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Artificial Intelligence in the Banking Sector: Development of a Framework for Effective Deployment

Ana Rita Figueiredo Tavares

Master Thesis

presented as partial requirement for obtaining a Master's Degree in Data Science and Advanced Analytics

NOVA Information Management School
Instituto Superior de Estatística e Gestão de Informação
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Artificial Intelligence in the Banking Sector: Development of a Framework for Effective Deployment

by

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Master Thesis presented as partial requirement for obtaining the Master's degree in Data Science and Advanced Analytics, with a specialization in Business Analytics

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STATEMENT OF INTEGRITY

I hereby declare having conducted this academic work with integrity. I confirm that I have not used plagiarism or any form of undue use of information or falsification of results along the process leading to its elaboration. I further declare that I have fully acknowledged the Rules of Conduct and Code of Honor from the NOVA Information Management School.

Lisbon, 15.07.2024

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ABSTRACT

This dissertation addresses the integration of Artificial Intelligence (AI) in the banking sector, with a particular focus on the development of a structured framework to guide the systematic adoption of AI technologies, offering systematic guidelines to assist the banking sector in identifying, evaluating, and effectively implementing AI technologies. The research employs the Design Science Research methodology, starting with an extensive review of existing literature on AI applications within the banking industry. Following this, the framework was built based on these findings and refined through the application of the Strategic Alignment Model (SAM), ensuring that AI implementations are aligned with the strategic objectives of banking institutions. Subsequently, a survey was conducted with two industry professionals, distinguished by their level of expertise, to gather insights and feedback, discussing the limitations and suggestions for future work, and highlighting areas for further refinement and enhancement of the framework. Despite its strengths, the volatility of the evolution of AI technology and the absence of multiple use case demonstrations are among the framework's limitations. Consequently, future research should focus on extending the framework's adaptability to different banking environments since it could expand the framework's scope to cover a wider range of banking services, implement it in a real bank for further refinement, and explore more use case scenarios to demonstrate its applicability and robustness in diverse contexts.

KEYWORDS

Artificial Intelligence; Banking Industry; Framework Development; Innovation Management; Technology Adoption

Sustainable Development Goals (SDG):

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LIST OF ABBREVIATIONS AND ACRONYMS

AGI Artificial General Intelligence

AI Artificial Intelligence

ANI Artificial Narrow Intelligence

ANN Artificial Neural Networks

ASI Artificial Super Intelligence

CRM Customer Relationship Management

DSR Design Science Research

IS Information Systems

IT Information Technology

KM Knowledge Management

LLM Large Language Model

ML Machine Learning

NLP Natural Language Processing

PCF Process Classification Framework

PoC Proof-of-Concept

ROI Return Over Investment

SAM Strategic Alignment Model

SAMM Strategic Alignment Maturity Model

1. INTRODUCTION

This dissertation analyzes the integration of Artificial Intelligence technologies in the banking industry, with the purpose of developing a structured framework for their implementation within the sector, supporting banks' strategic objectives. By discussing the opportunities and challenges associated with the adoption of such technologies, this dissertation provides valuable information into the expanding influence of AI in the banking sector.
To perform a successful analysis, it is paramount to have a clear organizational structure and make strategic choices, hence the decision to adopt the Design Science Research (DSR) methodology due to its consistent and adaptable framework, which ensures the research is concise, organized, and comprehensible (Brocke et al., 2020). Chapter 2 provides detailed information on this approach.
This study begins with an in-depth exploration of the Banking Industry, presented in Chapter 3, in which its structure, main areas, objectives, and challenges are analyzed.
Complementary, Chapter 4 presents the Literature Review, bridging the main concepts regarding the banking industry and AI to demonstrate its ability to transform the sector, emphasizing the historical background, its tools and technologies, the key concepts, and respective challenges. The fusion of banking and AI concepts enabled the development of the artifact, a structured framework designed to leverage AI technologies in a bank, ensuring their appropriate, structured, and responsible implementation.
Chapter 5 presents a detailed description of the framework and a guide to its use, as well as a discussion of the results, supported by a survey of two professionals in the field, distinguished by their level of experience and knowledge.
To conclude, the limitations of the framework and suggestions for future work may be consulted in Chapter 6.

This section describes the background, motivation, and objectives of this research.

1.1. BACKGROUND AND PROBLEM IDENTIFICATION

Artificial intelligence and its technological revolution have already demonstrated their potential to fundamentally transform various sectors with their extensive range of possible applications, which align tightly with the changes driven by evolving customer demands. Despite its complex nature, the economic narrative reflects this pattern: as AI continues to evolve and the urge to adapt swiftly to often unforeseen changes compels the sector to provide more innovative, efficient, and adaptable solutions to meet customer needs (Arrieta et al., 2019).

Economically, institutions handle vast amounts of sensitive data every day, and managing or manipulating this data without advanced and appropriate technologies may result in non-optimal decisions. In consequence, Artificial Intelligence allows institutions in this sector to make data-driven decisions that are more effective and objective, significantly enhancing their capability to tackle new challenges (Gatla, 2022).

In response to the positive reputation garnered by its solutions for improving customer experiences, the banking industry is intensifying its efforts to study and invest in these technologies (Noreen et al., 2023). AI covers a versatile array of technologies, including Machine Learning (ML), Deep Learning, Natural Language Processing (NLP), and Computer Vision, all aimed at improving diverse services with a common purpose (Abioye et al., 2021). However, as AI continues to evolve, it also introduces new risks and challenges that require cautious investment to address them effectively protect the bank's reputation, and maintain customer trust (Ghandour, 2021). Its associated challenges are of the most diverse natures, including technical, regulatory, ethical, and social dimensions. Furthermore, this highlights the critical need for thorough evaluation within the financial sector to navigate the challenges presented by advancements in AI (Akhter et al., 2024).

Despite the rapid integration of AI in various sectors, particularly in recent years, predicting its long-term evolution remains a major challenge. The uncertainty about its future applications and the originality of its creators in responding to the world's needs underscores the importance of continuously analyzing AI's impact (Filipova & Koroteev, 2023).

The responsible and successful implementation of AI reshapes business operations and provides banking institutions with a significant competitive advantage, enabling the delivery of more efficient, personalized, convenient, and optimized services to customers, while reducing operational cost (Svoboda, 2023).

1.2. IMPORTANCE AND RELEVANCE

As banks continue to adopt this technology, understanding its complex implications is challenging yet essential, as it enables banks to leverage AI to enhance operational efficiency, customer experiences, risk management, and product innovation, thereby facilitating strategic decision-making by using data-driven technologies to maintain competitiveness and adapt to evolving industry dynamics (Eni et al., 2023).

Consequently, AI-powered systems enhance the precision of banking services, customizing them to individual requirements and increasing the bank's overall operational efficacy (Arrieta et al., 2019). They also automate pivotal tasks in various departments, including decision-making, compliance, problem-solving, and customer support, facilitating the delivery of information (Ghandour, 2021). This automation serves to streamline back-office operations and to organize customer data more effectively, improving the quality and velocity of decision-making processes (Noreen et al., 2023). However, understanding the impact of AI is pivotal, enabling banks to effectively leverage this technology to reinforce their operational capabilities, reduce costs, increase revenues, and maintain a competitive advantage (Yi et al., 2023).

In addition, this dissertation provides valuable information on the economic benefits of integrating AI into the banking sector. Not only does it intend to improve understanding of how AI contributes to economic growth in banking based on existing implementations, but it

also seeks to promote continuous improvement and evolution in the sector, highlighting the strategic advantage that AI offers, encouraging further exploration and adaptation of AI technologies in financial institutions.

Summarising, the limited understanding of AI's full potential in the field, its integration challenges, and the difficulty in quantitatively analyzing its economic impact represent significant gaps and uncertainties in this concept (Maple et al., 2023).

Finally, despite gaps in the theoretical understanding of AI within the banking industry, the following research question can be formulated: “How can a structured framework optimize the deployment and management of artificial intelligence technologies in the banking sector?”. This framework serves as a systematic approach to evaluating and integrating AI effectively within banking processes.

1.3. OBJECTIVES

The research goal is to develop a framework for assessing the implementation and economic impact of AI technologies in banking. To achieve this, the following intermediate objectives were defined:

- Conduct a comprehensive study on the utilization of AI technologies and its technical, regulatory, ethical, and societal challenges in the banking industry;
- Build a framework for assessing and analyzing the implementation and economic impact of AI technologies in a bank;
- Demonstrate the practical utility of the framework in a real banking context;
- Validate the effectiveness of the framework;
- Produce conclusions.

Thus, this research aims to address these gaps and uncertainties, providing a deeper understanding of AI's impact on banking operations, quantifying economic benefits, exploring its limitations, and continually enhancing trust in customer relations, that is, according to Thayaseelan, the core of any bank (El-Gohary et al., 2021).

2. METHODOLOGY

This study employs the Design Science Research methodology, chosen for its emphasis on problem-solving and its capacity to create innovative solutions that contribute to the advancement of human knowledge. This methodology is especially appropriate for this research due to its demonstrated success in addressing intricate, real-world problems. It is aptly suited for examining the complex relationship between AI technologies and the banking industry, providing a methodical yet flexible framework to address the dynamic and evolving challenges in this field. Moreover, this methodology is particularly appropriate for assessing economic impacts and developing new practical theoretical models, making it a strategic selection for this thorough study (Brocke et al., 2020).

In this context, the methodology presents a dual benefit. First, it delivers a systematic approach to exploring and analyzing the economic effects of AI within the banking sector. Secondly, its iterative nature enables continuous refinement of the research model, with evaluations conducted at each phase. Additionally, this approach increases the relevance of the findings to real banking scenarios and enhances the potential for practical application and relevance within the industry (Venable et al., 2017).

In the following sections, a thorough exploration of the DSR methodology will be presented. This will include a detailed discussion of how DSR will be effectively implemented throughout this dissertation.

2.1. DESIGN SCIENCE RESEARCH

The Design Science Research paradigm is centered on addressing human problems through the creation of innovative artifacts that facilitate a deeper understanding of the problem, thereby contributing new insights to scientific evidence. This approach, while comprehensive, encounters a major challenge in consistently generating valuable artifacts, due to insufficient theoretical knowledge across different fields, which complicates the effective application of innovative and creative solutions (Hevner & Chatterjee, 2021).

The artifacts mentioned, which include constructs, models, methods, or instantiations, are developed during the research process to tackle specific challenges. These artifacts are indeed indispensable for comprehending and solving design problems. Therefore, their development relies on foundational theories, which are subsequently refined and expanded upon through the researcher's innovation, insights, and problem-solving capabilities. These conditions serve as proof of the effectiveness of the research and often lead to more generalizable knowledge that may be applied in similar contexts (Hevner et al., 2004).

In addition, Information Systems (IS) and Information Technology (IT) have an important relationship within DSR: this paradigm is the intersection and focuses on the development and examination of new IS artifacts that impact organizational management. It includes tools and techniques tailored for specific tasks and transforms data into information that is meaningful

to users, with the aim of enhancing the effectiveness and efficiency of these systems (Hevner et al., 2004).

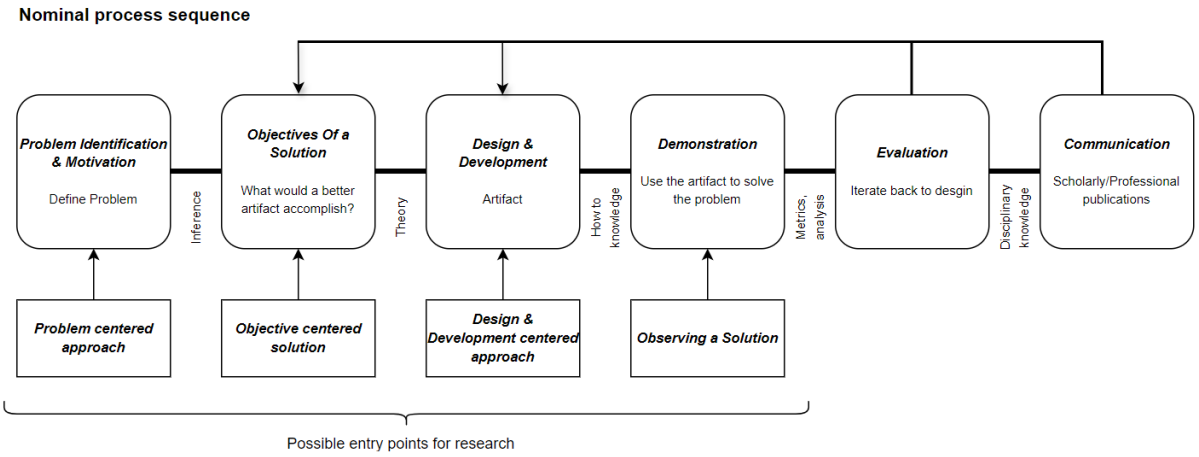

Figure 2.1.1 - Design Science Research – Source: (Peffers et al., 2019) Adapted.

Figure 2.1.1 provides a visual and overall interpretation of the DSR Process, illustrating the six major steps in its nominal sequence and highlighting its iterative nature, allowing researchers to be flexible and start in any step to produce improvements (Peffers et al., 2019).

The initial stage is pivotal, as it involves the identification of the specific research problem and understanding its importance, directing the creation of a viable artifact and stimulating the researcher's motivation to pursue the solution and embrace the outcomes. Following the initial identification of the research problem, the next step involves setting objectives that are either qualitative or quantitative and require a thorough understanding of the problem's current state, the effectiveness of existing solutions, and an assessment of what is both possible and feasible. Subsequently, the design and development phase involves constructing the artifact, based on defined objectives and relevant theoretical frameworks. Moreover, the demonstration phase tests the artifact's efficacy to solve the problem in one or more specific instances, leveraging a deep understanding of its application. Evaluation focus on observing and measuring the artifact's performance against the set objectives, which often leads to iterative refinements to enhance its efficacy. Finally, the communication phase involves articulating the significance of the problem and the utility of the artifact, guided by its effectiveness and methodological rigor (Peffers et al., 2019).

In summary, the diagram demonstrates the flexibility and adaptability of the research methodology, enabling researchers to initiate from multiple starting points. These include a problem-centered approach, starting with the identification of a critical issue; an objective-centered solution, beginning with a defined goal; or a design and development-centered approach, focusing initially on artifact creation. This flexibility supports diverse research strategies and objectives.

