how this type of organization functions and impacts different contexts. Considering the information collected, partial findings, and the professional experience of those involved in a larger research project, the main objective of this study is to present the Brazilian scenario related to digital banks from the analytical perspective of the research group. The methodological approach included analysis of partial results of a larger research project, bibliographic research, analysis of public data about digital banks in Brazil, and multidisciplinary discursive approach to conduct debates with the support of academic literature and experience from top managers working in major Brazilian financial institutions. Data on key performance indicators (KPIs), including cost breakdown, net revenue, return on equity (ROE), and cost-to-income ratio, are presented and analyzed for both traditional and digital banks. Furthermore, this study puts forward potential avenues for future research within three main research domains: digital operational efficiency for banks, customer attraction strategies employed by digital banks, and the utilization of digital financial services in the retail industry.

Keywords: digital banking; digitalization; digital service; virtual bank; online bank; brazil; fintech; financial service; digital transformation

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1. Introduction

Digital banks, also known as online or virtual banks, are financial institutions that offer banking services exclusively through digital channels, such as mobile apps and websites, without physical branches [1,2]. The rise of digital banks is driven by the growing adoption of digital technologies and the increasing demand for more convenient, efficient, and accessible banking services [3–5].

From a customer's perspective [6–8], digital banks offer several advantages such as the following:

- Convenience: customers can access banking services anytime and anywhere through their smartphones or computers without having to visit a physical bank branch;
- Lower fees: digital banks often have lower overhead costs compared to traditional banks, allowing them to offer lower fees and better rates on deposits and loans;
- Enhanced security: digital banks often use advanced security measures to protect customer data and prevent fraud, such as two-factor authentication and biometric authentication;
- Personalized services: digital banks can use customer data and artificial intelligence to provide personalized financial advice and tailored banking services.

From a business perspective [9,10], digital banks can offer several advantages such as the following:

- Lower costs: digital banks can operate with lower overhead costs than traditional banks, allowing them to offer competitive pricing on products and services;
- Agile operations: digital banks can quickly adapt to changes in the market and customer needs by leveraging technology and data analytics;
- Scalability: digital banks can expand their customer base quickly and efficiently by leveraging digital channels;
- Enhanced customer experience: digital banks can offer a seamless and personalized customer experience by leveraging technology and data analytics.

Overall, digital banks are disrupting the traditional banking industry by offering more convenient, efficient, and accessible banking services to customers. However, they still face challenges such as regulatory compliance, customer trust, product portfolio completeness, and cybersecurity risks [11,12].

Despite the highly appealing business model, the journey towards maturity remains a significant challenge. To date, many digital banks have struggled to achieve breakeven on their investments. Numerous digital banks in the United States and Japan have faced bankruptcy, while others continue to operate at a loss [13]. This scenario has garnered growing attention in the academic community, as evidenced by the evolution of academic publications (Figure 1).

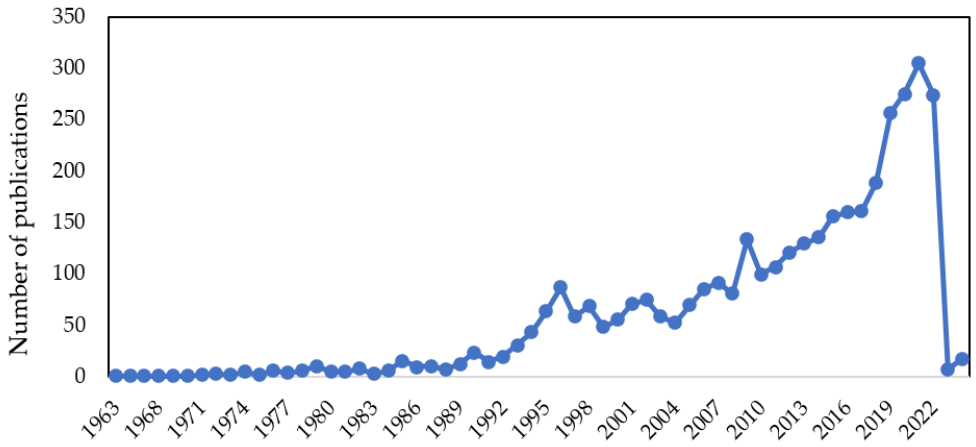

Figure 1. Publications related to digital efficiency in banks from 1963 to 2023.

Over the past five years (2018 to 2022), more than 1000 documents using the keywords "Bank", "Fintech", "Digital", "Efficiency", and "Performance" were published considering the Scopus and Web of Science. Despite this sharp growth, there is still a lot of room to understand the functioning and impact of this type of organization in different contexts. Among these, Brazil, a country with more than 214 million inhabitants, the 5th largest in terms of territory, and a country with a GDP of 1.6 trillion USD, has been minorly studied in relation to digital banks. In fact, a search in the Scopus database using the keywords "digital bank*" and "brazil*" results in only three documents, and these focus on very specific aspects such as digital credit [14], functional, psychological and emotional barriers to the use of digital banking services [15], and financial crimes in the context of digitalization [16].

The lack of studies on digital banks in developing countries like Brazil is a concerning gap that needs to be addressed. Conducting comprehensive research in these regions is important due to the potential of digital banks to drive economic and financial development [17], overcome barriers to financial access, and promote financial inclusion [18]. Without adequate studies, there is a risk of outdated policies and regulations [19]. Additionally, it is important to measure and compare the efficiency of digital banks against traditional banks to identify best practices and foster the adoption of more efficient models in the financial sector [20–22], ultimately enhancing economic development and improving people's quality of life [23].

These factors led to the development of this study, generated from a larger research project that involves both academics (researchers and university professors) and top management professionals from fintechs and financial institutions in Brazil. Considering the information collected, partial findings, and the professional experience of those involved in this larger project, the main objective of this study is to present the Brazilian scenario related to digital banks from the analytical perspective of the research group. Particularly, we aim to provide a broad portrait of digital banks in Brazil and instigate researchers interested in the subject to carry out future work in this rich context for research.

The methodological approach was based on other studies in the viewpoint style produced by the research group, including analysis of partial results of the mentioned larger research project, bibliographic research [24], analysis of public data about digital banks in Brazil, and multidisciplinary discursive approach to conduct debate among members of the research group [25,26]. In the following sections, we present the methodological procedures used to conduct this research and an overview of research involving digital banks, highlighting the lack of studies in Brazil. Then, we present key information and critical reflections about these organizations in this country.

2. Methodological Approach

This research was conducted in five steps, as depicted in Figure 2:

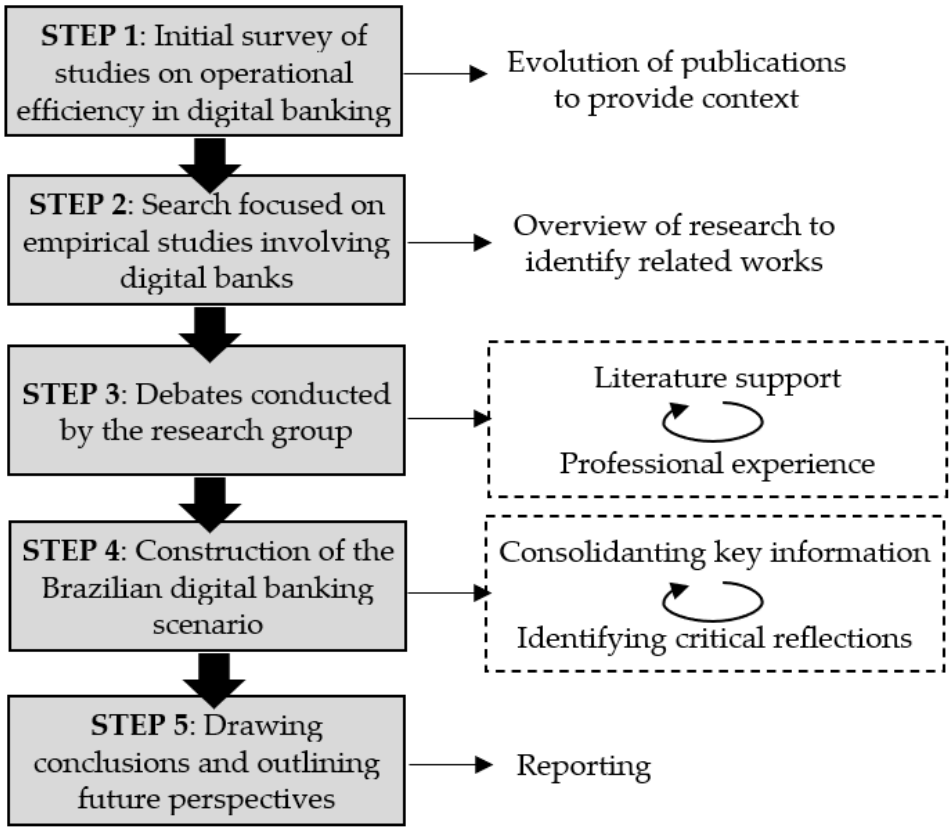

Figure 2. Methodological steps conducted in this research. Source: Developed by the authors based on Anholon et al. [24], Cazeri et al. [25], and Sigahi et al. [26].

Step 1 involved conducting a comprehensive survey of studies that explored topics related to operational efficiency in the context of bank digitization. As previously mentioned, this study is part of a larger project, and one of its outcomes is a systematic literature review on the subject, with the results derived from Step 1 intended for publication in an international journal.

In Step 2, a search was performed in the Scopus database to provide an overview of studies focusing on digital banking. The PRISMA protocol [27] was employed for document

analysis and selection, with inclusion criteria requiring the presentation of empirical results on the topic. Step 2 played a crucial role in confirming the lack of studies addressing digital efficiency in digital banks.

Step 3 marked the initiation of an iterative process wherein the research group organized debates supported by relevant literature and the professional experience of those involved in the project. It is noteworthy to mention the valuable contributions and insights provided by professionals holding top management positions in major financial institutions in Brazil.

In Step 4, the research group conducted another iterative process aimed at connecting the key information gathered in the previous steps and generating highly relevant topics for reflecting on the Brazilian digital banking landscape.

Finally, in Step 5, the main conclusions were drawn, and potential future research directions were established to advance the understanding of the subject matter both theoretically and practically.

3. Overview of Research on Digital Banks

Aiming to provide a comprehensive overview of studies focusing on digital banking, the following search string was used in the Scopus database: TITLE ("digital bank*") AND (LIMIT-TO (DOCTYPE, "article") OR LIMIT-TO (DOCTYPE, "review")) AND (LIMIT-TO (LANGUAGE, "English")). No temporal restrictions were imposed. Table 1 displays the criteria and filters used to select the studies.

Table 1. Selection process and filters to define the sample of studies on digital banks.

Selection Process	Action	Documents
Initial search	Search for documents with "digital bank*" in the title	171
Filter 1	Applying databases filter (document type): only articles and reviews	95
Filter 2	Applying databases filter (language): only English	95
Filter 3	Reading title, abstracts, and keywords to assess suitability for the study's scope	88
Filter 4	Reading methods and results section to search for empirical evidence	66
Final sample	Reading full text to map the research topic, sampla, and context	46

Source: Authors.

The search and selection process was conducted in May 2023 and resulted in 46 studies that presented empirical evidence, as summarized in Table 2. It is important to emphasize that our intention was not to conduct a comprehensive and in-depth literature review, but rather to present an overview, highlight key aspects discussed in the literature, and establish the broad context in which this study takes place.

Table 2. Summary of research on digital banks.

Research Topic	Sample/Data	Context	Reference
Impact of financial inclusion and fintechs on income inequality	Data from 39 African countries	Africa	[28]
Gender perspective of cybersecurity in the digital banking sector	50 participants from cybersecurity, engineering, and top management in banks	Bahrain	[12]
Resistance to the use of digital banking services	202 customers	Brazil	[15]
Impact of fintechs on banks' profitability	Industrial and Commercial Bank of China (the most representative bank in China, according to the authors)	China	[10]
Exclusion of people with visual disabilities from digital banking services	Not informed	Egypt	[29]

Table 2. *Cont.*

Research Topic	Sample/Data	Context	Reference
Influence of economic policy uncertainty, institutional quality, and corruption level on the growth of digital financial services	N/A	General	[19]
Impact of quality digital banking services delivered during the COVID-19 pandemic on customers' satisfaction and retention intentions	395 responses	Ghana	[30]
Central bank digital currency	CBDC design documents	Ghana and Nigeria	[31]
Impact of digital banking usage on women's economic empowerment	286 women	India	[32]
Impact of digital bank transactions on the performance of banks	32 public and private banks	India	[22]
Impact of customer's training of digital banking services on its acceptability by customers	402 training schedules	India	[33]
Intensity of the risk factors that influence customer satisfaction for digitalized banking services and products	222 customers	India	[34]
Financial inclusion in the digital banking age	3159 participants from rural villages	India	[17]
Impact of digital banking on the growth of micro, small, and medium enterprises	454 companies	India	[9]
Payment system indicators of digital banking ecosystem	N/A	India	[35]
Gamification implementation for digital banks	158 users	Indonesia	[36]
Factors influencing customer satisfaction in digital banks	408 respondents	Indonesia	[7]
Personal data protection in the context of digital banks	N/A	Indonesia	[11]
Predictors of usage attitudes related to digital bank channel distribution	616 university students	Indonesia	[37]
Sentiment analysis on customer satisfaction of digital banking	34,605 tweets related to three digital banks	Indonesia	[38]
Relationship between digital banking and intention to produce sustainability report	155 observations	Indonesia	[39]
Factors influencing customers to use digital banking application	300 respondents	Indonesia	[40]
Intensity of sales through digital banking	78 banks	Indonesia	[41]
Technology readiness and technology acceptance in digital banking	422 respondents from the millenial generation	Indonesia/ Malaysia	[21]
Banks' digitalization, blockchain, and crypto assets	100 articles	Islamic banks	[42]
Customer emotional experience generated during digital banking service delivery	502 participants	Israel	[43]
Customer experience of digital banking	247 digital bank users	Korea	[44]
Effect of perceived usefulness, banking system reliability, and COVID-19 pandemic on the digital banking effectiveness	228 clients	Malaysia	[45]
Sustainable human resource management change in the context of digital banking	4 business leaders, 7 human resources professionals, and 3 high potential talents	Malaysia	[46]
Integrating Total Quality Management practices and knowledge management in digital banks	100 employees the executive management team level	Malaysia	[20]
Financial inclusion through digital banking	12,446 households	Mexico	[18]
Legal issues concerning digital banking	306 respondents	Nigeria	[47]
Factors influencing the adoption of digital banking by retail banking customers	200 customers	Omani	[48]
Factors that drive non-users of digital banking services	208 customers	Pakistan	[49]
Impact of privacy, ease of use, and trust in digital banking	320 participants	Portugal and Spain	[50]
Customer loyalty in digital banking	10 bank managers	Sweden	[51]
Impact of digital banking on greenhouse gas emissions	36 banks	Turkey	[52]

Table 2. *Cont.*

Research Topic	Sample/Data	Context	Reference
Impacts of COVID-19 on the progression of digitalization of banks	4 vice presidents and 3 digital bank managers	Turkey	[53]
Improvement in the relations with clients in the banking sector	50 respondents from Ukraine and 50 respondents from Poland	Ukraine and Poland	[54]
Digital banks' adoption of a regulatory sandbox to foster innovation in financial sectors	24 challenger banks	United Kingdom	[55]
Effect of digital banking-related customer experience on banks' financial performance during COVID-19	456 customers of 20 Vietnamese commercial banks	Vietnam	[56]
Determinants of consumers' behavioral intention to adopt or use digital banking	241 participants	Vietnam	[57]
Factors affecting the intention to use digital banking	201 customers	Vietnam	[58]
Information safety and factors affecting the intention to use digital banking	329 customers	Vietnam	[59]
Effect of digital banking on financial performance of commercial banks	Not informed	Zimbabwe	[60]

Source: Authors.

