FinTech and the Level of Its Adoption in Different Countries Around the World

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ARTICLE INFO	ABSTRACT
	FinTech, or Financial Technology, refers to the use of modern technologies in the financial and banking sectors to improve and facilitate financial services. The adoption of this technology is rapidly increasing in many advanced societies. Investment in FinTech has surged in recent years, with key factors driving this growth including the rising demand for digital financial services, the rapid growth of the digital economy, the increasing popularity of blockchain technologies and cryptocurrencies, and, ultimately, supportive regulations for the FinTech industry. FinTech has expanded significantly in countries worldwide, especially in Asian nations and developing economies. In this study, we first provide an overview of FinTech, its objectives, and the necessary infrastructure for its implementation and then briefly discuss the extent of its development and adoption in various countries, followed by a review of several studies conducted by researchers in the FinTech field. Finally, we conclude with a discussion of the challenges faced in the development and investment in FinTech.

1. Introduction

In recent decades, with the acceleration of technological development and significant advancements in various fields, we have witnessed remarkable transformations in the financial industry. One of these transformations is recognized as FinTech (Financial Technology), a term now seen as a symbol of the integration of technology into financial services. FinTech, as a new concept, not only refers to the change in how financial services are provided but also, through the development of data-driven technologies, artificial intelligence, blockchain, and other innovations, is driving an unprecedented transformation in the financial world [1,2]. The combination of these technologies with various financial sectors, from banking to insurance and capital markets, has led to the creation of new services and products, as well as the improvement of existing processes. Investment markets, digital payments, asset management, and even financial advising are all witnessing the impact of FinTech in enhancing performance and increasing efficiency. This line of

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research builds upon prior work that leverages machine learning and data analytics to analyze complex systems, such as the economic factors affecting business and the development of secure systems in mobile social networks [3-5]. The primary objectives of FinTech include improving efficiency, reducing costs, increasing access to financial services, and enhancing customer experience [3].

Given that FinTech can play an important role in today's financial markets, this study aims to introduce this emerging technology. This paper is structured in five sections. In the second section, we introduce FinTech and explain its goals for creation and development, then discuss the technologies related to FinTech and briefly explain some of the various services provided by FinTech. In the third section, we briefly discuss some of the most important applications of FinTech in the modern world. In the fourth section, we review several studies conducted by different researchers in the field of FinTech. Finally, in the fifth section, we provide a conclusion and discuss the challenges in using, growing, and developing FinTech.

2. Concept of FinTech

The term "FinTech" is a combination of the words "financial" and "technology." The Oxford Dictionary defines it as: "computer programs and other technologies used to support or enable banking and financial services." In simpler terms, this relatively new term refers to the use of technology to make financial services more efficient. Therefore, FinTech can be understood as a collection of activities and businesses that leverage modern software (primarily web-based) to provide financial services on a large scale, independent of geographic boundaries. FinTechs can be seen as banking and financial technology startups that aim to transcend traditional financial intermediation boundaries. FinTech, or financial technology, is a sector of financial services that is built upon technological foundations. It also applies to digital startups or even traditional financial companies that have adopted new technologies to offer financial services. The goal of FinTech is to attract customers by offering products and services that feature user-friendly, efficient, transparent, and automated interfaces. In other words, FinTech refers to companies that aim to deliver financial services underpinned by technology in a more efficient manner. Given the novelty of the industry, most of the companies operating in this space are startups that seek to provide financial services with a new approach, or sometimes even eliminate traditional financial intermediaries, such as banks. A new generation of FinTech startups, characterized by flexibility, security, efficiency, and enhanced opportunities, is rapidly emerging and growing with the aim of infiltrating the heart of the financial and banking industries. Many experts and analysts believe that the future of the banking industry lies in the growth of FinTech companies, which is why there has been a significant increase in investment in this sector.

2.1 Main Objectives of Using FinTech

Some of the main goals of using FinTech are as follows [6,7]:
- Facilitating Access to Financial Services
- Reducing Customer Financial Costs
- Increasing Transparency and Security in Banking-Financial Services
- Facilitating Processes and Improving User Experience
- Creating Innovation in Financial Products and Services
- Increasing Competition in the Financial Industry

2.2 Technologies Related to FinTech

The growth and development of FinTech are dependent on the emergence and advancement of numerous innovative technologies, each of which plays a significant role in improving the quality of services provided and facilitating access to a wide range of services for users. Some of these key technologies include [8, 9] (Figure 1):