2.2. DSR IMPLEMENTATION

As highlighted in the 2004 paper "Design Science in Information Systems Research" by Hevner et al., design science has an important role within the IS discipline. It emphasizes the importance of aligning IS research with business needs and rigorously contributing to the knowledge base, thereby ensuring the relevance and rigor of research (Hevner et al., 2004).

Hevner's approach to IS research emphasizes maintaining a balance between practical relevance and theoretical rigor, aiming to benefit both business needs and the broader knowledge domain. This approach is characterized by three intrinsic research cycles: The Design Cycle, which emphasizes the iterative development and assessment of artifacts; the Relevance Cycle, which ensures that research is tested in real-world scenarios; and the Rigor Cycle, which both draws from and contributes to existing theoretical frameworks and domain knowledge, thereby enhancing the research knowledge base (Hevner, 2007).

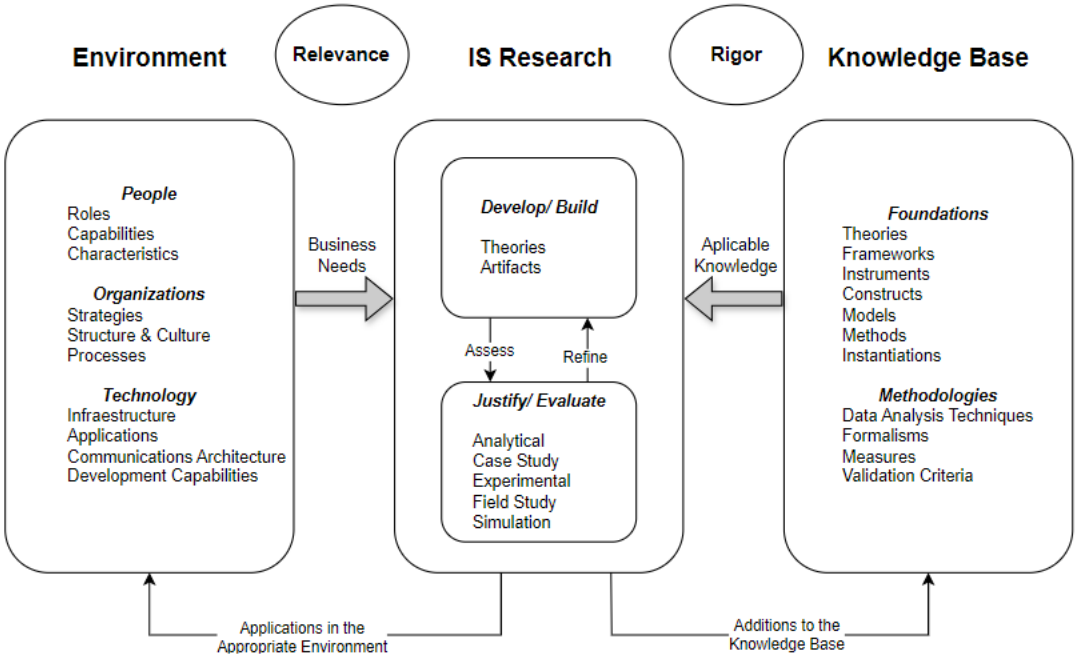

Figure 2.2.1 - DSR Implementation - Source: (Hevner et al., 2004) Adapted.

Figure 2.2.1 visually demonstrates that by combining practical relevance with theoretical rigor, the approach effectively addresses both business needs and knowledge advancement within the IS discipline. This framework emphasizes a cyclical process that integrates the environment, the development and improvement of artifacts, and the contribution to both business practices and knowledge base.

2.2.1. Relevance Cycle

This stage of DSR initiates by supplying the requirements for the research as inputs and establishes the criteria for evaluating the outcomes. Moreover, the results should be reintroduced into the environment for examination and assessment within the application field. Consequently, the clarity of these results determines whether additional iterations are

necessary, particularly if there are identified deficiencies in functionality or utility that could limit practical application. Furthermore, another iteration of the relevance cycle typically begins with the feedback received from the environment and the reconfirmation of research requisites derived from experience (Hevner, 2007).

In this context, the environment refers to the banking sector, including the roles, skills, organizational frameworks, processes, and specific technologies related to AI implementation. This focus ensures the research is aligned with practical needs in banking.

2.2.2. Rigor Cycle

The Rigor Cycle leverages a comprehensive and detailed knowledge base, divided between the existing expertise of the application domain and the scientific theories that underpin rigorous design science research. This cycle ensures that innovation is informed by established knowledge, demanding creativity and the meticulous selection of rigorous standards, thereby supporting the development of authentic innovation while avoiding the suppression of creative solutions through inappropriate theoretical constraints (Hevner, 2007).

Regarding this context, the knowledge base consists of economic theories and AI's theoretical underpinnings, methodologies, and prior research that both informs and is enriched by empirical studies within the banking sector. It emphasizes objectivity to ensure the veracity and dependability of findings, thereby enriching the scientific literature with new insights. This rigor is vital for the credibility and reproducibility of the research.

2.2.3. Design Cycle

The Design Cycle is central to DSR, featuring an iterative process where artifacts are built, evaluated, and refined. This cycle operates based on the requirements identified in the Relevance Cycle and the theories provided by the Rigor Cycle, functioning with a degree of independence and requiring a balance between the construction and evaluation of artifacts, ensuring both processes are deeply grounded in relevance and rigor. Multiple iterations of this cycle may be necessary before the contributions of the research are acknowledged within the Relevance and Rigor Cycles (Hevner, 2007).

3. Banking Industry

To construct a detailed framework that captures and evaluates the extensive impact of AI in the banking sector, it is fundamental to examine the industry's main components and primary operations.

This section provides an examination of the fundamental aspects of the banking industry, offering a comprehensive overview of the main operational areas and elucidating the significant challenges and opportunities currently facing banks. This analysis establishes the foundation for the identification of strategic opportunities for the deployment of AI technologies that may facilitate further progress within the sector.

3.1. OVERVIEW

In the current economy, which places a strong emphasis on customer services and customer satisfaction, the banking industry is actively seeking advancements to improve its business processes, enhance financial products and services, and contribute to economic expansion (Biswal, 2015). The evolution of this industry due to competition, complementary and co-evolution (Broby, 2021).

Beginning with fundamental concepts, the functions of financial institutions include both essential economic and financial operations and a growing emphasis on enhancing service quality and improving customer experiences, which the evolution of digital technology has the capacity to change the nature of banking (Broby, 2021). This holistic approach emphasizes the essential role of banks in driving economic development and their commitment to meeting the changing needs of their customers, thereby increasing customer satisfaction and profits (Zouari & Abdelhedi, 2021). The specific range of activities performed depends on the classification of the banking institution:

- Central Bank: this institution is pivotal in guiding and regulating a nation's banking system. It manages deposit accounts for all commercial banks and offers liquidity support as needed. Additionally, the Central Bank is responsible for implementing monetary policy, regulating the money supply, and ensuring financial stability (Federal Reserve, 2022).
- Commercial Bank: this type of bank provides a wide range of financial services, along with other essential banking functions. Although commercial banks cater to both individual and corporate clients, they typically emphasize meeting the financial requirements of business entities (Jiang, 2024).
- Retail Bank: it may be defined as a segment of the financial services industry that focuses on the intermediation between individual consumers and financial products, acting as financial intermediaries (Wu, 2023).
- Investment Bank: it is fundamental in supporting individuals, companies, and governments in raising funds, underwriting, and facilitating the issue of securities.

Additionally, it acts as an intermediary for investors interested in the financial markets, providing essential transactional support and strategic investment guidance (Y. Liu, 2023).

The functions of a bank cover a range of activities. Its core functions include financial services such as acting as intermediaries between savers and borrowers, granting loans with risk-adjusted interest rates, and maintaining deposit services. Beyond these, banks are also heavily involved in processing information by evaluating and managing the risks linked to their asset portfolios. Moreover, modern banking operations are significantly characterized by securitization activities (C. Wang, 2005).

The operational methods of banks have undergone a profound transformation as a consequence of the advent of new technologies (Roy et al., 2023). This technological evolution has transformed the landscape of financial services, offering clients enhanced efficiency and prompting institutions to invest in cutting-edge technology and innovation to meet the increasing complexity of demands (Mishra, 2015). The precision and accuracy of transactions and financial services have improved, increasing the accessibility of information and convenience for customers and, as a result, banks are forced to innovate and adapt in order to maintain customer trust and satisfaction, including the introduction of new forms of access and innovative services that are increasingly preferred over traditional in-person interactions, allowing customers to complete their financial activities effortlessly and conveniently (Broby, 2021)

Consequently, the banking sector faces ongoing challenges to improve its business models, aiming to convert obstacles into opportunities through the integration of technological innovations into core operations (Ghandour, 2021). The successful implementation of AI requires a robust foundation in four key areas: organizational structure, technological infrastructure, procedural frameworks, and environmental factors (Merhi, 2022). Therefore, it manages multi-disciplinary procedures through collaborations across the industry.

Furthermore, the integration of technology has spurred the development of innovative business models emphasizing digitalization, enhanced security, and personalized services. This evolution is driven by the need to adapt to disruptive innovations that are reshaping the traditional approaches to delivering value to consumers (Temelkov, 2020).

3.2. AREAS

The banking industry is divided into two principal areas, the front office and the back office, in order to facilitate the smooth operational flows that are necessary for the industry to function effectively allowing for specialization and efficiency gains. The front office is primarily responsible for customer interactions, determining strategies to attract new customers while retaining existing ones, and promoting their loyalty. The back office focuses on internal business processing and logistical tasks, using this information to refine and enhance processes and ensure efficient service delivery (Zomerdijk & Vries, 2007). The exchange of

information between these areas creates a dynamic environment that promotes mutual learning, leading to innovative solutions and improved operational efficiency within the bank (Huang et al., 2021).

Furthermore, the two divisions within the banking industry operate in a coordinated manner, providing a solid foundation for adopting and investing in advanced technologies. This integration facilitates the application of AI across different departments, ultimately aiming to improve financial returns and promote technological advancement within the institution (Huang et al., 2021).

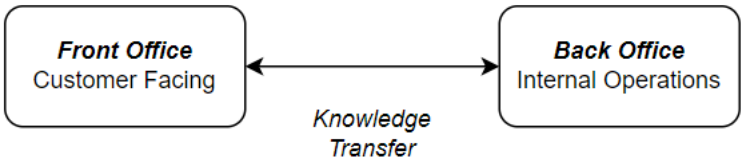

Figure 3.2.1 - Bank's operational structure – Source: (Huang et al., 2021) Adapted.

Figure 3.2.1 effectively represents the interconnection of the two main blocks within a bank, highlighting their continuous collaboration to achieve common goals and a homogeneous and cohesive system.

As stated in the section 3.1, the variety of services and processes within the banking sector is influenced by the classification of the institution. However, the American Productivity & Quality Center (APQC) provides comprehensive frameworks that enhance operational efficiency across multiple sectors, by conducting extensive benchmarking studies, researching and publishing best practices, improving processes, and offering training programs. Its Process Classification Framework (PCF) offers detailed processes tailored specifically for numerous industries, including banking, and helps institutions achieve greater operational consistency, streamline workflows, and enhance overall performance (American Productivity & Quality Center (APQC), 2019).

In the banking sector, this framework distinguishes two main categories: Operational Processes, and Management and Support Processes. Together, these categories describe industry processes in detail, covering a wide range of tasks from strategic development and product management to risk management and IT support (APQC & IBM, 2020). This structure ensures a holistic approach to managing and optimizing operations.

Table 3.2.1 - Process Categories in the Banking Industry – Source: (APQC & IBM, 2020) Adapted.

Operational Processes	*Management and Support Processes*
1. Develop Vision and Strategy	1. Develop and Manage Human Capital

2. Develop and Manage Products and Services	2. Manage Information Technology
3. Market and Sell Products and Services	3. Manage Financial Resources
4. Source and Procure Materials and Services	4. Acquire, Construct, and Manage Assets
5. Deliver Services	5. Manage Enterprise Risk, Compliance, Remediation, and Resiliency
6. Manage Customer Services	6. Manage External Relationships
	7. Develop and Manage Business Capabilities

Table 3.2.1 provides an overview of the primary process categories outlined by the PCF, specifically for the banking industry. Each category further divides into more detailed activities that extensively address both operational and management functions essential to banking operations. PCF is structured into five hierarchical levels: Category, Process Group, Process, Activity, and Task, each designated by a unique identifier (APQC & IBM, 2020). For simplicity and clarity, comprehensive descriptions up to the third level are included in Annex I.

3.3. OPPORTUNITIES AND CHALLENGES

A fundamental point to acknowledge is that banks must meet the evolving demands of their customers (Reliability, Tangibility, Responsiveness, Assurance, and Empathy) to significantly influence their operational strategies (Zouari & Abdelhedi, 2021). As customer expectations evolve and technological advancements continue to emerge, banks are required to enhance their technological capabilities: this intersection between changing consumer needs and technological expansion demands banks to innovate and evolve, ensuring they remain relevant, competitive, and profitable in the face of the devastating effects of digital transformation (Broby, 2021).

Therefore, it is paramount for banks to achieve an equilibrium between advanced digital processes and traditional customer service to effectively address the emerging challenges of security, privacy, and confidentiality, among others. It is of vital importance to achieve this equilibrium in order to guarantee customer satisfaction and loyalty in the digital age (Biswal, 2015).

3.3.1. Opportunities

The banking industry presents a multitude of opportunities for growth, innovation, and competitiveness. These opportunities are driven by a number of strategic initiatives, including the adoption of Internet technology, rapid technological advancements, deregulation, globalization, and changes in competitive and regulatory environments (Subburaj, 2023). Additionally, digital transformation acts as a fundamental catalyst, creating opportunities for innovation via digital channels, thereby enhancing customer experiences, accessing

unexplored sectors, and streamlining operational procedures. Therefore, this underscores the necessity for banks to adopt digital transformation to maintain their relevance and competitiveness (Ghandour, 2021).

Fintech, which stands for financial technology, refers to the application of innovative technological solutions to improve and automate financial services. The banking sector is undergoing significant digital transformation, which is heavily influenced by fintech innovations, which are reshaping traditional business models (Temelkov, 2020). Therefore, banks that establish partnerships with fintech companies may adopt these advanced technologies and innovative business models, which revolutionize traditional banking practices (Josyula, 2021). In summary, this technology enables financial institutions to more efficiently provide financial services, with greater flexibility, thereby enabling banks to employ advanced technologies and innovative business models, extending their range of services and increasing operational efficiency (Temelkov, 2020).