This mapping of the literature indicates that research on digital banks is highly concentrated in Asia, with 25 of the 46 studies identified. In particular, two countries alone, India and Indonesia, account for approximately 34% of the total sample. The lack of studies on digital banks is a concerning gap that needs to be addressed, especially in developing countries like Brazil [15].

There are several reasons why conducting comprehensive studies on this topic in these regions is crucial. Firstly, digital banks have the potential to play a fundamental role in the economic and financial development of developing countries [17]. They can overcome physical and geographical barriers, allowing for access to financial services in remote and underserved areas. This can drive financial inclusion, reduce poverty, and promote economic growth [18]. Furthermore, the lack of studies can result in inadequate or outdated policies and regulations [19].

Another important aspect is the need to measure and compare the efficiency of digital banks compared to traditional banks [22]. This comparative analysis can help identify best practices and promote the adoption of more efficient models across the financial sector [20,21]. This is especially relevant in developing countries, where access to efficient financial services can drive economic development and improve people's quality of life.

Although it is not the focus of the study, it is interesting to observe emerging themes gaining traction, such as financial inclusion [17,18,28,61]; sustainability aspects, such as greenhouse emissions [52], sustainability reporting [39], and sustainable human resource management [46]; cybersecurity [11,12,50]; and how COVID-19 impacted digital banking services [30,45,53].

Given this broad and diverse scenario, this paper seeks to position Brazil in the debate about digital banks and operational efficiency.

4. Portrait and Reflections on Digital Banks in the Brazilian Scenario

In Brazil, the digitalization process of banks begins in the 2010s, with Banco Original, Neon, and Inter focusing on the customer experience (App) while being supported internally by traditional or manual processes, a service model known as traditional inside-digital outside. This was a common approach at the time to accelerate the bank's launch in order to capture new customers with a digital proposal for the main daily needs, utilizing new technologies that are easier and faster to implement (App, Website, etc.). To run the business, core banking systems are more complex, and full integration between them and the customer journeys necessitates more effort, investments, and time. As a result, while the operation grows and system enhancements are implemented, such banks use a Software as a Service (SaaS) approach focused on core banking systems in conjunction with traditional

labor to run other processes, as traditional banks do. This leads to a partially digitalized operation and a business process that incurs high costs. For example, C6 has 67% of its costs attributed to operational expenses [62]. Figure 3 shows a comparison between traditional (Itaú, Bradesco, Banco do Brasil, and Santander) and digital banks' (BV, Nubank, and C6) operational cost breakdown.

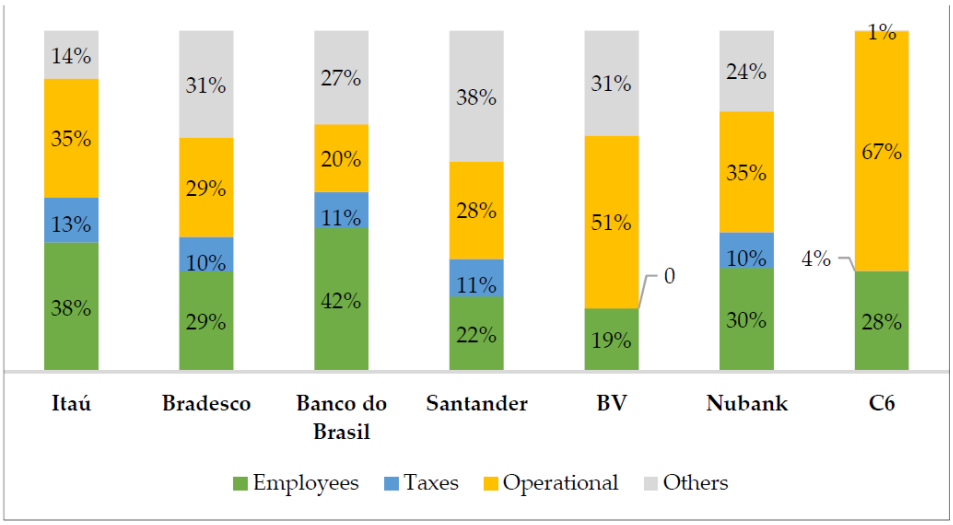

Figure 3. Cost breakdown on traditional and digital banks. Source: Developed by the authors based on the most recent official reports published by Itaú [63], Bradesco [64], Banco do Brasil [65], Santander [66], BV [67], Nubank [68], and C6 [62].

Typically, the banks in question provided digital accounts, credit cards, and a few credit products to meet the most common customer needs on a daily basis, but did not provide long-term products, such as mortgages. As a secondary business operation, those products were capable of capturing younger customers who were used to dealing with new technologies, as well as a larger number of clients who were interested in a better banking user experience and lower costs. As the digital banking competition matures and grows, some of them expanded their product portfolio. For example, Banco Original now offers, in addition to digital accounts, credit cards, and loans, other services such as basic digital products, investments, insurance, cashback programs, and corporate services. Inter has added FX transactions, a global digital account, and a loyalty program; C6, in addition to the previously mentioned features, offers partnership programs with telecom companies and odontological plans. Others, such as Nubank, continue to focus on credit cards and digital accounts.

As a result, the current state of the business model for digital banks falls short of achieving breakeven, particularly when considering financial key performance indicators (KPI) such as net profit and return on equity (ROE). A comparison between traditional banks (Itaú, Bradesco, and Banco do Brasil) and digital banks (BV, Nubank, and C6) reveals the disparities in net revenue (Figure 4) and ROE (Figure 5). The compiled information presents the results in billions of the Brazilian currency (reais or R$).

Larger new business models are also supported by digital banks. Some companies have identified the benefits of incorporating a banking unit into their structure in order to increase business profitability and leverage their current customer base. In Brazil, C6 and Tim formed a partnership with the basic strategy of offering financial products to Tim's clients in order to expand C6's customer base by offering rewards to them and vice versa. This collaboration was made possible by the lower entry barriers to establishing a digital bank. The retail industry is rapidly developing its own banking structure, such as Casas Bahia, which has assembled a proprietary bank (banQi, which is a digital bank) to assist their clients with payments and credit needs, as well as a loyalty program (cashback); Americanas with Ame (super App with digital wallet), etc.

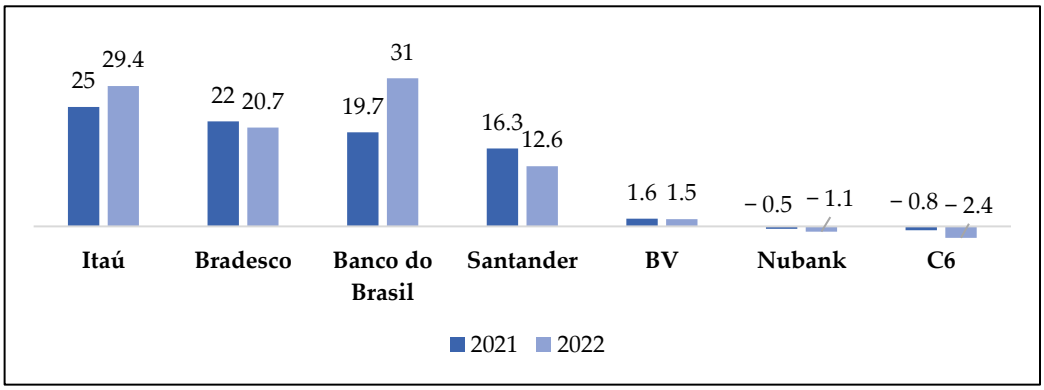

Figure 4. Net revenue (billions of R$) for traditional and digital banks. Source: Developed by the authors based on the most recent official reports published by Itaú [63], Bradesco [64], Banco do Brasil [65], Santander [66], BV [67], Nubank [68], and C6 [62].

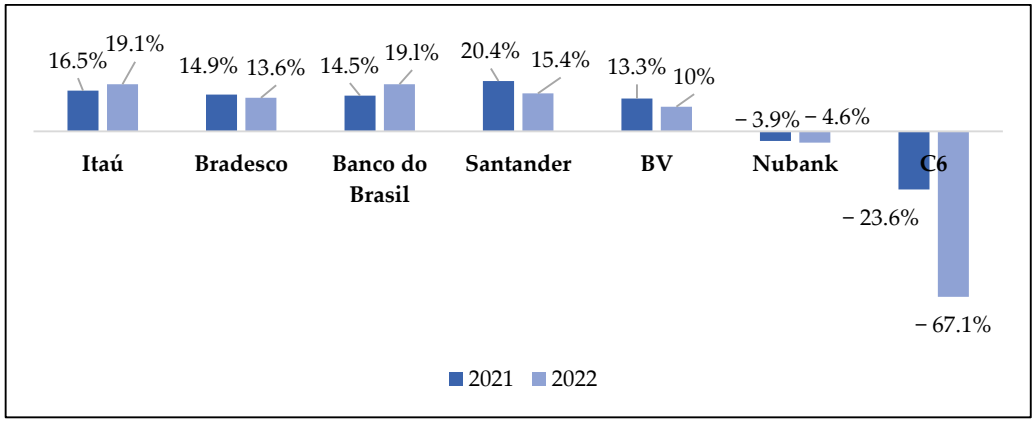

Figure 5. ROE (billions of R$) for traditional and digital banks. Source: Developed by the authors based on the most recent official reports published by Itaú [63], Bradesco [64], Banco do Brasil [65], Santander [66], BV [67], Nubank [68], and C6 [62].

Aside from financial services and retail, other industries have seen significant digital transformations, such as mobility with Uber, food delivery with iFood, and so on. As an outcome, customer behavior shifted from traditional/physical to digital and/or phygital [69,70]. This implies that customers have become accustomed to handling basic daily needs in entirely new ways, forcing traditional business models to reshape themselves.

In this scenario, traditional banks started reflections to determine the impact of those new competitors on the current business model and how they might respond to it. Many of these large banks embark on a digital transformation, aided by FinTechs, in order to improve and/or complete their customer experience, product, and service portfolio. Another strategy was to launch a new digital business. For example, Bradesco launched Next (digital account, credit card, investments, insurance, loyalty programs, etc.), and Ita launched iti (digital account and credit card), both aimed at younger customers. Even the wealth management industry has undergone a digitalization process, owing to XP Investments' value proposition: an easy and fast digital way to invest and track the results of your investments. In this specific sector, BTG Pactual has developed a digital strategy to compete, and Itaú has created a new business unit called Ion.

However, with all of this digital capacity to launch new businesses quickly and scale operations, frauds and operational risks became more sophisticated, necessitating an upgrade on the information technology, risks, and compliance teams. Some of those digital banks experienced a data leak in the recent past, exposing a major concern with client data. Especially since the risk of leakage could be in one of their providers, such as the cloud or a

call center. As a result, the providers were forced to improve their security features in order to be considered a valuable partner by those banks.

Like any other business, digital banks must evaluate their performance to determine their success and areas for improvement. In addition to the previous KPIs analyzed (i.e., costs breakdown, net revenue, and ROE), digital banks commonly use the following KPIs to evaluate their performance:

i Customer Acquisition Cost (CAC): Measures how much it costs the digital bank to acquire a new customer. A low CAC indicates that the digital bank is effective at attracting new customers.
ii Customer Retention Rate: Measures the proportion of customers who continue to use the digital bank's services over time. A high retention rate indicates that customers are satisfied with the services provided by the digital bank.
iii Net Promoter Score (NPS): Measures a customer's likelihood of recommending the digital bank's services to others. A high NPS indicates that customers are satisfied with the services provided by the digital bank and are likely to recommend it to others.
iv Average Revenue Per User (ARPU): Measures the average revenue generated by each customer over time. A high ARPU indicates that the digital bank is generating a substantial amount of revenue per customer.
v Cost-to-Income Ratio: Measures the cost efficiency of the digital bank by comparing the operating costs to the revenue generated. A low cost-to-income ratio indicates that the digital bank is effective at generating revenue while incurring few operating expenses.
vi Digital Engagement Metrics: Measures customers' engagement with the digital bank's digital channels, such as the mobile app or website. These metrics may involve logins, transactions, and time spent on digital channels.

Currently, the majority of pure digital banks in Brazil are struggling to reach the investment breakeven point. For example, C6, one of the most well-known digital banks, has yet to breakeven (see Figure 3). One possible explanation is that the profit generated by the customer base is out of balance with the operational costs (possibly because the optimal customer base has not yet been reached and/or the operations are still in the process of development and improvement). Figure 6 illustrates a comparison between traditional banks and digital banks (BV, Nubank, and C6), revealing higher values of this specific KPI for Nubank and C6. This indicates that these operations have achieved a level of efficiency comparable to, if not surpassing, their competitors, at least up until the present moment. For the latter, banks can take more action, such as automating operational processes, reducing labor force, and so on.

In summary, digital banks have become a reality in Brazil, bringing significant enhancements to customer products and services and challenging the traditional banks' existing modus operandi. However, the digital business model needs to be refined and accelerated to achieve profitability. Currently, many digital banks have not yet attained profitability, which could be attributed to factors such as a limited product portfolio, customer trust, and/or operational efficiency.

In addition, new business models for financial services and other industries are being developed. It could also be deduced that those banks could supplement and/or replace a portion of the traditional bank's offerings, but not, until now, the entire portfolio. Analytically, researchers and organizations should consider that digital banks will undergo a new evolution wave, possibly driven by the non-financial services industry, leveraging customer appeal to have relationships with companies that they can feel the benefits and/or the product, such as telecom (e.g., Tim plus C6, Vivo Money, Claro plus Inbursa) or retail (e.g., Casas Bahia plus banQi, Americanas plus Ame).

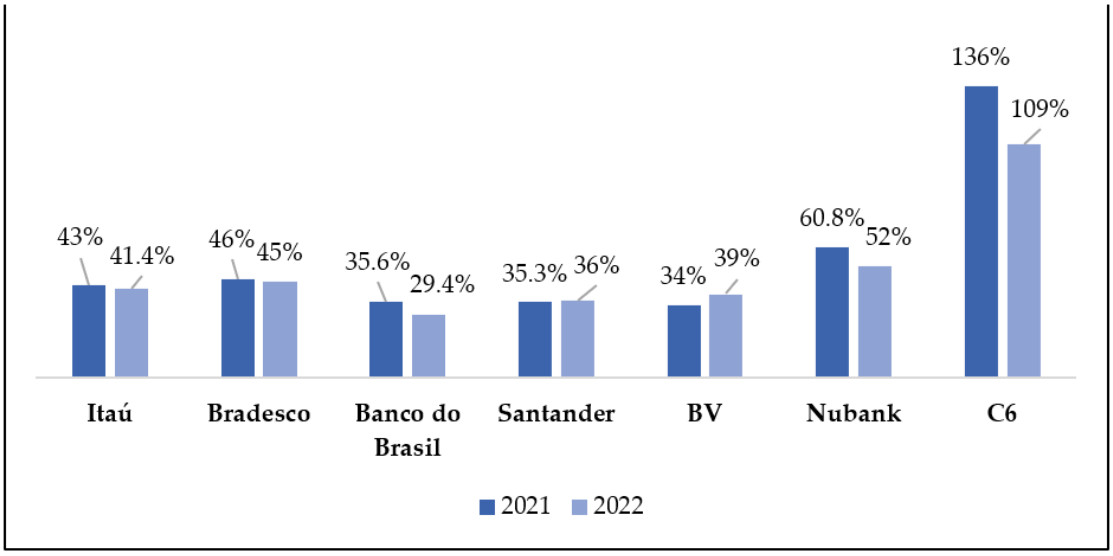

Figure 6. Cost to income for traditional and digital banks. Source: Developed by the authors based on the most recent official reports published by Itaú [63], Bradesco [64], Banco do Brasil [65], Santander [66], BV [67], Nubank [68], and C6 [62].

