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Industry 4.0 and its Impact on the Development of Vietnamese Commercial Banks

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ABSTRACT

The Fourth Industrial Revolution (Industry 4.0), with technological achievements in artificial intelligence, blockchain technology, big data, the Internet of Things, etc., has significantly affected various aspects of the economy, including the banking sector. **The aim** of this article is to evaluate and forecast the transformation of the banking industry globally and in Vietnam. This study employs **methods** of secondary data synthesis and comparative analysis and reviews the research reports of regulatory agencies and consulting organizations. The article **resulted** in identifying the characteristics of Industry 4.0 and its impact on the banking and finance industries. The author highlights the main challenges in applying digital technology in Vietnamese banks and draws the **conclusion** that digital technology in the banking sector in Vietnam is still at a low level, with one of the most critical issues being the lack of a legal framework related to digital finance and electronic transactions.

Keywords: Industry 4.0; digital banking; banking; digital technology; financial industry; commercial bank; Vietnam

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ОРИГИНАЛЬНАЯ СТАТЬЯ

Индустрия 4.0 и ее влияние на развитие коммерческих банков Вьетнама

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АННОТАЦИЯ

Четвертая промышленная революция (Индустрия 4.0) с технологическими достижениями в области искусственного интеллекта, технологии блокчейн, больших данных, интернета вещей и т.д. существенно повлияла на различные аспекты экономики, включая банковский сектор. **Цель** этой статьи — оценить и спрогнозировать трансформацию банковской отрасли во всем мире и во Вьетнаме. В статье использованы **методы** синтеза и сравнительного анализа вторичных данных, а также обзор исследовательских отчетов органов государственного управления и консалтинговых организаций. Результаты исследования позволили определить характеристики Индустрии 4.0 и ее общее влияние на банковскую и финансовую отрасли. В статье освещаются основные проблемы применения цифровых технологий в деятельности вьетнамских банков. Автор делает вывод, что цифровые технологии в банковском секторе Вьетнама все еще находятся на низком уровне, а одной из наиболее острых проблем является отсутствие законодательной базы, связанной с цифровыми финансами и электронными транзакциями.

Ключевые слова: Индустрия 4.0; цифровой банкинг; банковское дело; цифровые технологии; финансовая индустрия; коммерческий банк; Вьетнам

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1. Introduction and literature review

Industry 4.0, accompanied by the emergence of digital currencies, online payment platforms, and fintech service providers, as well as the entry and dominance of multinational companies with large data platforms and technological capabilities such as Google and Amazon, has a direct and profound impact on the banking and financial industries, creating unprecedented competitive pressure on traditional banking service providers. Many countries worldwide and advanced banks have accelerated the adoption of Industry 4.0 applications to develop banking services and build a customer-centric banking service ecosystem.

Several studies focus on various aspects of Industry 4.0, its components, and its impact on the banking system. Citigroup's 2018 [1] research shows that the growth drivers of banking digital transformation include: i) The increasing entry and dominance of financial technology companies (Fintech) and large technology companies (Bigtech) expanding into banking and financial services, such as Google, Amazon, Alibaba; ii) Changing customer needs and the growing demand for higher customer experiences; iii) Increasing compliance requirements, especially after the 2009 US financial crisis; iv) Rising costs of maintaining outdated core banking systems, inflexible designs focused on products rather than customers, prolonged and slow product life cycles; v) Gradual decline in profit margins. This research also revealed that the components of Industry 4.0, such as Big Data, machine learning, deep learning, artificial intelligence (AI), blockchain technology, big data, the Internet of Things (IoT), automation, and blockchain, have a significant impact on banking and financial services, influencing three crucial aspects: customer engagement, operations, and compliance and risk management. Research by Oliver Wyman in 2018 [2] and Baker McKenzie in 2022[1] on the impact of Industry 4.0 on the ecosystem, operational environment, and business models of banks interacting with financial technology companies (Fintech) shows that Fintech tends to collaborate and diversify the bank's ecosystem symbiotically. There are various forms of collaboration between Bigtech and banks to provide customer services. For example, Go-Jek collaborates with banks in Indonesia to provide microfinance for drivers; Amazon provides accounts through J.P. Morgan and Facebook*[2] partners with Western Union for real-time international money transfers with competitive exchange rates and real-time customer support on the Facebook* application.

In Vietnam, Industry 4.0 significantly transformed the nature of banking products and services. Many commercial banks have applied various Industry 4.0 technologies and solutions, such as big data analytics, artificial intelligence, and biometric authentication, to create digital payment services for digital banks, assess customer behavior, predict revenue and market demand, and issue risk warnings. Several studies in Vietnam have focused on Industry 4.0, including big data, digitization, bank's interaction with Fintech companies, and the development of the Fintech ecosystem. The research "Impact of the fourth industrial revolution on the banking industry and the digital banking goal of Vietcombank" by Nghiem Xuan Thanh (2020) [3], the reference book "Vietnam banking with the fourth industrial revolution and approaches" by Pham Xuan Hoe and co-authors [4], having examined the strategic development direction of Industry 4.0 outlined in the governmental guiding documents, stated that the Vietnamese government is determined in its digital transformation efforts. Simultaneously, a survey of the commercial banking system in Vietnam revealed that technological innovation is a central pillar in the development strategy of these banks. Most banks have plans to expand their operations with Fintech, particularly in areas such as payment services, internet banking, data research, personal finance, lending, and remittances.

The study "Digital banking — development orientation in Vietnam" by Pham Tien Dung in 2018 [5] assesses the current situation and digital banking development technologies in Vietnam. According to the survey conducted by the State Bank of Vietnam in April 2018, 94% of banks have started implementing or are

[1] URL: https://www.bakermckenzie.com/-/media/files/insight/publications/2022/02/baker-mckenzie — finding-balance — the-impact-of-new-technology-on-fis.pdf

[2] * Facebook designated as an extremist organization and banned in Russia. Marked with * throughout the text.