Furthermore, there is a substantial opportunity for the strategic utilization of knowledge management (KM) as a business practice, given that its effective adoption may result in a more favorable return on investment. While typically linked with IT departments, the benefits of knowledge management extend to several areas of banking operations due to its ability to approach competitive advantage (Jayasundara, 2008). In summary, there is empirical evidence of the power of KM in enhancing organizational competitiveness and efficiency, leading to enhanced process and employee performance, positively affecting market performance and, ultimately, the organization's overall success (Cebi et al., 2010).

Moreover, acknowledging the importance of sustainable banking offers significant opportunities for growth and innovation in the financial sector, enabling banks to access new market segments focused on green technologies and environmentally conscious customers while enhancing their reputation through a commitment to sustainability. In addition, sustainable banking practices may improve risk management by anticipating and mitigating the impacts of climate change (De Haas, 2023). It is increasingly seen as a strategic market advantage, including integrating environmental considerations into operations, developing green financial products, and formulating strategies to address climate change, while pursuing their profit-making activities. Therefore, by integrating sustainability guidelines into the strategic, financial, and operational decision-making processes, banks may significantly support environmentally and socially responsible projects, enabling them to play a pivotal position in the promotion of sustainable development (Carè, 2018).

In turn, globalization presents the banking industry with several opportunities, including the expansion into foreign markets, diversification of services, the integration of technology, market-driven innovations, and the formation of strategic alliances (R.K. & Rimpi, 2006). Globalization, coupled with the evolution of customer preferences, the pursuit of economies of scale, diversification of core business activities, regulatory changes, and technological advancements, has led to the advent of new business models (Temelkov, 2020).

In conclusion, the banking landscape is characterized by diversity and constant evolution. By adopting a strategic approach, banks may effectively meet consumer expectations, demands, and requirements, ensuring they maintain their unique identity while adapting to changes (Subburaj, 2023).

3.3.2. Challenges

In the rapidly evolving banking industry, banks face a multitude of complex challenges as they attempt to adjust to continual transformations. These challenges include customer satisfaction and retention, competition, the deployment of adequate technology, regulatory obstacles, and others (Biswal, 2015).

The banking industry faces numerous regulatory challenges that significantly affect its operations and integrity. The lack of robust regulatory frameworks aggravates these issues, allowing fraudulent activities to persist. In order to effectively address these regulatory challenges, it is necessary for the industry to implement comprehensive reforms, improve its technological infrastructure, and enhance collaboration among financial institutions (Roy et al., 2023).

Nowadays, banks are centering their operations around customer needs, with their expectations and demands guiding the industry's direction. The diverse range of customer perspectives and profiles demands highly personalized services, fundamental for maintaining customer loyalty. However, adapting to these needs is becoming increasingly challenging due to the rapid evolution of customer preferences (Indriasari & Gaol, 2019). The processing of large volumes of data represents a significant and complex challenge for the banking sector and inappropriate use of such data may lead to regulatory challenges for banks, including data privacy, algorithmic transparency, and the evolving regulatory landscape (Ahmadi, 2024).

Furthermore, accurately measuring and assessing competition poses a significant challenge for financial institutions, which must continuously adapt to keep up with the rapid evolution of the sector (Broby, 2021).

The emergence of alternative financial services providers, such as digital banks and neobanks, has intensified competition in the banking industry. These new entities challenge traditional banks to create more user-friendly and accessible financial products. This increased competition, especially from technology-oriented institutions, emphasizes the critical need for traditional banks to innovate and embrace digital transformation in order to remain relevant and competitive (Temelkov, 2020). To maintain competitiveness, banks must innovate their product offerings and enhance customer service experiences (Biswal, 2015).

The banking industry faces significant social and ethical challenges, particularly in the domain of customer care. These challenges are multifaceted and have significant implications for trust, transparency, data security and privacy, regulatory compliance, and erosion of reputation. In order to address these challenges, banks must establish a culture of ethical

behavior, ensure transparent communication, protect customer data, and practice fair lending (Samarathunga & Karunathilaka, 2023).

As digital banking platforms expand and electronic transactions become more prevalent, cybersecurity has emerged as a major issue for the financial industry (Zouari & Abdelhedi, 2021). The analysis and management of large volumes of sensitive financial data introduces significant risks that may compromise customer privacy, damage the reputation of financial institutions, and threaten their overall stability. Furthermore, the protection of data is of paramount importance in order to prevent substantial financial losses and severely diminish consumer trust (Abioye et al., 2021). Effective risk management is essential for banks, as they face various threats to their stability, profitability, and reputation, including operational, compliance, and technological risks. Moreover, risk management aims to prevent losses and to create a stable and secure environment that reinforces trust, meets regulatory standards, and supports informed decision-making. Additionally, banks must efficiently identify, assess, and monitor these risks to mitigate potential adverse effects and maintain a competitive edge (Al-Tamimi, 2007). This requires implementing comprehensive strategies that combine advanced analytics, rigorous internal controls, and a strong culture of risk awareness throughout the organization (Al-Tamimi, 2007).

Ultimately, improving operational efficiency in banks requires optimizing processes, managing resources effectively, and utilizing technology to increase productivity, lower costs, and improve service quality. The inherent complexities and occasional redundancies in banking procedures pose significant challenges and addressing these effectively demands a solid strategy, investment in advanced technologies, and a deep commitment to organizational enhancement. Optimizing operational efficiency is vital for banks to remain competitive, adjust to market fluctuations, and satisfy customer demands (Dumasiya, 2023).

In conclusion, by proactively addressing these multifaceted challenges, banks may ensure their continued efficiency in the constantly changing global financial environment (Dumasiya, 2023).

4. Literature Review

To structure the research and gain insights into optimal approaches, the literature review will be organized into two overarching sections, both subsequently split into more granular research components: "Artificial Intelligence" and "Assessment of the economic impact of technologies ". These subdivisions are intended to provide a comprehensive understanding of the analytical scope of the study, to make connections between the themes, and to facilitate a more in-depth exploration of the topic and the central issues addressed in the dissertation.

This section summarises existing research reports that promote a constructive assessment and identify the key focus areas related to the development of AI in the banking sector.

4.1. ARTIFICIAL INTELLIGENCE

This section will provide an overview of the field of artificial intelligence, followed by a mention of the technologies and tools within it, along with the challenges that it faces. Furthermore, a connection with the banking sector will be established, elucidating the impact of this technology within this industry.

4.1.1. Historical Background

An examination of the history of artificial intelligence reveals a fascinating progression characterized by significant discoveries and major advancements. From its early theoretical foundations to the substantial advancements seen in recent years, AI's development provides a compelling account of the ongoing efforts to replicate human intelligence in machines (Samuel, 2024).

Long before the advent of artificial intelligence in the mid-twentieth century, its foundational concepts were being explored. The formal study of AI commenced with John McCarthy, a computer scientist regarded as one of the "founding fathers" of Artificial Intelligence, in approximately 1955, who proposed a research project for the Dartmouth Summer Research Project inspired by Alan Turing's innovative 1950 research, which posed the question of whether machines could think. Turing's research demonstrated the distinctions between human cognition and machine functions, noting that although machines may execute commands, they lack the same capacity as humans to retain information (Russell & Norvig, 2020). Turing suggested that a machine’s intelligence could be recognized if its responses were indistinguishable from a human’s (Samuel, 2024). His test, known as the Turing Test, was designed to operationalize the concept of intelligence, requiring computers to demonstrate abilities such as natural language processing, knowledge representation, automated reasoning, and learning (Russell & Norvig, 2020).

Neural networks, which are designed to mimic the human brain's pattern recognition and decision-making capabilities, have undergone significant advancements since the development of the Mark 1 Perceptron by Frank Rosenblatt in 1967 (Russell & Norvig, 2020).

This marked the emergence of computer-based neural networks that learned through repeated trial and error. Furthermore, the decline in government funding for AI research and support, the lack of sufficient computing power, and the disappointments in machine translation resulted in the cessation of numerous investigations by scientists. This period, between 1974 and 1980, marked the commencement of the first AI winter (Schuchmann, 2019). Furthermore, AI has achieved significant breakthroughs, showcasing its capabilities in programs such as Deep Blue and AlphaGo. These AI platforms have demonstrated superior performance to human champions in complex games such as chess and have also exhibited a remarkable understanding of the strategic complexities of the Chinese game Go (Bory, 2019).

The recent advances in large language models (LLMs), such as ChatGPT, represent a significant shift in AI performance and have the potential to enhance business value, particularly through improving customer interactions, automating responses, generating content, and other applications, possibly leading to increased efficiency and new business opportunities. Furthermore, AI has become pervasive across all industries, functioning as a versatile and comprehensive tool to achieve diverse objectives in numerous practical scenarios: from control management and personalization to customer interaction and decision-making, AI plays a pivotal role in enhancing efficiency and capabilities in a diverse range of applications (Richter et al., 2019).

To summarize, Figure 4.1.1 provides a broad overview, illustrating the remarkable journey of AI, and demonstrating its profound impact on both technology and society. Each point on this timeline represents a pivotal moment in the development of artificial intelligence, highlighting its power and the ongoing demand for innovation in this field.

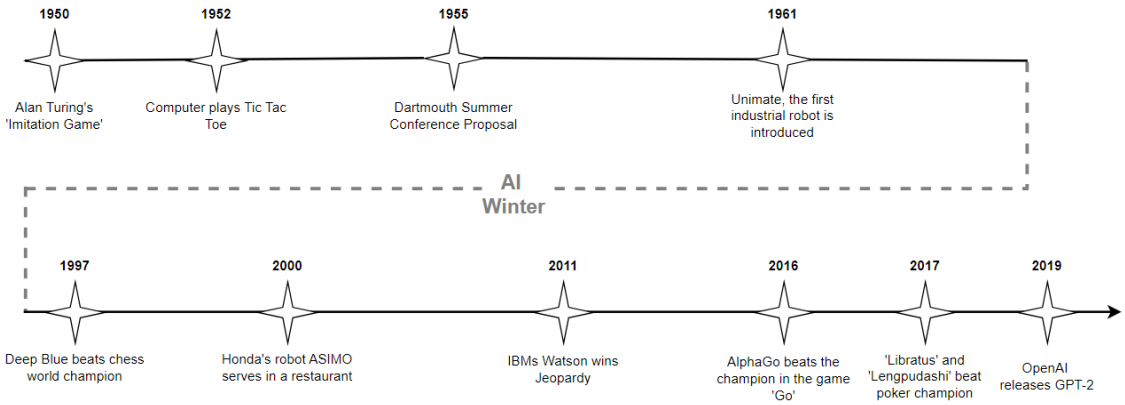

Figure 4.1.1 - Illustration of AI developments over time – Source: (Richter et al., 2019) Adapted.

The historical trajectory of AI has been marked by cycles of significant breakthroughs, followed by periods of significant achievements, excessive optimism, and a subsequent reduction in enthusiasm and funding. Despite these fluctuations, the field has been consistently reinvigorated by the introduction of new and innovative methodologies and the systematic refinement of existing approaches. Furthermore, the merging of AI subfields and its increasing

integration with other scientific disciplines highlighted the maturing presence of AI and its expanding significance across numerous applications (Russell & Norvig, 2020).

4.1.2. Concepts

As James Fetzer states at his book ‘Artificial Intelligence: Its Scope and Limits’, the precise definition of AI is a controversial topic, marked by a lack of consensus in its characterization (James Fetzer, 1990). In official terms, AI is defined as "the branch of computer science involved in designing computers, robots, programmed devices and software applications with the ability to mimic human intelligence and thought", according to the Oxford Dictionary (*Oxford English Dictionary*, 2024). Generally, the term refers to the detailed application of diverse technologies that perform tasks similar to human cognitive functions in multiple sectors and represents the potential to transform our technology and society (T. Liu & Li, 2024).

Furthermore, the value of this technology is unmatched, offering automation, driving efficiency, improving decision-making, optimizing customer experience, risk management, and ensuring regulatory compliance. This is fundamental for evolving operational strategies and optimizing customer service within the sector (Oluwaseyi & Potter, 2024).

In the early 1980s, American philosopher John Searle categorized Artificial Intelligence into two types: weak and strong AI, based on their capabilities. Weak AI, as noted in Liu's report in 2021, is constrained to the automation of specific tasks, particularly in the domain of understanding the design of simulations of intelligent human behavior (B. Liu, 2021). It is also easier to design and implement, which makes it a suitable choice for repetitive tasks. In contrast, strong AI is capable of learning and executing tasks at a level similar to human abilities, being able to adapt to new situations and generalize from its training data in order to apply knowledge to new scenarios (Searle, 2010). Known as the Chinese Room Argument, this argument has been the subject of a considerable amount of debate and critique, leading to new discussions about the nature of consciousness, the limitations of AI, and the potential for machine understanding and cognition (Moural, 2003).

Having established this fundamental distinction, the subsequent division of AI into three primary groups based on its capabilities becomes more comprehensible:

- Artificial Narrow Intelligence (ANI): represents the dominant form of AI currently available. ANI is designed to excel in a specific domain and to solve problems in a highly specialized manner (George & George, 2023);
- Artificial General Intelligence (AGI): it is often referred to as strong AI due to its ability to perform at a level comparable to human intelligence. Nevertheless, it remains a topic of controversy and debate, necessitating the integration of thousands of ANI systems that are interconnected (George & George, 2023);
- Artificial Super Intelligence (ASI): it is considered the highest achievement in Artificial Intelligence, existing presently only as a theoretical possibility. The exact

moment when it might emerge, achieving a singularity where machine intelligence surpasses human cognitive capabilities, is still undetermined (George & George, 2023).