5. Conclusions and Future Perspectives

The emergence of digital banks has brought about significant transformations in the financial industry, leading to a growing interest in studying these institutions within the academic community. However, there remains ample room for further exploration to fully comprehend the functioning and impact of digital banks across different contexts. This study aimed to shed light on the Brazilian scenario concerning digital banks, employing an analytical perspective based the information collected, partial findings, and the professional experience of those involved in a larger research project.

The analysis of key performance indicators (KPIs), such as cost breakdown, net revenue, return on equity (ROE), and cost-to-income ratio, is of utmost importance in understanding and evaluating the financial performance of banks, both traditional and digital. These KPIs provide valuable insights into the efficiency, profitability, and overall health of banks' operations.

The presented data on KPIs offer a basis for comparative analysis between traditional and digital banks, allowing for a comprehensive assessment of their performance. By examining these metrics, researchers can identify areas of strength and weakness in the operations of different types of banks. This analysis can help in understanding the factors contributing to the success or challenges faced by traditional and digital banks in various market conditions.

The findings from the analysis of KPIs can serve as a valuable resource for future research in several ways. Firstly, researchers can expand upon the existing analysis by incorporating additional variables or considering different time periods to track the performance trends of banks. This can provide a deeper understanding of the dynamics and factors influencing the financial performance of traditional and digital banks. Secondly, the KPIs can be utilized as benchmarks for evaluating the performance of individual banks within the industry. Professionals in the banking sector can use these benchmarks to assess their own bank's performance against industry standards and identify areas for improvement. This can aid in strategic decision making and resource allocation to enhance operational efficiency and profitability. Furthermore, the analysis of KPIs can contribute to the development of best practices and performance metrics specific to digital banks. As the digital banking sector continues to evolve, identifying the key drivers of success and profitability will be crucial for the sustainable growth of these institutions. Professionals

in the digital banking industry can utilize the findings to optimize their operations, refine business strategies, and meet the evolving needs of their customers.

Based on the analyses and discussions presented in this study, three potential avenues for future research are suggested:

- Digital operational efficiency for banks: investigate how operational efficiency can be effectively measured, taking into account the actual impact of digital transformation initiatives and investments on banking operations;
- Digital banks' attraction to customers: analyze the primary factors that influence customers' adoption of digital banks and their continued engagement with these institutions;
- Leveraging digital financial services in the retail industry: evaluate the benefits and challenges associated with implementing the new digital business model that integrates financial services with the retail industry.

By exploring these areas, future research can contribute to a deeper understanding of digital banking operations, customer preferences, and the potential synergies between financial services and the retail sector. This knowledge can inform the development of strategies and best practices that drive operational efficiency, customer satisfaction, and overall success in the evolving digital banking landscape.

In conclusion, the analysis of KPIs provides valuable insights into the performance of traditional and digital banks. It offers a foundation for future research, enabling researchers to delve deeper into the factors influencing bank performance and identify opportunities for improvement. Moreover, professionals in the banking industry can leverage these insights to benchmark their own performance and drive strategic decision making. Ultimately, the analysis of KPIs is instrumental in enhancing the overall understanding and effectiveness of both research and practice in the banking sector.

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Impacts of digitization on operational efficiency in the banking sector: Thematic analysis and research agenda proposal

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ABSTRACT

The purpose of this paper is twofold: (i) to identify the thematic categories and central topics connecting digitization and operational efficiency in the banking sector; and (ii) to develop a research agenda to guide future research endeavors to advance knowledge related to digital operational efficiency (DOE). Employing a two-stage content-centric review approach, this study comprehensively outlines overarching themes and subsequently delves into specific dimensions. The first stage aimed to provide an overview of research connecting operational efficiency and digitization in the banking sector and to refine the search criteria for content analysis. The second stage employed content analysis concentrated on journal articles published between 2018 and 2023. Central topics include enhancing banking industry performance through industry 4.0 technology and partnerships, the impact of the COVID-19 pandemic on bank digital transformation, organizational adaptations for embracing new digital business models, and elevating customer experience through novel operational paradigms. The research agenda proposed include the following: DOE conceptual development; digital bank break-even analysis; optimization of the product and service portfolio offered by digital banks; and consumer experience and level of service of digital banks. By delving into the impact of industry 4.0 technologies, pandemic, and digital business models, this paper enriches our understanding of the complex interplay between digitization and operational efficiency. The proposed research agenda offers a roadmap for future scholarly endeavors, contributing to the evolution of theoretical frameworks in this field. This paper offers insights relevant for banking industry professionals, providing them with valuable guidance on how to enhance their performance, optimize their digital product and service portfolio, and elevate the overall customer experience in the rapidly evolving landscape of digital banking.

1. Introduction

It is of utmost importance for banks and the financial services industry to assess the outcomes of their operations. This evaluation holds significant weight as it showcases their financial efficiency to various stakeholders, including the market, investors, competitors, and ultimately fosters a sense of trust among their customers (Pio et al., 2023). A well-established avenue to achieve this is through the utilization of the Operational Efficiency Index (OEI), which is determined by dividing the cost by the revenue (Nguyen, Tripe & Ngo, 2018; Khan & Shireen, 2020; Allen & Rai, 1996).

By employing this methodology, financial analysts and investors are empowered to conduct thorough financial analyses and comparisons across companies (Bangarwa & Roy, 2022). This encompasses scrutinizing variables such as payroll expenditures, revenues across distinct lines of business (e.g., credit cards and corporate banking), thereby enabling the identification of the most proficient companies. Furthermore, this approach aids in discerning which entities are most conducive for investment or divestment (Luo, Fan & Zhang, 2017).

The advent of digital transformation has brought about a paradigm

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shift in the banking industry, altering the landscape of traditional banking operations and reshaping the manner in which financial institutions interact with their clients (Al-Dmour, Asfour, Al-Dmour & Al-Dmour, 2022). This technological evolution has not only streamlined internal processes but has also revolutionized customer engagement through innovative digital channels (Pio et al., 2023; Bueno, Sigahi & Anholon, 2023). Rapid advancements in information technology, data analytics, high-layered datasets (Zaib & Ourabah, 2023) and artificial intelligence have paved the way for a digital ecosystem that transcends geographical boundaries and time zones (Singh et al., 2022). As banks embrace digital platforms, the scope and scale of their operations have expanded exponentially, enabling them to offer a diverse range of services, from mobile banking to digital wallets and virtual advisory services (Shaikh & Anwar, 2023). Consequently, the banking sector finds itself at a pivotal juncture, where the integration of digital tools has become instrumental in enhancing operational efficiency and positioning institutions at the vanguard of industry transformation (Bueno, Sigahi & Anholon, 2023).

The incorporation of digital technologies, including industry 4.0, within the banking sector has ushered in a new era of operational efficiency, redefining how financial tasks are executed, monitored, and optimized (Schepinin & Bataev, 2019; Arjun, Kuanr & Suprabha, 2021). Automation and digitization of routine tasks have not only reduced manual errors but have also expedited transaction processing, thereby leading to significant time and cost savings. Moreover, digital platforms enable banks to gather, process, and analyze vast volumes of data, offering insights that empower institutions to make informed decisions for resource allocation, risk management, and service enhancement (Al-Dmour, Asfour, Al-Dmour & Al-Dmour, 2022; Banna & Alam, 2021; Pandey, Mittal & Subbiah, 2021). Consequently, the paradigm shift towards digitization has not only elevated the efficiency of individual operational components but has also synergistically harmonized various facets of banking operations, thus augmenting the overall operational efficiency of the sector (Winasis, Wildan & Sutawidjaya, 2020; Beheshtinia & Omidi, 2017).

The pursuit of digital operational efficiency (DOE) in the banking sector bears profound implications not only for managers and stakeholders within the financial industry but also for broader society (Du et al., 2020; Sia, Weill & Zhang, 2021). As banks harness the power of digital technologies to optimize their operations, they are better poised to allocate resources effectively, optimize costs, and mitigate risks (Pandey, Mittal & Subbiah, 2021; Hoffmann, 2019). This heightened operational efficiency translates to improved financial performance and sustainable growth, thereby instilling confidence among investors and shareholders (Chhaidar, Abdelhedi & Abdelkafi, 2022). Moreover, the efficiency gains trickle down to customers in the form of enhanced services, quicker response times, and personalized experiences, all of which foster customer loyalty and trust (Pio et al., 2023).

From a societal perspective, a digitally efficient banking sector contributes to economic stability, financial inclusivity, and technological progress. As banks evolve into technologically adept entities, they play a pivotal role in driving innovation, spurring job creation, and bolstering economic resilience (Winasis, Wildan & Sutawidjaya, 2020; Anis et al., 2023). Thus, the pursuit of DOE transcends its immediate impact, resonating through both the microcosm of banking management and the broader canvas of societal advancement.

Given the context presented, the objectives of this paper unfold along dual dimensions: (i) to identify the thematic categories and central topics connecting digitization and operational efficiency in the banking sector; and ii) to develop a research agenda to guide future research endeavors to advance knowledge related to digital operational efficiency (DOE). This study is primarily driven by the recognition of the evolving landscape of banking operations amidst the ongoing process of digitization (Chauhan, Akhtar & Gupta, 2022). Given the relatively limited understanding in this area, there is a compelling need for a thorough examination and categorization of existing literature (Indriasari, Prabowo, Lumban Gaol & Purwandari, 2022). By undertaking this comprehensive review, we aim to establish a structured conceptual basis that not only synthesizes current knowledge but also paves the way for further research in this field.

The remainder of this paper is structured as follows: in the Section 2, the research methodology is detailed, comprising two cycles: the first cycle involves a comprehensive approach for an overview and refinement of the literature, while the second cycle employs a focused content review approach. Section 3 presents the results and discussions and is divided into three key components: "Categorization of the literature on DOE" presents the findings related to the thematic categorization of literature on digital operational efficiency (DOE); "Central topics in research on DOE" discusses the significant research themes identified in the study; and "Research agenda" outlines the proposed directions for future research. Lastly, Section 4 summarizes the main findings and their implications in the context of digitization and operational efficiency in the banking sector and state the research limitations.

2. Theoretical background

Digital transformation has emerged as a pivotal force reshaping the banking sector, propelled by rapid advancements in technology and evolving consumer preferences (Kitsios, Giatsidis & Kamariotou, 2021; Rodrigues, Ferreira, Teixeira & Zopounidis, 2022). This can be seen as a disruptive innovation, as coined by Christensen (Christensen, 1997), characterized by new technologies that disrupt existing markets and value networks, often leading to the displacement of established industry leaders by innovative newcomers.

In recent years, traditional banking operations have undergone significant digitization, encompassing a wide array of functions ranging from customer interactions to backend processes (Naimi-Sadigh, Asgari & Rabiei, 2022). This transformation is driven by various factors, including the proliferation of smartphones, increasing internet penetration, and the emergence of innovative financial technologies. As highlighted by Diener and Špaček (Diener & Špaček, 2021), banking institutions are increasingly recognizing the imperative to embrace digitalization to remain competitive and relevant in today's fast-paced digital landscape. However, this transformation is not without its challenges. Barriers such as legacy systems, regulatory constraints, and organizational inertia often impede the pace of digitalization efforts, underscoring the complex nature of the transition (Washington, Rehman & Lee, 2022).

Digital transformation in the banking sector has become synonymous with adapting to the demands of the modern era, where technology plays an increasingly central role in everyday life. The digitization of traditional banking operations extends far beyond mere automation; it represents a fundamental shift in how financial institutions engage with their customers, manage processes, and deliver value (Naimi-Sadigh, Asgari & Rabiei, 2022; Ramdani, Rothwell & Boukrami, 2020). This evolution is fueled by a confluence of factors, including the widespread adoption of smartphones and the internet, which have democratized access to financial services and empowered consumers with unprecedented levels of convenience and choice (Tuli, 2023). Moreover, the rise of innovative financial technologies, often spearheaded by nimble Fintech startups, has disrupted traditional banking paradigms, compelling incumbents to innovate or risk obsolescence (Boot, Hoffmann, Laeven & Ratnovski, 2021). As highlighted by Kitsios et al. (Kitsios, Giatsidis & Kamariotou, 2021), digital transformation in the banking sector is not merely a matter of technological implementation but a strategic imperative for organizations seeking to maintain relevance and competitiveness in an increasingly digital world.

Despite the undeniable benefits of digital transformation, banks face formidable challenges on the path to digitalization. Legacy systems, characterized by outdated infrastructure and fragmented data architectures, pose a significant obstacle to progress, hindering agility and interoperability (Dudin, Shkodinskii & Usmanov, 2021). Moreover,

navigating the intricate web of regulatory requirements, ranging from data privacy and (Rodrigues, Ferreira, Teixeira & Zopounidis, 2022; Al-Alawi, Al-Khaja & Mehrotra, 2023) to compliance with anti-money laundering (AML) regulations, adds layers of complexity to digitalization efforts. Regulatory constraints can stifle innovation and necessitate careful navigation to ensure compliance while driving digital transformation initiatives forward. Additionally, organizational inertia, stemming from entrenched processes, cultural resistance to change, and legacy mindsets, presents a formidable barrier to digital adoption (Almeida & Ramos, 2022). Overcoming these challenges requires a holistic approach that addresses technological, regulatory, and cultural dimensions, emphasizing the need for strong leadership, strategic vision, and cross-functional collaboration within banking organizations.

The digital transformation of banks faces significant barriers, with legacy systems and infrastructure posing one of the primary challenges. Many banks operate on outdated technology platforms that hinder agility and interoperability, making it challenging to integrate new technologies and adapt to evolving customer demands (Dudin, Shkodinskii & Usmanov, 2021). Upgrading or replacing these systems requires substantial investment and expertise, presenting a formidable hurdle to digital initiatives. Cultural resistance and organizational inertia within banking institutions also impede digital transformation. Banks are traditionally conservative institutions with entrenched processes and risk-averse cultures, making it challenging to embrace innovation and agility (Almeida & Ramos, 2022). Overcoming this resistance requires strong leadership and effective change management strategies to foster a culture of innovation and adaptability. Additionally, talent shortages and skills gaps present significant barriers, as banks struggle to attract and retain professionals with expertise in areas such as data analytics and cybersecurity (Diener & Špaček, 2021). Addressing these challenges requires a concerted effort from banks to invest in technology infrastructure, navigate regulatory requirements, foster a culture of innovation, and attract and retain digital talent.

Despite these barriers, the digital era has ushered in a myriad of benefits and trends within the banking sector, revolutionizing traditional banking practices and enhancing overall efficiency and customer experience (Ramdani, Rothwell & Boukrami, 2020; Dudin, Shkodinskii & Usmanov, 2021; Martino, 2021). One prominent trend is the proliferation of digital banking channels, offering customers unprecedented convenience and accessibility to financial services. As noted by Kaur et al. (Kaur, Kiran, Grima & Rupeika-Apoga, 2021), the adoption of digital banking channels is gaining traction, particularly in emerging economies, driven by factors such as the expansion of internet infrastructure and the proliferation of mobile devices. Moreover, digital transformation has enabled banks to streamline operations, reduce costs, and improve service delivery through the integration of innovative technologies such as artificial intelligence (AI) and machine learning (ML) (Rodrigues, Ferreira, Teixeira & Zopounidis, 2022). Additionally, the advent of Fintech firms has catalyzed innovation in the banking sector, fostering competition and driving incumbents to adapt and innovate to meet evolving customer demands (Kadyan, Bhasin & Sharma, 2022).

Furthermore, the digital era has witnessed a paradigm shift towards customer-centricity, with banks increasingly focusing on delivering personalized and seamless experiences across digital touchpoints. As elucidated by Chauhan et al. (Chauhan, Akhtar & Gupta, 2022), customer experience has become a strategic differentiator for banks, necessitating the adoption of user-friendly interfaces, predictive analytics, and AI-driven recommendation engines to cater to individual preferences and anticipate customer needs. Moreover, the convergence of digital banking with emerging technologies such as blockchain and Internet of Things (IoT) is expected to unlock new possibilities in areas such as payments, identity verification, and risk management (Indriasari, Prabowo, Lumban Gaol & Purwandari, 2022). These trends collectively underscore the transformative impact of digitalization on the banking industry, promising enhanced efficiency, agility, and customer-centricity in the pursuit of sustainable growth and competitiveness.