- Blockchain and Digital Currencies
- Artificial Intelligence (AI) and Machine Learning (ML)
- Natural Language Processing (NLP)
- Cloud Computing
- Biometrics
- Internet of Things (IoT)
- Application Programming Interfaces (APIs)
- Augmented Reality (AR) and Virtual Reality (VR)
- Big Data Analytics
- Cryptographic Technologies
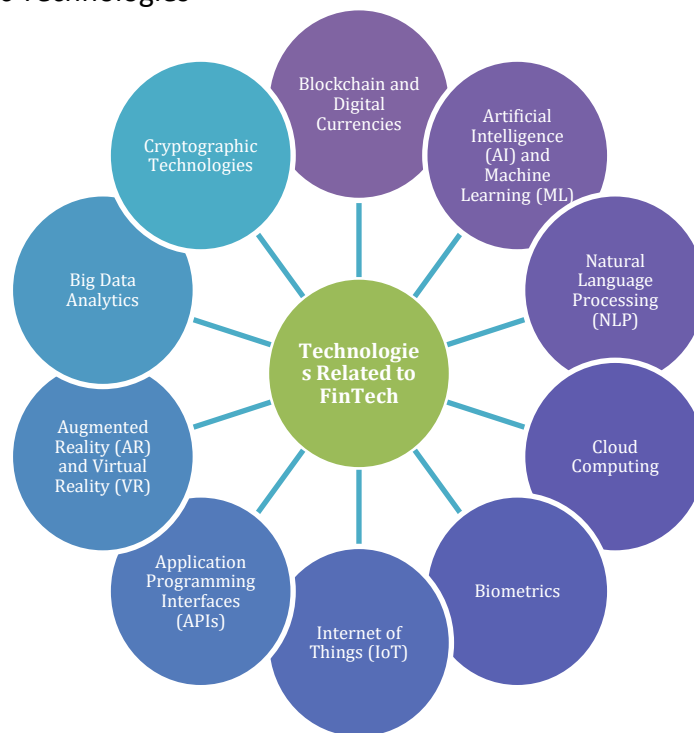
Fig. 1. Technologies Related to FinTech

The algorithms underpinning AI and ML not only power robo-advisors and fraud detection in FinTech but are also central to understanding and augmenting human decision-making in other fields, such as analyzing consumer impulse buying, improving educational recruitment, providing automated formative assessment, and enabling sophisticated optimization in industrial processes, supply chain management, and energy systems [10-16]. Furthermore, advanced ML techniques for analyzing complex network structures, such as graph summarization and robust subgraph learning, show significant promise for applications in financial network analysis and fraud detection systems [17,18]. The transformative potential of big data analytics, a cornerstone of FinTech, is evident in its application across other sectors such as public health and economics, where it is used to investigate complex relationships, for instance, between healthcare indicators and economic growth or to

evaluate the health outcomes of public policies [19,20]. The foundational technologies of the digital economy, including data analytics and IoT, are similarly revolutionizing other complex systems, as seen in their application for sustainable urban management [21] and in modeling the intricate, variable relationships within port-city spatial structures [22].

2.3 Types of Services Offered in FinTech

FinTech, as an innovation process in the financial sector, has rapidly become one of the key aspects of transformation in the financial industry and has significant impacts on the structure and processes of financial systems. These changes, in addition to improving financial services, are also seen as an opportunity to increase access to financial services and ensure the security of financial transactions. As a technology, FinTech encompasses a wide range of activities and financial services, some of which include [23, 24] (Figure 2):

- Digital Payments and E-Wallets
- Cross-Border Payments and Blockchain
- Wealth Management and Robo-Advisory
- Digital Banking and Information Technology in Banking
- Digital Insurance and InsurTech
- Identity Verification and Financial Security
- Cryptocurrency and Digital Currencies
- Lending
- Crowdfunding and Capital Raising
- InsurTech (Insurance Technology
- International Money Transfers
- Personal Financial Management
- RegTech (Regulatory Technology
- FinTech in Financial Wellness (WealthTech)
- Budget and Savings Management Platforms
- Crowdfunding

Each of these areas plays a vital role in transforming the financial industry. By leveraging technology, they help improve the delivery of financial services, increase security, and create innovative opportunities. The critical importance of user experience in these services is exemplified by research focused on measuring e-service quality and customer satisfaction for specific FinTech products, such as crypto wallets [25].

3. Examining the Use of FinTech in Different Countries

This section reviews several studies conducted by researchers in various countries around the world, examining the growth and development of FinTech in those regions.

