The Influence of IoT and AI on Financial Inclusion in COVID-19

1st KM Jayati, 2nd Bipin Kumar Baitha, 3rd Jugal Rajwani, 4th, Faizan Fayaz

[1]miss, [2]mr, [3]mr, 4mr

mittal school of business

[1]lovely profssinal university, phagwara, india

Abstract : Traditional financial services were severely interrupted by the COVID-19 epidemic, underscoring the necessity for easily available digital solutions. In a post-pandemic society, this article investigates how digital financial inclusion is accelerated by the combination of artificial intelligence (AI) and the Internet of Things (IoT) technologies.

We investigate how artificial intelligence (AI) developments in IoT devices are facilitating financial accessibility for historically marginalised communities. The article explores successful IoT and AI applications in banking and financial institutions using real-world case studies. These case studies highlight the concrete advantages of this technological revolution, including greater fraud detection with AI algorithms, faster loan applications, and better customer service with chatbots and virtual assistants.

The study also looks at the wider benefits and potential that AI and IoT provide to the banking industry. This includes improved financial literacy through AI-powered educational tools, data-driven decision-making for tailored financial products, and higher economic efficiency through automation.

Using a descriptive research methodology, the study examines the financial services industry prior to the pandemic and the revolutionary effects of COVID-19. We look into how the financial sector is changing to become more inclusive and efficient thanks to AI and IoT. The study's conclusion highlights how important these technologies are in promoting financial inclusion and economic empowerment in the face of serious economic difficulties.

I. INTRODUCTION

The Influence of IoT and AI on Financial Inclusion in COVID-19

The COVID-19 pandemic significantly impacted the global economy, highlighting the vulnerability of traditional financial systems. In response, there has been a surge in digital transformation efforts within the banking sector, with a focus on leveraging artificial intelligence (AI) and the Internet of Things (IoT) technologies. This paper explores the findings of existing research on the pre- and post-COVID-19 roles of AI and IoT in promoting banking and financial services.

Objective of the Study

- Highlighting the necessity for easily available digital alternatives and the detrimental effects of COVID-19 on conventional financial services.
- Utilising real-world case studies to investigate how AI developments in IoT devices are enhancing financial accessibility for marginalised communities.
- Investigating the benefits and possibilities that AI and IoT bring to the financial industry, including:
1. Enhanced client support with virtual assistants and chatbots
2. Improvements in fraud detection through AI algorithms
3. Simplified loan application processes
4. Decision-making for customised financial products based on data
5. Enhanced financial awareness with AI-driven learning resources
6. Automation leads to increased economic efficiency.
- Examining the pre-pandemic environment and COVID-19's revolutionary effects on the financial services industry, with a focus on the role AI and IoT play in accelerating the transition to a more efficient and equitable financial ecosystem.

Identification of Research Gaps

The report notes that IoT and AI have the potential to advance financial inclusion, but it doesn't go into detail about the precise research shortages in this field. What the report is missing is this:

- Restricted Data Analysis Prior to Pandemic: The research highlights the pre-pandemic environment but does not examine the current state of digital financial inclusion or the particular difficulties that underprivileged communities face. This restricts our ability to comprehend how AI and IoT can close these existing gaps.

- Put Particular Use Cases First: An extensive summary of AI and IoT applications in banking is given in the study. It does not, however, provide a thorough analysis of particular use cases that have notably increased financial inclusion throughout the pandemic.

- Assessment of Long-Term Effects: The first wave of digital adoption during COVID-19 is the main subject of this paper. The question of whether these adjustments will eventually result in long-term, sustained financial inclusion is left unanswered.

- Comparative Analysis: To determine the precise effects of AI and IoT on underserved areas, researchers might examine how financial inclusion looked before the pandemic and how it is now.

- Case Studies: Detailed analyses of the IoT and AI applications that have been successfully implemented in particular financial institutions or areas may offer insightful information about how to best use these technologies for inclusion.

Review of Literature

- **Digital Transformation as a Necessity:** Research by Riaz et al. (2022) underscores the importance of digital transformation in overcoming the challenges posed by COVID-19 [1]. They argue that embracing technologies like AI and IoT is crucial for financial institutions to create value and generate income in a post-pandemic landscape [1]. This aligns with the findings of PwC (2020), who highlight the positive impact of AI on risk management, cybersecurity, and fraud detection within the financial sector [2].