In a systemic perspective, the digital transformation of the banking sector represents a pivotal shift in how financial institutions engage with customers, manage processes, and deliver value (Naimi-Sadigh, Asgari & Rabiei, 2022; Ramdani, Rothwell & Boukrami, 2020; Salih, Alsalhi & Abou-Moghli, 2024). While the journey towards digitalization is fraught with challenges, including legacy systems, regulatory constraints, and cultural resistance, banks are increasingly recognizing the imperative to embrace digitalization to remain competitive and relevant in today's fast-paced digital landscape (Diener & Špaček, 2021). However, despite these barriers, the digital era has brought forth a myriad of benefits and trends within the banking sector, revolutionizing traditional practices and enhancing overall efficiency and customer experience. From the proliferation of digital banking channels to the adoption of innovative technologies such as artificial intelligence and machine learning, banks are poised to leverage digital transformation to drive sustainable growth and competitiveness in the digital age (Rodrigues, Ferreira, Teixeira & Zopounidis, 2022; Martino, 2021). As the banking industry continues to evolve, embracing digitalization will be crucial for organizations seeking to thrive in an increasingly digital world.

3. Materials and methods

In order to identify the main research topics, themes, and debates surrounding digital transformation and operational efficacy within the banking sector, a content-centric review approach (Sigahi & Sznelwar, 2023; Ng et al., 2022; Morooka et al., 2023) was selected. This study adopted a structured review approach as outlined by Vashar et al. (Varsha, Chakraborty & Kar, 2024), which was conducted in two stages (cycles), as explained in this section.

3.1. First cycle: comprehensive approach for overview and refinement

The first cycle (Fig. 1) aimed to provide an initial overview of research on the subject and conduct a preliminary analysis of the literature to refine the search criteria for the content review. As proposed by Vashar et al. (Varsha, Chakraborty & Kar, 2024), this preliminary review mapping aids researchers in assessing whether they can delve into a substantial body of material or if they must further refine their search to pinpoint a specific research query.

The Scopus and Web of Science databases were considered, utilizing the entire available search period and various document types. Employing this methodology, a total of 3765 documents were retrieved, distributed chronologically as depicted in Fig. 2.

The trajectory of research publications within the domain of the digitization of the financial sector paints a compelling narrative that mirrors the evolution of technological advancements. In the initial phase until 1995, a discernible dearth of scholarly outputs marked this nascent field, potentially reflecting the relatively incipient integration of digital technologies within the financial landscape. The period from 1996 to 2008 witnessed a consistent and measured rise in research endeavors, signifying a growing recognition of the transformative potential of digitization within the financial sector. During this interval, researchers and practitioners alike began to explore the multifaceted dimensions of digitization's impact on banking operations, customer experiences, and regulatory dynamics. The subsequent span from 2009 to 2018 is characterized by a systematic surge in research publications, underscoring an intensified academic and industry interest in comprehending the intricacies of the digital financial ecosystem. This phase aligns with a global acceleration of digital transformation and industry 4.0 initiatives (Arjun, Kuanr & Suprabha, 2021), prompting robust investigations into the implications of fintech innovations, cybersecurity challenges, and regulatory adaptations. Notably, the surge in research continued unabated from 2019 until April 2023, reaching unprecedented heights. This exponential increase reflects the contemporary urgency to dissect

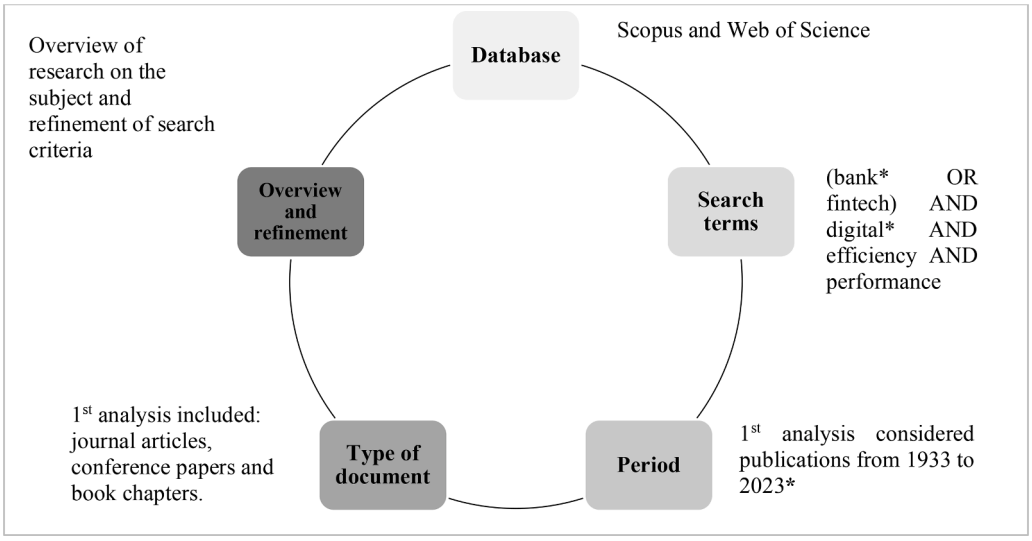

Fig. 1. First review cycle.
*__Note__: Publications up to the time of the study were considered, i.e., April 2023.

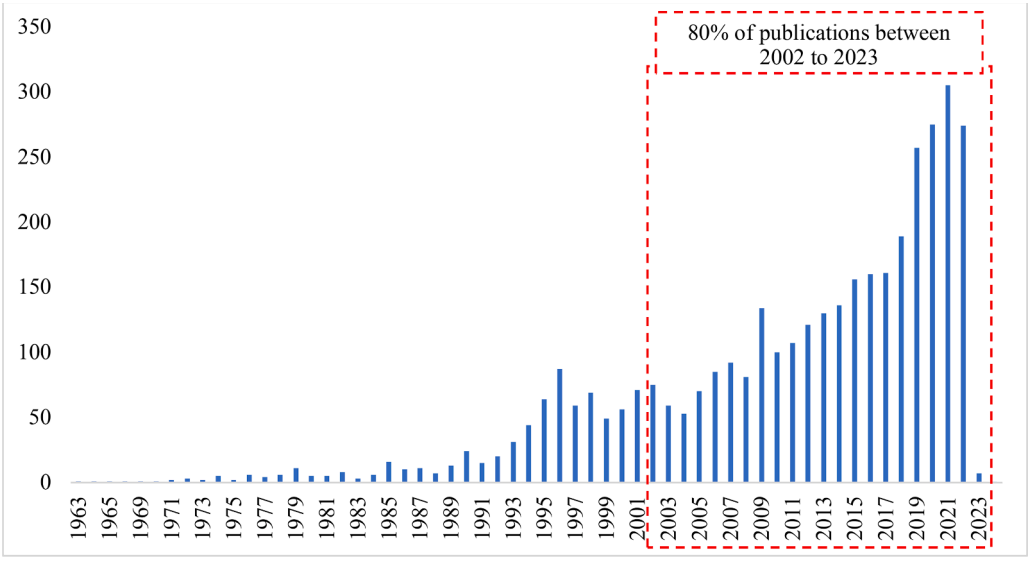

Fig. 2. Publication evolution.

the ever-evolving dynamics of digitization, encompassing emerging phenomena like blockchain, digital currencies, and the transformative potential of artificial intelligence within financial services (Singh et al., 2022; Mbaidin, Alsmairat & Al-Adaileh, 2023). Collectively, this chronological spectrum of research publication trends encapsulates the journey of academic inquiry, mirroring the unfolding narrative of digitization's indelible imprint on the financial sector.

It is worth noting that approximately 80% of the publications were conducted in the last two decades, signifying a significant degree of novelty in the subject matter. This observation prompted the content analysis to center on a more limited timeframe, prioritizing recent research endeavors.

3.2. Second cycle: focused content review approach

In order to further amplify the pertinence of the study, a subsequent phase was initiated, concentrating the analysis on journal articles published within the last six years (as depicted in Fig. 3).

The rationale behind selecting this time span emanates from its alignment with the recent apex of digital evolution within the financial sector. This era has borne witness to seminal developments in novel digital technologies, concomitantly accelerated by the catalytic impact of the COVID-19 pandemic, which propelled the digitization process at an unprecedented pace (Banna & Alam, 2021; Battisti, Alfiero & Leonidou, 2022). Furthermore, the second cycle of this review was meticulously tailored to heighten the pertinence of the analysis. Accordingly, a deliberate decision was made to focus on journal articles, deliberately excluding contributions presented at conferences or disseminated as book chapters.

Guided by this rationale, a search across the designated databases yielded a total of 1025 documents. Out of this corpus, 733 were deemed incongruent with the precise scope of this paper. Consequently, a refined and definitive sample of 292 articles was defined to serve as the basis for conducting this study.

The content review was developed following the recommendations from Elo and Kyngäs (Elo & Kyngäs, 2008), encompassing a structured progression through five phases:

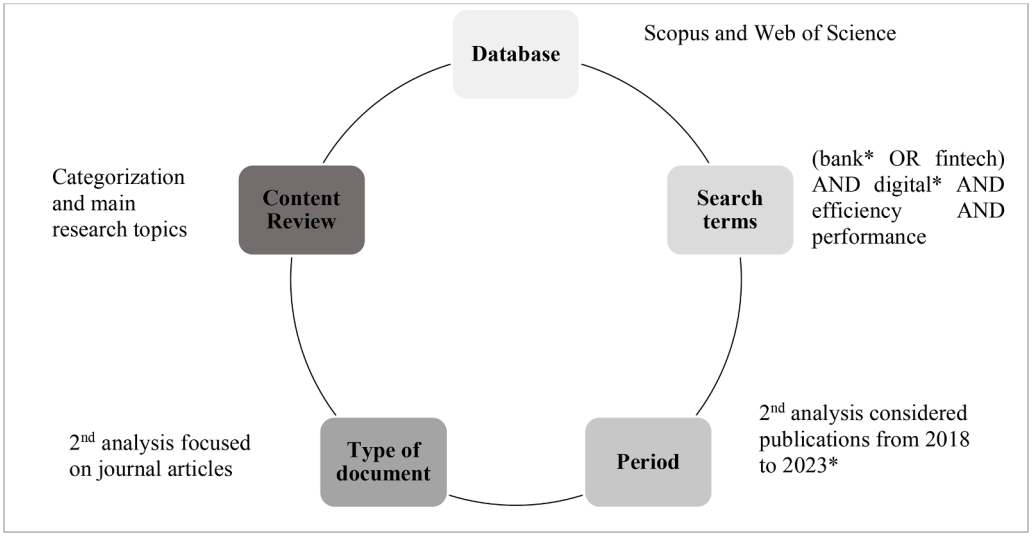

Fig. 3. Second review cycle.
*__Note__: Publications up to the time of the study were considered, i.e., April 2023.

I. Preparation: Initially, the researchers analyzed the preferred content analysis approach. Given the dearth of preceding insights concerning the topic under examination, the inductive approach was chosen. This decision is rooted in the intent to transmute specific discussions into a broader conceptual framework, thereby charting an organic evolution of understanding;
II. Open coding: This phase entails the concurrent annotation of notes and headings within the text as it is perused. This practice engenders an iterative process of analysis, facilitating the identification and delineation of emerging patterns, themes, and salient nuances intrinsic to the discourse;
III. Coding: Subsequently, the annotated notes are systematically transcribed onto coding sheets. These sheets function as reservoirs for the accumulation of notes, subsequently harnessed for the purpose of generating categories. The inherent flexibility of this approach permits the organic generation of categories, thereby accommodating the emergent complexity of the content;
IV. Categorization: The ensuing stage involves the logical consolidation of categories under overarching headings of higher order. This strategic aggregation serves the dual purpose of streamlining the taxonomy and curtailing the proliferation of categories, thereby engendering a more coherent and succinct framework;
V. Abstraction: This final phase is synonymous with the synthesis of understanding, achieved through the formulation of a comprehensive, generalized depiction of the research topic. This synthesis is executed through the generation of categories, underpinned by content-characteristic descriptors, aiming at encapsulating the core thematic fabric elucidated within the content analysis process.

4. Results and discussion

4.1. Categorization of the literature on DOE

The 292 documents selected were analyzed and categorized in 28 categories (Table 1). Those 28 categories were developed according to the content review method following the steps proposed by Elo and Kyngäs (Elo & Kyngäs, 2008), aiming to create groups which present meaningful categories representing the current articles discussions.

Further delving into the content of the 292 articles, it emerges that a subset of 23 exhibits a sharper confluence with the focal research topic. Those articles are distributed in the categories as shown in Table 2.

Table 1
Categorization of the DOE literature.

Categories	N° of articles	Frequency (%)	Cumulative frequency (%)
Performance of the banking sector	66	22.6	22.6
Blockchain / Tokenization	23	7.9	30.5
Digital currency	23	7.9	38.4
Fintech	22	7.5	45.9
Digital transformation	22	7.5	53.4
Technological reshaping	19	6.5	59.9
Benefits and risks analysis for digital finance adoption	15	5.1	65.1
New technological applications	15	5.1	70.2
Customer experience in banks	14	4.8	75.0
Artificial intelligence	13	4.5	79.5
Fraud	10	3.4	82.9
Bank's digital ecosystem	8	2.7	85.6
Digital financial inclusion	7	2.4	88.0
Digital finance and financial performance	6	2.1	90.1
Digital banking trends	5	1.7	91.8
Customer digital adoption	4	1.4	93.2
Digital banking service quality	3	1.0	94.2
Agile approaches in bank's sector	2	0.7	94.9
New digital products	2	0.7	95.5
Big data analysis	2	0.7	96.2
Open banking	2	0.7	96.9
MIS	2	0.7	97.6
Human capital and digital efficiency	2	0.7	98.3
Bank's growth roadmap strategy	1	0.3	98.6
Digital-only banks	1	0.3	99.0
Cloud	1	0.3	99.3
Marketing influence on bank's performance	1	0.3	99.7
Branchless banking	1	0.3	100
Total	292	100	100

Source: Authors.

4.2. Central topics in research on DOE

Through an in-depth content analysis of the articles and the convergence between the main topics of discussion, six distinct topics emerged (Fig. 4), serving to elucidate the central discussions within the DOE literature. These topics are elaborated upon in the subsequent

Table 2
Distribution of selected articles and key topics according to the categories.