The Industry 4.0 era involves using innovation and technology to change how businesses operate, focusing on models that can be easily repeated and expanded. Research by Kijkasiwat [26] explored the specific opportunities and challenges for FinTech startups in Thailand. By analyzing data from industry reports and conducting interviews, their study shows that these opportunities and challenges are shaped by three main factors: government technology policy and financial regulation, collaborative partnerships between businesses, and the public's level of digital and financial understanding. The authors provide a detailed discussion of these factors and give recommendations. These findings can help local leaders and policymakers improve conditions for FinTech companies, minimize potential risks, and promote long-term economic stability.
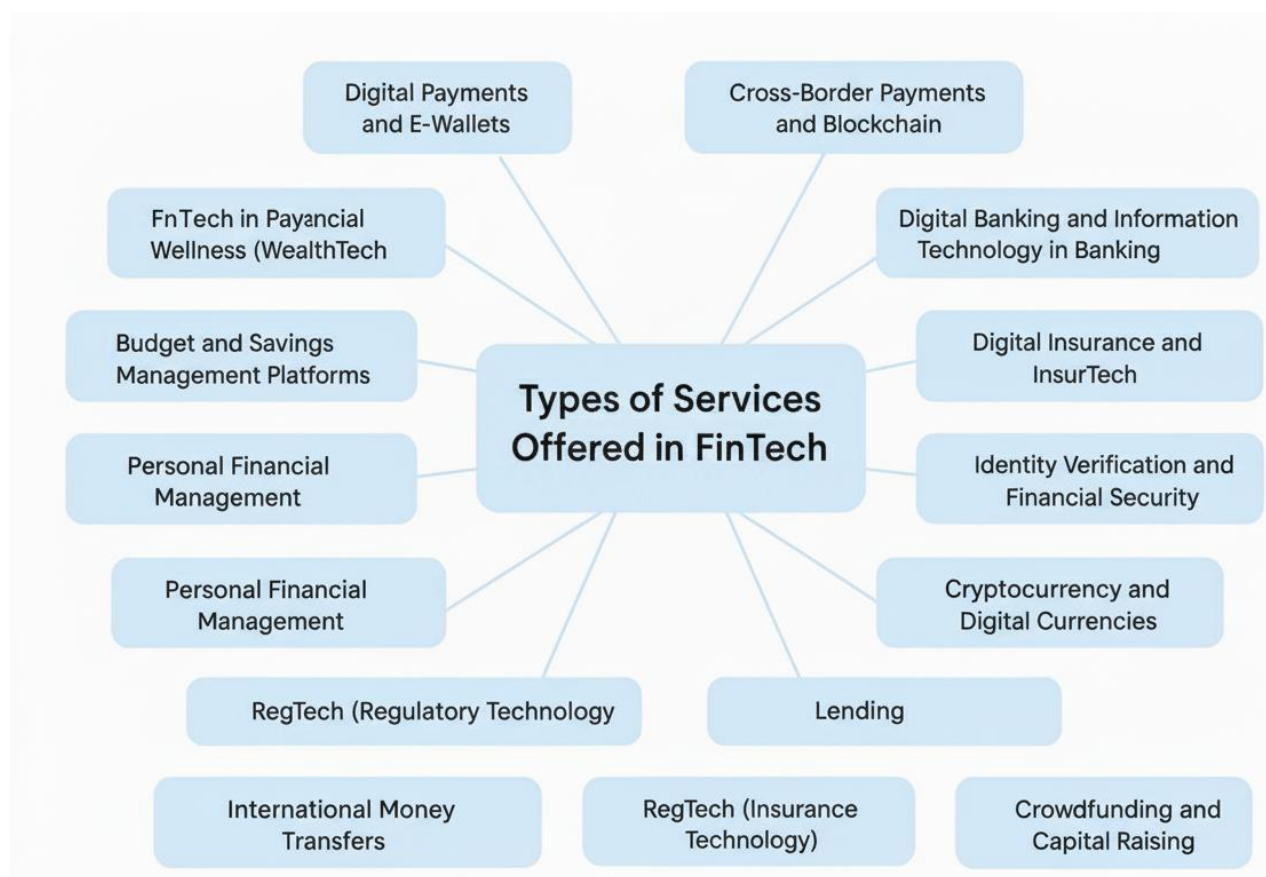
Fig. 2. Technologies Related to FinTech

The research found that FinTech startups in Thailand have a better chance of succeeding when they partner with other businesses, both within the finance industry and in other sectors. The study also shows how three things are deeply connected: a person's digital skills, their understanding of money (financial literacy), and their access to financial services (financial inclusion). Essentially, when people need to use financial tools in their daily lives, they are more motivated to learn the technology. Similarly, knowing more about money makes people more likely to use FinTech apps. For the government, the study suggests creating clear policies and national rules that help FinTech companies grow while also making users feel safe from online fraud. To support local businesses, officials should encourage people to use Thai FinTech platforms instead of foreign ones. This helps prevent sensitive data from going to international competitors, which could hurt Thai companies. The government could also help by cutting taxes for new startups and removing user fees to make these local apps more attractive. Banks and FinTech companies should work together, combining their strengths to create better services and overcome challenges. The study recommends two paths for future research. First, to use social analysis to better understand the relationships between FinTech startups and other organizations. Second, to compare these findings about Thailand with studies from other countries to get a more complete picture of the global FinTech landscape.

Albarrak and Alokley [27] examined the current state of the FinTech sector in Saudi Arabia. Their study highlighted several types of financial startups, such as online banking, digital payment and transfer services, crowdfunding platforms, peer-to-peer lending, and blockchain projects. Over the past five years, the ecosystem has gone through noticeable changes. For example, banks in Saudi Arabia have become more cautious, while technology firms and startups are working on innovations

to improve existing financial processes. The government has mainly focused on creating rules and regulations to guide the sector. Customers in Saudi Arabia are showing strong interest in financial products that are simple and convenient to use. The researchers also compared Saudi Arabia's FinTech environment with that of the UAE and offered suggestions for different stakeholders. However, the study faced some challenges. The biggest issue was the lack of detailed information about FinTech startups, and the small number of available cases made in-depth analysis difficult. Because of these limitations, the authors suggested that future studies should use qualitative methods to better understand the barriers faced by FinTech startups. They also recommended further research on how Saudi consumers adopt and use FinTech services.

FinTech creates new, digital ways for people to manage their money, offering options outside of traditional banks. As a relatively new field, it is quickly changing the financial industry. A study by Vijai *et al.* [28] set out to look at the potential and the difficulties for FinTech in India. The research describes how this industry has developed and the kinds of digital financial technology currently in use there. A major advantage of FinTech is that it allows for digital transactions that are often more secure. These services are also typically cheaper to run and easier for people to use. In India, the FinTech sector is growing faster than anywhere else in the world and is changing how people and businesses handle money. The study found that even though India's economy has long relied heavily on cash, people have been quick to adopt these new digital tools. This shift is largely thanks to the growth of online shopping and the widespread use of smartphones. The Indian government is also supporting this change by encouraging new ideas and innovations in the FinTech industry.

