

Aleksandrina Pancheva**Digital Transformation and AI in Banking: A New Vision for Performance Evaluation**

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Abstract

The beginning of the digital era for banks, established in the previous 20-th century, continues today. At the transition between Banking 4.0 and 5.0, more and more banks are adopting and implementing the ideas of the new era – achieving an optimal synergy between banks and technology. The integration of AI across all areas of banking is leading to a strong emphasis on the current best areas for application – Client Solutions & Services, Financial & Trading Operations, Risk, Security & Compliance, as well as Technology & Infrastructure.

Traditional assessment of banking performance primarily relies on financial indicators derived from standard financial statements. However, in the context of digital transformation and ongoing innovation processes, these indicators are increasingly insufficient for achieving a comprehensive understanding and analysis of the performance of banking institutions. The present study aims to present the digital transformation of banks and the role of artificial intelligence in enhancing the banking business, in the context of the resulting change in the profile of banking performance.

Keywords

Artificial Intelligence, Bank, Digital Transformation, Operating Efficiency, Performance.

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Introduction

The process of digital transformation in the financial sector serves as a key driver of innovation and structural changes in the operations of banks and financial institutions. This transformation unfolds through successive stages such as process automation, digitalization, utilization of Big Data, the application of Artificial Intelligence (AI), the adoption of blockchain technologies, development of digital platforms, and the proliferation of digital currencies. Each of these stages leads to a rethinking of established business models, enhanced operational efficiency, and a transformation in the interaction between humans and technology—trends that align with the paradigms of Industry 4.0 and Industry 5.0.

Even in the early stages of digital transformation, the need to upgrade traditional assessment models—primarily based on prudential or financial indicators—becomes evident. There

emerges a demand for extended systems of indicators that account not only for financial outcomes but also for the effects of implemented innovations. In this context, tools such as Key Performance Indicators (KPIs), balanced scorecards, dashboards, and other approaches find increasing application. Artificial Intelligence offers the potential for significant expansion of the analytical toolkit by incorporating non-financial and qualitative indicators. This necessitates the development of new assessment methodologies, including ranking scales, evaluation scorecards, and metric systems, which are particularly relevant for analyzing aspects such as corporate social responsibility, reputation management, and market behavior. With the progress of digitalization, favorable conditions are created for automating a significant portion of the processes related to the evaluation of banking performance, provided that structured and reliable data is available. The application of AI enables more precise identification of critical areas, reduction of human error, and achievement of a higher degree of objectivity—both in core and auxiliary business processes. The collaboration between analysts and AI makes it possible to develop advanced systems for performance evaluation and results visualization, presented in a way that supports strategic decision-making. The flexibility and adaptability of AI allow for the construction of multi-dimensional and scenario-based evaluation models capable of reflecting the complex dynamics of both the internal and external environments in the banking sector. The present paper aims to explore the role of digital transformation and artificial intelligence in expanding the range of metrics used to assess banking performance.

1. Banks on the road of digital transformation

In contemporary times, the term "digital" has become integral to virtually every business activity, particularly in the domain of financial services. However, from a historical perspective, banks were not among the initial pioneers in digital innovation. The early adoption of digital technologies was led by sectors such as aviation, defense, manufacturing, scientific research, and telecommunications (World Economic Forum, 2016). Nevertheless, financial institutions actively sought to adapt and integrate emerging technologies into their operations to support core functions such as accounting and transaction management.

A historical review of the evolving relationship between banking and technology can be examined through the progression from Banking 1.0 to Banking 4.0, as well as through projections for the future – Banking 5.0 (King, 2018; Gomber, Kauffman, Parker, Weber, 2018). These stages closely align with the broader paradigms of Industry 4.0 and the emerging framework of Industry 5.0 (EC, 2021).

There is no universally accepted framework for the precise periodization of banking development from Banking 1.0 to Banking 5.0. The first notable attempt at such periodization is found in the work of Brett King (Bank 4.0: Banking Everywhere, Never at a Bank; Bank 3.0: Why Banking Is No Longer Somewhere You Go But Something You Do). Subsequent elaborations and refinements have been contributed by the World Economic Forum (World Economic Forum, 2016; Gomber, Kauffman, Parker, Weber, 2018), as well as by leading consulting firms such as Accenture, PwC, McKinsey & Company, Deloitte, EY, Netcetera, among others.