Categories	N° of articles	Main topics of discussion
Performance of the banking sector	10	• Historical assessment focused on profitability, liquidity, asset quality • New dimensions introduced by digitalization on customer experience, operational efficiency and technological agility • Digital banking service quality, omnichannel engagement • Adaptation strategies for the digital age prompt critical examination
Digital finance and financial performance	3	• Paradigm shift due to digital finance impact on financial institutions • Blurring boundaries between banking and technology • Digital payment systems, mobile apps, automated investment platforms • Risk management, cost reduction, portfolio optimization
Technological reshaping	2	• Profound influence of AI, blockchain, tokenization adoption • AI-driven chatbots enhance customer service; blockchain ensures secure, transparent transactions • Tokenization offers fractional ownership, liquidity opportunities • Cybersecurity, data privacy, regulatory compliance • Operational landscape changes, risk management, regulatory adherence
Digital transformation	2	• Shift in banking operations through digital integration • Customer interactions, internal processes, and business models • Reimagination of value creation • Innovation culture, digital literacy, agile methodologies • Holistic approach aligning tech initiatives with strategic goals
Digital banking service quality	1	• Evolving customer expectations in digital age • User-friendly interfaces, personalized experiences, prompt issue resolution • Customer satisfaction, loyalty, brand perception • User experience design, efficient backend systems, data-driven insights • Determinants and impact on customer behavior
Bank's growth roadmap strategy	1	• Expanding market share, diversifying revenue streams, entering new segments • Strategies related to fintech partnerships, digital infrastructure investment, targeted marketing • Strategy effectiveness, financial performance implications, potential barriers • Decision-making for sustainable growth in the digital economy
Digital-only banks	1	• Operations exclusively in digital realm, with no physical branches • Offers cost savings, agility, enhanced customer experiences • Challenges related to trust-building, regulatory compliance, brand establishment
Benefits and risks related to digital finance adoption	1	• Potential benefits: operational efficiency, customer engagement, expanded market reach • Inherent risks: cybersecurity, data breaches, regulatory compliance, technology dependencies
Artificial intelligence	1	• Balancing short-term gains with long-term sustainability • Financial services landscape through data-driven decision-making, automation • AI-powered algorithms analyze datasets, optimize strategies, personalize experiences • Ethical concerns: bias in algorithms, job displacement • Role of AI in financial sector, impact on performance • Strategies to address ethical and regulatory challenges
Blockchain / Tokenization	1	• Secure, transparent transactions, new financial instruments • Blockchain's decentralized ledger ensures trust, immutability • Tokenization enables fractional ownership, increased liquidity • Challenges: scalability, interoperability, regulatory acceptance • Exploration of applications, benefits, challenges • Transformative potential, role in future of financial services
Total	23	–

Source: Authors.

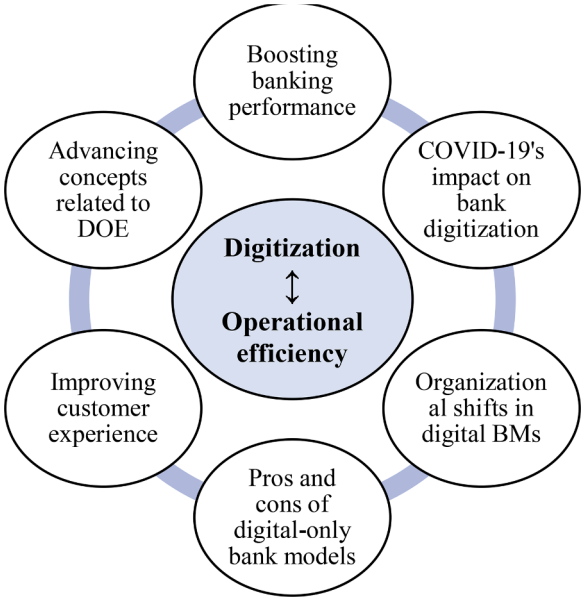

Fig. 4. Central topics connecting digitization and operational efficiency in the banking sector.
Source: Authors.

sections, providing valuable insights into the core debates in this domain.

4.2.1. Enhancing banking industry performance through technology and partnerships

This focal area encompasses 12 out of the 23 (approximately 52%) most pertinent articles. Notably, Chhaidar et al. (Chhaidar, Abdelhedi & Abdelkafi, 2022) shed light on the transformative impact of strategic partnerships and investments in fintechs, particularly for major banks with extensive operations. Their findings emphasize the significant

financial benefits derived from such collaborations, which streamline operations through innovative technologies. Conversely, Ozdemir (Ozdemir, 2022) provides an intriguing perspective on the advantages enjoyed by neobanks and smaller traditional banks through their partnerships with fintechs. By adopting advanced technologies unburdened by legacy systems, these entities can offer superior customer experiences. However, this transition presents challenges, including risk aversion, higher funding costs, increased capital requirements, and the formidable market dominance of larger financial institutions (Bueno, Sigahi & Anholon, 2023).

Moreover, the discourse encompasses the intricate dynamics of competition and concentration within the financial services sector. Borilli (Borilli, 2021) highlights a notable shift in market dynamics in Brazil between 2010 and 2020. The study reveals a reduction in market concentration alongside an evolving competitive landscape, attributed to the rising influence of emerging players such as digital banks and fintechs (Neves, Oliveira, Santini & Gutman, 2023). This shift prompts a recalibration of market shares among larger banking entities, signaling a significant transformation in the competitive landscape of the banking industry.

These insights offer a multifaceted view of the opportunities and challenges inherent in enhancing banking industry performance through technology and partnerships. While strategic collaborations present avenues for growth and innovation, they also require careful navigation of regulatory, operational, and competitive landscapes to realize their full potential in driving sustainable value for both banks and their customers.

4.2.2. The influence of the COVID-19 pandemic on the digital transformation of banks

The COVID-19 pandemic has catalyzed a rapid and profound transformation within the banking sector, accelerating the adoption of digital technologies and reshaping the way banks interact with their customers and operate their businesses.

One of the primary issues that have emerged in the wake of the pandemic is the urgent need for banks to enhance their digital capabilities to meet the evolving needs and expectations of customers. With social distancing measures and lockdowns limiting in-person interactions, consumers have increasingly turned to digital channels for their banking needs, including online banking, mobile banking, and digital payments. This surge in digital usage has placed immense pressure on banks to ensure the reliability, security, and usability of their digital platforms to accommodate the growing demand and deliver seamless customer experiences.

Moreover, the shift to remote work and virtual collaboration has necessitated banks to invest in technologies that enable employees to work remotely while maintaining productivity and efficiency. This includes deploying remote access solutions, collaboration tools, and cybersecurity measures to safeguard sensitive data and mitigate the risk of cyber threats in an increasingly remote and distributed work environment.

Furthermore, the pandemic has highlighted the importance of leveraging data and analytics to gain deeper insights into customer behavior, preferences, and needs. By harnessing the power of data analytics, banks can personalize their offerings, anticipate customer needs, and deliver targeted products and services that meet the unique requirements of individual customers. However, this also raises concerns around data privacy and security, requiring banks to strike a balance between leveraging customer data for innovation while respecting privacy rights and regulatory requirements.

In response to these emerging challenges, banks have begun to explore promising solutions to accelerate their digital transformation efforts and adapt to the new normal created by the pandemic. This includes investing in cloud computing, artificial intelligence, machine learning, and robotic process automation to automate routine tasks, streamline processes, and enhance operational efficiency. Additionally, banks are increasingly partnering with fintech startups and technology providers to leverage innovative solutions and accelerate their digital innovation initiatives.

Moreover, banks are embracing agile methodologies and organizational structures to foster innovation, adaptability, and responsiveness in an increasingly dynamic and uncertain environment. By adopting agile principles, banks can iterate quickly, experiment with new ideas, and respond rapidly to changing market conditions, enabling them to stay ahead of the curve and drive continuous improvement in their digital transformation journey.

Looking ahead, while the COVID-19 pandemic has presented unprecedented challenges for banks, it has also provided a unique opportunity to accelerate their digital transformation and emerge stronger and more resilient in the post-pandemic world. By addressing emerging issues, embracing promising solutions, and fostering a culture of innovation, banks can position themselves for long-term success in an increasingly digital-first and customer-centric landscape.

4.2.3. Organizational changes to adopt a new digital business model

A pivotal facet in the realm of digital transformation pertains to the indispensable support accorded to employees navigating this profound transition. Winasis et al. (Winasis, Wildan & Sutawidjaya, 2020) emphasize that effectuating a novel digital customer experience necessitates not only systemic shifts but also a concomitant recalibration of employee behaviors. The study examined 25 indicators – 11 delineating work stress and 14 encapsulating employee engagement – culled from diverse international journals. The research scrutinizes a cohort of 448 respondents within a Jakarta-based private bank, a crucible of sweeping technological metamorphosis during the 2018–2020 timeframe. The empirical insights unveil the deleterious impact of work stress on employee engagement, with profound implications warranting strategic interventions. To counterbalance this, strategic interventions encompassing curbing excessive working hours, instituting performance-based rewards, and furnishing comprehensive support during the transformative journey emerge as pivotal mitigating factors (Winasis, Wildan & Sutawidjaya, 2020). Thus, proactively charting a blueprint for requisite training and support to acclimate employees to the emergent technological landscape assumes paramount significance, pivotal to ensuring the seamless implementation of the new digital business paradigm.

The findings from the literature shed light on the intricate relationship between organizational changes and the successful adoption of a new digital business model (Almeida & Ramos, 2022). The negative impact of work stress on employee engagement underscores the need for proactive organizational interventions to support employees during times of technological transition (Winasis, Wildan & Sutawidjaya, 2020). This highlights the importance of fostering a supportive organizational culture that values employee well-being and provides the necessary resources and training to navigate the challenges posed by digital transformation (Santos, Hayward & Ramos, 2012). Moreover, the identification of specific strategic interventions, such as curbing excessive working hours and implementing performance-based rewards, underscores the role of targeted organizational initiatives in mitigating the adverse effects of work stress and fostering employee engagement (Winasis, Wildan & Sutawidjaya, 2020). Ultimately, by prioritizing organizational changes that prioritize employee support and engagement, businesses can position themselves for success in the adoption of new digital business models, driving innovation and sustainable growth in an increasingly digitized landscape.

4.2.4. Digital-only banks business models: benefits and risks

Digital-only banks epitomize a fresh and distinct business paradigm, predicated upon seamless client service and the removal of entry barriers through technological prowess. Integral to this innovation are features like user-friendly apps, core banking systems delivered as Software as a Service (SaaS), customer familiarity with digital

communication channels, and more. However, entrancing customers into this novel banking landscape is not devoid of challenges. Saif et al. (Saif et al., 2022) underscore that understanding customer behavior entails dissecting three core factors: external influences (critical mass, service variety, environmental considerations), customer autonomy (exemplified by trust), and the cognitive outlook on technology adoption (embracing convenience, financial efficiency, utility, and security perceptions, alongside perceived value). Notably, convenience, financial efficiency, service variety, trust, perceived value, and environmental concern wield positive influence in attracting customers. Yet, lingering concerns over functional and security risks cast a shadow, accounting for the struggles faced by digital-only banks in the United States and Japan.

In parallel, Schepinin and Bataev (Schepinin & Bataev, 2019) devised a methodology centered on gauging IT project returns, thereby estimating the prospective benefits of investments in this domain. Their findings underscore that a fledgling challenger bank must amass a minimum of 200,000 clients within its inaugural year to achieve successful trajectory. Hence, the digital-only banking model is a work in progress, striving to curate compelling products and services to captivate and enhance customer rapport, despite the potential hurdles of limited offerings and customer trust.

The connection between these papers underscores the multifaceted nature of the digital-only banking business model, which presents both benefits and risks. On one hand, the convenience, financial efficiency, and perceived value offered by digital banks can attract customers seeking streamlined and accessible banking experiences (Ramdani, Rothwell & Boukrami, 2020). Additionally, the scalability and potential for cost savings associated with digital infrastructure and SaaS solutions present compelling opportunities for profitability and growth. However, the challenges of establishing trust, mitigating security risks, and ensuring a diverse range of services underscore the complex nature of this endeavor (Dudin, Shkodinskii & Usmanov, 2021). Furthermore, the necessity of achieving a critical mass of customers within a short timeframe, underscores the high stakes and competitive dynamics inherent in the digital banking space. Overall, the interconnected insights from these papers highlight the dynamic interplay between customer preferences, technological innovation, and strategic decision-making in shaping the trajectory of digital-only banks.

4.2.5. *Elevating customer experience through novel operational approaches*

The bedrock of a robust customer experience rests on diverse facets, including comprehensive journey assessments, persona delineations, targeted segmentation, and the strategic employment of intelligent automation (IA) like chatbots and AVIRs (Mbama & Ezepue, 2018). As customer experience flourishes, so does the bank's overall performance, translating into diminished customer interactions such as chat sessions and phone calls (Mbama, Ezepue, Alboul & Beer, 2018).

A case in point is the investigation conducted by Andrade and Tumelero (Andrade & Tumelero, 2022), which probed the augmentation of customer service efficiency through IA integration. Amplifying the chatbot service's efficacy, synergized with IA for nuanced comprehension of customer requisites, service types, and query resolution, yielded a staggering 178 million interactions and 7.8 million attendances in 2020. This transformative stride resulted in a notable reduction in phone calls to human attendants at call centers, efficiently addressing frequent customer needs and affording human attendants the bandwidth to tackle more intricate requirements, thereby fostering an enriched customer experience. Conversely, Mir et al. (Mir, Rameez & Tahir, 2023) focus on evaluating online service quality in India's financial services sector and establish a clear correlation between digital banking service quality and customer satisfaction. Both studies underscore the importance of leveraging technology and refining service quality to elevate the customer experience, ultimately contributing to enhanced business performance.

The connection between these papers highlights the significance of elevating customer experience through novel operational approaches in the banking industry. By embracing IA and refining digital service quality, banks can not only improve customer satisfaction but also streamline operations and reduce costs. Collectively, these insights underscore the transformative potential of innovative operational approaches in enhancing the overall banking experience, ultimately driving business success and competitiveness in the digital era (Kaur, Kiran, Grima & Rupeika-Apoga, 2021).

4.2.6. *Conceptual advancement via expert surveys and panels*

A particularly interesting avenue for enriching the discourse lies in the formulation of concepts through surveys and panels – an approach with high potential to invigorate the exploration of DOE. This research methodology, steeped in empirical insights, offers an avenue to unravel nuanced dimensions of study.

Illustrating this approach, Al-Dmour et al. (Al-Dmour, Asfour, Al-Dmour & Al-Dmour, 2022) conducted a study delineating the nexus between marketing knowledge management and business performance. Undertaking a quantitative survey involving 336 managers across 13 Jordanian commercial banks, their findings illuminate a notable positive impact of marketing knowledge management on business performance, effectively bridging a gap in the existing literature. Another example is Shaikh and Anwar (Shaikh & Anwar, 2023), who harnessed the potential of panel research to discern the parameters that underpin the digital mode of transactions, influencing financial and operational performance while curbing bank costs. A comprehensive panel data set spanning 2011 to 2020, encompassing 32 public and private banks, underscored the potency of fostering Real-Time Gross Settlement (RTGS) and facilitating credit-based transactions in enhancing banks' performance and trimming funding costs.

By systematically gathering data and analyzing trends over time, researchers can gain valuable insights into the intricate dynamics of various factors influencing organizational performance in the banking sector (Salih, Alsalhi & Abou-Moghli, 2024). Expert knowledge-based approaches have the potential not only to enrich existing conceptual frameworks but also provides practical implications for banks seeking to optimize their operations and enhance performance in an increasingly digital landscape (Abubakar, Hashim & Hussain, 2016). Overall, expert surveys and panels offer a robust methodology for advancing conceptual understanding and driving innovation within the banking sector, paving the way for more informed decision-making and strategic planning.

4.3. *Research agenda*

Based on the discussions, four main research avenues were identified for future researchers advance knowledge on DOE: (*i*) DOE conceptual development, (*ii*) Digital bank break-even analysis, (*iii*) Optimization of the product and service portfolio offered by digital banks and (*iv*) Consumer experience and level of service of digital banks. Table 3 depict the key ideas identified in each of them.

4.3.1. *DOE conceptual development*

In the realm of DOE, a foundational research avenue beckons—one that hinges upon a comprehensive and nuanced conceptual framework. Pioneering scholars are urged to embark on an endeavor aimed at synthesizing and systematizing the fundamental tenets of DOE. This entails dissecting the intricacies of digitization processes within the financial sector, pinpointing key determinants, variables, and interdependencies that define operational efficacy. Researchers could delve into the evolving landscape of digital technologies, their amalgamation with traditional banking functions, and the emergent paradigms that underscore the digital transformation journey. By formulating a robust theoretical underpinning, this avenue lays the groundwork for subsequent empirical studies, enabling a deeper understanding of how digitization impacts operational efficiency across diverse banking domains.