Alkhazaleh *et al.* [29] conducted a study aimed at identifying the concept of financial technology (FinTech), its characteristics, contexts, development, and what it has gained from global investments. The study also examined the reality of FinTech in the Arab world, the most important emerging projects in this field, and the existing opportunities and challenges. One of the most important findings of this study is that FinTech is a newly established sector that offers all types of traditional financial services, but in a different, more complex, faster, and more precise style and form. The researchers also concluded that countries around the world have taken great strides in this area despite its novelty, while the use of FinTech and the volume of its transactions in the Arab world remain at a moderate level compared to the world's developed countries. The development of future strategies, electronic payment, and e-commerce that Arab countries are adopting for economic diversification encourages them to establish FinTech in their economies. The Arab world must seize the existing opportunities and confront the challenges facing the use of this technology, especially by developing modern regulatory laws that create a business environment that supports the economy generally.

The results of this research indicate that, despite the existing FinTech incentives in the Arab region, there are still many major structural and institutional limitations that restrict the growth of financial technology in Arab countries. The currently weak business climate in general, and the difficulties and restrictions that still exist for foreign entities entering the markets, hinder the entry of international FinTech companies that currently operate in European markets. Furthermore, the reduction of private capital and investment that underpins the existence and advancement of financial technology in the economy has contributed to creating a challenge in this area for every country. In fact, problems that need to be overcome quickly may include the lack of an appropriate level of legal regulations due to regulatory gaps that impede the growth of the financial technology sector. This is the case despite continuous work to develop regulatory frameworks for digital financial services and to draft laws concerning the issuance of digital currencies, as gaps still remain. On the other hand, the price and quality of internet and mobile services may be a factor creating pressure

and an obstacle in the financial technology sector, despite the high penetration rate of information and communication technology in recent years. Unfortunately, the necessary institutional support for a secure environment for FinTech remains below the required level, as few Arab countries have established sandboxes, startups, and accelerators to help increase FinTech use. These frameworks allow FinTech companies and institutions to conduct traditional innovation trials in a real-world environment. On the other hand, the demand for FinTech services, the "confidence gap," and financial awareness levels are a major limitation for FinTech startups, where the use of FinTech as a payment channel requires assurance to reduce uncertainty. Additionally, there is the problem of promoting these types of services and the issue of the level of customer education in Arab countries. Furthermore, there is the issue of cyber risk, where cyber-attacks might lead to operational disruption, financial losses, and damage to companies' reputations, potentially becoming a limitation or disability unless information security frameworks are strengthened. The strict implementation of bank secrecy law and money transfer regulations remains a constant threat to IMF FinTech companies. The IMF and World Bank introduced a joint plan called the Bali FinTech Agenda in 2018. Its purpose is to give governments and central banks a set of twelve guidelines to help them adopt and manage the rapid changes happening in financial technology.

Imam *et al.* [30] studied the growth chances and difficulties faced by different types of FinTech companies in the SAARC and ASEAN regions. Using Global Financial Inclusion data from the World Bank, they analyzed how people save, borrow, spend, and make payments. From this, they developed a new tool called the FinTech Opportunity Index (FOI) to measure both opportunities and barriers. Their findings show that while both regions have room for FinTech growth, the SAARC region offers more opportunities than ASEAN. However, the demand for services is not the same everywhere. In ASEAN, areas such as crowdfunding, Neobanks, and InsurTech appear promising, supported by strong interest in entrepreneurship and investment. In SAARC, healthcare-focused InsurTech, lending platforms, and Neobanks seem to have the greatest potential.

Although many studies have looked at FinTech in SAARC and ASEAN countries, important gaps remain. Most earlier work relied on small groups of participants, while this study uses a much larger sample from both regions. The dataset includes detailed questions on borrowing, saving habits, use of digital payments, and other financial activities. This broader information helps identify new opportunities for FinTech growth in these areas. Unlike previous research, this paper offers a fresh perspective on how FinTech is adopted in SAARC and ASEAN. One major gap in earlier studies was the lack of tools to measure both opportunities and challenges for FinTech firms. To address this, the authors created the FO, which evaluates opportunities and barriers by looking at people's saving, borrowing, spending, and payment preferences. The FOI is unique because it focuses on micro-level data—individual financial behaviors—rather than only macro-level indicators. While large-scale data such as the AFAI index is useful, micro-level insights provide a deeper understanding of how FinTech can expand in these regions. According to the authors, no index with this level of detail has been developed before. This study therefore fills an important research gap by offering a new way to assess FinTech opportunities and challenges in SAARC and ASEAN countries.

The research by Rahman *et al.* [31] explored the FinTech ecosystem, challenges, and prospects in Bangladesh, noting the increasing reliance of local financial institutions on these advanced services. Using a questionnaire and SPSS-based ranking analysis of IT-related individuals, the study found that FinTech is beneficial for users, business growth, and service diversification, particularly as international virtual transactions rise due to globalization. Key findings confirmed significant FinTech growth in Bangladesh. Blockchain technology and fund transfer were identified as the most disruptive technologies. Mobile applications currently have the highest impact, followed by websites

as key FinTech channels. However, the biggest challenges to FinTech growth are traditional business models and data storage issues. The study highlighted the human capital barrier as the most significant constraint, a point supported by a separate 310-survey review confirming that human capital development is the most critical factor for FinTech growth in the country. The authors note that this is the first study of its kind in Bangladesh, filling an important research gap by analyzing financial sector experts to identify primary opportunities and disadvantages.