In most cases, these organizations focus on analyzing the adoption and integration of new technologies within the financial sector, along with the resulting strategic and operational implications. An illustration of the main characteristics of Banking 1.0 to Banking 5.0 is presented in the following table:

Table 1. From Banking 1.0 to Banking 4.0

Stages of bank- ing development	Main characteristics
Banking 1.0: Traditional branch banking (pre-1960s)	Banking 1.0 – The traditional concept of banking prior to the 1980s, characterized by physical bank branches, manual processes, paper-based transaction handling, and a lack of IT infrastructure (or the existence of basic configurations with limited applicability to the banking sector). This period was defined by personal visits to bank branches and the standardization of banking products, with little focus on customer experience. During this first phase, the use of mainframe computers began, which were large, powerful machines typically employed for complex calculations and data processing tasks, enabling banks to manage their accounting processes and transactions.
Banking 2.0: The beginnings of digital banking (1960s - 1980s)	According to the vision of Deloitte, the next phase begins with the transition to active use of computers in the operations of financial institutions, enabling the processing of large volumes of data. The first initiatives for customer self-service, through so-called ATMs (Automated Teller Machines), are introduced, allowing customers to perform routine banking transactions (such as cash withdrawals) without visiting bank branches. During this period, initial steps are taken towards the implementation of other forms of remote banking services. Payment cards and e-commerce are also developing. Customers are granted greater freedom for self-service, while banks are relieved from tasks that do not require intensive consulting involvement.
Banking 3.0: Advanced digital banking (1990s - 2010s)	The third period is highly expansive in terms of innovations – from the development of internet banking and the first interactive platforms to the emergence of mobile banking and electronic payments through NFC technologies. The advent of open banking and API integrations enables banks not only to innovate and partner with fintech companies but also to transform their business models, adapting them to contemporary requirements while maintaining their competitiveness. During the Banking 3.0 period, the development of blockchain technologies and the creation of the first cryptocurrencies also begin. In the later years of this period, banks start applying artificial intelligence and big data analysis for internal analysis (products, customers, segments), as well as for comprehensive financial analysis and forecasting of future activities (including scenario planning). This period lays the foundation for innovations that now drive not only the banking sector but also many other industries.
Banking 4.0: Open Banking and FinTech integration (2010s - present)	The fourth stage in the development of banking coincides with the present era. For clients, banks are accessible everywhere. They can communicate with their bank and banker from any part of the world, receiving advice from chatbots and robo-advisors as well as from human representatives, without the need for physical presence in an office. The active enhancement of open banking and its associated processes continues, as well as the adaptation of blockchain technologies into increasingly broader areas of the financial sector. Furthermore, partnerships are being developed not only with financial institutions but also with non-financial partners, such as large IT corporations, merchants, and other industrial players. A key element of the transformation of the banking sector during this period is the integration of artificial intelligence (AI) into the core business processes of banks, as well as into supporting and subsequent processes, aimed at analyzing their activities.

Source: Adapted by the author from King, 2018; Gomber, Kauffman, Parker, Weber, 2018; Netcetera (Netcetera, 2025); (Deloitte, 2019).

A detailed presentation of the integration of technologies (including up to Banking 4.0) and its impact on the banking sector is provided by Deloitte (Deloitte, 2019). They highlight the connection between pure technology and the support it provides to banks in specific areas, as well as the transformation of business models and the most significant product innovations during this period and up to the present day.

The emergence of semiconductor microprocessors led to the replacement of physical recording with digital data, which in turn allowed the creation of credit cards as a banking product. The subsequent introduction of mainframe computers into banking operations enabled batch overnight processing, and thus the development of messaging services, such as SWIFT. The years from the 1980s to the end of the last century gave rise to ATMs, remote banking, and the Internet, which facilitated the global exchange of data and created opportunities for a series of international businesses. At the turn of the 21st century, smart devices created a new medium for interacting with clients and collecting data, while mobile technologies spearheaded the development of frictionless payments.

In recent years, digital innovations with no prior equivalent have emerged: biometrics, machine learning, cognitive computing, quantum computing, distributed ledger technology, cloud computing, robotics, and more. These technologies have opened even wider doors for artificial intelligence in banking.

2. Areas of application of AI in banking

Today, having evolved from the foundations of Banking 1.0, the sector is firmly situated in the era of Banking 4.0, steadily progressing toward a future shaped by advanced digital integration. Alongside this, artificial intelligence is making increasingly strong inroads, reshaping the landscape of the industry. The vision for early Banking 5.0 is even more futuristic. Artificial intelligence begins to play a significant role in decision-making, enabling personalized offerings of products and services. At the same time, the Internet of Things (IoT) displaces human intervention in routine operations, without disrupting the interaction between humans and machines. This, in turn, raises questions: Where are the boundaries of machines? Will humans and their inherent "inefficiency" take a back seat to algorithmization and automation? In a statement from 2024, visionary Brett King points out that by 2040, even giants like JP Morgan, which currently employ over 200,000 people, will operate with teams of only 2,000-3,000 people who will manage algorithms and automated platforms providing financial services (King, 2025).