Stuart Russell and Peter Norvig emphasize the interdisciplinary nature of AI, incorporating insights from a range of disciplines, including computer science, mathematics, psychology, linguistics, philosophy, and others. Furthermore, they argue that AI covers a vast array of subfields, establishing it as an intellectually and universally versatile field (Russell & Norvig, 2020). Moreover, the research areas of AI are specially composed by Machine Learning, Expert Systems, Robotics, Intelligent Decision Support Systems, and Pattern Recognition. These fields frequently provide the foundation for the development of novel solutions across a range of domains, facilitating the efficient processing and interpretation of large data sets and the generation of new knowledge from past experiences. Furthermore, by imitating the problem-solving abilities of human experts, techniques in knowledge representation and reasoning are employed to address complex issues typically solved by specialists. Additionally, Robotics is committed to the design, construction, operation, and application of robots, incorporating AI algorithms to facilitate autonomous decision-making, with a primary focus on the control and processing of objects, frequently necessitating sophisticated perception abilities to interpret environments via sensors. Ultimately, Intelligent Decision Support Systems enhance decision-making by using AI to analyze data and propose actions. Concurrently, Pattern Recognition identifies consistent patterns and regularities within data, which are essential for tasks such as image recognition and speech analysis (Zhang & Lu, 2021).

In essence, the true value of this technology lies not merely in the technologies and tools themselves, but in the manner in which companies deploy them. This deployment must be responsible and must be accompanied by balanced regulation to ensure the integrity, security, and ethical use of AI (Oluwaseyi & Potter, 2024).

4.1.3. Technologies and Tools

Artificial intelligence embraces a multitude of sophisticated tools and techniques, each with its own unique characteristics and performance. Its fundamental role in producing high-impact outcomes makes it a highly valuable resource in many fields. Nevertheless, the efficacy of AI is contingent upon a multitude of factors, including ethical considerations, continuous learning, adaptability, and numerous other variables (Farayola et al., 2023). In addition, ethical considerations and regulatory frameworks may influence the development and deployment of highly autonomous AI systems. In her analysis, Sofiat Abioye identifies the following as the most commonly used and impactful AI technologies (Abioye et al., 2021):

- Machine Learning: In accordance with the Oxford Dictionary, machine learning is defined as the use and development of computer systems that are capable of learning and adapting autonomously (*Oxford English Dictionary*, 2024). These systems operate based on algorithms and statistically oriented models, which are

used to analyze patterns in data and to draw inferences from them. It is a foundational branch of AI that enables computers to learn from data and improve their performance through the use of algorithms to analyze patterns and make decisions (Alzubi et al., 2018). It englobes other important approaches and definitions:

a) Supervised Learning: this process entails the identification of patterns and relationships between input and output data, utilizing labeled data sets (Alzubi et al., 2018).
b) Unsupervised Learning: This approach employs ML algorithms to analyze and cluster unlabelled datasets, thereby facilitating the discovery of hidden patterns or data groupings (Alzubi et al., 2018).
c) Reinforcement Learning: this method involves agents interacting with an environment to learn from the outcomes of their actions and doesn't require pre-labeled data. Instead, the agent learns by taking actions and receiving rewards (positive or negative) based on the outcomes (Eren et al., 2023).
d) Deep Learning: uses artificial neural networks (ANNs) inspired by the structure of the human brain that processes information through multiple layers, automatically extracting increasingly complex features from data. This allows deep learning to excel at tasks with a large number of inputs and outputs, such as image and speech recognition, without needing extensive programming for feature extraction (Kumar et al., 2023).

- Knowledge-based systems: they are a type of AI that incorporates the collective expertise of one or more experts into a large repository of structured information, known as a knowledge base. These systems use this knowledge to make informed decisions by applying logical rules and reasoning processes and are designed to simulate the decision-making abilities of human experts in specific domains (Akerkar & Sajja, 2010):
    a) Expert Systems: the knowledge base is comprised of task-specific knowledge derived from an expert in a particular domain, with the objective of mimicking human decision-making processes in order to solve issues specific to that domain (Abioye et al., 2021).
    b) Intelligent Systems: this refers broadly to systems that exhibit intelligent behavior, using machine learning, reasoning, and knowledge-based techniques to achieve specific goals, and are characterized by their ability to adapt, learn from data, make decisions under uncertainty, and potentially improve their performance over time through interaction with their environment and users (Akerkar & Sajja, 2010).
    c) Case-based Reasoning Systems: its knowledge base is constituted by past experiences or historical cases, which are employed to elucidate, interpret, or evaluate new situations (Abioye et al., 2021).

d) Linked Systems: recognized as networks of interconnected digital elements that facilitate the sharing and navigation of information across different nodes or platforms (Abioye et al., 2021).

- Computer Vision: it is the field that allows computers to understand and interpret the visual world through images and videos by employing algorithms to analyze visual data, such as identifying objects in pictures. Techniques such as facial recognition exemplify the power of computer vision in this area (Zhang & Lu, 2021).
- Robotics: combines AI with mechanical engineering to create robots that may perform tasks simulating human behavior. The robot is capable of analyzing the information it perceives, controlling its behavior, responding to changes in the environment, and completing complex tasks (Zhang & Lu, 2021).
- Automated Planning and Scheduling: on one hand, planning is a discipline that focuses on guiding intelligent entities to formulate a series of actions aimed at achieving specific goals, being these actions chosen for their expected results. On the other hand, scheduling is the process of determining the most appropriate plans and allocating the necessary time and resources, considering all available resources, to achieve these goals (Abioye et al., 2021).

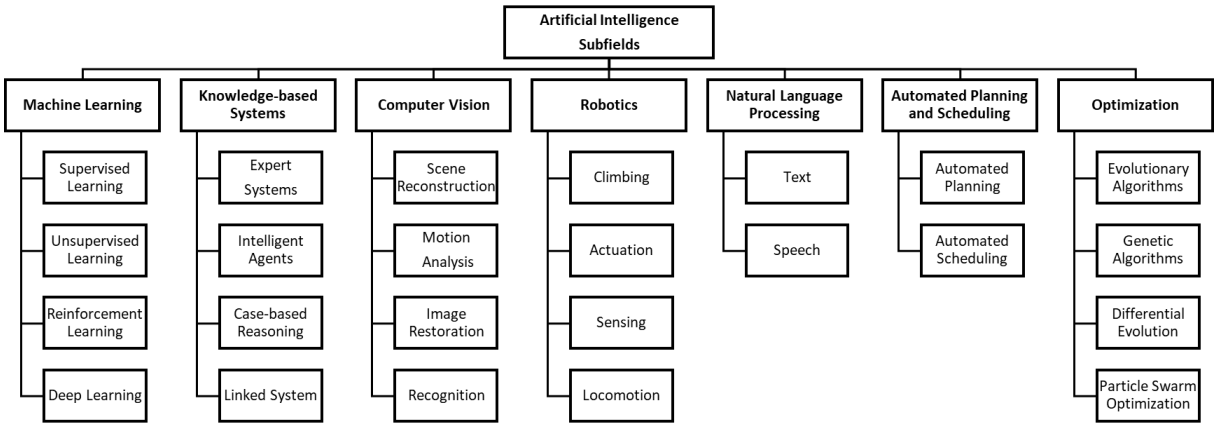

Figure 4.1.2 - AI Subfields - Source: (Abioye et al., 2021) Adapted.

Furthermore, Machine Learning is a foundation point in the broader field of Artificial Intelligence, supporting several of the most significant advances in this field: it drives the development of complex AI systems and significantly enhances their capabilities. Therefore, the importance of ML is emphasized by its ability to enable increasingly sophisticated applications that may autonomously generate new content, make intelligent decisions, and solve complex problems with a high level of precision and efficiency (Daniel & Vivky, 2024).

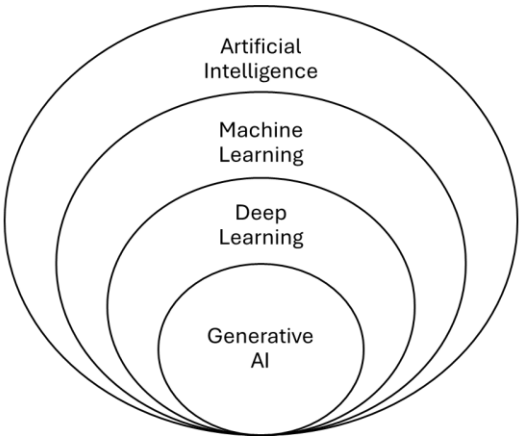

Figure 4.1.3 - Hierarchical Structure of AI Technologies - Source: (Zhuhadar & Lytras, 2023) Adapted.

As illustrated in Figure 4.1.3, this structured progression from AI to machine learning, then to deep learning, and finally to generative AI illustrates an increasing level of specialization and capability in which each layer builds on the technologies and methodologies of the previous layers and refines them, leading to more advanced and specialized applications and innovations (Zhuhadar & Lytras, 2023). Such hierarchical structuring is fundamental to the development of increasingly sophisticated AI applications capable of dealing with complex tasks.

These tools and technologies play a pivotal role in the development of AI systems, driving the rapid growth of the field and significantly increasing its impact across multiple sectors. In order to achieve greater output from them, banks must leverage their capability to harness such advanced technologies fully, maximizing AI's potential as a driver of economic growth and industry transformation (Divya, 2024).

4.2. AI TECHNOLOGIES IN THE BANKING INDUSTRY

As previously stated, the potential for AI to drive economic growth is considerable, and it is anticipated that it will enhance decision-making processes and facilitate continuous monitoring of economic banking activity based on a more comprehensive range of information (Govindharaj, 2024).

Consequently, the profound impact of AI is significantly determined by the extent to which companies adopt it and how well stakeholders are prepared across intellectual, technological, political, ethical, and social dimensions. This comprehensive preparation allows the banking industry to match technological developments by diversifying and enhancing its product offerings through increased technology integration and automation (Govindharaj, 2024).

The integration of ML in banking has the potential to significantly enhance automation, analysis, and decision-making processes, providing a new way to meet customers' demands. Furthermore, this technology plays a pivotal role in the maintenance and enhancement of customer experiences and trust through a profound comprehension of their preferences and

behaviors (Donepudi, 2017). Consequently, banks may offer personalized services, improve their investment strategies, and gain new insights into the competitive landscape (Sahu et al., 2023). Furthermore, machine learning enhances operational efficiency by automating routine tasks and processes, thereby reducing the reliance on manual labor. Additionally, it facilitates the management of risk by accurately evaluating borrower risks and streamlining loan decision processes. In summary, ML tools facilitate the detailed and precise analysis of extensive business and customer-related datasets, combining various data elements to extract valuable insights (Ghandour, 2021).

Subsequently, the field of deep learning has been demonstrated to have extensive applications across a range of domains, including computer vision, natural language processing, speech recognition, and recommendation systems (Olaoye & Potter, 2024). In the banking sector, this technique is employed for a variety of innovative applications, including the analysis of transaction patterns to identify fraud and the use of predictive analytics to accurately forecast customer behavior and market trends (Ghandour, 2021). Consequently, this industry is one of the fastest expanding this sophisticated form of ML (Govindharaj, 2024), in order to achieve substantial advancements in a relatively short period.

Furthermore, the utilization of NLP and chatbots is becoming increasingly prevalent in the financial services industry due to the fact that it assists banks in overcoming traditional challenges by enhancing customer service and automating routine tasks: this technology streamlines interactions, enabling AI to play a pivotal role in reducing customer service time and increase customer satisfaction (Ridha & Maharani, 2022). Nevertheless, as banks adopt this technology, it is particularly important to ensure it enhances their services in order to retain customers, since the reduced human contact, high expectations from customers, and the high rate of perceived risks may not guarantee higher service quality and potentially erode customer loyalty (Gatla, 2018). Furthermore, this technology automates the customer service process, records a substantial amount of customer data, provides personalized responses and recommendations, ensures the delivery of accurate and credible communications, and enhances customer satisfaction (Sari & Adinda, 2023). Consequently, it significantly enhances the overall customer experience.

Additionally, the implementation of AI-based systems enables banks to automate tasks, reduce errors, and personalize customer experiences, allowing banks to streamline their operations and better serve their tech-savvy customers. Additionally, AI's ability to analyze vast amounts of data empowers banks to make data-driven decisions in areas such as risk management and loan approvals (Donepudi, 2017).

Furthermore, a study by Patrick Ulrich and Vanessa Frank emphasizes how this offer of opportunities and tools for process automation and efficient data utilization leads to an acceleration of processes, potential savings, and ultimately leads to enhanced decision-making. Additionally, the development of new business models and improvements in risk

management are significant outcomes of this technological advancement (Ulrich & Frank, 2021).

These innovative tools have the potential to integrate with the core components of the banking sector, thereby impacting the two banking blocks previously mentioned in distinct ways. Firstly, direct customers are increasingly managed by AI, notably through chatbots or virtual agents, leading to a wide range of benefits, including enhanced advice, tailored offers, and time savings. Finally, the back-office leverages AI to identify anomalies and exceptions, while attempting to mitigate risks, such as over-reliance on AI and the costs associated with implementing initiatives. In this group direct customer benefits might not be immediately apparent, yet it plays a critical role in threat detection and risk mitigation (Lakhangaonkar & Kamath, 2021).

In summary, the financial sector is increasingly adopting AI technologies and implementing dynamic and innovative models that are employed to accurately enhance risk management, enhance customer experience, and sustain competitiveness (Svoboda, 2023).

4.3. AI CHALLENGES IN BANKING INDUSTRY

The rapid advancement of advanced AI and data science technologies in recent years has created a new era of technological opportunities in the financial sector, with applications extending to a wide range of financial domains. However, it has also introduced numerous challenges and uncertainties (Ness & Muhammad, 2024): the integration of AI into banking operations is accompanied by a series of challenges, including concerns regarding data privacy, ethical considerations, the need to comply with regulatory requirements, and the potential for job displacement. Furthermore, as AI technologies continue to advance and evolve, the considerations surrounding their development become increasingly complex, potentially threatening conventional business strategies and profitability (Svoboda, 2023).

The *2023 AI Index Report* has identified that the number of AI incidents and controversies within different sectors has increased 26 times since 2012, as can be confirmed by analyzing the Figure 4.3.1. This expansion is indicative of greater use of AI technologies and growing recognition of the potential for misuse (Stanford Institute, 2023).