The importance of studying this topic extends beyond academia and directly influences the practical landscape of the financial industry. In

Table 3
Research agenda proposal.

Research avenue	Key topics	Key references
DOE conceptual development	• Development of a comprehensive conceptual framework for DOE • Research aiming to consolidate fundamental DOE principles • Conceptual research on banking operations and customer experiences in the digital era • Guidelines for policymakers and regulatory bodies in shaping informed policies for the digital era	(Arjun, Kuanr & Suprabha, 2021; Neves, Oliveira, Santini & Gutman, 2023; Bangarwa & Roy, 2022)
Digital bank break-even analysis	• Understanding the intricacies of digital bank break-even dynamics, including the determinants that drive financial sustainability • The interplay between transaction volumes, fee structures, technology adoption costs, and customer acquisition to identify critical thresholds • How both traditional banks and new entrants adapt to the evolving digital landscape • Insights for policymakers and regulators to ensure a stable and competitive financial ecosystem	(Mbaidin, Alsmairat & Al-Adaileh, 2023; Saif et al., 2022)
Optimization of the product and service portfolio offered by digital banks	• Optimization of digital bank product and service portfolios • High-demand services, fintech integration, and personalized product recommendations through data analytics and machine learning • How to tailor offerings to customer preferences and leveraging advanced technologies	(Pandey, Mittal & Subbiah, 2021; Alonso-Robisco & Carbó, 2022; Mirza, Afzal, Umar & Skare, 2023)
Consumer experience and level of service of digital banks	• How to enhance consumer experience and service quality in digital banks • Impact of technology, including intelligent virtual assistants, chatbots, and AI-driven customer support • Data privacy, security, and transparent communication's role in nurturing customer trust	(Singh et al., 2022; Pio et al., 2023; Mir, Rameez & Tahir, 2023)

Source: Authors.

today's fast-paced digital age, financial institutions face unprecedented challenges and opportunities due to technological advancements. Understanding the intricate relationship between digitization and operational efficiency in banking is not merely an academic pursuit; it is a strategic imperative for businesses in this sector. By conducting in-depth research in this area, financial institutions can gain valuable insights into how to optimize their operations, enhance customer experiences, and stay competitive in a rapidly evolving landscape. Additionally, regulatory bodies and policymakers can benefit from this research to develop informed policies that foster innovation while ensuring the stability and security of financial systems. In essence, the importance of this research transcends theoretical exploration and directly impacts the way we conduct and regulate financial services in the digital era.

4.3.2. *Digital bank break-even analysis*

Another compelling trajectory for future exploration lies in unraveling the intricate fabric of digital bank break-even dynamics. This avenue invites researchers to embark on an empirical journey, dissecting the determinants that steer digital banks toward equilibrium – where revenues and costs attain a harmonious balance. Investigating the interplay between transaction volumes, fee structures, technology adoption costs, and customer acquisition, scholars can decipher the critical thresholds that govern digital banks' financial sustainability. Furthermore, an in-depth analysis could uncover the temporal dimensions of break-even, considering how factors like technological advancements and market dynamics influence the break-even point over time. This line of inquiry holds profound implications for digital banking strategies, shedding light on the pivotal junctures where digital banks transition from investment-intensive phases to self-sustaining models.

It is important that future research projects study the unraveling dynamics of digital bank break-even points cannot be overstated, as it has far-reaching implications for the financial industry's evolution. In an increasingly digitized world, traditional banks are facing disruption from agile digital counterparts. Understanding the factors that determine when and how digital banks reach financial equilibrium is vital for both incumbents and new entrants in the sector. For established banks, this knowledge can inform strategies for competing effectively in the digital space, helping them adapt and innovate to stay relevant. For emerging digital banks, it offers a roadmap for achieving financial sustainability, a critical milestone in their growth trajectory. Additionally, policymakers and regulators can benefit from this research to ensure a stable and competitive financial ecosystem, balancing innovation with consumer protection. In essence, unraveling the complexities of digital bank break-even dynamics is central to shaping the future of banking and finance in a rapidly evolving digital landscape.

4.3.3. *Optimization of the product and service portfolio offered by digital banks*

Within the burgeoning digital banking landscape, the strategic curation of product and service portfolios emerges as an avenue ripe for exploration. Researchers are invited to traverse this trajectory, delving into the intricacies of product offerings and service dimensions within the digital banking realm. This involves a meticulous analysis of customer preferences, market trends, and competitive benchmarks to ascertain the optimal configuration of digital bank offerings. Avenues for investigation encompass the identification of high-demand services, the integration of cutting-edge fintech solutions, and the strategic alignment of offerings with customers' financial needs and aspirations. The research could also probe the efficacy of cross-selling strategies and the potential for personalized product recommendations fueled by data analytics and machine learning. By optimizing the digital bank's product and service ecosystem, this avenue promises to amplify value proposition, foster customer engagement, and underpin sustainable growth.

The importance of studying the optimization of digital bank product and service portfolios extends beyond the banking industry itself, influencing the broader landscape of financial technology and customer-centric business models. In an era where convenience, accessibility, and tailored experiences are paramount, digital banks are at the forefront of redefining how financial services are delivered. As they navigate the delicate balance between innovation and customer satisfaction, the outcomes of this research have the potential to transform not only banking but also set new standards for customer-centricity across industries. By tailoring their offerings to customer preferences, harnessing advanced technologies, and leveraging data-driven insights, digital banks can create a paradigm shift in how financial services are consumed. This research, therefore, holds the key to reshaping the

future of financial services by offering customers more personalized, efficient, and value-added solutions while guiding businesses toward sustainable growth in the competitive digital banking landscape.

4.3.4. Consumer experience and level of service of digital banks

In the digital era, consumer experience and service quality stand as linchpins of competitive differentiation for digital banks. As such, an imperative research trajectory revolves around unraveling the nuanced contours of consumer interactions and service delivery within the digital banking sphere. Scholars are beckoned to scrutinize the intricacies of user journeys, appraising the touchpoints that shape customer perceptions, satisfaction, and loyalty. An exploration into the adoption and efficacy of intelligent virtual assistants, chatbots, and AI-driven customer support mechanisms can unveil the transformational potential of technology in enhancing service accessibility and responsiveness. Moreover, investigating the role of data privacy, security protocols, and transparent communication in nurturing customer trust in digital banking environments remains a pivotal dimension of this research avenue. By discerning the facets that underscore superior customer experiences, researchers can inform digital banks' strategies, accentuating customer-centricity, and engendering enduring relationships in the dynamic digital realm.

The value of further investigating consumer experience and service quality within digital banks cannot be overstated in today's highly competitive financial landscape. As digital banking continues to disrupt traditional models, the quality of customer interactions becomes a key driver of success. Research in this area has far-reaching implications, not only for the financial sector but also for the broader realm of customer-centric businesses. By delving into the intricacies of user journeys and the impact of technology on service delivery, this research can set benchmarks for superior customer experiences in the digital age. It informs digital banks on how to effectively leverage technology, secure customer trust through robust data privacy measures, and maintain transparent communication practices. Ultimately, the insights gained from this research help digital banks create lasting customer relationships, differentiate themselves in the market, and contribute to the evolution of customer service standards across industries, fostering trust and loyalty in the dynamic digital realm.

5. Conclusion

This research paper has navigated the dynamic landscape of digitization in the financial sector, unveiling a nuanced tapestry of insights that collectively redefine the contours of operational efficiency and customer experience. The synthesis of contemporary literature, empirical analyses, and conceptual deliberations has culminated in a comprehensive understanding of the pivotal dimensions shaping the trajectory of banking in the digital age.

In terms of contributions, this paper sheds light on the pivotal role of digital technologies and partnerships in shaping the performance of the banking industry. It unravels the transformative impact of the COVID-19 pandemic, underscoring how digitization became a pivotal strategy for resilience and adaptation. Moreover, it delves into novel operational approaches and emphasizes the paramount importance of customer-centricity, offering a comprehensive research agenda that propels future inquiries.

These insights bear implications for both theory and practice. The conceptual development of DOE lays a robust foundation for further theoretical exploration, while the analysis of digital bank break-even dynamics and optimization of product portfolios guide practical strategies for sustainable digital banking models. The elevation of customer experience underscores the imperative of crafting seamless, technology-driven interactions that resonate with evolving consumer expectations, shaping a customer-centric paradigm in financial services.

While this study endeavors to offer a comprehensive review of the literature on digital banking operational efficiency, it is essential to acknowledge its limitations. Firstly, the content-centric approach adopted may inadvertently overlook certain nuanced aspects inherent in individual studies. Despite efforts to ensure thoroughness, the inherent biases and limitations present in the selected articles could impact the overall interpretation of findings. Moreover, the research trajectory outlined in this study provides a generalized framework, which may require validation through context-specific analyses to ensure its applicability across diverse banking environments. Furthermore, the quality of the reviewed literature warrants critical examination, as variations in research methodologies, sample sizes, and data sources could influence the robustness and reliability of the findings. This issue becomes even more important to consider due to the still incipient knowledge produced and published in high-impact journals. Additionally, the dynamic nature of the digital banking landscape poses inherent challenges in capturing the evolving facets of operational efficiency and customer engagement accurately. Future research endeavors should aim to address these limitations by adopting more nuanced methodologies, incorporating diverse perspectives, and continually reassessing findings in light of emerging trends and developments. Despite these challenges, this research serves as a valuable foundation for ongoing explorations into the multifaceted nature of digital transformation within the financial sector, emphasizing the need for adaptive strategies and continuous reevaluation in response to evolving market dynamics.

Regarding potential future directions, there is a need to delve deeper into the impact of emerging technologies such as artificial intelligence, blockchain, and IoT on operational efficiency within the banking sector. Understanding how these technologies are adopted and integrated into banking operations can provide valuable insights into their effectiveness in optimizing processes. Additionally, further investigation into the long-term effects of the COVID-19 pandemic on bank digital transformation efforts is warranted. Analyzing how banks have adapted their operations in response to the pandemic and assessing the sustainability of these adaptations can offer valuable lessons for future crisis preparedness and resilience building. Moreover, exploring the organizational adaptations required for banks to effectively embrace and implement new digital business models is essential. This could involve studying changes in organizational structure, culture, and processes necessary to support digital innovation and transformation initiatives. Furthermore, efforts to optimize the product and service portfolio offered by digital banks and enhance the overall customer experience in digital banking through novel operational paradigms should be prioritized. By addressing these research directions, scholars can contribute to advancing knowledge in the field of DOE in banking, supporting the evolution of theoretical frameworks and practical strategies for enhancing bank performance in the digital era.

CRediT authorship contribution statement

Luiz Antonio Bueno: Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Tiago F.A. C. Sigahi:** Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Methodology, Funding acquisition, Formal analysis, Data curation. **Izabela Simon Rampasso:** Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Resources, Funding acquisition, Formal analysis. **Walter Leal Filho:** Writing – review & editing, Visualization, Validation, Supervision, Resources, Project administration, Funding acquisition. **Rosley Anholon:** Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Project administration, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Digital banking operational efficiency: an analysis considering the Brazilian context using the Delphi process

Abstract: This study aimed to conduct a Delphi process with experts in the digitalization process, focusing on the context of Brazilian banking organizations, to gain a deeper understanding of aspects related to digital operational efficiency. The Delphi process was developed with 14 participants, with data collected and analyzed through content analysis in each round. As the main conclusion of the study, it was evidenced that most Brazilian banking organisations are transitioning from physical to digital processes; however, there is a need for better alignment between the digitalisation process and organisational strategies. In addition, as a result of the Delphi process, KPIs were generated to measure the digital operational efficiency and possible improvement opportunities for Brazilian banking organisations. The information presented in this paper is helpful for other researchers and bank managers.

Keywords: Digital banks; Digital Operational Efficiency; Digitalisation; Brazil; Delphi.

1 Introduction

Schepinin and Bataev (2019) argue that digital transformation has been changing entire economic sectors, and the banking sector has also been undergoing this transformation. Digital transformation contributes to the evolution of financial activities in organisational processes and customer services (Gul *et al.*, 2024; Shkodina *et al.*, 2019) As mentioned by different authors, by focusing on digital transformation, banks improve their overall efficiency and reduce operational costs .(Gul *et al.*, 2024; Khattak *et al.*, 2023; Zhu and Jin, 2023a, 2023b) Golubev et al. (2020) emphasise that digital transformation in the banking sector affects organisations of all sizes and all types, including small and medium-sized ones that must update themselves regarding new technologies, employee training and offering new customer experiences.

According to Zuo *et al.* (2021), the digitalisation of the banking sector began in the last decade, but the COVID-19 pandemic accelerated it. After the pandemic, this process became increasingly evident, including to society. The most evident aspect for society in the bank process towards digitalisation is the evolution of communication channels from physical to digital media and platforms (Spasenić et al., 2023). However, it is essential to remember that the banks' digital transformation is much more than the aspect mentioned.

When we talk about operational efficiency in the banking sector, we currently consider the "revenue/cost" relationship useful to measure the efficiency in traditional banking models; however, it is not used to capture all the complexity of the new digital banking model. According to Bueno *et al.* (2023), thinking of new ways of measuring banks' operational digital efficiency is necessary. Shkodina *et al.* (2019) recognise that measuring the gains resulting from the digital transition projects in the banking sector is not easy.

Zamaslo *et al.* (2021) in their study present some indicators to monitor the digital transition in banks, dividing these indicators into static, dynamic and structural; however, as mentioned by Schepinin and Bataev (2019), one of the main challenges in banking digitalisation is characterised by the measure of global efficiency of digital processes, which have multiple dimensions. This highlights an interesting research gap that needs to be debated by academia.

The present study aims to conduct a Delphi process with experts in banking digital transition to analyse the concept of digital operational efficiency and related aspects. In addition to this introduction, this paper presents four more sections. The section two is dedicated to the theoretical background. It discusses issues related to the benefits of digital banking transformation, the main technological tools applied, and the impact of cybersecurity on this new reality. Issues such as the importance of human capital, leadership and the correct definition of strategies are also highlighted. Section three presents the methodological procedures used to reach the results from the bibliographical research to data analysis. Section four presents the Delphi process's results and the associated discussions. Finally, section five presents conclusions and final considerations.

2 Theoretical background

The digital transformation process in the banking sector is not homogeneous and it is important to highlight different levels of digitalisation in banks worldwide (Shkodina *et al.*, 2019). Shanti *et al.* (2023) remember that the investment for the banking digital transition is considerable, and not all organisations can develop at the same speed.

Ionașcu *et al.* (2023), studying banking institutions from Romania, emphasised how innovations resulting from the use of digital technologies provided an advantage competitive to those institutions; the gains were observed in terms of processes, cost reduction and new experiences for customers. Do *et al.* (2022) analysed digital transformation in Vietnamese commercial banks and also noted a positive impact on bank performance. Another benefit to be highlighted in banking digitalisation is the reduction of risks, as pointed out by Yao and Song (2023). For the aforementioned authors, the transition to digital channels and AI and blockchain

tools reduces information asymmetry (Yao and Song, 2023). Jia and Liu (2024) corroborate that digital transformation reduces the uncertainties and risks of the banking institution, improving its competitiveness. Examples of technologies adopted in banking digitalisation processes and service improvements can be cited: facial and optical recognition, cloud technology, artificial intelligence, biometry, blockchain, and big data, among others (Cucari *et al.*, 2022; Gan *et al.*, 2021; Gul *et al.*, 2024; Shkodina *et al.*, 2019)

Mărăcine *et al.* (2020) highlight the evolution of these technologies in banking sector organisations in the last ten years and point out some areas in which they can provide significant improvements: cost reduction, business optimisation, better customer selection and segmentation and the introduction of platforms specialised. It is essential to periodically evaluate the technologies used to improve their use in the banking systems towards a better quality of services provided to customers (Rashwan and Kassem, 2021).