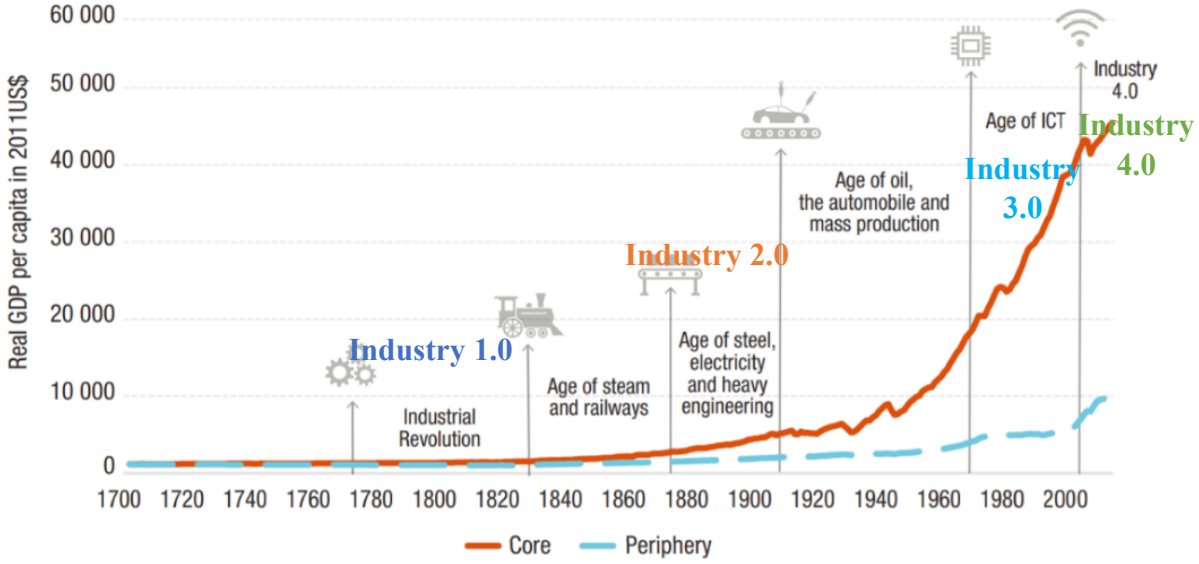

Fig. 1. **Technological changes and income disparity across the stages of Industrial Revolutions**

Source: UNCTAD [6].

researching and building a digital conversion strategy, with 59% of banks starting to implement it in practice. Cloud computing and big data analytics are applied and considered to impact digital transformation strongly. Artificial intelligence and blockchain technologies have great potential, whereas the Internet of Things and robotic automation are not widely applied. Evaluating the current deployment, most Vietnamese banks have implemented digital banking at the process level (improving automated transaction systems) and communication channels (some banks have implemented virtual assistants and 24/7 service advice on social media). Building on the results of research on various aspects, this paper takes a cross-sectional approach to developing banking services based on general technology applications, specifically Industry 4.0 technology.

2. Impacts of Industry 4.0

In the course of global industrial development history, there have been three industrial revolutions, and we are currently in the fourth industrial revolution (*Fig. 1*).

The First Industrial Revolution — Industry 1.0 (1784 — mid-19th century) was a revolution in the manufacturing sector, originating in England and later spreading worldwide with the development of steam engines and railways, replacing the simple, small-scale labor-based economy with an industrial economy and large-scale machinery manufacturing.

The Second Industrial Revolution — Industry 2.0 (1860–1960) was a revolution driven primarily by internal combustion engines and machinery using electricity. Economic and technical advancements were achieved through the development of the telegraph, telephone, railways, and mass production assembly lines.

The Third Industrial Revolution — Industry 3.0 (1969–1997) was a revolution in automated production based on the emergence and development of information technology, electronic devices, and the Internet. This revolution occurred with advancements in electronic infrastructure, computers, and digitization. These technologies were driven by the development of semiconductors, supercomputers, personal computers, and the Internet, along with technological developments in Western Europe, Australia, Canada, New Zealand, the United States, and Japan, which surged ahead to become the world's development centers. At the same time, other countries remained in the peripheral regions. The income gap between areas increased with development trends. Some East Asian countries (South Korea, Taiwan, etc.) later caught up through learning, imitation, and technological innovation [6].

The Fourth Industrial Revolution — Industry 4.0 (starting in the early 2000s) is characterized by integrating technologies from various fields, blurring the physical, digital, and biological boundaries (*Fig. 2*). Compared to previous revolutions, Industry 4.0 has developed

Fig. 2. **Overview of Industry 4.0**

Source: Amir Mehdiabadi et al (2020) [7].

exponentially rather than linearly. Technological breakthroughs occur rapidly, and mutual interaction accelerates the creation of a digitized, automated, and increasingly intelligent world, breaking existing standards in most industries worldwide. The breadth and depth of these changes foreshadow the transformation of the entire production, management, and governance systems.

In previous industrial revolutions, steam power, oil, and electricity were the fuels driving economic development. However, in the era of Industry 4.0, data are believed to become a new fuel source. In Industry 4.0, IoT technology and blockchain are "data drills," pouring into the reservoir of Big Data and refined by AI on cloud computing platforms into helpful information before being transferred to automation and IoT applications.[3] The Fourth Industrial Revolution (Industry 4.0) has profoundly impacted the global economy and the financial banking market.

2.1. For the economy

First, Industry 4.0 fundamentally changes the methods of global economic production and labor organization. While previous industrial revolutions focused on tangible production assets (steam engines, electricity with mass production assembly lines, the internet network), Industry 4.0 is a synthesis of digital, biological, and physical technological revolutions. It introduces unprecedented technological breakthroughs, forming new production and consumption models. Industry 4.0 also enhances specialization in the service sector by creating high-concentration business platforms that bring specific groups together horizontally through interactive models (P2P, the sharing economy with applications like ride-sharing and hotel services).

Global economic growth is calculated based on GDP and production activity indices. However, the latest technological revolution has shifted this dependence on services and technology. According to the World Economic Forum (WEF) [8], investing $1 in digital technology has increased GDP by an additional $20 over the past 30 years, whereas a similar investment in non-digital technology has only increased GDP by another $3 during the same period. WEF forecasts that 24.3% of global GDP will come from digital technologies such as artificial intelligence and cloud computing by 2025, while Market Watch predicts that the emerging

[3] URL: https://www.economist.com/leaders/2017/05/06/the-worlds-most-valuable-resource-is-no-longer-oil-but-data