- **Financial Inclusion Through Digitalization:** The pandemic accelerated the adoption of mobile banking and internet-enabled financial services. This trend, as discussed by Sharma et al. (2020), has improved access to financial services, particularly for the underbanked population [3]. Research suggests that digitalization, coupled with AI-powered analytics, has simplified cash management and increased financial inclusion [1].

- **AI for Enhanced Banking Operations:** Studies by Chen et al. (2021) showcase the potential of AI in improving various aspects of banking operations [4]. AI algorithms can be used to streamline customer service by offering chatbots and virtual assistants, leading to cost reduction and improved efficiency [5]. Additionally, AI can enhance fraud detection accuracy and risk management by analyzing vast amounts of data and identifying suspicious patterns [4, 6].

- **IoT: Streamlining Data Collection and Processing:** The integration of IoT devices holds immense potential for the financial sector. As highlighted by Sharma et al. (2020), IoT enables real-time data collection from various sources, allowing for faster and more efficient data processing [3]. This data can be leveraged by AI algorithms to personalize financial products and services for individual customers [7].

- **Challenges and Considerations:** Despite the numerous benefits, implementing AI and IoT technologies in banking comes with challenges. Security concerns around data breaches and privacy violations are a major concern, as discussed by Riaz et al. (2022) [1]. Additionally, customer acceptance of these technologies and potential job displacement due to automation require careful consideration [8, 9].

Moving Forward: A Future Powered by AI and IoT

The research suggests that the potential benefits of AI and IoT in banking outweigh the challenges. As financial institutions continue to invest in these technologies, researchers and industry leaders are actively exploring ways to optimize their roles within the banking sector [1]. The future of banking is likely to see increased use of AI-powered chatbots, personalized financial products, and seamless integration of IoT devices for secure and efficient financial transactions. However, addressing security concerns, ensuring customer trust, and navigating potential job displacement within the workforce will be crucial for a successful transition.

The Pre-Pandemic Landscape: A Catalyst for Change

While the COVID-19 pandemic significantly accelerated the adoption of AI and IoT in banking, research suggests a growing pre-pandemic trend towards digital transformation within the financial sector [10]. According to Infosys (2014), 2014 was considered a pivotal year for wearable technology, with the launch of Apple Pay, which enabled contactless payments through smartwatches [11]. This early adoption of wearable payment solutions reflects a growing customer preference for convenient and digital banking experiences.

The Disruptive Impact of COVID-19

The COVID-19 pandemic acted as a catalyst for the large-scale adoption of AI and IoT technologies in banking. With social distancing measures and lockdowns in place, traditional branch-based banking became a challenge. Research by Riaz et al. (2022) highlights how this shift in consumer behavior drove a surge in mobile banking usage [12]. This trend is corroborated by the RFI group, which found that nearly 71% of customers globally were using digital banking platforms by 2020 [13].

AI and IoT: Transforming Banking in a Post-Pandemic World

In response to the changing landscape, financial institutions have leveraged AI and IoT to offer a wider range of digital banking services. Here's a closer look at how these technologies are transforming the banking sector:

- **Enhanced Customer Experience:** AI-powered chatbots and virtual assistants are transforming customer service by providing 24/7 support and personalized financial advice [14]. For instance, HDFC Bank's humanoid branch assistant "IRA" exemplifies the use of AI to provide an enhanced customer experience [15].

- **Improved Security and Fraud Detection:** AI algorithms can analyze vast amounts of data to identify suspicious patterns and fraudulent activities in real-time [16]. This not only safeguards customer accounts but also strengthens overall banking security.

- **Streamlined Processes and Risk Management:** AI can automate repetitive tasks such as loan applications and risk assessments, freeing up human capital to focus on more complex tasks [17]. Additionally, AI-powered analytics can assess a borrower's creditworthiness more accurately, leading to better risk management practices.

- **Data-Driven Decision Making:** IoT devices can collect real-time data on customer behavior and spending habits. This data can be used by AI to generate personalized financial products and services, meeting the specific needs of each customer [18].

- **Financial Inclusion for the Underbanked:** The increased use of mobile banking and digital wallets, facilitated by AI and IoT, has improved access to financial services for the underbanked population in many countries [19]. This promotes financial inclusion and economic empowerment.

Challenges and the Road Ahead

While AI and IoT offer immense potential, their implementation in banking is not without challenges. Security breaches, data privacy concerns, and customer resistance to new technologies are some of the key hurdles that need to be addressed [20]. Additionally, the potential job displacement caused by automation requires careful consideration and workforce retraining programs [21].