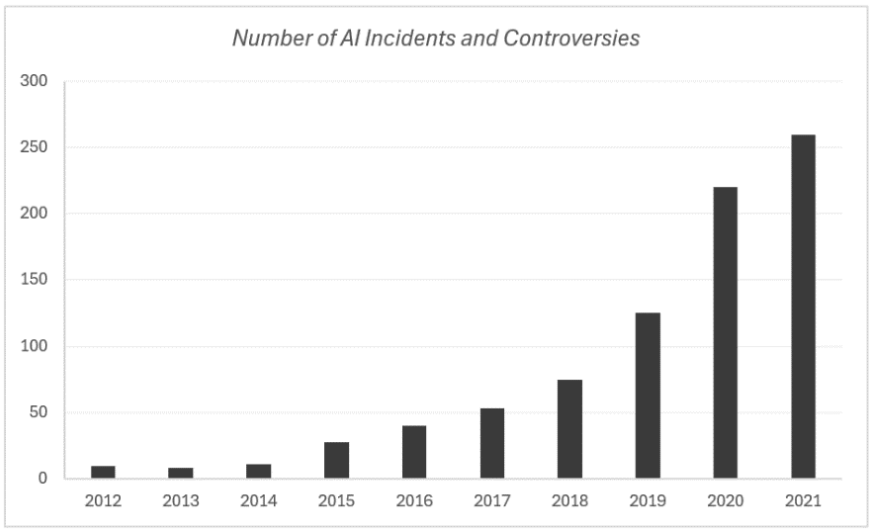

Figure 4.3.1 - Number of AI incidents and controversies, 2012-2021 – Source: (Stanford Institute, 2023) Adapted.

The challenges in the banking industry can be aggregated into technical, regulatory, ethical, and societal (Akhter et al., 2024). The initial challenge includes obstacles from the management of data, which is influenced by both the quantity and quality of the data and may result in a potential lack of quality, as the prediction power of an algorithm may be compromised (Mhlanga, 2020). Furthermore, the lack of adequate quality datasets may also significantly affect the quality and trustworthiness of the AI models being trained (Ghandour, 2021). Additionally, financial constraints, deficiencies in institutional information technology infrastructures, and a lack of technical expertise present additional challenges to the effective implementation of technologies (Ulrich & Frank, 2021). An excessive reliance on AI to automate decision-making and problem-solving processes might also suppress workers' creativity and adaptability, thereby limiting the dynamic capabilities of the workforce (Ghandour, 2021). The issue of data security and privacy, as well as transparency in the algorithms, remains a significant regulatory concern for the sector (Ahmadi, 2024). Consequently, the absence of definitive regulatory guidelines complicates the implementation of AI solutions in the banking industry, requiring continuous and multifaceted approaches (AL-Dosari et al., 2022). Furthermore, the banking sector is subject to risk-oriented regulations that may prove inadequate in recognizing the distinctive circumstances of vulnerable groups, given that the use of new kinds of data introduces new privacy and data security issues (Mhlanga, 2020). Moreover, the development of intelligent systems presents a significant challenge in achieving high transparency and interpretability, as it may lead to a lack of trust and confidence in their outputs, which may have detrimental effects on the credibility of the system (Wortham et al., 2016). Complementary, the emergence of AI-driven banking brings significant societal challenges. Firstly, the varying levels of technological accessibility across different social groups contribute to and shape the unequal distribution of these advanced services: the challenge of digital financial inclusion is a significant issue for banks (X. Wang & He, 2020). Similarly, there are concerns about the potential impact of these technologies on

existing employment patterns. In particular, there is a fear that they could result in the obsolescence of certain skills, which in turn could lead to the displacement and loss of jobs (Ghandour, 2021).

Furthermore, as previously stated, while it is evident that AI has the potential to enhance business productivity, its ultimate impact on growth remains dependent on the effectiveness of its implementation (Oluwaseyi & Potter, 2024). This complexity serves to highlight the relevance of William J. Baumol and William G. Bowen's concept of "Baumol's cost disease", which was formulated in the 1960s. This concept states that "growth can be limited not by what we are good at, but rather by what is essential and yet difficult to improve". Even in the event of automation replacing a significant number of roles, growth may still be constrained by areas that remain essential but are difficult to improve (Jones et al., 2017).

In order to fully leverage the innovative potential of this technology and to successfully implement AI, banks must adopt a comprehensive approach that addresses the challenges referenced above that limit the deployment of AI technologies throughout the institution (Brightwood, 2024):

- Clearly define the business objectives;
- Develop a robust data strategy;
- Collaborate with technology partners;
- Start with small-scale Proof-of-Concept (PoC) projects to validate AI solutions and assess their effectiveness;
- Ethical considerations;
- Implement a change management strategy to support the cultural shift;
- Ensure compliance with regulatory frameworks and industry standards;
- Continuous monitoring and evaluation;
- Plan for future growth and expansion of AI capabilities.

In summary, the systematic literature has demonstrated that although AI offers significant opportunities for the banking sector, the resulting challenges persistently influence various aspects of the industry. Consequently, ensuring the proper and successful integration of AI into the banking sector depends on tackling these challenges (Svoboda, 2023).

4.4. Assessment of Economic Impact of Technologies

Assessing the economic impact of such technologies requires a comprehensive approach and further analysis, given the limited number of comprehensive studies that establish causal relationships between AI systems and their effects, highlighting the urgent need for more in-depth research in this field.

The main components of a comprehensive technology assessment, according to Joseph F. Coates and his research, are based on the following principles (Coates, 1974):

1. Examine problem statements;
2. Specify systems alternatives;

3. Identify possible impacts;
4. Evaluate impacts;
5. Identify the decision apparatus;
6. Identify action options for the decision apparatus;
7. Identify parties of interest;
8. Identify macro system alternatives (other routes to goal);
9. Identify exogenous variables or events possibly influencing;
10. Conclusions (and recommendations).

This approach ensures a holistic understanding of the economic impact of technologies, helping to develop strategies that maximize benefits while minimizing negative impacts (Coates, 1974).

The roles of IT architects and their importance to IT-business alignment are still underrated in both theory and practice. However, it is known that the principal objectives of IT-Business alignment are to enhance organizational performance, including reducing costs, increasing revenues, and improving returns on investment, to improve quality and to foster positive reactions to emerging opportunities, and to gain a competitive advantage through IT (Gellweiler, 2022). This fusion enables the alignment among various business functions, enhancing both effectiveness and efficiency and evolving into a dynamic relationship where IT and other business sectors collaborate to adapt their strategies (Luftman, 2001). Furthermore, it is achieved through the requirement of an ongoing effort of strategic planning, realignment of objectives, and implementation of best practices to support and define business strategies (Chen, 2010).

The Strategic Alignment Model (SAM) by Henderson and Venkatraman, and the Strategic Alignment Maturity Model (SAMM) by Luftman are fundamental for aligning IT frameworks and applications with business strategies in the digital banking landscape. While SAM provides a model for research and practice of strategic management of information technology (Henderson & Venkatraman, 1994), Luftman's model offers a practical method to evaluate and enhance this alignment's maturity over time (Luftman, 2001). Both models will be discussed in detail in the subsequent sections.

4.4.1. Strategic Alignment Model by Henderson and Venkatraman

By recognizing the limitations of existing frameworks in providing fundamental knowledge and guidance, Henderson and Venkatraman introduced their Strategic Alignment Model in 1994, marking the beginning of a new era in research on the subject. The proposed model is based on four main domains: business strategy, organizational infrastructure and processes, IT strategy, and IT infrastructure and processes (Henderson & Venkatraman, 1994).

The conceptual framework suggests that by integrating both external and internal business components, companies may effectively synchronize their IT and business objectives, thereby achieving competitive advantage and operational excellence. Additionally, SAM defines these

components into two key bivariate fit relationships: strategic fit which refers to the alignment between external and internal components of the organization (strategic level), and functional integration referring to alignment between business and IT domains within the organization (operation level) (Henderson & Venkatraman, 1994).

The model proposes that the integration of cross-domain perspectives, which includes these dimensions, is more effective than any individual bivariate fit relationship in enhancing the strategic IT management effectiveness (Henderson & Venkatraman, 1994).

4.4.2. Strategic Alignment Maturity Model by Luftman

Jerry Luftman emphasized that understanding the alignment maturity of an organization and taking the necessary action to improve the IT-business harmony is pivotal (Luftman, 2001).

The primary objective of this framework is to provide organizations with a tool to assess the maturity of their strategic choices and alignment activities, thereby identifying opportunities to improve strategic congruence. In addition, the model provides a mechanism for assessing the level of maturity of strategic decisions and alignment efforts, identifying areas for potential improvement (Chen, 2010).

In accordance with Luftman's conceptualization, strategic alignment includes twelve elements distributed across four domains: Business Strategy, Organization Infrastructure and Processes, IT Strategy, and IT Infrastructure and Processes (Chen, 2010). Each domain is comprised of three key components (Luftman, 2001):

- Business Strategy:
  - Business Scope**:** Includes markets, products, services, customer groups, and geographic locations where the company competes, as well as competitors and potential competitors that influence the business environment;
  - Distinctive Competencies: Includes critical success factors and core competencies that provide the firm with a potential competitive edge;
  - Business Governance: Focuses on the relationships between management, stockholders, and the board of directors.
- Organization Infrastructure and Processes:
  - Administrative Structure: the manner in which the firm structures its business operations;
  - Processes: the manner in which the firm’s business activities are conducted and proceed;
  - Skills.
- IT Strategy:
  - Technology Scope: outlines the key information applications and technologies;
  - Systemic Competencies: those capabilities that distinguish IT services from one another;

        - IT Governance: concerned with the definition of roles and responsibilities for IT resources.
    - IT Infrastructure and Processes:
        - Architecture: the foundation for creating a cohesive and operational IT system;
        - Processes: activities or operations performed with the objective of developing and maintaining applications and managing the associated IT infrastructure;
        - Skills.

Furthermore, the strategic alignment is based on six IT-Business maturity categories (Luftman, 2001).

1. Communication Maturity: this category evaluates the issues of leveraging information for mutual understanding and knowledge sharing between business and IT;
2. Competency/Value Measurement Maturity: it refers to the capacity of IT organizations to demonstrate their value in a manner that is comprehensible and acceptable to the business;
3. Governance Maturity: it refers to the structured process where business and IT leaders formally discuss and prioritize IT resources, ensuring alignment. In order to manage and allocate resources effectively, it is necessary to have clearly defined decision-making authority;
4. Partnership Maturity: it refers to the collaborative relationship between business and IT organizations and emphasizes the importance of IT having an equal role in defining business strategies, promoting mutual trust, having business sponsors and champions for IT initiatives, and sharing risks and rewards;
5. Scope & Architecture Maturity: it assesses the capacity of IT to facilitate the implementation of a flexible and transparent infrastructure that serves all business partners and customers. This includes the capability to extend beyond the front and back offices, the effective application of emerging technologies, the facilitation or driving of business processes and strategies, and the provision of customizable solutions;
6. Skills Maturity: this evaluates the human resource aspect, particularly the level of IT and business skills across the organization, toward change and innovation. It includes an evaluation of the organization's readiness for change, the personal responsibility individuals feel for business innovation, the ability to learn from experiences rapidly, and the capacity to leverage innovative ideas and entrepreneurship.

Complementarily, the model involves five levels of strategic alignment maturity that, in turn, describes the categories mentioned previously (Luftman, 2001):

1. Initial/Ad Hoc Process: Organisations that meet this level are categorized by the minimal alignment between IT and business strategies and by the highly improbable likelihood of achieving an aligned IT business strategy. Organizations at this level lack formalized processes for aligning IT initiatives with business objectives.
2. Committed Process: at this level, organizations begin to recognize the importance of alignment and commit resources towards it. The effort to establish more structured processes between IT and business units may still be inconsistent and challenging to achieve.
3. Established Focused Process: at this third level, the business has already established a focused Strategic Alignment Maturity, with IT becoming increasingly involved.
4. Improved/Managed Process: this fourth level considers IT as an innovative area, allowing a high level of alignment to reinforce the concept of IT as a value center, which in turn enables the achievement of competitive advantage.
5. Optimized Process: the last level exhibits an optimized and fully integrated IT-business alignment. At this level, the enterprise is capable of leveraging IT for strategic advantage.

Ensuring and maintaining strategic alignment requires a dedicated effort to amplify the factors that facilitate alignment (enablers) and, at the same time, actively mitigate the barriers that prevent it (inhibitors) (Luftman, 2001).

5. FRAMEWORK PROPOSAL

The implementation of AI in banking represents a strategic transformation that improves the quality and efficiency of the services provided, potentially revolutionizing core banking functions and its gradual but widespread adoption raises several critical considerations – addressed in previous sections – emphasizing that a structured approach is needed to harness AI's full potential effectively.

After an extensive review of the current landscape of AI applications in financial services, along with the technological advancements and the operational challenges it faces, this section introduces a comprehensive framework designed to guide banks through the systematic integration of AI technologies into their existing operations.

This framework has been designed to address the challenges faced by this technological implementation, providing a simple process for banks to pursue in their implementation, emphasizing not just the technical aspects of AI integration, but also the operational and human factors that are pivotal to a successful outcome. Furthermore, it considers appropriate communication and collaboration, ensuring that the AI solutions implemented are properly aligned with the bank's overall strategic goals and operational requirements.

In essence, through this structured approach, banks may manage the complexities of AI incorporation, converting challenges into opportunities for innovation and further expansion.

This section commences with the Assumptions, which establish the fundamental foundations that serve as the basis for the subsequent analysis. Subsequently, the Proposal section presents the proposed framework in detail, describing its structure and intended application. Thereafter, the Evaluation examines the application of the framework, analyzing the interaction between AI technologies and banking services. The chapter concludes with a demonstration of a use case and discussion of the framework, in which the results are subjected to rigorous examination, validated against the real-world use case, and discussed in order to provide meaningful conclusions regarding the impact of AI on the banking landscape.

5.1. ASSUMPTIONS

Based on the extensive review of existing literature on the intersection between AI and banking services, coupled with the understanding of the available technologies and their adoption within the industry, it was established that a strategy to identify and advance the implementation of AI technologies in a chosen banking process should consider the following points:

- Banking departments can be systematically classified using a structured table, similar to the APQC's recognized Process Classification Framework (PCF) (APQC & IBM, 2020).

- Artificial Intelligence is a field of computer science dedicated to creating computer systems capable of performing tasks that typically require human intelligence, including a range of technologies designed to replicate human cognitive functions (Noreen et al., 2023).
- The application of AI technologies has the potential to optimize banking processes, reduce operational costs, and enhance decision-making capabilities through the analysis of large datasets and trend predictions, significantly improving the efficiency and accuracy of financial services (Govindharaj, 2024).
- The successful implementation of AI in the banking sector depends on understanding the technology and the specific banking context, which requires a balanced attention to technical sophistication and practical applicability (Noreen et al., 2023).
- The key to a successful implementation of AI in the banking sector depends on identifying and aligning it with the institution's strategic objectives, ensuring that technological advances translate into tangible benefits (Noreen et al., 2023).
- The banking industry may benefit from a wide range of AI technologies, including ML for predictive analytics, natural language processing for customer service automation, robotics for process automation, computer vision for identity verification, and deep learning that analyzes and interprets complex data patterns for more detailed assessment. Each of these technologies plays a vital role in strengthening financial institutions' abilities to better serve their customers, manage risks, and improve operational efficiency (Noreen et al., 2023).