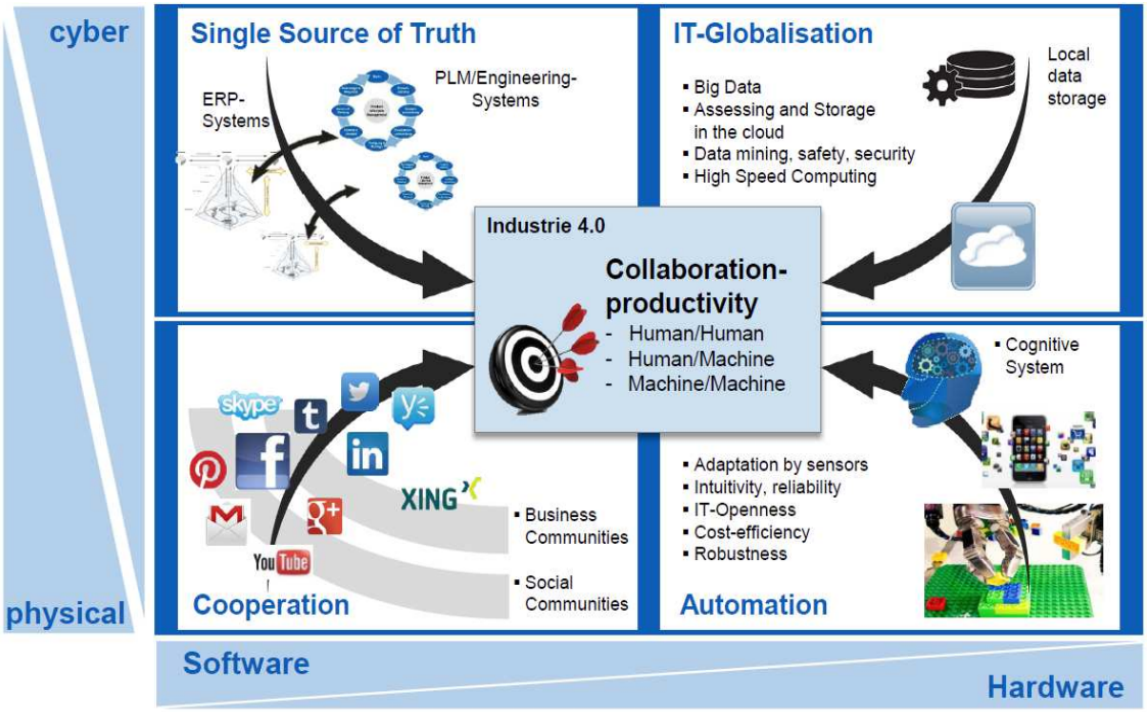

Fig. 3. **Four main preconditions of productivity growth**

Source: Jozef Hercko and Jozef Hnat (2015) [11].

self-driving car industry is expected to grow by USD 319.41 billion, accelerating at a CAGR of 38.45% between 2022 and 2027.[4]

Second, Industry 4.0 impacts global production capabilities' technology and comprehensive factors (*Fig. 3*). Industry 4.0 has the potential to increase international income levels and improve the quality of life for people worldwide. In the current conditions, the relatively high accessibility to digital and advanced technologies such as IoT, AI, cloud computing, big data, etc., has helped increase the daily life efficiency of the global population. Technological innovation in the coming years will provide more opportunities for access to the digital environment, delivering long-term benefits in terms of efficiency and productivity. WEF predicts that new technologies will reduce transportation and communication costs, leading to more efficient global logistics and supply chains. Reducing trade costs opens up new market opportunities, promotes global economic growth. Because it is less limited by marginal productivity and the scarcity of resources, Industry 4.0 is expected to create non-linear growth in global output and employment. McKinsey (2019) [9, 10] estimates that Industry 4.0 has the potential to create value for manufacturers and suppliers of $3.7 trillion by 2025. Though Industry 4.0 is an opportunity for countries to accelerate and rise strongly, it could also be a risk if countries lag behind in their integration into the game.

2.2. For the financial banking sector

Industry 4.0 is predicted to revolutionize operations, from online payments and network-based lending to digital currency and online foreign exchange transactions. Industry 4.0 brings various new opportunities for organizations operating in the financial banking sector:

Industry 4.0 introduces new models and business areas. The new technology eliminates financial intermediaries, facilitating faster and more cost-effective financial transactions and increasing accessibility to financial services 24/7 in real-time. According to Nielsen Research, mobile devices have become a new standard for banking activities, with the Asia-Pacific and African regions being the main drivers of global mobile banking growth. In the U.S., over 70% of stock transactions are algorithmically

[4] URL: https://www.marketwatch.com/press-release/autonomous-vehicles-market-size-is-projected-to-reach-a-growth-value-of-usd-319–41-billion-from-2022–2027-increasing-demand-for-autonomy-of-vehicles-by-oems-to-drive-the-market-growth-technavio-817cc0f0

determined, saving a significant amount on financial advisory services. Importantly, technology provides opportunities for the impoverished and those facing financial difficulties to access financial solutions for the first time. In Bangladesh, technology-supported microloans have opened a new era of empowering financial autonomy for those in challenging circumstances in rural areas.

Industry 4.0 enhances the customer experience. Technology enables companies to improve customer experiences up to tenfold by providing visual, personalized, and highly connected interactions. With big data, companies can access in-depth information about customer habits, preferences, and needs. AI helps companies easily adjust customer experiences, reach customers at crucial touchpoints, and modify products and services, accordingly, thus increasing customer satisfaction. Surveys show that 70% of customers consider connected processes a primary requirement, and 59% consider adjusted and contextually relevant interactions based on previous interactions as crucial factors in choosing financial service providers.

Industry 4.0 enhances efficiency and security. One of the inevitable consequences of Industry 4.0 is the transformation of the comprehensive banking system with the emergence of digital currency, particularly blockchain technology. Blockchain transparently and securely records transactions, allowing people worldwide to instantly send money everywhere at low costs. These transactions are protected by encryption, significantly minimizing the risk of attacks.

Industry 4.0 enhances the flexibility of financial organizations. Industry 4.0 places increasing pressure on industries to respond to events and customers immediately, 24/7. To achieve this, banks and financial organizations must be as flexible and agile as possible to quickly solve problems and change directions. Industry 4.0 also brings opportunities to apply technology, making financial organizations more flexible. For example, Hybrid Cloud is an IT infrastructure connecting public and private cloud spaces to create a relaxed and unique cloud environment. Additionally, Industry 4.0 applications help financial organizations market efficiently and purposefully, support effective customer service through low-cost robots, expand operational areas, minimize risks through data-driven assessments, improve business management, reduce human errors in financial activities, and enhance transparency and reliability with accountable explanations and more straightforward repairs.

However, along with the opportunities, Industry 4.0 also presents significant challenges for financial institutions and banks. These challenges are listed below.

Increase in cybersecurity risks and cybercrime. Network threats, including ransomware, fraud, information leaks, and daily data breaches, are becoming more sophisticated. The growing integration of technology into the financial industry through Industry 4.0 also amplifies the risk of companies facing cyberattacks. TechJury statistics reveal that up to 34% of financial enterprises are affected by internal threats annually, with fraudulent attacks accounting for 14% of total data breaches. A cyberattack not only has financial implications for an organization, with an average cost of approximately USD 18.3 million, but it can also cause irreparable damage to its reputation. For example, in the case of the consumer credit reporting agency Equifax, a cyberattack resulted in the exposure of 15.2 million customer profiles, unauthorized access to 10,000 credit card numbers, and over 15,000 customers being compromised with accessed personal information (usernames, passwords, security questions, phone numbers, and email addresses).