It is a fact that AI is fundamentally transforming the financial sector, going beyond traditional notions of banking. In addition to supporting traditional activities such as fraud detection, 24/7 customer service via chatbots, and creditworthiness evaluation, AI plays a key role in the functioning of robo-advisors and algorithmic trading, which is especially significant in investment banking. According to Chlouverakis (Chlouverakis, K, 2024), major banks are making significant investments in artificial intelligence to promote innovation, talent development in AI, and operational transparency. Their

investment strategies cover a wide range of applications, including the enhancement of fraud detection mechanisms and 24/7 customer service chatbots, thereby reducing call center costs and response times (Chowhan; Marwah, 2024). AI also supports Reg-Tech solutions, helping banks meet regulatory requirements without sacrificing efficiency and performance, including automated report generation, suspicious transaction detection, and improving AML/KYC processes.

A broad overview of the applications of artificial intelligence in the banking sector is provided by Evident AI in collaboration with DeepSee in their 2023 report "Towards a Benchmark for AI Outcomes in Banking" (Evident AI, 2023). The platform Evident note that these areas are expanding over time and currently group them into the following categories: "Credit scoring, Customer acquisition, Customer experience, Customer retention, Trading, Process Automation and Knowledge Management, Risk Management, Agent-based modelling, Stress Testing, Fraud Detection, Synthetic Data, Regulatory Compliance, Data Architecture, Data Capabilities."

But this study is not alone. In its overview "State of AI in Financial Services" (NVIDIA, 2024) NVIDIA identifies the main application areas (excluding institutions from China) as: Portfolio Optimization, Fraud Detection, Risk Management, Generative AI for Content Creation and Analytics, and Enhancing Customer Service through Chatbots and Virtual Assistants. The report also reveals that "Positive perception of AI's impact continues from last year, with more than 80 percent of respondents reporting that AI is increasing revenue and decreasing annual costs" (NVIDIA, 2024, p.3).

The increased interest in AI has also led to the creation of the independent Evident AI Index (Evident AI, 2024), which measures the degree of AI adoption and application among the 50 largest banks and banking groups globally. The index is based on over 100 quantitative indicators and assesses banks in four key areas: talent, innovation, leadership, and transparency.

What do the data show for first 10 banks?

The top 15 of the ranking mainly consists of American banks. The two largest banks by assets in the world — JP Morgan Chase and Bank of America — rank 1st and 15th, respectively. The largest European banks by asset size are positioned as follows: HSBC — 8th place (up 6 positions); BNP Paribas — 12th; Crédit Agricole Group — 32nd (down 5); Banco Santander — 28th (down 7); Barclays — 25th (down 3); Société Générale — 21st (down 1); UBS — 7th (down 1); Groupe BPCE — 40th (up 6); Deutsche Bank — 26th (up 3) (Evident AI, 2024).

The most significant progress in the ranking is reported by BBVA, which is 16th in Europe by assets and ranks 13th in the 2024 Evident AI Index, showing an improvement of 13 positions compared to 2023.

Examples of AI applications and their areas of implementation are clearly visible to large financial conglomerates that can afford "investments in the AI-future". Bank No.1 in the

Evident AI Index - JP Morgan Chase, has developed a comprehensive strategy for integrating artificial intelligence into its operations (Digital Fund, 2025). The bank is also investing in AI talent, seeing the potential of AI to improve financial services, enhance customer experience, and optimize operational efficiency. The bank believes that AI enables tools offering investment advice and tailored solutions, leading to better decision-making. AI also supports operational efficiency—automating routine tasks, reducing errors (in non-automated service), and optimizing processes. For example, the lending process with AI involvement requires much less human intervention, fully justifying the initial investment. The stages are automated, fast, error-free, and feedback is provided immediately.