The study by Yuniarti and Rasyid [32] analyzes the development potential, opportunities, and challenges of FinTech lending in Indonesia. The growth of this sector is fueled by the significant unmet financial needs of the public, which banks haven't addressed. The sector's formal foundation rests on the Financial Services Authority Regulation (POJK) No. 77 of 2018, which had led to 127 registered lending FinTechs by August 2019. However, the rapid growth has been accompanied by a surge in illegal FinTech companies and persistent issues regarding consumer protection. The legal research concluded that the existing regulations (POJK No. 77/2018 and the Code of Conduct) are currently insufficient to provide adequate legal protection for consumers. Therefore, the authors emphasize the need for a comprehensive new regulation to increase public confidence. Finally, the paper calls for further research to assess the efficacy of existing consumer protection measures, particularly concerning data protection, and to study the numerous lending activities that are not registered with the Financial Services Authority.

The study by Ahmed *et al.* [33] used a systematic literature review to assess the potential of big data to drive economic growth and innovation within Malaysia's FinTech sector. The research first outlined the current state of FinTech in Malaysia, including big data usage, key initiatives, and industry players. It then identified development challenges by analyzing technical, organizational, and environmental factors affecting big data use. Finally, it proposed strategies for organizations to overcome these obstacles. The findings highlight the immense potential of big data for financial institutions, enabling them to gain insights, identify trends, and improve operational efficiency. Big data is transforming financial service delivery by enhancing risk management, reducing fraud, predicting customer behavior more accurately, and improving customer experience. Leveraging data analytics allows FinTech firms to make informed decisions and offer personalized solutions, ultimately leading to greater convenience and improved services for customers. The primary challenges identified are data security and privacy, implementation/maintenance costs, and a lack of standardization. The authors recommend that financial institutions counter these by investing in data security infrastructure to realize the significant benefits big data offers the FinTech industry.

The research by Hao *et al.* [34] analyzed the rapidly growing FinTech market and startup ecosystem in Vietnam. The study found that the number of FinTech firms has quadrupled over the past three years, with the market valued at $9 billion in 2020. This growth is driven by high smartphone use (72% of adults), high internet penetration (64% of the population), a tech-savvy youth demographic, flourishing e-commerce, and government support, confirming Vietnam as a high-potential market. The authors note that Vietnam possesses the three core elements of a robust FinTech ecosystem: market access, government/legal support, and access to capital. To minimize risks and fully capitalize on opportunities, the paper emphasizes the critical need to develop the legal framework and government support policies.

The study proposed several mechanisms to enhance FinTech startup opportunities: Refining Policies: Completing existing mechanisms and studying new support and investment policies for startups. Establishing Support Centers: Creating National Digital Entrepreneurship Centers (for funding) and Creative Startup Centers in universities (for student resources and infrastructure). Ecosystem and Diversification: Building a comprehensive FinTech ecosystem involving banks, tech

companies, and government agencies, while diversifying products beyond basic payments and lending into areas like financial management, online investment, and personalized financial advice. Communication: Organizing regular digital forums and FinTech seminars to share experiences and provide policy recommendations to promote the sector.

The research by Laldin and Djafri [35] employed a qualitative, inductive, and descriptive approach to study FinTech innovation in Islamic finance and its adherence to Shariah parameters. The core finding is that FinTech is generally welcome (maslaha or beneficial) in Islamic finance, provided it does not explicitly contradict fundamental Shariah law. FinTech is seen as a positive development because it reduces costs, increases operational flexibility, expands customer reach, and improves capital efficiency. Islamic financial institutions should leverage it to innovate and develop products that benefit society and promote economic development, aligning with the broader objectives of Shariah (Maqasid al-Shariah)—human welfare. Crucially, the study emphasizes the need for a robust Shariah governance framework and for regulators to develop explicit Shariah standards specific to FinTech operations. The authors argue that the Shariah compliance rules for FinTech contracts should be the same as for any other financial contract. Specific regulations and standards are required to monitor FinTech activities, maintain stakeholder trust, and ensure the realization of Maqasid al-Shariah.

The research by Clements *et al.* [36] investigated the regulatory landscape and unique risks of FinTech in Canada and the United States, noting that while the two markets are similar, they face distinct challenges. The study highlights that in Canada, FinTech development is largely controlled by major banks, constrained by high entry barriers and fragmented regulation in non-federally supervised sectors. The Canadian regulatory structure is principles-based and features a working regulatory sandbox for securities. In contrast, the United States operates under a rules-based framework that may lead to regulatory dispersal, though there is a growing movement toward principles-based supervision. The researchers focused on jurisdictional differences, FinTech-specific risks, and regulatory issues like agency overlap and multiplicity of rules. They concluded that regulatory concerns for FinTech firms in both countries span key areas, including prudential standards, market conduct, anti-trust issues, credit risk, and connectivity risk.

A study compared how FinTech expands financial access in Africa and the United States [37]. In Africa, mobile money and digital banking have successfully reached people who lack traditional bank accounts. In the U.S., apps for payments, investing, and lending have made services more efficient and user-friendly. The research found that despite different economic conditions, both regions face similar obstacles. These include complicated government rules, a lack of public comfort with digital tools, and inadequate technology infrastructure. The study concludes that FinTech is a powerful tool for including more people in the financial system. It suggests that policymakers, banks, and tech companies must work together to address the common challenges of regulation, digital literacy, and infrastructure.