Uddin *et al.* (2020) and Shkodina *et al.* (2019) remember, however, that the transition of operational processes to the digital environment, while improving the bank's efficiency and providing new experiences to customers, also increases vulnerabilities and chances of fraud. As a consequence, banking organisations must invest massively in cybersecurity. Finding the optimal point between investments in cybersecurity and quality of operations is essential for banks to have competitiveness, reputation and stability (Uddin *et al.*, 2020)

The reputation of banking organisations is also affected by the digitalisation process. Bernini *et al.* (2022) analysed the effects of digital transformation on reputation in Italian banks; they noted that banking digitalisation significantly contributed to reputation, especially in terms of effective communication with customers. Consequently, banks must view digitalisation as a critical factor and consider it in a multi-perspective approach.

Campanella *et al.* (2023) corroborate the multi-perspective approach, naming this process "multifaceted" and mentioning the importance of human capital in this journey. It is essential to provide training for employees in the company to enhance their capability and increase their knowledge to contribute to digital transition projects. Spasenić *et al.* (2023) also highlighted the importance of employees in the banking digital transformation in their study.

Shkodina *et al.* (2019) point out that cultural issues rooted in traditional banking models, distorted strategies and employees' lack of knowledge can lead digitalisation projects to failure. Cheng *et al.* (2023) emphasise the importance of well-defined strategies and mention that the strategies for the banking digitalisation transition do not have a linear process; bank managers must be prepared to deal with this by acting as leaders, as mentioned by Sagala *et al.* (2022).

3 Methodological procedures

This research was carried out through four well-defined stages, presented in Figure 1.

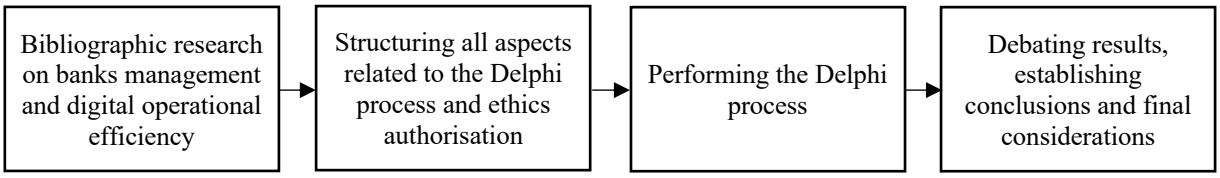

Figure 1. Stages carried out in this research to reach the results. Source: Authors' own creation.

In Stage 1, bibliographical research was carried out to establish the theoretical foundation of the themes "management of banking organisations" and digital operational efficiency of "banking organisations". The scientific databases consulted were Scopus and Web of Science. The analysed papers allowed us to verify that the topic is still not very mature; therefore, there are significant research possibilities.

Subsequently (Stage 2), we structured the research instrument for the Delphi process. Regarding this method, it is essential to highlight that it is widely used in studies in which knowledge is not fully formalised, as mentioned by different authors (Cazeri *et al.*, 2022; Flostrand *et al.*, 2020; Hasson *et al.*, 2000; Linstone, 1985; Rampasso *et al.*, 2021)

In the Delphi process (Step 3), a question or set of questions is presented to a group of experts in the first round, and the participants need to express their opinions anonymously. After a period, a moderator collects the information provided by participants and summarises it, presenting a summary panel. A new round is started in which participants, analysing the information provided, can maintain their opinion, complement it or even change their opinion. The Delphi process continues until a consensus is reached. (Cazeri *et al.*, 2022; Flostrand *et al.*, 2020; Hasson *et al.*, 2000; Linstone, 1985; Rampasso *et al.*, 2021). In the literature, there is no recommendation for the number of participants in the Delphi process; however, most of the papers invited to the process from 10 to 30 participants (Ahmad and Wong, 2019). Regarding the percentage of agreement to convergence, it is common to observe papers using a 75% or 80% cutoff.

We opted for a research instrument with three initial questions in this study:

1. How do you define digital operational efficiency in the banking industry?
2. What are the main KPIs to measure digital operational efficiency, considering current operations?

3. For Brazilian banks, what are the main improvement opportunities that can be adopted towards digital operational efficiency?

The project and the research instrument for data collection were submitted to a Research Ethics Committee, as regulated by Brazilian Law, and approved.

In total, 14 experts participated in the Delphi process (stage 3). The experience average of this group is 21 years. The organisational positions of those 14 experts are: 3 are C-Level (21%); 5 are Directors (36%); 4 Superintendents (29%) and 2 are Managers (14%) from the most significant financial services/banking organisations in Brazil.

There were two rounds of interaction. In the first round the participants answered the questions freely to express their perceptions about the topics. After the first round, the authors developed a content analysis following the recommendations from Elo and Kyngäs (Elo and Kyngäs, 2008) to compile the ideas for each question. Regarding Content Analysis, this process followed an inductive analysis because the authors analysed the experts' responses to each question and created codes to identify the main aspects, as Elo and Kyngäs (2007) recommended.

Once the codes were collected, the overlaps were adjusted, and the similarities were grouped, allowing us to understand the categories defined within the three questions. Similar topics noted in the content analysis process were: "Process, digital process, operations"; 'Investments, revenues, costs"; "Digital solutions"; "Quality"; "Employees, professionals, people"; "Customer experience"; "Scalability"; "Strategic planning, business alignment, KPIs, OKRs"; "Regulatory". In the second round, 11 of the 14 experts reviewed the compiled answers, where they could agree, disagree and point out new perceptions or adjustments. After the second round the authors identified that questions 1 and 3 reached 81,2% of consensus, and question 2 reached 100%. The authors discussed all the findings, and conclusions were established (Stage 4).

4 Results and discussions

As mentioned, after two rounds, the Delphi process developed in this study reached convergence, and the results are presented below. Regarding the definition of the term digital operational efficiency for banks, the result obtained was the following:

> *"Brazilian banks are moving forward with the process transformation, from physical to digital processes, aiming to collaborate with cost reduction and revenue increase. However, investments without alignment with the organisation's strategy, which should consider customer experience*

and regulatory drivers in digital environments, could lead to digital inefficiencies, such as systems redundancy, processes, document storage, scalability challenges, and others. Thus, adopt measurement mechanisms for the integrated and synergic usage of automation, data, cloud computing, AI, APIs, agile, skilled professionals, which optimise the banking processes, lead to a better product and service offer, besides the customer experience excellence. At this point, there will be the digital operational efficiency" (Source: Data from research).

When participants were asked about the main KPIs to measure digital operational efficiency, the convergence led to the following results:

"There are traditional/usual result measurement elements, from costs (per transaction, direct, indirect, product development and services), revenues, operating time, fail rate, percentage of digitalised services, SLA, time to market, downtime, etc. The selection/development of those elements must be aligned with the organisational strategic planning, which must consider the target customer, service/product type, generating the OKRs (KPIs). In addition to those traditional elements, some new ones were raised, such as solution scalability, processes automation level for process/service type, team skills, internal communication, team rewards, and NPS. But the right connection among those elements do not be established to develop a single index, in the same way of the traditional Operational Efficiency Index (cost/revenue)" (Source: Data from research).

Finally, regarding the opportunities for improvements associated with digital operational efficiency in most Brazilian banks, the following aspects were highlighted:

- Macro strategy to guide all the organisation through the digital transition process;
- Management through OKR;
- Provide the physical offering to support customer's self-service needs/desires;
- Increase the self-service offering to customers;
- Transition, even gradual, of customers from traditional to digital channels;
- Escalate the existing digital processes;
- Process review – develop a straight-to-process approach;
- Develop a digital operational efficiency index;
- Leverage data usage in the decision-making process;

- Increase the platforms integration because many large organisations have a considerable number of legacy systems (from the merge and acquisition process);
- Update the technological park, usually out of date, to be efficient and supportive in the digital process area needs;
- Leverage more efficient technologies, such as Artificial intelligence (AI), Robotic Process Automation (RPA) and new tactics of low-code, no-code, to eliminate operational work, support credit decision-making process, suitability, fraud prevention, etc.;
- Invest in employee reskilling/training in the new technologies;
- Contribute to the banking sector to reduce regulatory bureaucracy, which reduces the capacity to enhance and implement digital process.

Analysing the results from the Delphi process, firstly, it is possible to note that experts mention that Brazilian banks are in a transition process to digital operational excellence and, for this, Brazilian banks need to understand better all the scenarios, composed of customer-centric perspectives and internal operational dynamics. Failure to understand these aspects can lead to erroneous investments and failure. In their studies, Ionașcu et al. (2023) and Do et al. (2022) highlight the importance of customer-centric strategies and internal operational dynamics.

The findings highlight the multifaceted nature of digital operational efficiency, encompassing both traditional metrics such as costs and revenues and dimensions such as process optimisation, technological innovation and regulatory compliance. It is essential to highlight that integrating these elements is imperative to promote synergy and maximise the effectiveness of digital initiatives in banking operations. These statements are in line with the considerations of Campanella et al. (2023), Spasenić et al. (2023) and Zamaslo et al. (2021)

The experts' debates in the Delphi process also highlighted the importance of projects alignment with organisational strategies, organisational agility and technological integration to reach digital operational efficiency. The recommendations provided by the experts in the Delphi process cover a broad spectrum of strategies, ranging from management transformations to process optimisation and technology adoption. It is worth remembering here the arguments of Cheng et al. (2023)which emphasise the importance of well-defined strategies and well-aligned projects; this aspect can represent the difference between success and failure. Cheng et al.

(2023) also mention that the strategies in the banking digitisation context are not characterised as linear processes, and managers must be led by this.

The improvement opportunities mentioned by experts for most Brazilian banks towards the digital transition still deserve to be highlighted, such as the need for employee training considering the new technologies adopted and new business model (in line with statements of Spasenić et al. (2023), the importance of human capital in the banking digital transition, the management of this process using (aligned with the ideas of Zamaslo et al. (2021) - who believes that indicators are extremely interesting for monitoring the evolution of the process of digital transition), among other aspects.

Many Brazilian banks still have origins in mergers and acquisition processes; according to experts, this aspect can cause difficulties transitioning to a digital environment due to issues rooted in traditional business models, different cultures, and other aspects. This is in line with the statements of Shkodina et al. (2019) and Shanti et al. (2023).

5 Conclusions and final considerations

The digital transition in the banking sector is a topic that has attracted the attention of academia, and in particular, issues associated with measuring digital operational efficiency in this reality require further debate. This study aimed to conduct a Delphi study with experts in the banking digitalisation process considering the Brazilian context. Given the results presented, it can be said that the objective was achieved.

This study's main conclusion shows that most Brazilian banks are transitioning from physical to digital processes, which can provide more efficiency; however, attention must be paid mainly to the alignment of the projects carried out with organisational strategies. The list of the main KPIs proposed to measure digital operational efficiency and the improvement opportunities mentioned for most Brazilian banks can significantly contribute to organisations in the digital transition journey.

The research consulted experts with extensive knowledge of banking digitisation and the Brazilian banking context; however, the research sample comprised certain professionals. By choosing other professionals with other experiences or analysing other regions, some differences in the results could be evidenced; therefore, the sample size can be considered a research limitation. As future research propositions, we recommended investigating the digital transition process in banks of different sizes and segments.

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3 DISCUSSIONS

This work was developed considering an incremental research analysis approach, in three steps of the financial services industry focused on the digital transformation evolution and how to evaluate the performance generated by this new business model. The first analysis considered to develop a Viewpoint about the Digital Banks, initiating the analysis with 4 customer perspectives (convenience, low fees, enhance security and personalized services) and 4 business perspectives (lower costs, agile, scalability and enhanced customer perspective) from the SMEs. Besides this, this research considered benefits, challenges, and business models evolution in Brazil. The second analysis performed a content review to identify the main research topics, themes, and debates surrounding digital transformation and operational efficacy within the banking sector. The articles analysis considering the most relevant publications generated 10 main clusters (Performance of banking sector; Digital Finance and financial performance; Technological reshaping; Digital transformation; Digital banking service quality; Bank's growth roadmap strategy; Digital-only banks; Benefits and risks analysis for digital finance adoption; Artificial intelligence and Blockchain / Tokenization). Thus, the results indicate originality of the Digital Operational Efficiency (DOE) concept. The third analysis performed Delphi research with financial services experts (SMEs – Subject Matter Experts) focusing to explore a possible concept for DOE, the main KPIs that should be considered for DOE calculation and enhancements for the Brazilian financial services industry regarding DOE. The analysis of SMEs contributions generated 8 main discussing topics clusters (“Process, digital process, operations”; “Investments, revenues, costs”; “Digital solutions”; “Quality”; “Labor, employees, people”; “Customer experience”; “Scalability”; “Strategic planning, business alignment, KPIs, OKRs”; “Regulatory”).

The research process for DOE concept was designed on the three developed articles and its connections could be observed on Table II.

Table II. Articles topics connection.

Index	Viewpoint – SME's Perspective	Index	Content Review Categories	Viewpoint x Content Review	Index	Delphi Clusters	POV x Content x Delphi
	Customer	C1	Performance of the banking sector	P1; C1	D1	Process; digital process; operations	P8; C4; D1
P1	Convenience	C2	Digital finance and financial performance	P5; C2	D2	Investments; revenues; costs	P5; C7; D2
P2	Lower fees	C3	Technological reshaping	P6; C3	D3	Digital solutions	P6; C3; D3
P3	Enhanced security	C4	Digital transformation	P8; C4	D4	Quality	P1; C1; D4
P4	Personalized services	C5	Digital banking service quality	P1; C5	D5	Labor; employee; people	P4; C9; D5
	Business	C6	Bank's growth roadmap strategy	P8; C6	D6	Customer experience	P1; C5; D6
P5	Lower costs	C7	Digital-only banks	P5; C7	D7	Scalability	P7; C10; D7
P6	Agile	C8	Benefits and risks analysis for digital finance adoption	P3; C8	D8	Strategic planning; business alignment; KPIs; OKRs	P8; C6; D8
P7	Scalability	C9	Artificial intelligence	P4; C9	D9	Regulatory	P3; C8; D9
P8	Enhanced customer perspective	C10	Blockchain / tokenization	P7; C10			

Source: Author (2024).

To develop the connections among the articles, presented on Table II, it was established a comparison from the SME's Perspectives concept, stated in the first article (labeled from P1 to P8) and the equivalent concept from the Content Review Categories, stated in the second article (labeled from C1 to C10) and also the equivalent concept from Delphi Clusters, stated in the third article (labeled from D1 to D9). The connections analysis presented a 1 to N relationship between some of the "P" , "C" and "D" itens, because of their concepts.

It could be observed that 7 of 8 initial perspectives from the Viewpoint have a clear connection with the Content Review and Delphi analysis. In practice, only the "Lower fees" (P2) perspective wasn't identified during the research process. Another interesting finding is that "Convenience" (P1) and "Enhanced customer perspective" (P8) are the most frequent topics discussed.

The "Convenience" perspective connects with publications of "Performance of the banking sector" and with the "Digital banking service quality". Besides this, connects with SME's categories of "Quality" and "Customer experience". This means that, for customers convenience perspective, banks should provide a superior quality on the digital services, products, being available anywhere, anytime in a user-friendly approach.

The "Enhanced customer perspective" connects with publications of "Digital transformation" and with the "Bank's growth roadmap strategy". Besides this, connects with SME's categories of "Process, digital process, operations" and "Strategic planning, business alignment, KPIs, OKRs". This means that, banks should provide a customized and seamless customer journey in alignment with the corporate strategy. The management and measurement

of this new business models must be performed with OKRs and KPIs to fulfill the strategic goals.

Thus, to evaluate the operational performance of this new business model requires a broader view, especially considering that digital banks initial operations are digital outside and traditional inside. This discussion wasn't identified in the latest research studies. Most of them focused on the usage of the digital channels, its benefits related to cost reduction.