Challenges in building trust and relationships with customers. 95% of customers stated that trust in a company increases their loyalty. However, building trust becomes increasingly challenging with Industry 4.0 and the move towards a world where everything is virtually digitized with minimal human interaction. Computers and connected technologies cannot provide customers with emotions, creativity, imagination, empathy, or intuition. Banks will need to find new and innovative ways to incorporate human elements and personal touches into online services, and AI-based chatbots may become standard tools in this effort.

The intensifying competitive pressure in the financial industry. The emergence of new competitive players, such as FinTech and BigTech, along with rapid advancements in digital tech-

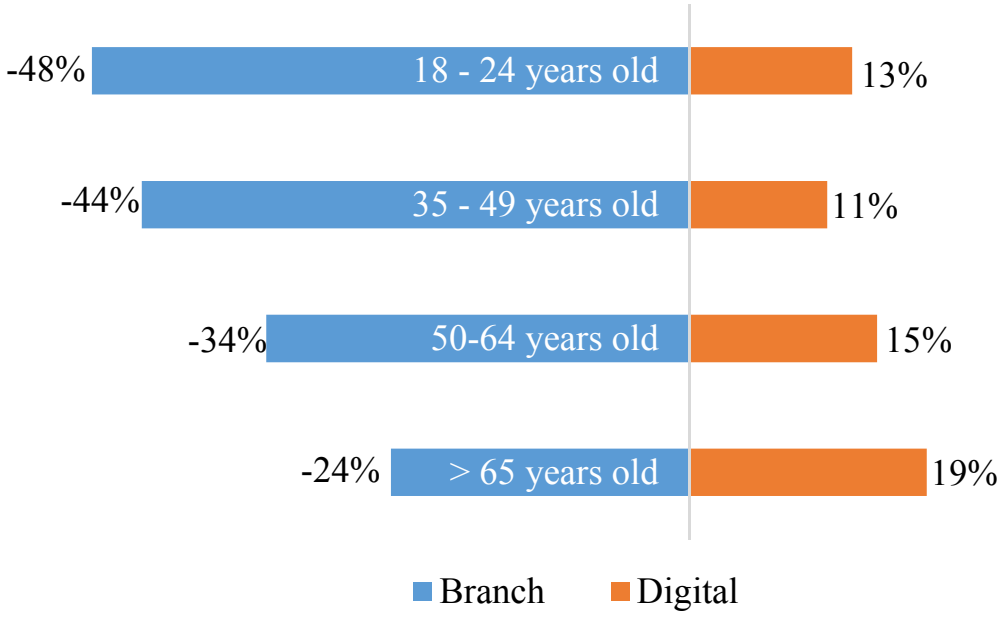

Fig. 4. **Changes in the number of bank customers across distribution channels by quarter, 2015–2020**

Source: Based on Deloitte (2021) [12].

nology, has created a substantial increase in competitive pressure in the financial sector. Research Gate assesses that the new competitive landscape could put banks at risk of losing one-third of their profits, and the subsequent stages of digital transformation may lead to even deeper declines in bank profits. Banks and financial organizations must adjust their operations, enhance competition with innovative digital services, embrace online services, and adapt to mobile-friendly systems. Based on these adjustments, financial organizations will gradually shift from traditional financial organizational forms to dynamic platforms focused on digital technology, offering competitive products and services with seamless user experiences based on customer data analysis.

3. Trends in the development of banking services

3.1. Global trends

The financial sector, particularly banking, is a dynamic industry with fierce competition for products and services. Banks continually strive to develop and transform to avoid falling behind their competitors. The history of banking competition has progressed from providing the first ATM, the first telephone banking, the first online banking, and the first mobile banking applications to the current race toward a digital banking structure.

Adverse impacts from the 2007–2008 financial crisis, such as slow economic growth, low interest rates, and increased compliance costs, led to a significant decline in bank profits (return on equity for banks, according to McKinsey's statistics [9], decreased from 16% to 8–10%). As a result, banks are facing intense competitive pressure. The combination of financial services and technology provides an opportunity for banks to penetrate the market rapidly.

Banks worldwide have capitalized on the development of new technology in the era of Industry 4.0 to upgrade not only the products and services provided to customers but also their internal operational distribution processes. Some prominent trends in the application of technology by banks worldwide in recent times include:

Expanding digital distribution channels. According to statistics from various research organizations, the number of physical branches of banks worldwide peaked in 2016 and began to decline later. The significance of non-branch banks is increasingly considered a result of digital banking. The digital banking market in the United States is estimated to reach $4.3 billion in 2021, holding a 28.78% market share globally. China, the world's second-largest economy, is forecast to have an estimated market size of $4.6 billion by 2026, with a compound annual

growth rate (CAGR) of 19.9% during the analysis period. Japan and Canada are predicted to grow at 11% and 13.1%, respectively. In Europe, Germany is expected to grow at a CAGR of approximately 14.5%.

The field of mobile banking has emerged as a new customer attraction channel, becoming the dominant channel for retail banking rather than just one of the segments in the previous stages. Financial organizations also consider mobile platforms necessary for effective competition. Some banks use the mobile channel as a strategic differentiator because customers can leverage it anytime, anywhere to access various banking products and services (balance inquiries, payments, fund transfers between accounts, account information access, account opening, credit or loan renewal applications, branch or ATM location search, investments, and access to content services). Customers are shifting based on age, and younger generations are predicted to drive the demand for mobile banking services. The lack of branch infrastructure in developing markets is also expected to boost the demand for mobile banking services, consequently driving mobile data traffic (*Fig. 4*).

Apart from distribution channels such as automated teller machines (ATMs), the internet, and mobile devices, banks can now reach their customers on alternative platforms through self-developed applications, providing more value to customers in an open environment through using API.[5] APIs are powerful tools to reshaping the old architecture of the banking information system and adjusting the operating methods to fit current conditions, thus increasing the flexibility of the banking information system and opening up new growth opportunities by separating products into new role-playing components at various levels of the value chain. With a banking system based on an API-driven open architecture, the payment infrastructure is expected to become commonplace shortly without requiring physical cards or point-of-sale terminals (Badr Machkou, 2020) [13]. In the UK, Monzo, an online bank entirely operated through an app established in 2015, now has over 5 million users, rapidly gaining market share from financial institutions that have been in the market for centuries. However, to successfully implement API-driven open banking ecosystems, banks require a clear strategy, enhanced data, robust technological architecture, and the ability to manage multiple business models in an investment portfolio.