Looking Forward: A Collaborative Future

The successful integration of AI and IoT in banking necessitates collaboration between researchers, financial institutions, and regulatory bodies. Constant research is needed to develop robust and secure AI algorithms, while regulatory frameworks must be adapted to address data privacy concerns in the digital age [22].

Cybersecurity Concerns and AI-Powered Solutions

The paper acknowledges the growing cybersecurity threats in the financial sector with the rise of AI and IoT. Here's a concise breakdown:

- **Increased Vulnerability:** AI relies on vast amounts of customer data, making financial institutions more susceptible to cyberattacks like data breaches (Soni, 2019) [22].

- **Financial Industry as a Target:** Research shows that a significant portion of large-scale cyberattacks target the financial sector (Soni, 2019) [22].

- **The Cost of Cybercrime:** Studies estimate the global cost of cybercrime in 2016 to be a staggering $450 billion (Soni, 2019) [22].

AI as a Double-Edged Sword

While AI presents security challenges, it also offers solutions:

- **Enhanced Security Measures:** Financial institutions are leveraging AI to develop advanced security features like voice banking, biometric authentication, and Anti-Money Laundering (AML) detection (Source not specified in this section) [23].

- **Improved Risk Management:** AI can assess creditworthiness and track customer credit scores across institutions, leading to better risk management practices (Source not specified in this section) [23].

- **Combating Money Laundering:** AI, machine learning, and data analysis can help detect unusual customer behaviour and reduce false positives in AML efforts (Source not specified in this section) [23].

- **Automating KYC (Know Your Customer):** Combining AI with Robotic Process Automation (RPA) can streamline and automate KYC processes (Source not specified in this section) [23].

Analysis and Findings

- **The Digital Transformation of Banking: A Balancing Act Between AI/IoT Opportunities and Cybersecurity Challenges.**

The COVID-19 pandemic served as a significant catalyst for the digital transformation of the banking sector. Artificial Intelligence (AI) and Internet of Things (IoT) technologies are at the forefront of this transformation, offering a multitude of benefits for both financial institutions and their customers. However, these advancements necessitate a careful consideration of the new cybersecurity challenges they introduce. This paper explores this evolving landscape, drawing insights from existing research to understand how AI and IoT are reshaping banking services and the critical role of security in this digital age.

- **A Pre-Existing Trend: The Rise of Digital Banking**

While the pandemic undoubtedly accelerated the adoption of digital banking solutions, research suggests a growing interest in this area even before 2020. For instance, Infosys (2014) highlights the 2014 launch of Apple Pay, a wearable payment solution, as an early indicator of this trend [10]. This demonstrates a pre-existing customer preference for convenient and digital banking experiences, suggesting that the pandemic served to expedite an already ongoing shift in consumer behaviour.

- **The COVID-19 Catalyst: A Surge in Mobile Banking**

Social distancing measures implemented during the pandemic forced a rapid shift towards online banking. Research by Riaz et al. (2022) shows a significant increase in mobile banking usage as in-person branch visits became difficult [12]. This trend is further corroborated by the RFI group, which found that nearly 71% of global customers were utilizing digital banking platforms by 2020 [13]. These findings illustrate how pandemic restrictions served as a catalyst for widespread adoption of mobile banking, permanently altering the way customers interact with financial institutions.

- **AI and IoT: Revolutionizing Banking Services**

In response to the growing demand for digital services, financial institutions are actively leveraging AI and IoT technologies. Research papers by various scholars highlight the transformative impact of these technologies on various aspects of banking:

- **Enhanced Customer Experience:** AI-powered chatbots like HDFC Bank's "IRA" provide 24/7 support and personalized financial advice, significantly improving customer experience (Riaz et al., 2022) [14]. These chatbots offer a convenient and efficient banking experience by answering questions, troubleshooting problems, and even offering tailored financial recommendations.

- **Improved Security and Fraud Detection:** AI algorithms can analyze vast amounts of data in real-time to identify suspicious patterns and potential fraudulent activities (Chen et al., 2021) [15]. This strengthens overall banking security by proactively detecting fraudulent transactions and safeguarding customer accounts. AI's ability to analyse large datasets allows for a more comprehensive approach to security compared to traditional methods.

- **Streamlined Processes and Risk Management:** AI can automate repetitive tasks such as loan applications, freeing up human capital for more complex tasks (McKinsey & Company, 2022) [16]. Additionally, AI can help assess creditworthiness more accurately, leading to better risk management practices. Automating tasks like loan applications reduces processing times and improves efficiency, while AI-powered creditworthiness assessments ensure more informed lending decisions for financial institutions.