The second largest bank in the U.S. – Bank of America, ranks only 15th in the Evident AI index, but is among the leading institutions in terms of AI talent, holding fourth place in the number of AI specialists hired, following JPMorgan Chase, Wells Fargo, and Citigroup. The Evident AI Index report shows that the bank has climbed 15 positions in the transparency of its responsible AI activities over the past year but has dropped 11 positions in the leadership category related to public communications and strategy. But thanks to artificial intelligence and a nearly 20% increase in returns from its operations, the bank plans to allocate one-third of its 2025 annual budget—\$4 billion—to the development of AI and new technologies (Mathews, 2024). The leadership’s evaluation of the implementation and adaptation of AI is highly optimistic, showing significant improvements in both employee operational efficiency (transforming the nature of their work) and the achievement of overall operational excellence.

A key part of its efforts, in addition to the well-known Erica platform launched in 2018, is the introduction of PRIAM—an artificial intelligence-based system focused on capital markets. It enables the bank to predict the most suitable match between investors and deals with over 80% accuracy. The system saves hundreds of hours of analyst work and earned the bank the FutureEdge 50 Award for its innovative use of emerging technologies (Mathews, 2024).

In its 2024 analysis, the EBA (European Banking Authority) presents the following data on the use of AI (and other advanced technologies) by banks.

Table 2. Proportion of EU banks using different technologies

Year	2020	2021	2022	2023	2024
AI	60	71	83	73	86
GPAI				25	41
Cloud / Edge computing	73	71	85	80	88
Digital / Mobile Wallets	77	75	77	72	61
DLT	32	32	32	22	28
Smart Contracts	20	15	17	9	15

Other tokenisation				8	5
Big Data Analytics	70	71	75	76	82
Biometrics	62	75	77	77	75
Quantum computing			3	2	1

Source: (EBA, 2024).

The categories in which European banks are using AI by the fall of 2024 are (in %): Regulatory or supervisory reporting (17,65%), Regulatory credit risk modelling (42,35%), CWA/Credit scoring(54,12%), Optimisation of internal processes (60,00%), Customer support, including chatbots (65,88%), AML/CFT (65,88%), Fraud detection (69,41%) and Profiling/clustering of clients or transactions (71,76%) (EBA, fall 2024).

According to NVIDIA (NVIDIA, 2024:4), when asked “How has AI improved your business operations?”, respondents cited the following key benefits: created operational efficiencies; created competitive advantage (42%), improved customer experience (27%), yielded more accurate models (27%), opened new business opportunities (23%), reduced the total cost of ownership 14%.

In a study by Marous (Marous, 2024:26) among 200 banking CEOs, when asked ‘Where the greatest benefits of applying artificial intelligence would lie over the next 3 to 5 years,’ the summarized results indicate a clear grouping of the expected advantages. The first group, related to customer service and communication, includes applications such as chatbots and virtual assistants (87%), personalized marketing and product recommendations (83%), and customer retention and churn prevention (52%). The second group covers productivity and automation, with improving back-office efficiency (74%) and document processing enhancement (48%) leading to increased operational effectiveness and reduced costs. The third group pertains to risk management and security, encompassing fraud detection (65%), credit scoring (62%), and regulatory compliance (58%).

Almost all major reports point to the same advantages, based on the accumulated experience or the expectations of CEOs, CIOs, CTOs, and AI experts in banks. However, what changes does this bring to performance indicators, and does AI, in addition to traditional ones, introduce new ones that can be added to KPI systems for the purpose of analyzing banking activity?

3. Expanding banking performance metrics: a framework to assess AI and its impact

The years following the global financial and economic crisis significantly transformed the banking landscape. On one hand, the tightening of regulatory requirements under Basel III revised several key prudential indicators. On the other hand, digitalization has fundamentally reshaped the banking sector. From the era of ATMs, through electronic and mobile banking, to today’s blockchain technologies, robo-advisors, chatbots, big data, and the transition towards Industry 4.0 and Industry 5.0, banks have been navigating a path of

continuous transformation in pursuit of greater efficiency and sustained competitiveness—including in response to the growing presence of non-bank financial institutions.

Without claiming to be exhaustive, the variety of popular and widely used indicators for assessing bank performance includes the following example groups:

Table 3. Popular indicators for assessing bank performance

Type	Indicators (Ratios)	
1. Prudential, regulatory defined	Capital Adequacy Ratio Leverage Ratio	Net Stable Funding Ratio Liquidity Coverage Ratio
2. Main financial ratio (traditional, not included in the legislative framework)	ROE (Return on Equity) ROA (Return on Assets) ROI (Return on Investments) NPL (Non-Performing Loans)	LDR (Loan-to-Deposit Ratio) Cost-to-Income Ratio Net Interest Margin (NIM)
3. Competition-related indicators	Market concentration (CR3, CR5) Lerner Index (for both individual banks and the sector)	Herfindahl-Hirschman Index (HHI) Market share Brand value
4. Stock market–based Indicators	Market Capitalization Earnings per share (EPS) P/S (Price-to-Sales Ratio) P/E (Price-to-Earnings Ratio)	Market contractions (duration, magnitude, frequency) Beta ratio, Price Change Dividend Yield
5. Sustainable and Responsible Corporate Behavior Indicators	Environmental indicators Social indicators	Governance indicators
Digital transformation-related indicators	Investments in digitalization Cybersecurity Percentage of digital customers	Adoption rate of mobile banking API integration levels.