Optimizing internal operational processes. Most financial organizations rely on cloud computing technology and data analysis to increase efficiency and enhance business analysis systems. However, organizations must seek new digital support tools that meet growing customer demand, processing speed, and higher security requirements. Financial organizations worldwide see these challenges as part of their business strategy and are currently using several new digital technology solutions to increase revenue, optimize costs, and minimize risks:

Robotic Process Automation (RPA) for process automation. Implementing RPA can enable banks to reduce manual efforts, provide better compliance, minimize risks, and enhance the overall consumer experience. For example, RPA can streamline the loan processing workflow to a record of 10–15 minutes by automatically extracting information from documents, using machine learning for data analysis, and generating automatic confirmation emails. RPA can also track all accounts, send automated reminders, automatically cancel transactions, directly record debts, and change interest rates and transfer fees. RPA collects customer information, filters and verifies data to shorten processing time, minimizes errors in customer verification, and helps save Know Your Customer (KYC) costs (up to USD 500 million per year, according to Thompson Reuters statistics). Furthermore, the most significant advantage of automation for banks and financial organizations is that it requires no additional infrastructure and provides easy access.

Integration between back-end operational support systems and user interaction (front-end). According to a study by the Capgemini World FinTech Report (2020) [14], over half of the surveyed banks do not provide an integrated experience, making it difficult for customers to access a single platform due to legacy systems, paper-based documentation, and complex manual processes slowing down information

[5] Application Programming Interface — information technology solutions that enable applications to communicate and exchange service data with each other.

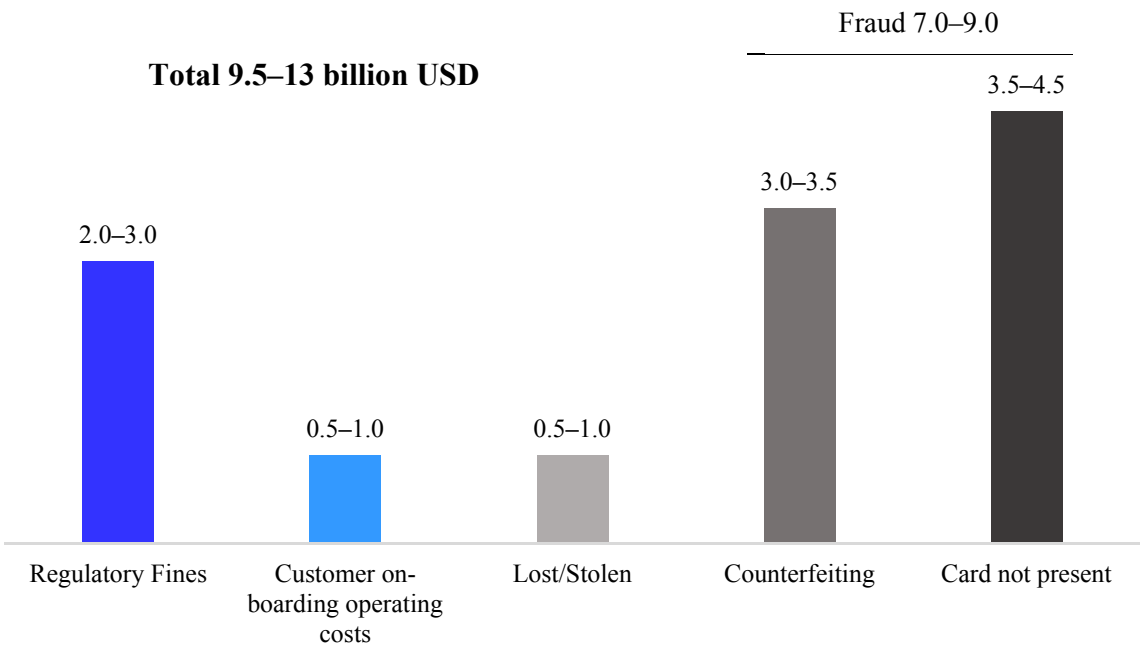

Fig. 5. **Cost savings in the banking industry due to blockchain solutions (billion USD)**

Source: Based on McKinsey (2019) [10].

technology systems and congesting the digital ecosystem that banks are striving to establish. Capgemini's statistics (2020) [14] show that banks have 300–800 intermediate processes and offices on a scale of operations with many complex processes extending across various business units. Many banks worldwide are collaborating with FinTech companies to build a customer journey map that places data collection at the center of the process, facilitating innovation for operational support departments within the bank. Some examples include Abbank and Datameer collaborating on data analysis and management; United Overseas Bank and Tookitaki Holdings collaborating on enhancing and applying technology in AML (anti-money laundering); DZBank and Vectra collaborating on using technology in security, electronic signatures, and electronic contract management; Deutsche Bank and Finantix collaborating on online customer verification (KYC); Morgan Stanley and Box collaborating on applying API technology in document processing to reduce intermediaries.

Application of Distributed Ledger Technology (Blockchain). Blockchain is considered to be the core of 4.0 technology, one of the most important innovative technologies in the financial industry's digital transformation. Blockchain can be used in three ways: asset transfer (money, securities, etc.), tracing the origin of assets and products, and executing smart contracts. Consequently, blockchain can perform e-commerce, banking, notary, and government transactions faster, cheaper, and more safely. Many banks worldwide have applied this technology, such as ABN Amro, ING, and Rabobank (Netherlands), which have announced R&D activities on Blockchain technology to improve payment systems; Bank of America, Deutsche Bank, Goldman Sachs, Citigroup, and Santander have also invested significantly and established research laboratories. According to McKinsey, banks will save 9.5–13 billion USD annually by applying blockchain solutions (*Fig. 5*).

3.2. Improving customer experience and increasing accessibility

As more customers opt for digital services, their expectations also rise. Investing in customer experience can yield clear profit margins by providing a seamless, multi-channel experience that enhances customer attraction and retention while reducing customer defection rates from the organization. Digital services can also help gather additional customer behavior data to identify new needs better, increasing cross-selling and upselling products and services to

