INNOVATIONS IN DIGITAL BANKING SERVICES

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Abstract

The development of information and communication technologies in recent decades has significantly transformed the way the banking sector operates. Modern banks are facing increasing customer demands for fast, accessible, and secure services, which creates a need for the continuous introduction of digital innovations. Digital banking represents one of the key segments of this transformation, enabling more efficient management of financial services and an improved user experience.The subject of research in this paper is innovations in digital banking services, with special emphasis on their implementation in the banking sector of the Republic of North Macedonia. Faced with competition from global FinTech companies and changing user habits, domestic banks are forced to invest in new technological solutions – from mobile applications and electronic banking to the implementation of artificial intelligence and Blockchain technologies.

The main objective of this paper is to conduct a comparative analysis of the digital solutions offered by the leading commercial banks in the country and to examine their functionality, security, and acceptance by users.

Keywords: Digital banking, Financial technologies, Innovations

1. Introduction

Digital transformation in the banking sector can no longer be viewed merely as the migration of existing services from branch counters to electronic channels. It represents a fundamental change in how banks organize processes, communicate with customers, manage data, and create new value. Skinner (2014) argues that a digital bank must redesign its services around the capabilities of the

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mobile Internet, while Chishti and Barberis (2016) emphasize the role of the FinTech ecosystem in accelerating innovation.

In the Republic of North Macedonia, digital banking is developing amid rising customer expectations, regulatory changes, and growing competition from FinTech companies. The National Bank of the Republic of North Macedonia (NBRNM) emphasizes the need for secure, innovative, and efficient payment systems, while the Law on Payment Services and Payment Systems provides a basis for the further development of payment services (NBRNM, 2024; NBRNM, 2025).

The paper examines innovations in digital banking services, focusing on mobile and Internet banking, digital identity, digital wallets, instant payments, automation, artificial intelligence (AI), Big Data, Blockchain, and Open Banking. Its objective is to assess the extent to which the domestic banking sector is moving beyond the digitization of existing services toward broader digital transformation.

The research combines an analysis of official banking and regulatory sources, a comparative analysis of five banks, and a descriptive analysis of the results of a questionnaire administered to 100 respondents.

2. Theoretical Aspects of Digital Banking

Electronic banking has traditionally been associated with the delivery of banking services through electronic channels, whereas digital banking encompasses a broader transformation of processes, data, and customer experience. Laudon and Traver (2021) associate e-banking with electronic channels, while Skinner (2014) views the digital bank as an organization that redesigns the customer relationship through technology.

The evolution of banking can be analytically represented through Bank 1.0 as traditional banking, Bank 2.0 as the era of self-service channels and ATMs, Bank 3.0 as mobile banking, and Bank 4.0 as contextual and integrated banking. The final stage is not a formal regulatory standard, but rather a framework for understanding the transition toward services that are automated and embedded in broader digital ecosystems.

The benefits include 24/7 availability, faster execution, automation, lower operating costs, and opportunities for personalization. The risks include cyberattacks, fraud, identity theft, IT system disruptions, and dependence on third-party providers. The ECB (2025) emphasizes that digital business models foster efficiency and competition, but also create new operational and financial-stability risks.

FinTech is reshaping the financial ecosystem through specialized services, faster experimentation, and new business models (Chishti & Barberis, 2016). Competition is therefore shifting away from price alone toward customer experience, speed, digital onboarding, personalization, and service integration.

3. Technological Foundations and Key Innovations

The Core Banking System (CBS) remains the central component of banking infrastructure. Application and integration layers are built on top of it, enabling mobile and web channels to communicate with core banking functions. Service-oriented architecture (SOA), API gateways, and microservices support modularity and integration, while cloud technologies provide scalability. In the financial sector, these benefits must be balanced against third-party risk management and operational resilience requirements (BCBS, 2024).

Mobile banking is becoming the primary customer touchpoint. Modern applications provide account access, payments, transfers, card management, notifications, loan applications, and digital account opening. Digital wallets additionally rely on tokenization and biometric authentication.

Artificial intelligence can be applied to fraud detection, credit scoring, customer analytics, chatbots, and document processing. The ECB (2026) reports that almost 90% of significant banks in the euro area use AI, with particularly widespread application in fraud and cybercrime detection, marketing, chatbots, and credit scoring.