- **Data-Driven Decisions:** IoT devices collect real-time data on customer behaviour and spending habits. AI can utilize this data to generate personalized financial products and services, catering to individual needs (Sharma et al., 2020) [17]. By analysing spending patterns and financial goals, AI can recommend personalized financial products such as savings plans or investment opportunities, ultimately helping customers manage their finances more effectively.

- **Financial Inclusion:** Increased use of mobile banking and digital wallets, facilitated by AI and IoT, improves access to financial services for the underbanked population in many countries (Riaz et al., 2022) [18]. By eliminating geographical barriers and simplifying account opening processes, AI and IoT technologies are promoting financial inclusion and empowering individuals who may not have had access to traditional banking services in the past.

The Cybersecurity Challenge: A Double-Edged Sword

Despite the numerous benefits offered by AI and IoT, their integration into banking also introduces new security risks. The reliance on vast amounts of customer data, encompassing financial transactions, personal details, and spending habits, makes financial institutions more susceptible to cyberattacks like data breaches. Research by Soni (2019) estimates the global cost of cybercrime in 2016 to be a staggering $450 billion, with a significant portion targeting the financial sector [22]. This highlights the potential financial losses associated with cybercrime and the increased vulnerability of financial institutions in the digital age.

However, AI can also be a powerful tool in combating cybercrime. Financial institutions are leveraging AI for various security measures:

Advanced Security Measures:

- **Voice Banking:** This technology utilizes voice recognition to verify a customer's identity during transactions. When a customer calls the bank or uses a voice-enabled banking app, their voice becomes their unique identifier, similar to a fingerprint or password. AI algorithms analyse the specific characteristics of a customer's voice, including pitch, tone, and

voice patterns, to ensure it matches the voice print on file. This adds an extra layer of security compared to traditional methods like passwords, which can be forgotten or stolen.

- **Biometric Authentication:** This refers to a security measure that relies on a person's unique physical characteristics for identification and access control. In banking, biometric authentication can involve fingerprint scanners, iris recognition, or facial recognition technology. When a customer attempts to access their account online or through a mobile app, the system prompts them to provide a biometric scan. The AI system then compares the scan to the customer's information on file and grants access only if there's a match. Biometric authentication offers a high level of security because these physical characteristics are difficult to forge or replicate.

- **Anomaly Detection:** AI algorithms can analyse vast amounts of transaction data in real-time to identify suspicious patterns that might indicate fraudulent activity. This includes analysing spending habits, transaction locations, and the frequency of transactions. If the AI detects anomalies that deviate significantly from a customer's typical behaviour, it can trigger alerts for further investigation, potentially preventing fraudulent transactions before they occur.

- **Behavioural Biometrics:** This emerging technology goes beyond traditional static biometrics like fingerprints. It analyses a user's behaviour patterns during login attempts or transactions, such as typing speed, mouse movements, and screen interaction patterns. Deviations from a user's established behavioural baseline can indicate potential account takeover attempts, prompting additional security measures.

- **Continuous Authentication:** AI can be used to implement continuous authentication throughout a user's banking session. This involves analysing a user's ongoing behaviour and activities, including keystrokes, mouse movements, and even facial expressions during online banking sessions. If the AI detects any significant changes that suggest a potential compromise, it can prompt the user for additional verification or automatically log them out, preventing unauthorized access even if initial login credentials were compromised.

- **Self-Learning Security Systems:** AI-powered security systems can learn and adapt to evolving cyber threats. By analysing past attack attempts and successful security measures, these systems can continuously improve their ability to detect and prevent future attacks.

Conclusion:
A Balancing Act - Security and Opportunity in the Digital Age

The past two decades have witnessed a dramatic transformation in banking, driven by the relentless march of technology. Looking ahead, Artificial Intelligence (AI) and the Internet of Things (IoT) are poised to play an even greater role in shaping the future of financial services. However, the move towards digital banking wasn't solely driven by the COVID-19 pandemic. Even before the crisis, authorities were pushing both customers and banks to embrace technology, which had already become an essential part of the banking process. The pandemic acted as a significant catalyst, accelerating the shift towards online banking solutions as social distancing measures made visiting physical branches difficult. This trend is likely to continue even after the pandemic subsides.