These assumptions reflect the essence of the framework, emphasizing the innovative role of AI technologies in various banking services and the importance of a methodological approach in assessing their economic impact.

5.2. PROPOSAL

The preceding section's assumptions have led to the development of a proposed framework designed to systematically assess and harness the power of AI technologies in the banking sector.

This framework aims to recap the various functionalities of AI, offering a structured perspective through which banks may assess the integration and impact of these technologies on their services and operations, serving as a model for identifying the areas in which AI may provide the most significant advantages, as well as for identifying the challenges and opportunities inherent in its adoption.

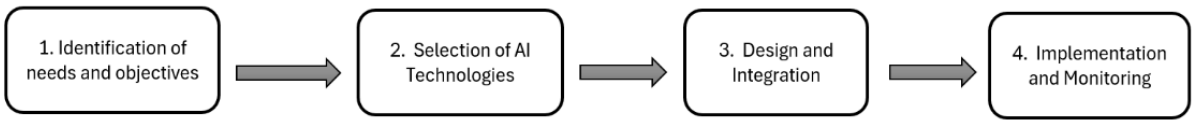

Figure 5.2.1 - Proposed Framework.

The initial phase focuses on a comprehensive analysis of the bank's current operations to identify potential areas where AI can add significant value, and involves reviewing existing processes, identifying inefficiencies, and defining clear objectives for AI integration. To support such decisions, informative tables and a flowchart are provided.

Following this, the second phase consists of a careful evaluation of the available AI tools and solutions, considering factors such as compatibility with existing systems, cost, ease of integration, and regulatory compliance, with the aim of choosing AI technologies that align with the bank's strategic objectives and the specific needs identified earlier.

In the third step, the user creates a detailed plan that aligns with the bank's objectives and may integrate the selected AI technology into the bank's existing systems.

Finally, the final phase focuses on the physical implementation of AI technologies and their operational supervision, including training staff if necessary, and continuous monitoring against predefined metrics to ensure they deliver expected benefits and remain compliant.

In the further sections, there is a detailed explanation of each step of the framework.

5.2.1. Identification of needs and objectives

The first step involves identifying the bank's needs and objectives to determine the main areas where AI may add value.

This initial phase involves a comprehensive review of the bank's existing operations in a specific department in order to understand the current state of processes and identify both efficiencies and areas in need of improvement. It involves identifying each process, determining the scope and scale of operations, and recognizing the elements that contribute to the overall performance of banking services, thereby providing the basis for identifying specific needs and defining clear objectives for the integration of AI technologies. Ultimately, the user will be able to select the technologies most advantageous for their objectives, guided by a flowchart.

A structured approach to this preliminary stage would be as follows:

1. Select the banking department.
2. Collect insights from the selected department.
    a. Identify any inefficiencies or areas where AI could offer improvements by conducting a survey.

3. Select processes that need to be addressed or optimized.
    a. Use the APQC's recognized PCF, presented in Annex I.
4. Decide which issues/processes are most critical to address first.
5. Select adequate AI Technologies.
    a. Use the flowchart to make decisions.

Once the department has been chosen, it is imperative to investigate its requirements in advance. To achieve this, the user must conduct a survey with the managers of the selected department and accomplish an organized outcome, full of clear information about the inefficiencies and processes in that area. To ensure it successfully, the user must follow the general survey bellow:

- What are your department's primary responsibilities and objectives?
- What are the biggest challenges facing the department in its operations?
- List the tasks that consume the most time in your daily work routine.
- How would you prioritize the needs for AI integration in your department?

Complementary, there is a pre-defined list in Annex I that the user must use to validate the process(es) within the department of the bank that wants to focus on. This list is extracted from the most recent APQC PCF for the banking industry (APQC & IBM, 2020). These pre-defined processes/categories help to streamline the objectives into a more concise form and allow the user to fully understand the definitions of each of these categories, specifically adapted to the banking industry.

Furthermore, to prioritize and sort the processes that need to be addressed, an auxiliary table was constructed. The table categorizes the issues identified in step 3) of this stage into effort, including time, cost, and number of resources required, and possible return value, including monetary value and customer satisfaction, and prioritizes those that have a balanced relationship between the two metrics.

Table 5.2.1 - Overall Priority Score.

Issue Identified	Possible Return Value	Effort Required	Overall Priority Score
Issue nº1	x	y	z

Table 5.2.2 - Overall Priority Score Decision.

Possible Return Value (x) / Effort Required (y)	Very High	High	Moderate	Low
Very High	High Priority	Medium Priority	Low Priority	Not recommended
High	High Priority	Medium Priority	Low Priority	Not recommended
Medium	Very High Priority	High Priority	Medium Priority	Low Priority
Low	Very High Priority	High Priority	Medium Priority	Low Priority

By the end of this phase, with the aid of the flowchart presented in Appendix B, the most appropriate technologies must be selected to eventually address the identified problems and processes. These technologies must be solutions that not only address the current identified needs but are also capable of adapting to future challenges and opportunities.

Appendix A provides the user with a detailed overview of this initial phase.

5.2.2. Evaluation and Selection of AI Technologies

This phase involves a rigorous evaluation of the available AI tools and solutions, taking into account compatibility with existing systems, the potential to address identified challenges, cost, ease of integration, and compliance with regulatory standards.

The main objective is to select the AI technology that best aligns with the bank's operational context and strategic goals, based on its ability to address the issues identified in the initial phase of this framework.

To achieve this, it is required to follow these main steps:

1. Document the requirements that any proposed AI solution must meet, considering the objectives set (Budget, Data Management, Integration and Operational Costs, Software compatibility, Security, maintenance, and support).
2. Technology Matching.
    a. Map the chosen technologies to the selected banking process in stage 1 using the Table 5.2.3.
3. Select the most promising technology for the objective.
    a. Prioritize AI technologies based on their relevance to the actual banking function.
    b. Based on a comprehensive analysis and stakeholder input.

Table 5.2.3 - Qualitative metrics for evaluating AI technologies.

	Qualitative metrics for evaluating the impact of AI Technologies									
Process/ Issue	AI technology	Reduction of process complexity	Operational Costs	Potencial Revenue	Compliance and Risk	User experience Impact	Maintenance Requirements	Stakeholders Opinion	Facility for integration	Overall Assment
		Possible Answers	**Possible Answers**	**Possible Answers**	**Possible Answers**	**Possible Answers**	**Possible Answers**	**Possible Answers**	**Possible Answers**	**Possible Answers**
		High	Low	High Potential	No Risk	Positive	Low Maintenance	High confidence	Easy Integration	Good Candidate
		Medium	Moderate	Moderate Potential	Review needed	Neutral	Moderate Maintenance	Moderate Confidence	Some challenges	Search for a better candidate
		Low	High	Low Potential	Too Risky	Negative	High Maintenance	Low Confidence	Complex Integration	Not reccomended

Therefore, the specific AI technology best suited to improving the previously identified banking process is selected, clearing the way for the next stages of integration and implementation.

5.2.3. Design and Integration

At this stage, the chosen AI technology is carefully designed and integrated into the existing systems of the bank and involves the creation of a detailed plan that aligns with the objectives. This phase is based on the previous assessments and integrates the knowledge from the Table 5.2.3, ensuring that each technology fits exactly into the operational framework, having as the main objective the development of a well-defined action plan to incorporate AI technologies into the banking infrastructure.

The aim is to ensure that the integration of AI improves banking services, enhances customer experiences, and provides a competitive advantage in the market.

The structure of this stage should be based on these steps:

1. Develop an integration plan that includes timelines and resources for the selected technology.
    a. Define desired outputs.
2. Update Table 5.2.3 with any updates related to compliance or risk mitigation measures associated with each AI technology.
3. Finalize integration plans and communicate deployment schedules and expectations to all relevant stakeholders.
4. Training and Support (Optional).
    a. Provide comprehensive training for the bank workforce on the new AI systems, focusing on how to use them effectively and understanding the changes to their workflows, if necessary.

The integration strategy is based on thorough planning and continuous feedback, with the Table 5.2.3 being a vital tool for tracking progress and performance.

5.2.4. Implementation and Monitoring

This final phase concentrates on implementing the selected AI technology in the bank's physical environment and supervising its operation to ensure that it meets the company's strategic objectives. While the implementation phase involves integrating AI solutions into existing banking systems and communicating changes to stakeholders, the monitoring phase is a process where the performance of AI technologies is continually assessed against predefined metrics to ensure they deliver the expected benefits, maintain compliance with regulations, and adapt to evolving banking needs.

Finally, the last stage may be organized as follows:

1. Transit the AI system into operational use.
2. Performance Monitoring.
    a. Use data analytics to gain insights into the AI implementations' impact on banking operations and services.
    b. Establish regular monitoring routines using metrics to evaluate. Examples of metrics:
        i. Measure the accuracy of AI predictions or decisions.
        ii. Track improvements in process speeds.
        iii. Measure the reduction in manual intervention needed due to AI automation.
        iv. Monitor ROI (Return Over Investment) to ensure the AI investment is delivering financial benefits.
        v. Monitor customer engagement by using feedback mechanisms and analyzing the usage of AI-powered banking channels.
        vi. Collect feedback from employees.
        vii. Ensure that AI systems are following banking regulations.
3. Regularly document and report on the performance, highlighting successes, challenges, and the value added to the bank.
4. Initiate continuous improvement cycles where insights from monitoring and feedback from users and stakeholders are used to refine and enhance AI system performance.

By following these steps, it is expected to successfully operationalize AI technologies in the banking environment, ensuring that they operate smoothly and improve banking services as intended.

5.3. USE CASE DEMONSTRATION

To provide a clearer understanding, a use case focused on soft churn within a bank was examined.

5.3.1. Identification of needs and objectives

It is assumed that the Customer Relationship Management (CRM) team in the Marketing department was selected for intervention and that insights into its operations were gathered during a meeting with the department manager:

- What are your department's primary responsibilities and objectives?
  - "The CRM team is primarily responsible for managing clients' relationships, understanding their needs, and improving client retention strategies and our objectives include increasing the retention of customers, improving their satisfaction rates, and automating customer segmentation processes to enable more personalized marketing campaigns."
- What are the biggest challenges facing the department in its operations?
  - "One of the department's principal challenges is to enhance customer engagement in the context of intensifying competition and evolving customer expectations."
- List the tasks that consume the most time in your daily work routine.
  - "The most time-consuming tasks are currently data analysis and reporting, along with customer segmentation for targeted campaigns."
- How would you prioritize the needs for AI integration in your department?
  - "AI integration would be prioritized in areas that could immediately improve operational efficiency and customer satisfaction."

Furthermore, soft churn (customer segmentation/ retention) was prioritized as a critical issue to improve in this context, since it has a balanced relationship between the two metrics: the possible return value is categorized as 'Very High' since it has a direct impact on monetary value by retaining revenue that would otherwise be lost and increases customer satisfaction by providing more personalized services, and the bank's existing AI capabilities and cloud-based infrastructure provide a solid foundation, resulting in a moderate effort required.

Table 5.3.1 - Priority Score of Soft Churn.

Issue Identified	Possible Return Value	Effort Required	Overall Priority Score
Soft churn	Very High	Medium	Very High

According to this stage of the framework, an adequate AI technology for the service must be chosen. The chosen category for this issue, with the aid of the information presented in Annex I, was *Market and Sell Products and Services (10004)* - and, with the support of the flowchart, since 'Prediction' was the type of AI considered the most adequate and we have labeled data, the following AI technologies have been identified as suitable for addressing soft churn:

- Supervised Learning (Classification): Classification models may accurately predict the probability of soft churn by analyzing labeled historical data.

- Deep Learning (Neural Networks): Deep learning neural networks can capture complex patterns and relationships in large datasets, providing more precise predictions and deeper insights into factors contributing to soft churn.
- Time Series Forecasting: Time series forecasting models can identify trends and seasonal patterns in customer behavior over time, allowing for early detection of potential churn and timely intervention strategies.

5.3.2. Evaluation and Selection of AI Technologies

The requirements that any proposed AI solution must meet, considering the objectives set, were documented:

- Budget: the budget needs to consider the costs associated with acquiring or developing an AI solution. Given the competitive market, a moderate to high investment is expected.
- Data management: since cloud services are already in operation, the investment in data management could be more efficient and less costly.
- Integration and operational costs: operating costs may be reduced due to existing AI implementations and the integration effort might focus on compatibility and expansion, with a moderate budget commitment.
- Software Compatibility: the current software is probably compatible with advanced AI solutions, so the software upgrade effort should be relatively low.
- Security: incremental updates to security measures are required with moderate effort due to previous AI implementations.
- Maintenance and Support: routine maintenance practices that are already in place should streamline the incorporation of new AI technologies, requiring a moderate level of additional effort.

The assessment of the impacts of each technology chosen helps in making a strategic decision about which one might be best suited for addressing soft churn effectively within the bank. Additionally, the table mentioned in Step 2 has been comprehensively filled to facilitate this decision-making process:

Table 5.3.2 - Evaluation of AI technologies for addressing Soft Churn.

	Qualitative metrics for evaluating the impact of AI Technologies									
Process/ Issue	AI technology	Reduction of process complexity	Operational Costs	Potencial Revenue	Compliance and Risk	User experience Impact	Maintenance Requirements	Stakeholders Opinion	Facility for integration	Overall Assment
Soft churn	Supervised Learning	High	Moderate	High Potential	Review needed	Positive	Moderate Maintenance	High Confidence	Some challenges	Good Candidate
Soft churn	Deep Learning	High	High	High Potential	Review needed	Positive	High Maintenance	Moderate Confidence	Complex Integration	Search for a better candidate
Soft churn	Time Series Forecasting	High	Moderate	High Potential	Review needed	Positive	Moderate Maintenance	High Confidence	Some challenges	Good Candidate

Regarding the reduction of process complexity, the three technologies are highly effective due to their ability to automate and optimize decision-making processes. In addition, Time Series Forecasting is also valuable for predicting trends and identifying early signs of potential soft churn, providing crucial insights that may help pre-empt customer disengagement.