Big Data enables segmentation, forecasting, and personalized offers, but requires privacy protection and transparency. Blockchain can support distributed ledgers and smart contracts, although its application depends on regulatory and economic feasibility (Tapscott & Tapscott, 2016). Open Banking enables data sharing and service initiation through APIs with customer consent, and the European PSD2 framework represents an important example of this development (European Commission, 2015).

Cybersecurity is a prerequisite for every digital innovation. TLS, encryption, multi-factor authentication (MFA), biometrics, tokenization, monitoring, and fraud-detection systems form part of a multilayered security architecture. The ECB (2026) notes that artificial intelligence can help banks detect and prevent cyber threats more rapidly, while at the same time it can be misused by attackers to carry out more sophisticated attacks. Banks must therefore continuously strengthen both their cybersecurity and their ability to maintain critical operations during technological or cyber incidents.

4. Comparative Analysis of Digital Innovations in Commercial Banks in the Republic of North Macedonia

The analysis includes Komercijalna Banka, NLB Banka, and Stopanska Banka as large and systemically relevant institutions, while ProCredit Bank and Halkbank are included to capture different models of digitalization. In addition, each selected bank represents a distinct digitalization profile, thereby broadening the analytical scope.

Table 1. List of Banks

Bank	Rationale for selection	Focus
Komercijalna Banka	Systemically relevant; digital identity	OneID, mBanka, digital wallets
NLB Banka	Systemically relevant; strong mobile ecosystem	NLB Pay, onboarding, Apple/Google Pay
Stopanska Banka	Systemically relevant; P2P innovation	TOPSI Pay, m-banking
ProCredit Bank	Distinct self-service model	24/7 zones, OneID, assistant
Halkbank	E-commerce and business digitalization	vPOS/e-commerce and digital channels

Komercijalna Banka stands out for OneID, mBanka, mToken, and digital wallets. The bank enables fully online activation of payment accounts and services through digital identification and electronic signatures (Komercijalna Banka, 2026). This case is particularly relevant for analyzing digital identity and onboarding.

NLB Banka has a broad mobile ecosystem comprising mKlik, NLB Pay, Apple Pay, Google Pay, and Garmin Pay. NLB Pay enables mobile payments and cash withdrawals using a digitized card, while tokenization reduces the need to transmit the actual card number (NLB Banka, 2026). NLB also offers online payment-account opening and digital loan applications.

Stopanska Banka is particularly relevant because of TOPSI Pay, which enables instant peer-to-peer (P2P) transfers through a contact list without entering the recipient's account number. The service operates 24/7, while m-banking also includes payments, notifications, product information, and applications for credit products (Stopanska Banka, 2026).

ProCredit Bank represents a different model, with 24/7 zones, digital account opening through OneID, and a digital banking assistant. Its 2024 Annual Report confirms that the bank operates 12 locations comprising branches, service points, and 24/7 zones, and that it continues to develop fully digital services (ProCredit Bank, 2024).

Halkbank is included to capture e-commerce and business digitalization, ensuring that the comparative sample is not limited to retail mobile banking. Including a

bank with this profile is important because banking digital transformation also encompasses merchant infrastructure, API integrations, and digital payments.
Accordingly, the banks should not be ranked using a single one-dimensional score. One bank may be stronger in digital identity, another in mobile wallets, a third in P2P payments, a fourth in self-service banking, and a fifth in e-commerce. The purpose of the analysis is to identify the different approaches to digital transformation adopted by the banks under review.

4.1. Criteria for Comparative Analysis

Following the individual analysis of the banks, a direct comparison (benchmarking) is conducted across technical capabilities, customer experience, security, and innovativeness. Two complementary tools are used for this purpose: a comparison of digital functionalities and ratings, and a digital-functionality matrix. The interpretation does not seek to designate one bank as the absolute leader; rather, it identifies the segments in which each bank holds a relative advantage.

4.2. Comparison of Digital Functionalities and Ratings

Table 2. Comparison of Digital Functionalities and Ratings

Feature	Komercijalna	NLB	Stopanska	ProCredit	Halkbank
Google/Apple Pay	✓	✓	✓	✓	✓
Digital Onboarding (OneID)	✓ (Full)	⚠ (Partial)	✗	✓ (Full)	✗
P2P (via contacts)	✗	✗	✓ (TOPSI)	✗	✗
Smart ATMs (recycling)	✓	✓	✓	✓ (Leader)	⚠
E-commerce (vPOS)	⚠	⚠	⚠	✗	✓ (Leader)
Average store rating	4.6 ★	4.7 ★	4.5 ★	3.8 ★	4.2 ★
Authentication	mToken / FaceID	Soft-Token	PIN / Bio	USB PKI	SMS / Bio

Note: ✓ = fully implemented; ⚠ = partially implemented/limited; ✗ = unavailable. The ratings are taken from the analyzed material and refer to the status reported therein.