As this work aims to support not only an academic perspective, but also a practical usage of the research results, the Delphi analysis presented the current view of some financial services SMEs about DOE. It was mapped 15 KPIs which should be considered to calculate the DOE, such as, traditional ones: investments, cost and new ones: NPS, downtime, system scalability, etc. Even though, those KPIs were mapped, the relationship among them weren't defined, being an opportunity for a new research topic. Another interesting perspective is to notice that customers and systems dimensions were identified during the discussions, which reinforce that the digital business model requires more sophisticated view to be evaluated.

It also should be considered that the first and third articles were based on a Brazilian perspective. Thus, those analysis presents an opportunity to be expanded considering other countries perspectives/realities for the financial services industry. It will be valuable to understand more digital societies perspectives, for instance, China versus less digital societies for instance, Iran.

Additionally, banks should develop a detailed approach to implement the academic concepts to the day-to-day activities / practical usage. For instance, one of the improvements identified in the Delphi analyses is "Scale the current digital processes" to all bank's units. It requires not only business alignments, but also technical alignments and besides this, a clear approach to perform this implementation. Otherwise, bank's units will keep focused on their OKRs.

"Pari passu", the detailed implementation approach must consider the barriers/blockers for its fulfillment. Using the previous improvement example again, "Scale the current digital processes", those alignments stated before are a challenge task, because usually bank's units are focused on their own P&L, their contributions to the OKRs, but until certain point. Once their own KPIs are under discussion align the units' priorities requires a superior governance model, possibly oriented by the major DOE perspective. This could mean, with system improvement, implementation should be prioritized, which unit should drive the process discussion, etc. It also important understand and bring to this discussion the fact that the rewards

(bonus) are based, in the majority, on the unit's performance (share the total rewards through the bank's units). Thus, the total rewards models should be aligned with the global bank's performance and evaluate in a broader perspective the unit's contribution.

Thus, the earlier analysis and discussions presents the path to new research agenda related to digital performance for banks, including the discussion related to DOE formula.

4 CONCLUSIONS

This work aims to provide a better understanding not only for academia but also for financial services industry about a new and suitable concept to measure DOE for banks in Brazil. The research was performed considering the perspective from banking SMEs, the available literature, and a deeper discussion about DOE with a broader and senior group of banking SMEs.

The result of the research reveals a necessity for a proper approach to evaluate the new banking business model which is being implemented / adopted nowadays in Brazil. As identified in the Viewpoint analysis, it is expected that digital banks should be, with a traditional measurement approach, more efficient than traditional banks. But it is not necessarily.

The content review analysis presented some very interesting discussions regarding usual dimensions considered to evaluate the business efficiency, such as digital banking performance, digital transformation, technology reshaping, customer experience, etc. In total 23 of the 292 selected articles have a closer relationship with the DOE discussion. But those articles didn't present an approach / discussion which consider how evaluate the digital banking business model connecting new digital business dimensions. It reveals a possibility of originality in the discussion.

Those new digital business dimensions for instance, system scalability, process seamless, customer experience, etc., where identified through the Delphi analysis with a broader group of senior SMEs in the financial services industry. Also, the new digital business dimensions are relevant to guarantee the correct evaluation of this digital business model. But the proper correlation among the 15 dimensions (KPIs) identified in this analysis was not focus of this research.

It is important to notice that the articles present some limitations on their reach: the first article, Viewpoint, was focused in the Brazilian perspectives and SME local deep knowledge; the second article, Content Review, presents the results for the articles research as an innovative topic, the discussions were based on the available publications; the third article, Delphi analysis, also was focused in the Brazilian perspectives and SME local deep knowledge.

Based on the presented discussions in this work, three potential future research agendas are suggested:

a) Digital operational efficiency for banks: Investigate how operational efficiency can be effectively measured, considering the actual impact of digital transformation initiatives and investments on banking operations;
b) Optimization of the product and service portfolio offered by digital banks: Investigate the customer's daily needs to be fulfilled by the optimal digital bank's products portfolio;
c) Leveraging digital financial services in the retail industry: Evaluate the benefits and challenges associated with implementing the new digital business model that integrates financial services with the retail industry.

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ATTACHMENT 1 – Authorization Research Ethics Committee

PARECER CONSUBSTANCIADO DO CEP

DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: Eficiência digital operacional em bancos: uma análise exploratória sobre o tema
Pesquisador: ROSLEY ANHOLON
Área Temática:
Versão: 1
CAAE: 63132322.6.0000.5404
Instituição Proponente: Faculdade de Engenharia Mecânica
Patrocinador Principal: Financiamento Próprio

DADOS DO PARECER

Número do Parecer: 5.676.565

Apresentação do Projeto:
As informações contidas nos campos "Apresentação do Projeto", "Objetivo da Pesquisa", "Avaliação dos Riscos e Benefícios" e "Comentários e Considerações sobre a Pesquisa" foram obtidas dos documentos apresentados para apreciação ética pelo CEP e das informações inseridas pelo(a) PESQUISADOR(A) RESPONSÁVEL pelo estudo, na Plataforma Brasil.
A revolução digital vem mudando as operações de todos os tipos de organização e não é diferente com as organizações do setor bancário, que precisam estar preparadas para esta nova realidade (Sia, Weill e Zhang, 2021). A correta integração entre os elementos tecnológicos e os aspectos
de gestão se faz essencial na busca pela melhor eficiência operacional. Ao usar todos os elementos decorrentes das digitalização, as organizações bancárias conseguem expandir sua atuação e aumentar sua competitividade (Kolodiziev et al., 2021). Apesar a importância do tema eficiência operacional digital de organizações bancárias, ainda são poucos os estudos com esse foco. A presente pesquisa se enquadra na linha de pesquisa “Sistemas de Engenharia de Produção” desenvolvida na Faculdade de Engenharia Mecânica da Universidade Estadual de Campinas.
Hipótese:
Pelo fato do estudo ser classificado como exploratório, a hipótese não é aqui definida.

Objetivo da Pesquisa:
Objetivo Primário:
O objetivo deste projeto de pesquisa é melhor compreender os principais aspectos que norteiam a

eficiência digital operacional em organizações do setor bancário.

Avaliação dos Riscos e Benefícios:

Riscos:

Entendemos que, para o estudo proposto, os riscos não são mensuráveis e previsíveis, visto que o participante tem a liberdade de apresentar sua opinião dentro do tema. Entretanto, caso sinta qualquer tipo de desconforto, o participante tem o direito de não responder ou procurar os
responsáveis pela pesquisa para esclarecer dúvidas.

Benefícios:

Os resultados desta pesquisa trazem de forma indireta benefícios relacionados para a área de gestão empresarial das organizações bancárias.

Comentários e Considerações sobre a Pesquisa:

Trata-se de um estudo científico que será realizado por um pesquisador da Faculdade de Engenharia Mecânica-Unicamp, sob coordenação de um docente dessa Unidade.

Metodologia Proposta:

O estudo utilizará o método Delphi. Neste método, um grupo de especialistas discute um determinado tema ao longo de sucessivas rodadas até que se alcance o consenso (Carneiro Caneda e Chapado Fernadez-Ardavin, 2011; Flostrand, Pitt e Bridson, 2020; Powell, 2003). Nesta pesquisa o tema será a Eficiência Operacional Digital de Organizações bancárias. Cabe destacar que consenso não significa unanimidade. Ao longo das rodadas do Delphi, os participantes vão tendo contato com as opiniões de outros participantes e, se for caso, podem alterar ou complementar seus pontos de vista (Carneiro Caneda e Chapado Fernadez-Ardavin, 2011; Flostrand, Pitt e Bridson, 2020; Powell, 2003). O método Delphi é um processo utilizado em muitas áreas de pesquisas acadêmicas. A primeira rodada do método Delphi nesta pesquisa terá início com as seguintes perguntas:

1) Como você define o termo Eficiência Digital Operacional em organizações do setor bancário?

2) Quais são os elementos chaves para sua mensuração, considerando a realidade das operações atuais.

3) Em especial para as organizações do setor bancário atuantes no Brasil, quais são as principais oportunidades de melhorias ainda plausíveis de serem adotadas, caso julgue que estas existam?

A colocação das perguntas supracitadas justifica-se em uma realidade no qual o tema Eficiência Digital Operacional em organizações do setor bancário ainda demanda mais debates na literatura acadêmica. A previsão é de que ocorram ao menos duas rodadas e o intervalo entre cada rodada seja de 15 dias. Na literatura é possível observar estudos utilizando o método Delphi que

convergem em algumas poucas rodadas (duas) até estudos que demandam maior número de rodadas, não existindo assim um padrão (Carneiro Caneda e Chapado Fernadez-Ardavin, 2011;
Flostrand, Pitt e Bridson, 2020; Powell, 2003).
Metodologia de Análise de Dados:
As informações apresentadas pelos respondentes entre cada uma das rodadas serão analisadas via técnica de análise de conteúdo.
Desfecho Primário
As informações exploratórias obtidas na pesquisa em muito contribuirão para os debates sobre a gestão empresarial das organizações bancárias e sua eficiência operacional.
Foi apresentado orçamento e a informação que o estudo será custeado com recursos do proponente.
Cronograma de Execução
Estruturação dos textos científicos: 01/05/2023 a 30/07/2023
Coleta de dados, após aprovação do CEP: 01/11/2022 a 31/01/2023
Análise de dados: 01/02/2023 a 30/04/2023

Equipe da pesquisa:
Coordenador: Prof. Dr. ROSLEY ANHOLON-Departamento de Engenharia de Manufatura e Materiais-Faculdade de Engenharia Mecânica-Unicamp
Pesquisador: LUIZ ANTONIO BUENO

Considerações sobre os Termos de apresentação obrigatória:
A UNICAMP e os órgãos de fomento solicitam inserção dos dados, anonimizados, em repositório de dados (REDU-REpositório de Dados da Unicamp). Assim, solicita-se que seja inserido, no campo "Ressarcimento e Indenização" do TCLE, o texto citado abaixo, para que os participantes de pesquisa possam ser esclarecidos.
"Tratamento dos dados:
Esta pesquisa prevê o armazenamento dos dados, anonimizados, coletados nesta pesquisa, em repositório institucional de dados, em local virtual, de acesso público, com objetivo de possível reutilização, verificação e compartilhamento, em trabalhos de colaboração científica c!formações Básicas do projeto, o projeto detalhado, o Termo de Consentimento Livre e Esclarecido, o comprovante de vínculo funcional do proponente do estudo e o Questionário, denominado "Eficiência digital operacional em bancos: uma análise exploratória sobre o tema", a ser aplicado aos participantes da pesquisa.

sobre o tema.

Recomendações:

TCLE

a) A UNICAMP e os órgãos de fomentos solicitam à inserção dos dados anonimizados em repositório de dados. Diante disso, para esclarecimentos dos participantes da pesquisa, solicitamos que seja inserido no TCLE, abaixo do item "ressarcimento e Indenização", o seguinte texto:

“Tratamento dos dados: Esta pesquisa prevê o armazenamento dos dados coletados em repositório de dados, em local virtual de acesso público, com o objetivo de possível reutilização, verificação e compartilhamento em trabalhos de colaboração científica com outros grupos de pesquisa.

Sua identidade não será revelada nesses dados, pois os dados só serão armazenados de forma anônima (isto é, os dados não terão identificação), utilizando mecanismos que impeçam a possibilidade de associação, direta ou indireta com você. Cabe ressaltar que quem compartilhar os dados também não terá possibilidade de identificação dos participantes de quem os dados se originaram. Sendo assim, não haverá possibilidade de reversão da anonimização”.

b) Colocar no TCLE (além da informação que já está no TCLE de que não há benefícios diretos para os participantes) quais são os benefícios indiretos da pesquisa.

c)Os campos para colocar nome e assinatura do pesquisador e do(a) participante da pesquisa devem estar na última folha. Nesta, os campos para as respectivas rubricas devem ser eliminados.

Conclusões ou Pendências e Lista de Inadequações:

APROVADO COM RECOMENDAÇÕES (VIDE ITEM ACIMA "RECOMENDAÇÕES").

Considerações Finais a critério do CEP:

- O participante da pesquisa deve receber uma via do Termo de Consentimento Livre e Esclarecido, na íntegra, por ele assinado (quando aplicável).

- O participante da pesquisa tem a liberdade de recusar-se a participar ou de retirar seu consentimento em qualquer fase da pesquisa, sem penalização alguma e sem prejuízo ao seu cuidado (quando aplicável).

- O pesquisador deve desenvolver a pesquisa conforme delineada no protocolo aprovado. Se o pesquisador considerar a descontinuação do estudo, esta deve ser justificada e somente ser realizada após análise das razões da descontinuidade pelo CEP que o aprovou. O pesquisador deve aguardar o parecer do CEP quanto à descontinuação, exceto quando perceber risco ou dano não previsto ao participante ou quando constatar a superioridade de uma estratégia diagnóstica ou terapêutica oferecida a um dos grupos da pesquisa, isto é, somente em caso de necessidade de ação imediata com intuito de proteger os participantes.

- O CEP deve ser informado de todos os efeitos adversos ou fatos relevantes que alterem o curso normal do estudo. É papel do pesquisador assegurar medidas imediatas adequadas frente a evento adverso grave ocorrido (mesmo que tenha sido em outro centro) e enviar notificação ao CEP e à Agência Nacional de Vigilância Sanitária – ANVISA – junto com seu posicionamento.

- Eventuais modificações ou emendas ao protocolo devem ser apresentadas ao CEP de forma clara e sucinta, identificando a parte do protocolo a ser modificada e suas justificativas e aguardando a aprovação do CEP para continuidade da pesquisa. Em caso de projetos do Grupo I ou II apresentados anteriormente à ANVISA, o pesquisador ou patrocinador deve enviá-las também à mesma, junto com o parecer aprovatório do CEP, para serem juntadas ao protocolo inicial.

- Relatórios parciais e final devem ser apresentados ao CEP, inicialmente seis meses após a data deste parecer de aprovação e ao término do estudo.

-Lembramos que segundo a Resolução 466/2012 , item XI.2 letra e, “cabe ao pesquisador apresentar dados solicitados pelo CEP ou pela CONEP a qualquer momento”.

-O pesquisador deve manter os dados da pesquisa em arquivo, físico ou digital, sob sua guarda e responsabilidade, por um período de 5 anos após o término da pesquisa.

Este parecer foi elaborado baseado nos documentos abaixo relacionados:

Tipo Documento	Arquivo	Postagem	Autor	Situação

Informações Básicas do Projeto	PB_INFORMAÇÕES_BÁSICAS_DO_PROJETO_2013250.pdf	09/09/2022 16:36:06		Aceito
Folha de Rosto	folhaDeRosto_luiz.pdf	09/09/2022 16:35:54	ROSLEY ANHOLON	Aceito
Outros	ID_Unicamp_Rosley.pdf	09/09/2022 16:33:58	ROSLEY ANHOLON	Aceito
Outros	questionario_luiz.pdf	09/09/2022 16:32:48	ROSLEY ANHOLON	Aceito
TCLE / Termos de Assentimento / Justificativa de Ausência	TCLE_Luiz.pdf	09/09/2022 16:32:34	ROSLEY ANHOLON	Aceito
Projeto Detalhado / Brochura Investigador	Projeto_CEP_Luiz.pdf	09/09/2022 16:32:25	ROSLEY ANHOLON	Aceito

Situação do Parecer:
Aprovado

Necessita Apreciação da CONEP:
Não

CAMPINAS, 30 de Setembro de 2022

Assinado por:
Renata Maria dos Santos Celeghini
(Coordenador(a))

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Kind regards,
Ms. Joyce Gu
E-Mail: joyce.gu@mdpi.com

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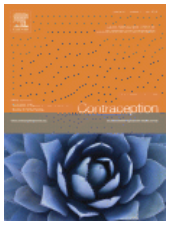

Impacts of digitization on operational efficiency in the banking sector: Thematic analysis and research agenda proposal

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