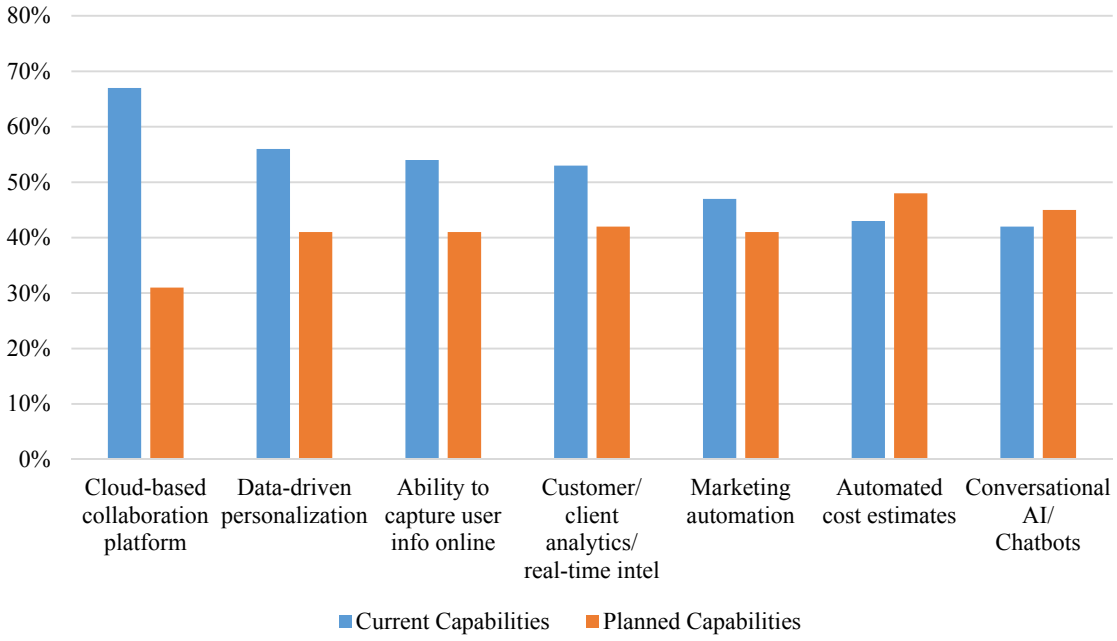

Fig. 6. **Deployment status of digital technology solutions in financial organizations**

Source: Based on BDO (2021) [15].

customers. According to Accenture's survey, 74% of consumers believe that "live data" with detailed personal interests would be valuable for managing personalized banking experiences, products, offers, and solutions. Banks hold and store a large amount of transaction, behavioral, and demographic data from customers, as many extensive data studies have shown to be crucial, especially in improving marketing operations in commercial banks, customer relationship management (CRM), fraud detection, risk management, and investment banking. In the last decade, chatbots have been a prominent trend in many financial banking products. The use of chatbots is expected to become widespread due to the familiarity with mobile devices, and the daily texting habits of Generation Y and Generation Z (*Fig. 6*). Chatbot applications in American Express (Amexbot) and Bank of America (Erica) are considered leading applications in the industry, and are expected to replace customer support centers.

The Covid-19 pandemic has profoundly impacted and disrupted global activities. Organizations are compelled to shift to remote work and use technological solutions to support these operations. Most financial organizations worldwide recognize that the Covid-19 pandemic is becoming a driving force for integrating new technologies within their structures. Mobile banking, Banking as a Service (BaaS), and AI technology are identified as the most rapidly developing areas in 2021 (*Fig. 7*). Conversely, the frequency of cyberattacks and online fraud has increased. According to a study by Finastra (2021),[6] 83% of the surveyed financial organizations increased their cybersecurity investments during the Covid-19 pandemic. The corresponding percentages in the UAE, United States, Singapore, and Hong Kong are 87%, 83%, 85%, and 81%, respectively (*Fig. 8*).

4. Discussion

4.1. Trends in Vietnam

The banking system in Vietnam is rapidly embracing Industry 4.0 as the demand for the application and development of high technology in the operations of banks in Vietnam is increasing. Most Vietnamese banks have implemented or are developing digital transformation strategies, including digitizing specific business segments, internal processes, and end channels. Some key trends in recent times include:

Banks have focused on developing services to enhance customer experience. Domes-

[6] URL: https://www.finastra.com/sites/default/files/documents/2021/06/financial-services-state-of-the-nation-survey-2021.pdf

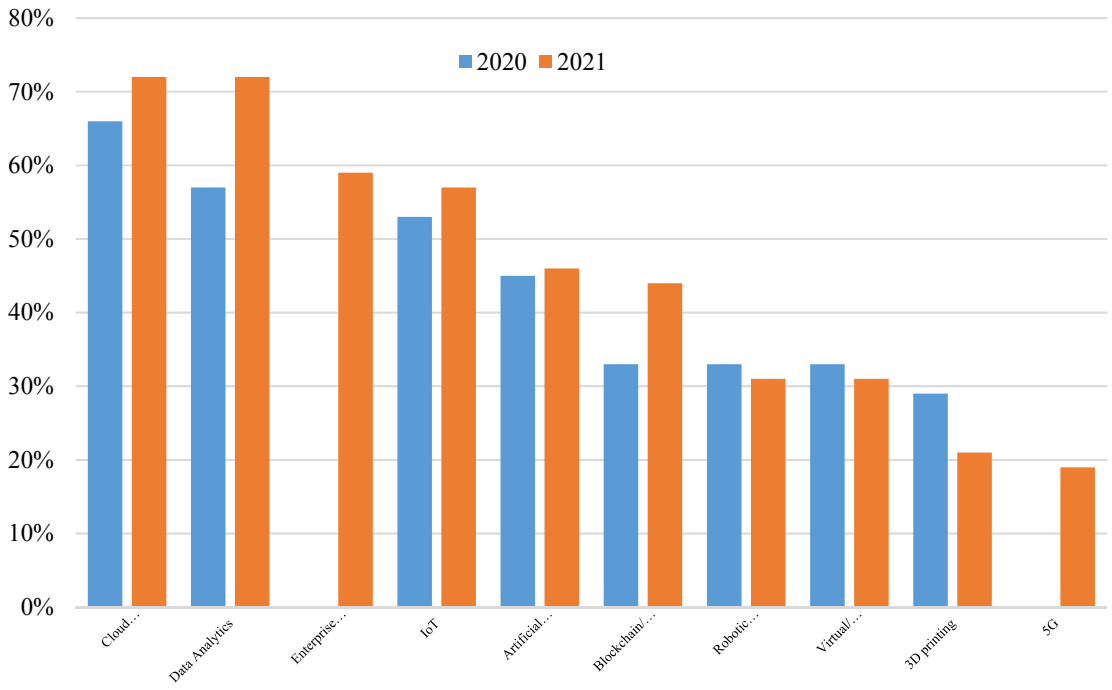

Fig. 7. **Technology adoption in financial organizations**

Source: Based on BDO (2021) [15].