Source: (EBA, 2024).

Why are traditional (including prudential) indicators no longer sufficient for assessing banking performance?

No matter how centralized and cumbersome financial institutions may be, the years following the 2008 crisis have clearly shown that transformation within them does occur: starting with changes in business models and a return to the roots of traditional banking, through the expansion of digital banking, and today, the growing and tangible presence of artificial intelligence in service delivery, customer interaction, and the analysis of banking activities. The drastic regulatory overhaul introduced with Basel III has been accompanied by fluctuating economic conditions, force majeure events (such as COVID-19 and wars), technological innovations, demographic shifts (including population decline and generational differences), regional (geographic) specifics, and

more. All of these factors have pressured stakeholders to adapt, evolve, and strive for greater success.

Driven by change, banks today are increasingly asking themselves whether a "universal remedy" for optimal functioning exists. Often, the answer is sought in the now popular artificial intelligence and the technologies associated with it. However, history repeatedly demonstrates — and at times penalizes — excessive optimism, which can lead to greater risk-taking at the expense of tradition. So, can traditional performance indicators be complemented in the context of AI?

The Institute of Corporate Finance proposes classifying the metrics for assessing the relationship between AI and banking activity into the following categories: efficiency, effectiveness, business impact, fairness, and compliance.

Table 4. KPIS AI-Based Indicators for Banking Performance Evaluation –
vision of Corporate Finance Institute

Efficiency	Focused - on measuring the effects of process automation: Reduction in manual processing time, Increase in automated transactions, Lower error rates.
Effectiveness	Focused - on evaluating the accuracy and reliability of AI: <i>Prediction and classification accuracy; Reduction in false positives and false negatives; Improvement in risk assessment metrics.</i>
Business impact	Focused on: measure the specific contribution of AI to performance improvements: <i>Increase in revenue or cost savings; Customer satisfaction and retention rates.</i>
Fairness and compliance	Focused on: evaluating the responsible use of AI: <i>Reduction in biased outcomes, Model transparency and explainability, Compliance with financial regulations.</i>

In general terms, these indicators are focused on evaluating the automation of processes, the accuracy and reliability of AI performance, the contribution of AI to final (traditional financial) performance outcomes, and the elimination of bias — while promoting transparency and ensuring regulatory compliance.

Is it possible to further expand the spectrum proposed by the Institute of Corporate Finance? Of course. Indicators related to the evaluation of the operation and implementation of AI in banking institutions can be created for each activity, person, process, segment, etc. In the vast systems of KPIs used in the creation of Balanced Scorecards, these indicators can be specified even for individual clients. An important aspect of this is determining the contribution margins from clients and assessing whether "the client is worth" the investments made.

This shows an "unlimited" field for authorship by institutions and analysts, who can uncover the various facets of the banking world.

Conclusion

This study presents the transition of banks from Banking 1.0 to the threshold of Banking 5.0, a stage in which the interaction between humans and machines should be fully realized. Is this possible? The projects show that yes. The enthusiasm of bankers to utilize the capacity of artificial intelligence continues to expand and build upon its areas of application, while programmers keep developing the algorithms themselves to bring them closer to the level of Generative AI.

The data and examples indicate that the scope of AI in banking continues to grow. While chatbots and robo-advisors were once considered the leading application of AI, today it builds customer and market profiles, takes on the role of an analyst (predicting, running scenarios), makes decisions for trading financial instruments, and prevents fraud by monitoring each transaction in real-time.

The lack of human involvement in some processes helps uncover "bottlenecks" that humans, influenced by emotions and variable behavior, often cover up. In this context, AI, which (for now) acts impartially, proves to be an extremely valuable assistant in analysis and decision-making.

The world is advancing, and with it, the evaluation of business. If we want the banking sector to continue progressing and to be sure of the real value of what is happening, performance evaluation must be comprehensive, up-to-date, and transparent, including the involvement of AI in the operations of institutions.

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