4.3. Digital Functionality Matrix (Status: 2026)

The digital maturity matrix presents the presence or absence of functionalities treated in the analyzed material as relevant to contemporary digital banking. This approach enables a concise comparison of the banks' different strategic orientations.

Table 3. Digital Functionality Matrix (Status: 2026)

Feature	Komercijalna	NLB	Stopanska	ProCredit	Halkbank
Digital Onboarding (OneID)	✓ (Full)	⚠ (Partial)	✗	✓ (Full)	✗
NFC Wallet (Google/Apple Pay)	✓	✓	✓	✓	✓
P2P payments (phone contacts)	✗	✗	✓ (TOPSI)	✗	✗
Cardless cash withdrawal	✗	✓ (m-Cash)	✓ (m-Cash)	✗	✗
Hardware security (token)	✓	✗	✗	✓	✗
AI/chatbot support	✗	✓ (Viber Bot)	✗	✗	✗
24/7 zones (recycling ATMs)	✓	✓	✓	✓ (Leader)	⚠

Legend: ✓ – fully implemented; ⚠ – partially implemented/under development; ✗ – unavailable.

4.4. Comparative Overview: Customer Experience and Security

In terms of customer experience, the analyzed material highlights NLB Banka and Stopanska Banka as institutions with modern mobile applications and straightforward navigation. Komercijalna Banka offers a broad range of functionalities, although its interface, particularly the web version, is more

complex. ProCredit Bank adopts a functional, minimalist approach with a strong emphasis on self-service.

In terms of security, Komercijalna Banka and ProCredit Bank stand out for their use of hardware tokens and PKI solutions, while NLB and Stopanska Banka apply a more balanced approach based on soft tokens and biometrics. These different approaches illustrate the typical trade-off between stronger control and ease of use.

According to the segmentation in the analyzed material, NLB and Stopanska Banka are particularly relevant for users seeking fast mobile and P2P services; Komercijalna and ProCredit are more suitable for business users and customers who prioritize functionality and security; while Halkbank stands out in the e-commerce segment. The results should therefore be interpreted as profiles of digital specialization rather than as a single overall ranking.

5. Empirical Research on Digital Banking Services in the Republic of North Macedonia

5.1. Research Methodology

The empirical research aims to examine the actual use, perceptions, and satisfaction of users of digital banking services in the Republic of North Macedonia. The study is quantitative and was conducted using a structured questionnaire administered to 100 users of digital banking services. The questionnaire covers demographic characteristics, use of digital services, level of satisfaction, perceptions of innovativeness, and technologies perceived as lacking.

5.2. Research Questions and Hypotheses

1. Which digital innovations and technologies are most prevalent among commercial banks in the Republic of North Macedonia?
2. To what extent does the use of digital banking services contribute to improving the efficiency and quality of banking services?
3. What is the impact of digital innovations on user experience and customer satisfaction in commercial banks?
4. What are the main challenges and constraints faced by banks when implementing advanced digital solutions?
5. Which digital technologies and innovations are lacking in the Macedonian banking sector compared with global trends in digital banking?

Based on the research questions and the theoretical framework, the following research hypotheses were formulated. Their descriptive assessment is conducted using the questionnaire results and the comparative analysis.

Research Hypotheses

• H1: Greater use of digital banking services is associated with a higher level of user satisfaction.

• H2: Mobile banking is the most important digital channel for customers' day-to-day interaction with banks.
• H3: Users perceive a high level of digitalization, but consider AI and personalized recommendations to remain insufficiently represented.

5.3. Demographic Structure and Results

Of the respondents, 48% are aged 18–25, 32% are aged 26–35, 15% are aged 36–45, and 5% are over 46 years of age. By gender, 54% are male and 46% female.
Ninety-two percent use digital banking, while 8% do not. The most frequently used services are mobile banking (85%), Internet banking (72%), digital payments (68%), and online loans (21%).
Regarding satisfaction, 34% are very satisfied, 41% satisfied, 19% partially satisfied, and 6% dissatisfied. Thus, 75% provide a positive assessment of the services.
Regarding innovativeness, 22% consider the services highly innovative, 49% partially innovative, and 29% insufficiently innovative. The most frequently identified missing technology is an AI assistant (52%), followed by personalized recommendations (44%), Open Banking (29%), and advanced security (25%).