The research by Ololade [38] investigates the transformative influence of FinTech on financing for Small and Medium Enterprises (SMEs), conducting a comparative literature review between Nigeria and the United States. The study aimed to show how FinTech innovation is redefining SME financing by increasing access and efficiency. The analysis provided a dual perspective on FinTech's impact: United States: FinTech has transformed financing through alternative lending platforms, offering faster, less cumbersome options than traditional banks and expanding capital access for a wider range of SMEs. Nigeria: FinTech helps SMEs get the financing they often struggle to receive from traditional banks. Tools like mobile money and digital banking make this possible by solving common problems, such as a business not having enough assets for a loan or lacking a local bank

branch. The study found that three main things are causing this FinTech growth: helpful government rules, improvements in technology, and SMEs themselves wanting more adaptable financial services. Finnaly, the research shows that while using FinTech to boost business growth and the economy comes with both difficulties and possibilities, its overall role is very significant.

The research by Hikida and Perry [39] explores how the modern FinTech revolution—characterized by ubiquitous smartphone access to financial data and lower business costs from cloud computing/AI—is helping to overcome behavioral biases and constraints that prevent U.S. households from effectively smoothing intertemporal consumption. The study highlights that since the Great Recession, technological progress (mobile/cloud/AI) and increasing distrust in large financial institutions have fueled an explosive growth in FinTech startups. This has challenged traditional financial firms while creating new opportunities for households in areas like investment, credit, insurance, and payments. The authors note that empirical evidence suggests households routinely make suboptimal financial decisions (e.g., undersaving, overpaying on investments, poor debt management). The main contribution of the paper is demonstrating how FinTechs address these issues by improving access, choice, and efficiency. While the direct impact of FinTechs on households may be small due to low market penetration, the indirect effects are significant. FinTech's competitive entry forces incumbent financial firms to innovate (via partnerships, acquisitions, and new features), leading to downward pressure on pricing, accelerated innovation, and better choices for households.

The research by Ioannou and Wójcik [40] investigated the link between FinTech development and financial geography in Latin America, specifically focusing on Brazil, Mexico, and Argentina. They used a mixed-methods approach (quantitative data and expert interviews) to fill a gap in the literature. The study found that while FinTech adoption is growing rapidly (due to high bank costs and pro-inclusion policies), it remains on the periphery of both the global FinTech industry and Latin America's own established financial systems. Critically, the authors argue that FinTech has not challenged the high geographic concentration of financial services; instead, it has reinforced it. This is because FinTech firms tend to locate near existing financial centers where incumbent banks, capital, and skilled labor—the same hubs that host the technology industry—are concentrated. The researchers concluded that FinTech has not yet improved the region's low financial integration level. This persistent lack of integration is attributed to political, economic, and financial instability, coupled with inconsistent financial regulations.

4. Relevant Studies

This section provides a brief overview of several studies conducted by various researchers on the use of FinTech for different applications.

Research by Al Nawayseh [41] explored why people in Jordan used financial technology apps during the COVID-19 pandemic. The study, which surveyed 500 people, found that two main factors encouraged adoption: people needed to see a clear advantage in using the apps, and they were influenced by friends and family using them. A surprising finding was that potential risks, like security concerns, did not directly stop people from wanting to use FinTech. The most important factor was trust. The study showed that strong customer trust can make people overlook potential risks. The researchers concluded that for FinTech to be widely adopted, companies should focus on making their apps helpful, easy to understand, and most importantly, secure with user data to build that essential trust.

Leong and Sung [42] described FinTech as a field that integrates finance, technology management, and innovation management. They shared this definition with diverse groups,

including students and business professionals, and found that it helped audiences better understand FinTech and its potential impact. To explain how FinTech adds value to businesses, they grouped its applications into four key areas: (i) Payments, (ii) Advisory Services, (iii) Financing, and (iv) Compliance. They also highlighted emerging FinTech technologies and discussed how these innovations contribute to creating business value.

Over the past ten years, FinTech has drawn significant interest from researchers. Key questions include whether FinTech improves innovation efficiency at the regional level and whether its impact varies across different stages of the innovation process.

Prompted by these questions, Yang and Wang [43] examined how FinTech affects innovation efficiency and its spatial spillover effects using regional data from China. They applied a two-stage Data Envelopment Analysis (DEA) to measure innovation efficiency, focusing on both R&D efficiency and commercialization efficiency across different innovation processes. Using a spatial Durbin model (SDM) alongside a FinTech development index, their analysis showed that FinTech improves overall innovation efficiency and commercialization efficiency but has a smaller effect on R&D efficiency. The study also found that FinTech can have negative spatial spillover effects in neighboring regions during the commercialization stage. Additionally, they explored how the scope (breadth) and intensity (depth) of FinTech influence innovation and different types of patents. The results reveal that FinTech's impact is uneven, highlighting important considerations for regional development policies in the digital age.