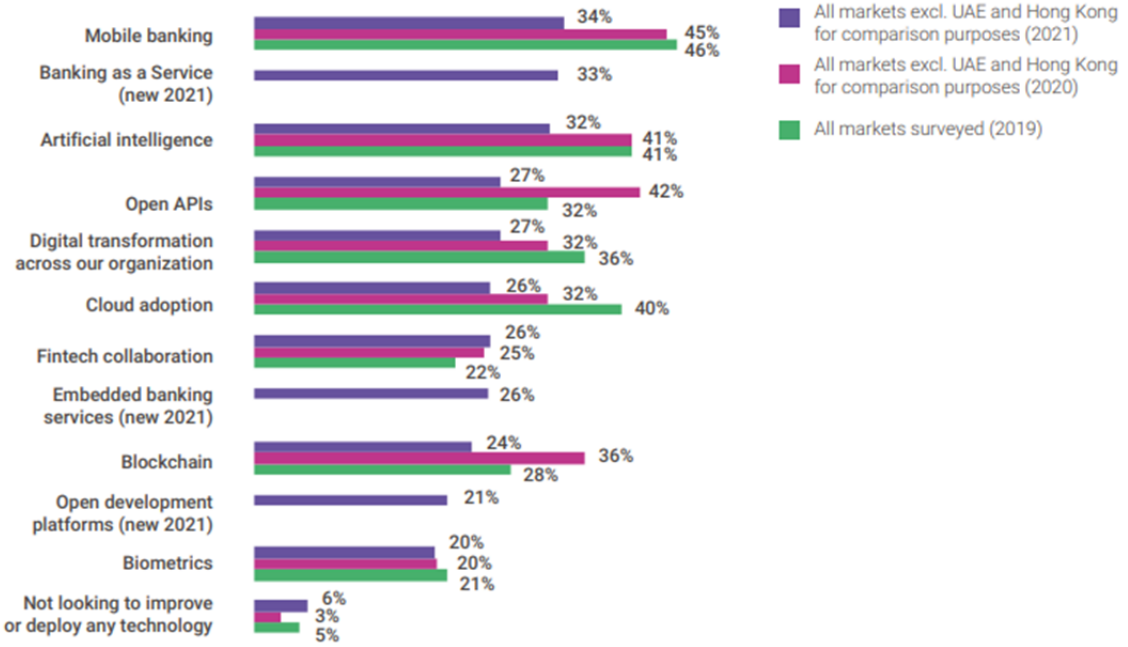

Fig. 8. **Technologies planned to be deployed or improved over the next 12 months**

Source: Finastra (2021). URL: https://www.finastra.com/sites/default/files/documents/2021/06/financial-services-state-of-the-nation-survey-2021.pdf

tic commercial banks have strengthened the provision of digital banking services to their customers. Large commercial banks in the system have quickly developed new services; for example, Techcombank and VIB allow customers to transfer money through social networks (Facebook*, Zalo, etc.) and withdraw money from ATMs without a card. VPBank has applied IBM's data analysis technology to synchronize customer data, supporting rapid customer behavior analysis. Regarding payment services, banks have deployed various convenient and fast

Table 1
The current status of cooperation with fintech by some Vietnamese banks

Commercial Bank	FinTech	Collaborative content
Techcombank	Fastcash	Transfer money via Facebook* and Google+
	Trusting Social	Develop credit scoring criteria
Vietcombank	M_Service	Money transfer payment
	VnPay	Services on a Mobile banking application
Vietinbank	Opportunity Network	Providing digital platforms for businesses
MBBank	Startup FinTech	Providing banking services in Facebook's* Messenger application
VIB	Wezzi Digital	Providing product MyVIB Keyboard — a new application to help transfer money via social networks

Source: Compiled by the author.

payment methods and channels 24/7, such as QR codes, contactless payments, mobile device Visa, and POS (mVisa, mPOS). Among these, QR codes and contactless payments are the most strongly implemented. Banking applications, beyond providing core financial services such as payments, deposits, and loans, have gradually expanded to include various other services such as payment of essential utility services (electricity, water, telecommunications), payment for public services (education, health care), shopping for goods and services, insurance, travel, entertainment, etc.

Banks have been directed toward transforming their business models, shifting from traditional banks to digital banks (examples include VPBank's Timo, TPBank's LiveBank, and BIDV), or aiming to develop the banking service ecosystem through collaboration with FinTech and BigTech to build an open bank with a comprehensive banking service ecosystem. Collaboration and partnership between commercial banks and technology financial companies (FinTech) on BigTech platforms is a prominent trend. Collaboration between banks and FinTech primarily focuses on payment (mobile payment solutions, e-wallets, or intermediary payment solutions) and customer authentication (*Table 1*). Some banks have also been pioneers in cooperating and investing in FinTech and have achieved specific successes, such as VPBank and Mastercard announcing the collaboration with Amazon Web Services (AWS) to issue the Mastercard — VPBiz credit card for SMEs using AWS cloud computing; VietinBank collaborating with 7 FinTech companies, such as ON (UK), BE Group (Sweden), etc., in various fields to bring technology products and services to customers; BIDV has connected with 24 FinTech companies and 756 service providers to provide over 1,500 spending payment services for customers.

However, many banks in Vietnam have implemented only multi-channel distribution systems or inter-channel compatibility between the Internet and mobile banking but have not actually achieved omnichannel compatibility. The current conditions in Vietnam have not yet met the conditions of an open banking ecosystem. IoT in Vietnam is not yet widespread, and embedding the banking service ecosystem in customers' daily lives through technology devices has not been fully realized.

Regarding internal management models, many banks are transitioning to data-driven management models. An exemplary case is Techcombank, which established the Data and Analytics (DnA) Division in 2020. Banks have also begun adopting agile working methods. For instance, Techcombank has created a "flat" and flexible cultural environment at the Techcombank Agile Center, where there is virtually no hierarchical distance between employees and leaders. Small group meeting areas are designed like café corners with lightweight partitions that can transform into whiteboards for easy idea presentation and discussion. In addition, many banks have established digital banking centers or financial solution centers. For ex-

Table 2
Actual implementation of core banking and database upgrades in some banks.

Commercial Bank	Status of core banking and the database
Vietinbank	Successfully replaced the CoreBanking system in February 2017 (Core SunShine), operated the new enterprise data warehouse (EDW) from April 2017
Vietcombank	Transform new generation Core banking and build a modern enterprise data storage facility EDW
VIB	Invest heavily in projects on automation, AI, and machine learning and pay special attention to standardizing Big Data to provide products according to each individual. VIB has combined with Amazon Web Services (AWS) to implement input data standardization projects and new investment in core banking and scorecard systems…
Vietbank	Replaced Finastra's Core Banking system; Investing in the entire core system for Cardzone cards; Prepared to replace Internet banking with a new digital channel system

Source: Compiled by the author.

ample, BIDV built the Digital Banking Center to build a consumer financial ecosystem. MBB and LienvietPostbank have also established digital banking units. ACB formed a technology team directly managed by the CEO or the Board of Directors, and Vietinbank decided to launch the Customer Financial Solution Development Center.

There is an emphasis on upgrading, innovating, and building a modern digital infrastructure. Many banks invest in technological innovation and prioritize international standard security measures. Some banks operate on multi-channel platforms to ensure customer experience, analyze behavior, and attract customers through an in-depth understanding of individual customers. For instance, OCB recently implemented an Omni-Channel platform. To support data analysis, many banks have upgraded their core banking systems and banking databases (Enterprise Data Warehouse — EDW) (*Table 2*).