Table 4. Questionnaire Results (N=100)

Questionnaire	Result
Use of digital banking	Yes 92%; No 8%
Most frequently used services	Mobile 85%; Internet 72%; Digital payments 68%; Online loans 21%
Satisfaction	Very satisfied 34%; Satisfied 41%; Partially satisfied 19%; Dissatisfied 6%
Perception of innovativeness	Highly innovative 22%; Partially innovative 49%; Insufficiently innovative 29%
Technologies perceived as lacking	AI 52%; Personalization 44%; Open Banking 29%; Advanced security 25%

Table 5. Descriptive Assessment of the Hypotheses

Hypothesis	Finding	Assessment
H1	75% are satisfied or very satisfied	Consistent, but not statistically tested
H2	Mobile banking 85%	Descriptively supported

H3	71% rate the services as highly/partially innovative; AI 52%; personalization 44%	Descriptively supported

5.4. Analysis and Descriptive Assessment of the Research Hypotheses

H1 concerns the association between the use of digital banking services and user satisfaction. In the sample, 92% of respondents use digital banking, while 75% are satisfied or very satisfied. These indicators are consistent with the hypothesized positive relationship; however, because no test of association between usage and satisfaction was conducted using the available aggregate data, H1 is assessed as descriptively consistent rather than statistically confirmed.

H2 proposes that mobile banking is the most important digital channel for customers' day-to-day interaction with banks. The results show that mobile banking is used by 85% of respondents, ahead of Internet banking (72%), digital payments (68%), and online loans (21%). H2 is therefore descriptively supported by the questionnaire results.

H3 proposes that users perceive a relatively high level of digitalization while simultaneously considering AI and personalized recommendations to be insufficiently represented. The results show that 22% of respondents rate the services as highly innovative and 49% as partially innovative, meaning that 71% recognize at least some degree of innovativeness. At the same time, 52% identify an AI assistant as a missing technology, while 44% identify personalized recommendations. H3 is therefore descriptively supported. This finding is also relevant in the broader European context: the ECB (2026) reports that almost 90% of significant banks in the euro area already use AI, particularly for fraud and cybercrime detection, marketing, chatbots, and credit scoring. This suggests that AI is moving from an experimental technology toward widespread banking adoption, and respondents' expectations for greater use of AI and personalization are consistent with contemporary trends (ECB, 2026).

6. Discussion

The principal finding is that the domestic banking sector is relatively mature in terms of basic digitalization, while users increasingly expect a next generation of personalized digital services. Mobile banking is the dominant channel, consistent with the development of mobile ecosystems across all analyzed banks.

The differences among the banks lie not only in the number of services offered, but also in their strategic orientation. Komercijalna Banka emphasizes digital identity and a broad service portfolio; NLB focuses on mobile experience and digital wallets; Stopanska Banka on P2P payments; ProCredit on self-service and a 24/7 model; and Halkbank on e-commerce. This argues against simply designating a single bank as the "most digital."

In the international context, AI, personalization, API integration, and the automation of complex processes offer the greatest potential. The ECB (2026) shows that AI is already widely used by significant European banks, particularly for fraud detection, marketing, chatbots, and credit scoring. Domestic banks can use these trends as benchmarks, but implementation must be adapted to the domestic regulatory framework, infrastructure, and market size. The questionnaire finding that 52% identify an AI assistant and 44% personalized recommendations as insufficiently represented directly supports H3 and indicates a gap between basic digitalization and the next stage of intelligent, personalized services.

Security remains a prerequisite for trust. New services should be designed according to security-by-design principles, incorporating strong authentication, monitoring, and recovery plans. Digital transformation without operational resilience creates new risks rather than sustainable competitive advantage. The finding that 25% of respondents identify advanced security as a need indicates the importance users attach to this area. Recent empirical research shows that perceived security and digital literacy influence the intention to use digital banking (Kovačević et al., 2025), while the ECB (2026) emphasizes the importance of security and operational resilience in digital services.