The operational costs associated with Supervised Learning and Time Series Forecasting are considered moderate due to the bank's already implemented cloud services, which provide scalable and cost-effective computing resources. In contrast, Deep Learning incurs higher operational costs due to the possible employee training required to effectively deploy and use these technologies, as well as the complexity and sophistication of the models.
Furthermore, Time Series Forecasting has moderate potential revenue improvement by predicting trends and seasonal patterns. In comparison, Supervised Learning and Deep Learning have higher potential due to their advanced prediction capabilities, which can more accurately identify potential churn and optimize customer retention strategies by analyzing complex patterns and relationships in vast amounts of data. Additionally, there are inherent risks associated with these technologies, including potential biases in models and data privacy concerns, which require rigorous risk management.
Finally, the integration of Deep Learning is complicated by the scale and complexity of the data systems involved. Although cloud infrastructure provides scalable resources and high computational power, the nature of Deep Learning still requires careful planning and specialized knowledge for effective deployment. Time Series Forecasting, on the other hand, is typically easier to integrate due to its simpler model structure, while Supervised Learning presents some challenges, but it is still very user-friendly.
After an exhaustive analysis, Supervised Learning was selected to deal with soft churn, presenting itself as a viable and effective solution.

5.3.3. Design and Integration + Implementation and Monitoring

With reference to the table described in the framework, the third phase of the implementation process was exhaustively planned and executed, as described below:

- This project was expected to be scheduled for completion over six months, starting with a two-month phase for data preparation and initial model training. Following this, one month for model refinement and validation, and finally, a three-month phase for integration and testing. The schedule was respected. This project was implemented in the could infrastructure already implemented within the bank, with a dedicated team of data scientists and data engineers and a complex set of data allocated in the cloud service.
- The model was designed to comply with the GDPR and other relevant data protection regulations, ensuring that all customer data is handled securely.
- The information above was delivered to the stakeholders through reports, meetings, and presentations.

This organized structure ensured a smooth and orderly delivery of the project. No additional training was required, making the implementation and monitoring phase straightforward. Performance was evaluated monthly, including its precision and other key metrics.

5.4. EVALUATION AND DISCUSSION

To assess the relevance of the proposed framework designed to facilitate the integration of AI in the banking industry, interviews were conducted. These interviews aimed to evaluate the effectiveness of the framework and to provide insight into possible improvements.

To achieve this, two distinct profiles were interviewed based on their level of knowledge and expertise: one year's experience in the field and a senior data scientist.

To facilitate the evaluation, a comprehensive presentation, attached in APPENDIX C, was created and shared with the interviewees to provide a clear overview of the framework and gather detailed feedback.

Following this, a structured survey was conducted:

- Do you think that the proposed framework is useful? Why/ why not?
  - Data scientist Trainee: "Yes, it seems useful. The step-by-step layout helps understand where the process is at and what needs to be done next."
  - Senior Data Scientist: "Yes, I believe the framework is highly beneficial. However, it appears to be particularly advantageous for traditional banks that are just beginning to explore the potential of AI. Besides that, its strength comes from its ability to align with the specific needs of the bank, rather than simply following the latest trends, thereby providing a comprehensive assessment of the required effort, associated risks, and potential benefits! This well-structured approach is a significant advantage, setting the foundation for successful tech integration!"
- Do you consider the framework to be clear and understandable?
  - Data scientist Trainee: "Yes, I do. I really appreciate the flowchart; it seems to be an indispensable visual element in this context. It is very easy to understand and manage. However, there are areas within it that could benefit from greater specificity and more detailed explanations. I would also incorporate annotations between certain steps."
  - Senior Data Scientist: "Yes, I do find it useful. I believe that its success doesn't rely on the user's level of expertise because it uses clear vocabulary and concepts that are easy to understand. It is well-grounded in basic banking principles, which makes its aims and methods clear. It also reminds me of an ML pipeline, although it is more of a preliminary theoretical framework!"
- What improvements would you suggest for this framework?
  - Data scientist Trainee: "Beyond what I already suggested, I believe introducing feedback loops, either directly within the flowchart or as part of the departmental survey, would help in continuous refinement. The last steps of the framework should also have some visual representation, I think. I also consider that adding a component related to technological developments might prevent abrupt changes."

- Senior Data Scientist: “I understand the objective of the framework and recognize that modifying even a single step or an auxiliary tool could be complex due to their interdependence. However, I believe the bank could benefit more if, for example, the development of an integration plan was established earlier in the process, not just in the third step. The framework's ‘cyclical’ nature, which I appreciate, seems to delay reaching conclusions: if I select a banking process and then choose specific technologies to assess individually, I must progress to at least the third step to determine if integration is feasible before considering an alternative, since the timeline, resources, and the requirements any AI solution must meet are only detailed in later steps. This approach would take the bank's technological maturity and capacity into account right from the start, preventing the proposal of unfeasible solutions."

Table 5.4.1 - Advantages and disadvantages of the framework.

Advantages	*Disadvantages*
Legibility	Scalability
Applicability	Adaptability
Clarity	

The overall utility of the framework received positive validation from the participants. However, the feedback also highlighted a need for a more concise layout, particularly emphasizing the inclusion of visual representations for the final stages of the framework. In addition, the insights from the trainee were particularly valuable in assessing the framework's legibility and understandability, which is fundamental for users with lower experience levels. With regard to the Senior Data Scientist, an alternative approach was proposed: the order of some steps could be altered in order to enhance the practicality and effectiveness of the process of selecting the most appropriate AI technology for the selected process.

Moreover, a significant gap identified in the framework is the lack of specificity during the technology selection phase within the flowchart. Addressing this could enhance the adaptability of the framework and make it particularly beneficial for banks that are in the early stages of integrating AI technologies. Furthermore, it would lead to decisions aligned with their specific contexts and technological capabilities, providing clearer guidance.

It was also observed that the absence of annotations and examples in critical decision points could significantly affect user comprehension and engagement, making this a critical requirement for future work.

In summary, although the framework has demonstrated its overall effectiveness through feedback from participants, the contributions gathered highlight essential aspects to be improved in order to maximize its usefulness that may transform the framework into a more

intuitive and effective tool and facilitate a smoother adoption and integration of AI technologies across the banking sector.

6. CONCLUSIONS AND FUTURE WORK

This chapter summarizes the work developed within the scope of this dissertation, clearly defines the significant results, and establishes the basis for the transformative integration of AI in the banking sector and future work, mentioning its limitations.

The primary objective of this study was to establish a methodical framework to facilitate the integration of Artificial Intelligence technologies into banking operations, enhancing overall service delivery and operational efficiency. The framework was designed to accommodate various AI applications, with soft churn serving as one illustrative example.

The four-step framework was methodically developed, facilitating a systematic approach to the selection and implementation of AI technologies in the banking sector. This framework not only outlined the methodical identification and assessment of banks' specific needs but also highlighted the strategic alignment of AI technologies with these requirements to optimize banking operations. It was meticulously developed by synthesizing insights from extensive literature reviews and adapting best practices from the industry.

The research question presented in the Introduction: “How can a structured framework optimize the deployment and management of artificial intelligence technologies in the banking sector?” has been addressed through the demonstration of the use case effectiveness presented in Chapter 5.3. The results validate the framework's potential as a valuable tool for banking institutions seeking to leverage AI for strategic advantage.

6.1. FRAMEWORK LIMITATIONS

While the framework designed to integrate AI technologies into banking operations has demonstrated potential, and despite achieving the overall goals of this dissertation, there are inherent limitations that should be acknowledged:

- Since the framework is based on the APQC's classification of the banking process it may limit its adaptability to the specific operational nuances of each bank since it assumes the standardization of the services offered by banks;
- The flowchart presented in the initial stage of the framework is relatively generic and would benefit from being subdivided into more relatable and specific categories that align closely with practical banking operations;
- The absence of multiple use case demonstrations may limit the practical validation of the framework across different scenarios and contexts within the banking sector.
- Certain steps may be implemented too late, which could result in the process taking longer than necessary.
- The field of AI technologies is rapidly evolving, and the framework must be continuously updated to incorporate the latest advancements and best practices to remain relevant and effective.

The framework must be dynamically refined and adapted based on ongoing feedback and evolving conditions within the banking sector.

6.2. FUTURE WORK

Once this master's dissertation is fully completed, it may serve as a valuable artifact to aid in the integration and implementation of AI technologies within a banking institution. To ensure the continued relevance and effectiveness of this framework, numerous improvements could be achieved. These enhancements aim to expand the framework's applicability and utility:

- The framework should be applied in an actual banking environment in order to establish a practical foundation for ongoing refinement.
- Include more customizable options in the auxiliary tables, allowing banks to tailor AI integration strategies to their specific operational contexts and customer needs.
- Incorporate a broader range of use case examples across different banking services to illustrate diverse applications and benefits.
- Consider reordering the framework's implementation and include use case examples for comparison with established practices.
- As the regulation and governance of AI become increasingly significant, particularly with the introduction of the European AI Act, aligning this framework with the requirements of the AI Act would be highly beneficial. Furthermore, this alignment would enhance the framework's focus on risk management, transparency, and ethical considerations, thereby making it more robust and suited to meet industry standards and regulatory expectations.

By addressing these, the framework could probably evolve into a more robust tool that meets the current demands of the banking industry and is also adaptable to future changes and challenges, ensuring its viability and success in facilitating AI integration.

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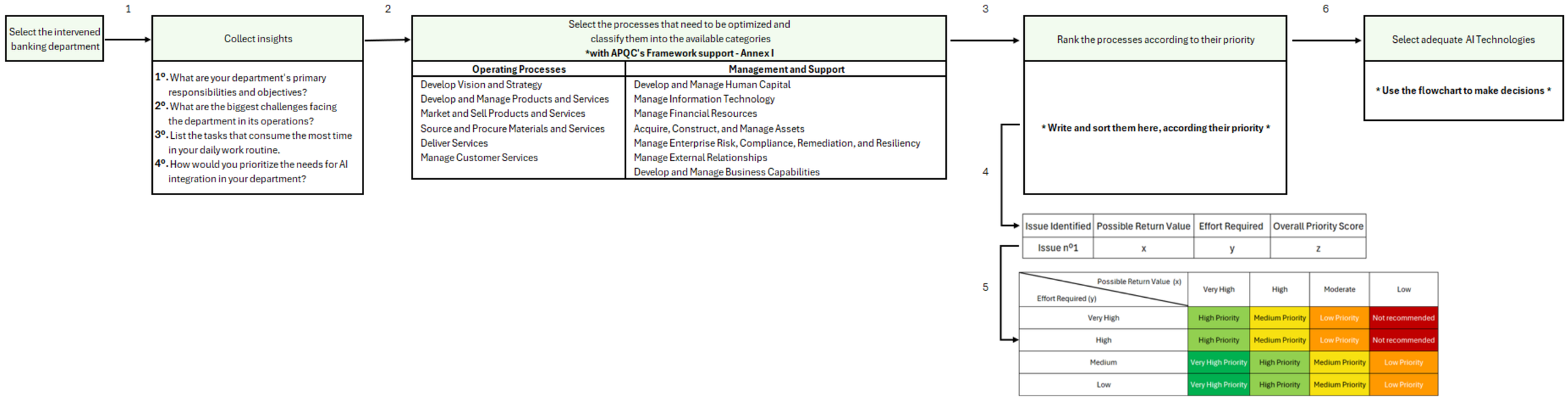
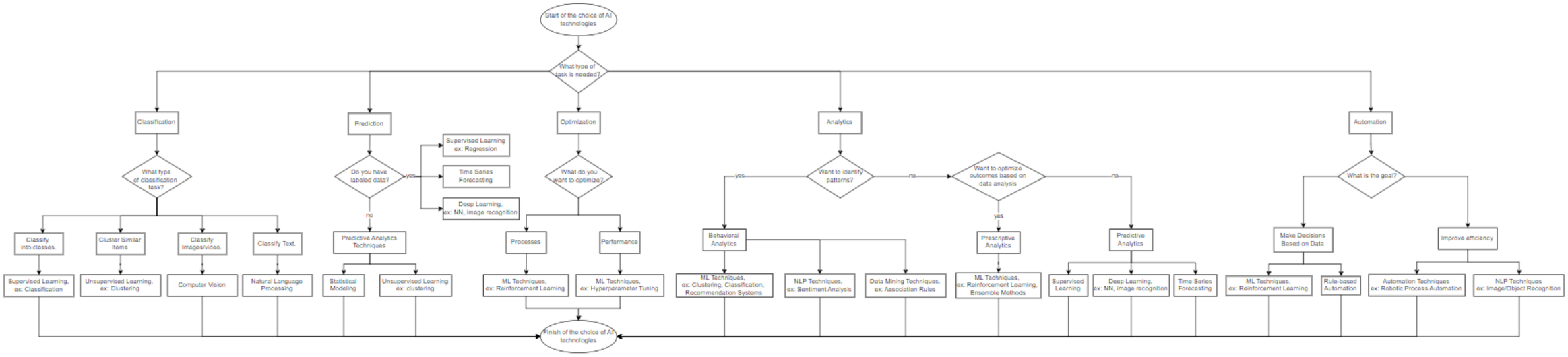
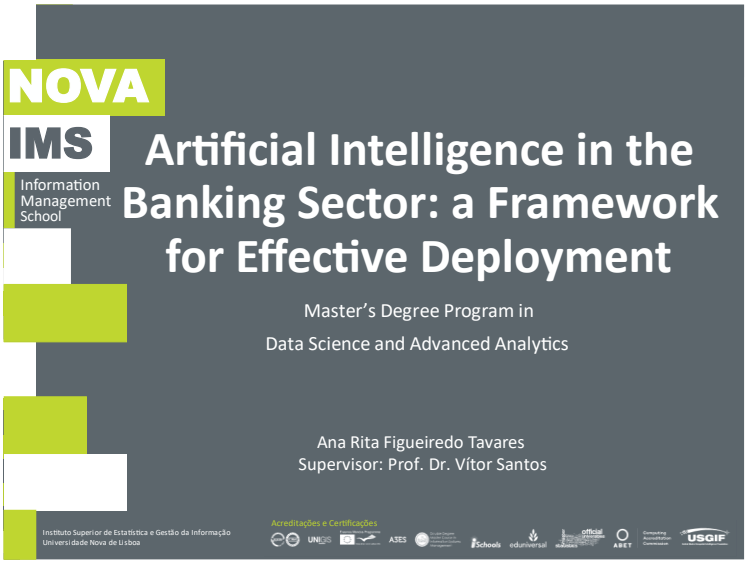
APPENDIX A