The combination of AI and cloud computing has reshaped many industries, including FinTech. In this sector, using AI alongside cloud technology has greatly improved the security of applications. Kunduru *et al.* [44] explored how AI enhances cloud-based FinTech security. They looked at AI-driven tools such as anomaly detection, fraud prevention, threat intelligence, and risk assessment. The study also considered the challenges and risks of applying AI in this context. Through case studies and real-world examples, the research showed that AI provides clear benefits in safeguarding sensitive financial information and maintaining the reliability of FinTech applications.

FinTech, is a rapidly growing sector in the global market. As online transactions increase, the use of IT to automate financial services has become essential. FinTech allows institutions to offer services to customers worldwide around the clock, often providing easy access and enabling real-time transactions. These benefits contribute to its widespread popularity. However, because FinTech relies heavily on information, security has become a major concern. Weaknesses in these systems can lead to fraud, causing significant harm to both users and providers. To address this, ML techniques are applied for anomaly detection in FinTech applications. These techniques identify unusual activities in financial data and build models to predict potential fraud. Stojanović *et al.* [45] studied this issue and evaluated various anomaly detection methods. They tested several real-world and synthetic fraud datasets, finding that ML approaches help detect fraudulent activities with varying levels of success. The study also analyzed how specific features affect the performance of these methods and discussed the implications for enhancing the security of FinTech applications in the future.

The rapid expansion of the FinTech industry, fueled by mobile applications, has transformed financial services and offered users greater convenience than ever before. However, this growth also brings significant cybersecurity challenges. Mustapha *et al.* [46] explored the evolving cybersecurity landscape in mobile FinTech applications, aiming to identify key threats and propose practical solutions. These threats include data breaches, malware attacks, phishing, and identity theft. Because FinTech apps handle sensitive financial information, they are prime targets for cybercriminals. The study examined current security strategies and emerging technologies, such as

advanced encryption, biometric authentication, and AI-based anomaly detection. It also highlighted the importance of regulatory frameworks and industry standards in guiding cybersecurity practices. The researchers assessed how compliance requirements affect FinTech firms' ability to protect user data and analyzed real-world cases to understand the consequences of security breaches. The study provides practical recommendations for FinTech companies, regulators, and cybersecurity experts to strengthen security, build user trust, and support ongoing innovation in the mobile FinTech sector.

Crowdfunding is increasingly being used as an alternative way to raise funds for medical purposes, allowing capital to come directly from a wide and diverse group of contributors. Grassi *et al.* [47] conducted a systematic review of medical crowdfunding literature to explore its role in the healthcare sector. The healthcare industry, particularly the pharmaceutical field, has faced challenges in creating sustainable research and business models that satisfy both economic systems and investors. The study showed that patients and caregivers worldwide use online crowdfunding campaigns to cover medical expenses, often through one-time donation- or reward-based schemes, regardless of whether the healthcare system is public, private, insurance-based, or mixed. The research also examined factors influencing campaign success, including social and environmental behaviors, as well as basic demographics and medical conditions of campaigners. Additionally, it highlighted social and regulatory issues, such as growing inequality and stigma. While equity crowdfunding is changing how many businesses raise capital, the study found little consistent data on the effectiveness of medical equity crowdfunding in the healthcare sector.

With the rapid growth of IT in finance, FinTech has become an important area for organizations, offering tools to improve information processing and financial services. Traditional text passwords, despite their widespread use, have many security weaknesses. To strengthen authentication, Meng *et al.* [48] explored Graphical Passwords (GPs) as a safer alternative to complement standard password systems. Various GP methods, such as PassPoints, DAS, Cued Click Points, and GeoPass, have been proposed, with the Path-Based GP using a world map path as a credential. In their study, 120 participants—half with FinTech experience—tested the RouteMap scheme against two similar methods. Results showed that RouteMap improved authentication accuracy and memorability of multiple passwords. This research highlights the potential of combining graphical passwords with FinTech applications and encourages further studies to enhance security in the financial technology sector.

Priyadarshi *et al.* [49] examined how FinTech applications have expanded access to financial services, giving individuals and businesses more control over their finances. These applications have driven financial innovation, challenged traditional business models, and increased competition in the financial sector. They also have the potential to support economic growth, improve financial literacy, and promote financial inclusion globally. FinTech tools play a key role in gathering, storing, and analyzing information to help investors make better decisions, boosting investment activity and participation in capital markets. Traditionally, retail investors were often overlooked due to limited capital, risk aversion, and high servicing costs. FinTech has lowered these barriers, enabling broader participation. Using both quantitative and qualitative methods, including 150 online surveys, the study found that equity investors are increasingly relying on digital platforms, with cultural and behavioral factors also influencing their financial decisions.

FinTech companies are usually small to medium-sized startups aiming to challenge traditional financial systems. They differ in terms of their services and target customers. In Korea, Peer-to-Peer (P2P) lending firms are particularly prominent. P2P lending allows individuals to borrow or lend money online without going through traditional financial institutions, with services delivered entirely via mobile or web platforms. As a result, the number of mobile P2P lending users is growing rapidly.

Lee *et al.* [50] studied how users accept mobile P2P lending apps using the Technology Acceptance Model. Their findings showed that perceived ease of use, perceived usefulness, and user satisfaction strongly influence acceptance. These factors also shape users' attitudes toward the apps and their intention to continue using them.