Moreover, many new digital technologies have been and are being implemented in banks:

Mobile Device Payment Technology: This is the most widely applied technology, with a variety of mobile payment applications such as Vietcombank DigiBank, MyVIB, F@st Mobile (Techcombank), TPBank Mobile, Agribank E-Mobile Banking, Vietinbank Ipay, eFAST, OCB OMNI.

Biometric Technology: Serving user identification (eKYC) in the digital space, as of October 2021, the State Bank of Vietnam (SBV) reported that 21 banks officially implemented this, with over 2.2 million eKYC accounts actively operating and conducting around 23 million transactions.

Data Analysis, Artificial Intelligence (AI): AI in banks primarily serves compliance (AML) and operations. However, some banks have begun researching AI for analyzing customer behavior. For example, BIDV is testing the application of IBM Watson's artificial intelligence to analyze customer data, Techcombank is deploying AI to analyze trends and consumer behavior for highly personalized services, and VIB effectively combines AI with Big Data and e-signatures in the credit card approval process, allowing customers to open a credit card in just 15–30 minutes (1/500th of the average time in the market).

Cloud Technology: Used to enhance flexibility and interaction and synchronize with partners. In September 2021, Techcombank announced that it was selecting AWS as its cloud computing service provider and plans to migrate most of its applications from the bank's data center to AWS. VIB also signed a cooperation program with AWS to transfer technology innovation projects to the cloud computing platform.

Open Application Programming Interface (Open API): Some banks in Vietnam are pioneers in developing and applying Open Banking and open APIs, such as VietinBank, OCB, Agribank, Bac A, BIDV, VPBank, Vietcombank, etc. VietinBank has more than 127 APIs on the market and has relationships with over 73 partners (iConnect platform); OCB has implemented

more than 30 open APIs; BIDV has deployed the BIDV Paygate platform; Timo's digital banking application, in collaboration with VPBank and Ban Viet Bank, and TPBank recently introduced payment connection services through Open API, facilitating large enterprises with thousands of daily fund transfer orders.

Internet of Things (IoT) and Virtual/Augmented Reality (VR/AR): Recently, BIDV launched a new digital banking universe on the extended reality (XR) technology platform, encompassing virtual reality (VR) and augmented reality (AR) technologies to provide a combined physical and digital experience for customers.

Blockchain Technology for Value Exchange and Payments: Banks have researched and applied blockchain technology to certain services. Some Vietnamese banks, including HDBank, HSBC, VCB, Vietinbank, and MB, have joined Contour, an open commercial finance network, to enhance trade finance capabilities on the digital platform. NAPAS and three banks, VietinBank, VIB, and TPBank, successfully tested a blockchain-based money transfer model while sharing cloud computing resources. TPBank participated in the Ripple platform for cross-border payment and money transfer.

4.2. Challenges arising with the development of 4.0 technology banking services in Vietnam

Although the banking sector in Vietnam is poised to benefit from numerous advantages and significant opportunities for development, Industry 4.0 (4.0) technology presents several substantial challenges to the future growth of the Vietnamese banking industry.

4.2.1. First, legal framework issues

This is the most critical challenge and a prerequisite for advancing digital technology to develop banking products and enhance banking business operations. Various legal constraints pose significant obstacles for banks. The laws on electronic transactions and regulations on electronic transactions in the banking sector, enacted from 2005 to the present, have many provisions that are no longer compatible with digital transformation, general digital technology applications, and banking operations concerning issues such as electronic signatures, electronic contracts, electronic negotiations, etc. Regulations related to accounting, handwriting, signatures, circulation, and storage of accounting documents seem suitable for manual processes (two signatures, paper documents, fresh signatures, etc.) or digitally transformed manual processes. At the same time, Industry 4.0 technology allows changes to be made according to new models. Regulations related to lending activities are also not suitable for fully automating the approval, assessment, and post-lending monitoring processes, especially for the needs of small retail loans for individual customers. There are no regulations on issuing bank cards or restrictions on foreign exchange transactions through electronic means. Banks face challenges collaborating with FinTech due to the lack of legal documentation regulating collaboration mechanisms. Specific areas also lack legal frameworks, and the banking industry currently lacks regulations on the Sandbox to experiment with and test innovative models, products, and services.

4.2.2. Second, user perception issues with digital financial products and services

The increase in income, demographic shifts, and rapid development of technology have led to significant growth in online banking service customers. In June 2020, this indicator increased to 2.6 times (year over year) from 1.4 in the year before, with online transactions accounting for over 40% of total bank transactions, especially reaching up to 80% for some banks (Vietnam Digital Report, 2021). However, at present, users of electronic financial services still face several limitations: (i) uneven levels of understanding and application of technology among customer groups; (ii) the confidence in the security of information and the accuracy of transactions in the digital space in specific customer segments (mainly the middle-aged and older) still needs time to improve. From May 2020 to May 2021, according to the report of the Ministry of Public Security, over 5,400 cases of property fraud were detected, involving billions of Vietnamese dong (Vietnam's national currency), and nearly half of these cases occurred through cyberspace, a 1.5-fold increase compared to the same period in the previous year. The main reason for this is that education programs to enhance awareness of banking services in the digital age have not been systematically and comprehensively implemented to reach customers of all ages.

4.2.3. Third, high-quality human resources issues

The labor market in the banking industry will change by reducing the number of transaction officers and direct sales personnel at branches and increasing the source of high-quality, specialized human resources in banking finance while understanding information technology. The issue of high-quality human resources is a challenge for the banking industry and other sectors. Developed countries such as the United States have incorporated curricula on artificial intelligence and machine learning into MBA programs and university courses; South Korea and Taiwan have entered phases of training and preparing high-quality human resources; while in Vietnam, the availability of human resources in this segment is still minimal. According to a study by The Asia Foundation [16], the Vietnamese workforce ready for digital technology is not high, and university training programs change very slowly compared to the trend, which is the main reason for this slow development.

5. Conclusions

Industry 4.0 provides opportunities to drive economic growth, increase social productivity, and directly impact the financial banking industry. Vietnamese banks are not exempt from the global trend and have implemented or are in the process of developing digital conversion strategies, including digitizing specific business segments, internal processes, and end channels. However, the conversion and application of digital technology in the banking sector in Vietnam are still at a low level because the ecosystem is still in the process of perfection and faces many challenges, with one of the most critical issues being the lack of a legal framework related to digital finance and electronic transactions. With the rapid development of technology, digital technology-driven banking products and services will continue to expand. Regulatory bodies need to understand market changes and take measures to create conditions for developing digital technology applications in the financial sector, ensuring that domestic credit institutions can compete regionally and globally.

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