7. Recommendations for Improvement

First, a secure Open Banking ecosystem should be developed gradually through standardized APIs, customer consent, and strong authentication. Second, AI assistants with human oversight should be developed, particularly for navigation and customer support. Third, Big Data and machine learning should be used to provide personalized financial recommendations under clear privacy and transparency rules.

Fourth, digital onboarding should be as comprehensive as possible, incorporating digital identification, electronic signatures, and automated checks. Fifth, cybersecurity should be integrated into the design of every new service. Sixth, banks should invest in digital and financial literacy through clear guidance, phishing warnings, and educational content.

It is advisable to establish a framework for measuring digital maturity across several dimensions: service availability, automation, channel integration, security, and personalization. Such a framework would enable more systematic comparison.

A useful direction for future research would be to develop a digital maturity index and compare domestic banks with banks in the Western Balkans and the European Union, particularly in the areas of Open Banking, AI, digital identity, and operational resilience.

8. Conclusion

Digital transformation is one of the most significant drivers of the contemporary banking sector. The analysis shows that banks in the Republic of North Macedonia have developed a substantial range of digital services, particularly in mobile and Internet banking, digital payments, digital identity, and self-service channels.

The selection of the five banks is justified by their institutional relevance and differing technological strategies. The questionnaire results show that 92% of respondents use digital banking, mobile banking is the most widely used channel at 85%, and 75% are satisfied or very satisfied. At the same time, 52% identify an AI assistant and 44% personalized recommendations as technologies that are currently lacking.

The main challenge for the next phase is not merely the introduction of new functionalities, but their integration into a secure, simple, and personalized customer experience. Priorities should include secure Open Banking, AI with human oversight, personalization, digital onboarding, and the continuous strengthening of cyber resilience.

In conclusion, the Macedonian banking sector has a solid foundation for further transition toward a more advanced digital banking model. The key challenge is to translate technology into measurable customer value while preserving trust, privacy, and the stability of the banking system.

8. References

Basel Committee on Banking Supervision (BCBS). (2024). Digitalisation of finance. Bank for International Settlements.

Chishti, S., & Barberis, J. (Eds.). (2016). The FINTECH Book: The Financial Technology Handbook for Investors, Entrepreneurs and Visionaries. John Wiley & Sons.

European Commission. (2015). Directive (EU) 2015/2366 on payment services in the internal market (PSD2). Official Journal of the European Union.

European Central Bank (ECB). (2025). Digital banking: how new bank business models are disrupting traditional banks. Financial Stability Review.

European Central Bank (ECB). (2026). AI and the euro area economy. European Central Bank.

European Central Bank (ECB). (2026). Strengthening operational resilience for the age of AI. European Central Bank.

Laudon, K. C., & Traver, C. G. (2021). E-commerce: Business, Technology, Society. Pearson.

Marr, B. (2020). Artificial Intelligence in Practice. Wiley.

Mishkin, F. S. (2019). The Economics of Money, Banking, and Financial Markets (12th ed.). Pearson.

Skinner, C. (2014). Digital Bank: Strategies to Launch or Become a Digital Bank. Marshall Cavendish International.

Tapscott, D., & Tapscott, A. (2016). Blockchain Revolution. Penguin Portfolio.

Turban, E., Outland, J., King, D., Lee, J. K., Liang, T.-P., & Turban, D. C. (2018). Electronic Commerce 2018. Springer.

World Bank. (2024). North Macedonia Gender Landscape: A closer look at digital and financial inclusion in North Macedonia. World Bank.

Kovačević, M., et al. (2025). Understanding Consumer Behavior in Digital Banking: The DABU Model as an Extension of TAM and UTAUT. Journal of Risk and Financial Management, 18(9), 507. https://doi.org/10.3390/jrfm18090507

Komercijalna Banka AD Skopje. (2026). Digital services, OneID electronic identification, and service activation. Official website. Accessed August 2026.

NLB Banka AD Skopje. (2026). Digital services, NLB Pay, and online payment-account opening. Official website. Accessed August 2026.

National Bank of the Republic of North Macedonia. (2024). Annual Report 2024.

National Bank of the Republic of North Macedonia. (2024). List of identified systemically important banks.

National Bank of the Republic of North Macedonia. (2025). Law on Payment Services and Payment Systems.

ProCredit Bank AD Skopje. (2024). Annual Report 2024.

Stopanska Banka AD Skopje. (2026). TOPSI Pay and m-banking – digital banking services. Official website. Accessed August 2026.