Digital payments in FinTech are rapidly increasing, creating a need for secure and efficient cryptographic protocols for IoT-based wearable devices. These devices store user information and support payment functions through technologies like NFC and Bluetooth, ensuring authentication and confidentiality. However, wearable payment systems face multiple security threats. Bojjagani *et al.* [51] proposed a framework to address these risks, using a three-factor authentication approach that includes biometrics. The scheme combines Elliptic Curve Integrated Encryption Scheme (ECIES), Elliptic Curve Digital Signature Algorithm (ECDSA), and Advanced Encryption Standard (AES) to secure communication between devices. Its security was validated using the Real-or-Random (RoR) oracle model and the Scyther verification tool. The study also compared the proposed framework with existing methods, showing that it offers strong security while maintaining low communication costs and computational overhead. This makes it suitable for various remote and proximity payments, including nano, micro, and macro transactions via wearable devices.

5. Conclusion and Existing Challenges

Fintech refers to a collection of businesses that provide novel services by integrating financial solutions with the capabilities derived from information technology. Essentially, Fintech firms are nascent companies that use new technologies, often via the internet platform, to offer all financial products and services or financial services with greater speed and lower cost. In this article, we first provided a brief introduction to Fintech, briefly mentioned the goals of using Fintech, and offered explanations regarding the technologies related to Fintech and the types of services provided by Fintech. Next, we provided explanations about the various applications of Fintech in today's world. We then detailed some of the research conducted by different scholars concerning the use of Fintech in various aspects of human life. In this section, we will point out some of the challenges in using or developing Fintech. Some of the challenges of using Fintech include:

Different Legal Environments Across Countries: Despite the high acceptance of Fintech and the desire of countries and large corporations to invest in creative businesses, nascent companies have yet to adapt to the numerous legal environments. This issue has complicated the development of Fintech in many markets and hindered their expansion and globalization. This is particularly evident for foundational technologies like blockchain, where a lack of standardized regulations for smart contracts creates significant barriers to interoperability and global adoption [52]. According to technology experts, only 25 percent of Fintech firms potentially possess the capability for globalization. This figure is very low compared to other players in the Information Technology sector. One of the main reasons for this problem is the national laws (e.g., regarding Bitcoin) and the divergent legal frameworks of countries.

Lack of Financial Regulation: Fintech firms face at least three unique challenges for financial regulation: Fintech has led to a proliferation of small and large economic-financial actors who may be more sensitive to external shocks compared to traditional financial institutions. The operations of Fintech companies are considerably dependent on large, traditional financial institutions. If effective monitoring of their performance and behaviors is not possible for supervisors, problems arise, and the supervisory operation becomes difficult. Due to their small size and dispersed nature, Fintech companies have fewer restrictions concerning the requirements for their credit and reputation compared to large financial institutions.

Difficulty Attracting Investors within the Legal Framework: Given their nascent status, governments generally do not warmly welcome Fintech firms. Governments often align their strategies with large investment companies, making it difficult for Fintech firms to attract investment.

Lack of Confidence and Certainty in the Market: Fintech firms have disrupted the traditional business models of their competitors by exploiting their inherent agility compared to banks. This has negatively affected countries' economic growth rates and resulted in confusion, doubt, and price fluctuations in related markets. This uncertainty is further compounded by broader macroeconomic factors, such as the documented relationship between monetary policy uncertainty and stock market volatility, which can deter investment in innovative but perceived-as-risky sectors like FinTech [53]. Due to investors' tendency to reduce risk and the high uncertainty in Fintech-related markets, attracting investment in this area faces numerous challenges.

Money Laundering and Fraud: Changes in financial and non-financial markets are inevitable, and customers are increasingly inclined to use simple and practical software. Companies use the internet as a development infrastructure. Since the supervision of national and international bodies over this infrastructure is very limited, the risk of fraud and money laundering is higher in Fintech than for other financial market players. Therefore, it seems Fintech will face serious challenges in the not-too-distant future under the headings of controlling financial flows, money laundering, and terrorist financing.

Security: One of the greatest challenges in financial technologies is infiltration and attack on supporting systems. To develop certain business models, Fintech firms are compelled to access the information systems of supporting banks. On the other hand, banks are obliged to protect their customers' information, and customers are also reluctant to disclose their personal information. Addressing these threats requires robust technical countermeasures, such as novel, secure routing protocols for the interconnected devices that underpin many FinTech services [54], as well as a deep understanding of the human and organizational factors that influence cybersecurity effectiveness [55]. Therefore, Fintech companies must adopt effective measures to gain the trust of the banking industry and customers, providing the necessary guarantees to protect their information against cyberattacks.

Possibility of Money Creation: Money creation is the exclusive and definitive right of the Central Bank. Despite this, it appears Fintech has caused misunderstandings in the area of money creation.

Changing and Complex Technologies: The technologies used in Fintech are rapidly changing and developing. These changes can pose challenges for companies regarding system updates, staff training, and adaptation to new standards.

Cultural Barriers and User Acceptance: In some regions and cultures, the adoption of new and digital technologies can be slower. This challenge is significant for Fintech firms in markets where individuals have greater trust in traditional financial services or where access to digital technologies is limited. Overcoming these barriers requires a deep understanding of user perception, a challenge that is also central to technology adoption in other sectors, from the role of VR quality in shaping tourist intentions [56] to the cognitive frameworks that influence learning [57].Looking forward, as the sector matures, it may also need to adopt frameworks from other fields, such as strategic green control models, to address its environmental footprint and align with broader sustainable development goals [58].

Conflicts of Interest

The author declares no conflicts of interest.

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