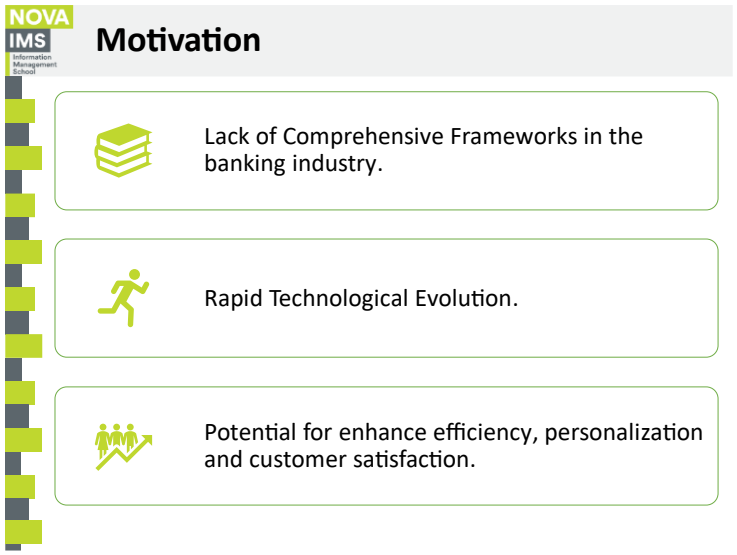

1
Select the intervened banking department
Collect insights
1º. What are your department's primary responsibilities and objectives?
2º. What are the biggest challenges facing the department in its operations?
3º. List the tasks that consume the most time in your daily work routine.
4º. How would you prioritize the needs for AI integration in your department?
2
Select the processes that need to be optimized and classify them into the available categories
*with APQC's Framework support - Annex I
Operating Processes
Develop Vision and Strategy
Develop and Manage Products and Services
Market and Sell Products and Services
Source and Procure Materials and Services
Deliver Services
Manage Customer Services
Management and Support
Develop and Manage Human Capital
Manage Information Technology
Manage Financial Resources
Acquire, Construct, and Manage Assets
Manage Enterprise Risk, Compliance, Remediation, and Resiliency
Manage External Relationships
Develop and Manage Business Capabilities
3
Rank the processes according to their priority
* Write and sort them here, according their priority *
6
Select adequate AI Technologies
* Use the flowchart to make decisions *
4
Issue Identified
Possible Return Value
Effort Required
Overall Priority Score
Issue nº1
x
y
z
5
Possible Return Value (x)
Effort Required (y)
Very High
High
Moderate
Low
Very High
High Priority
Medium Priority
Low Priority
Not recommended
High
High Priority
Medium Priority
Low Priority
Not recommended
Medium
Very High Priority
High Priority
Medium Priority
Low Priority
Low
Very High Priority
High Priority
Medium Priority
Low Priority

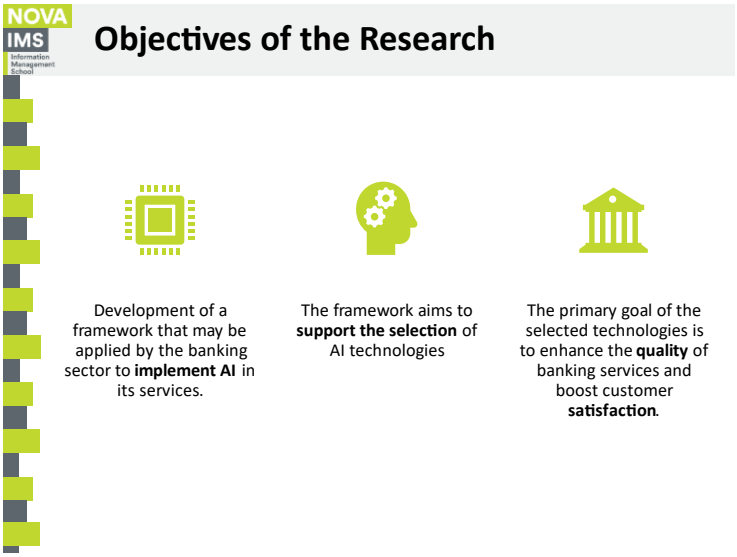
APPENDIX B


Start of the choice of AI technologies
What type of task is needed?
Classification
What type of classification task?
Classify into classes.
Supervised Learning, ex: Classification
Cluster Similar Items
Unsupervised Learning, ex: Clustering
Classify Images/video.
Computer Vision
Classify Text.
Natural Language Processing
Prediction
Do you have labeled data?
yes
Supervised Learning ex: Regression
Time Series Forecasting
Deep Learning, ex: NN, image recognition
no
Predictive Analytics Techniques
Statistical Modeling
Unsupervised Learning ex: clustering
Optimization
What do you want to optimize?
Processes
ML Techniques, ex: Reinforcement Learning
Performance
ML Techniques, ex: Hyperparameter Tuning
Analytics
Want to identify patterns?
yes
Behavioral Analytics
ML Techniques, ex: Clustering, Classification, Recommendation Systems
NLP Techniques, ex: Sentiment Analysis
Data Mining Techniques, ex: Association Rules
no
Want to optimize outcomes based on data analysis
yes
Prescriptive Analytics
ML Techniques, ex: Reinforcement Learning, Ensemble Methods
no
Predictive Analytics
Supervised Learning
Deep Learning, ex: NN, image recognition
Time Series Forecasting
Automation
What is the goal?
Make Decisions Based on Data
ML Techniques, ex: Reinforcement Learning
Rule-based Automation
Improve efficiency
Automation Techniques ex: Robotic Process Automation
NLP Techniques ex: Image/Object Recognition
Finish of the choice of AI technologies

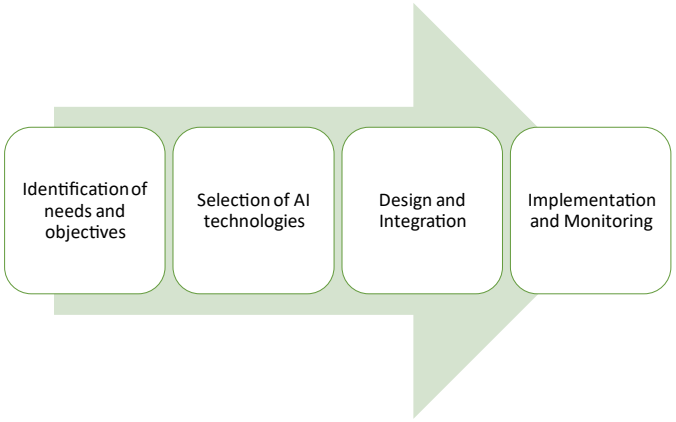
APPENDIX C


NOVA
IMS
Information Management School
Artificial Intelligence in the Banking Sector: a Framework for Effective Deployment
Master's Degree Program in
Data Science and Advanced Analytics
Ana Rita Figueiredo Tavares
Supervisor: Prof. Dr. Vítor Santos
Instituto Superior de Estatística e Gestão da Informação
Universidade Nova de Lisboa
Acreditações e Certificações

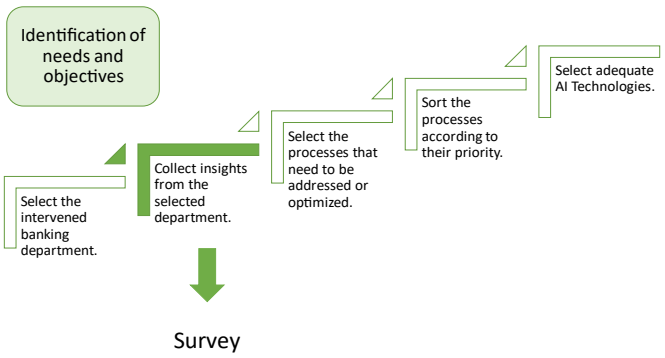

NOVA
IMS
Information Management School
Motivation
Lack of Comprehensive Frameworks in the banking industry.
Rapid Technological Evolution.
Potential for enhance efficiency, personalization and customer satisfaction.


NOVA
IMS
Information Management School
Objectives of the Research
Development of a framework that may be applied by the banking sector to implement AI in its services.
The framework aims to support the selection of AI technologies
The primary goal of the selected technologies is to enhance the quality of banking services and boost customer satisfaction.

Framework



Framework



Framework

Identification of needs and

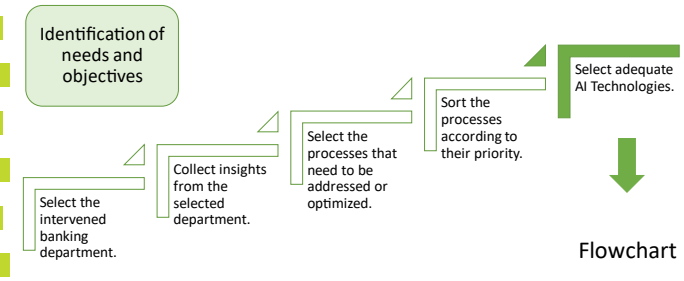
- What are your department's primary **responsibilities** and **objectives**?
- What are the **biggest challenges** facing the department in its operations?
- List the tasks that consume the **most time** in your daily work routine.
- How would you **prioritize** the needs for AI integration in your department?

Framework

Effort Required (y) \ Possible Return Value (x)	Very High	High	Moderate	Low
Very High	High Priority	Medium Priority	Low Priority	Not recommended
High	High Priority	Medium Priority	Low Priority	Not recommended
Medium	Very High Priority	High Priority	Medium Priority	Low Priority
Low	Very High Priority	High Priority	Medium Priority	Low Priority

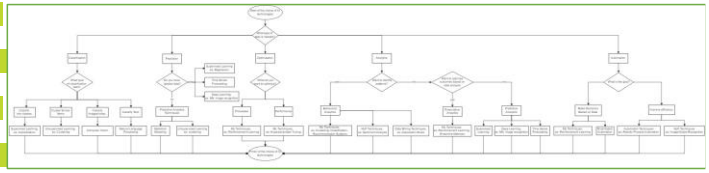
Issue Identified	Possible Return Value	Effort Required	Overall Priority Score
Issue n°1	x	y	z

Framework

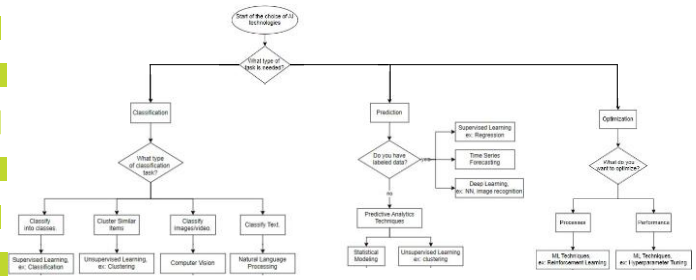


Flowchart

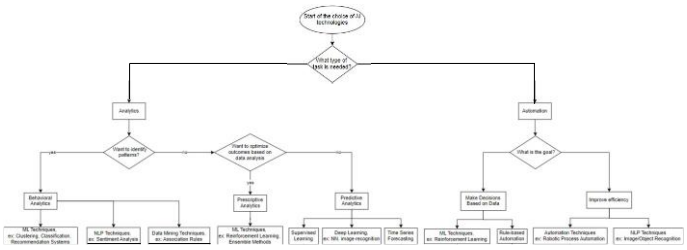
Framework



Framework



Framework



Framework

Selection of AI technologies

Map the chosen technologies to the selected banking process

Select the most promising technology for the objective.

Document the requirements that any proposed AI solution must meet.

Process/ Issue	Qualitative metrics for evaluating the impact of AI Technologies									
	AI technology	Reduction of process complexity	Operational Costs	Potencial Revenue	Compliance and Risk	User experience Impact	Maintenance Requirements	Stakeholders Opinion	Facility for Integration	Overall Assment
	Possible Answers	Possible Answers	Possible Answers	Possible Answers	Possible Answers	Possible Answers	Possible Answers	Possible Answers	Possible Answers	Possible Answers
	High	Low	High Potential	No Risk	Positive	Low Maintenance	High confidence	Easy Integration	Good Candidate
	Medium	Moderate	Moderate Potential	Review needed	Neutral	Moderate Maintenance	Moderate Confidence	Some challenges	Search for a better candidate
	Low	High	Low Potential	Too Risky	Negative	High Maintenance	Low Confidence	Complex Integration	Not reccomended

- Budget
- Data Management
- Integration and Operational Costs
- Software compatibility
- Security

Framework

Design and Integration

- Develop an integration plan.
- Update the table with any updates related to compliance or risk mitigation measures.
- Communicate deployment schedules and expectations to all relevant stakeholders.
- Training and support (optional).

- Includes Timelines and Resources

Framework

Implementation and Monitoring

- Transit the AI system into operational use.
- Performance Monitoring.
- Regularly document and report.
- Initiate continuous improvement cycles

Insights from monitoring and feedback from users and stakeholders are used to refine and enhance AI system performance.

Thank you!

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Phone: +351 213 828 610 Fax: +351 213 828 611

Acreditações e Certificações

Instituto Superior de Estatística e Gestão da Informação
Universidade Nova de Lisboa

ANNEXES

ANNEX I – APQC's Process Framework, Banking Industry. Adapted by the author.

Level	Name	ID
1.0	**Develop Vision and Strategy**	10002
1.1	Define the business concept	17040
1.1.1	Assess the external environment	10017
1.1.2	Survey market and determine customer needs and wants	10018
1.1.3	Assess the internal environment	10019
1.1.4	Establish strategic vision	10020
1.1.5	Conduct organization restructuring opportunities	16792
1.2	Develop business strategy	10015
1.2.1	Develop overall mission statement	10037
1.2.2	Define and evaluate strategic options to achieve the objectives	10038
1.2.3	Select long-term business strategy	10039
1.2.4	Coordinate and align functional and process strategies	10040
1.2.5	Create organizational design	10041
1.2.6	Develop and set organizational goals	10042
1.2.7	Formulate business unit strategies	10043
1.2.8	Develop customer experience strategy	19959
1.2.9	Communicate strategies internally and externally	18916
1.3	Execute and measure strategic initiatives	10016
1.3.1	Develop strategic initiatives	10057
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