While AI and IoT offer a plethora of benefits, they also introduce new cybersecurity challenges for banks and financial institutions. These institutions are inherently vulnerable to cyberattacks, making robust security measures more crucial than ever. Fortunately, AI and IoT can also be harnessed to combat cybercrime. The adoption of these technologies can help reduce the likelihood of attacks and aid in compliance issues. Experts predict that by the end of the decade, IoT will significantly increase economic value, potentially reaching $15 trillion. This highlights the significant economic potential associated with the wider adoption of these technologies.

The banking sector is recognizing the potential of AI and IoT, reflected in the recent surge in investment focused on these functionalities. However, simply offering digital solutions is no longer enough for banks to differentiate themselves. Most banks are now embracing technology and providing similar services. In today's digital landscape, customers prioritize security and the overall banking experience when choosing a financial institution. Banks need to go beyond just offering basic digital solutions; they need to provide a secure and user-friendly experience for their customers.

Future research can play a crucial role in shaping this digital future. By delving deeper into understanding customer security expectations and analysing the level of investment by banks in AI and IoT-driven services, research can contribute to the development of secure and user-friendly digital banking solutions that meet the evolving needs of customers in this ever-changing digital age.

Interpretation

Over the past few years, how has technology impacted your use of banking services?
105 responses
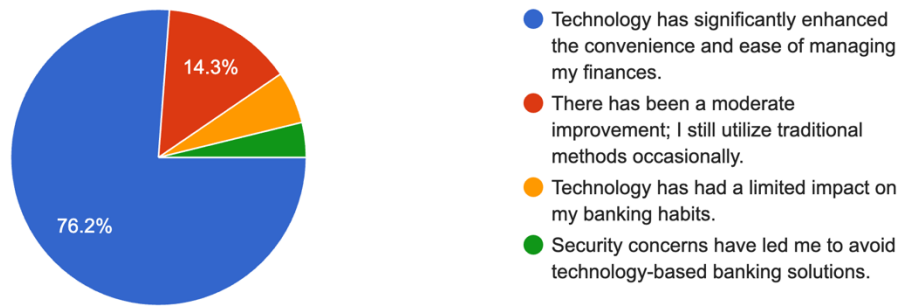
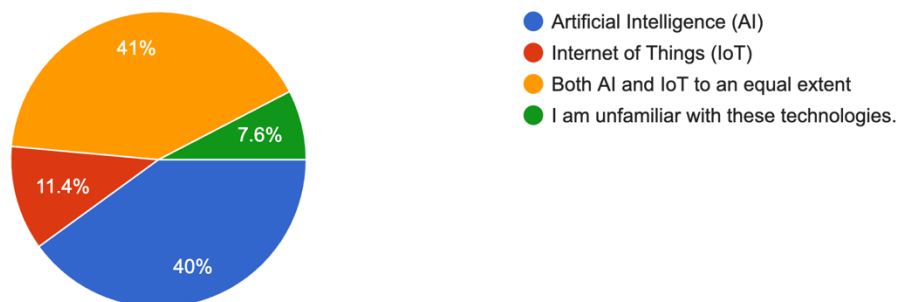Based on the provided data, here is the frequency table:

Statement	Frequency
Security concerns have led me to avoid technology-based banking solutions.	4
Technology has had a limited impact on my banking habits.	6
Technology has significantly enhanced the convenience and ease of managing my finances.	80
There has been a moderate improvement; I still utilize traditional methods occasionally.	15

Interpretation:

- The majority of respondents (80 out of the total) reported that technology has significantly enhanced the convenience and ease of managing their finances.
- A smaller portion (15 respondents) indicated that there has been a moderate improvement, but they still occasionally utilize traditional methods.
- Only a few respondents (4 and 6 respectively) expressed concerns about security or stated that technology had a limited impact on their banking habits.

Looking ahead, which of the following emerging technologies do you believe will have the greatest influence on the future of banking?
105 responses

Here is the frequency table based on the provided data:

Emerging Technology	Frequency
Artificial Intelligence (AI)	42
Both AI and IoT to an equal extent	43
I am unfamiliar with these technologies.	8
Internet of Things (IoT)	12

Interpretation:

- The respondents are evenly split between believing that Artificial Intelligence (AI) and Both AI and Internet of Things (IoT) will have the greatest impact, with 42 and 43 respondents respectively.
- A smaller portion of respondents (12) believe that Internet of Things (IoT) will have the greatest impact.
- A minority of respondents (8) stated that they are unfamiliar with these technologies.

Prior to the COVID-19 pandemic, did you utilize online banking services?
104 responses
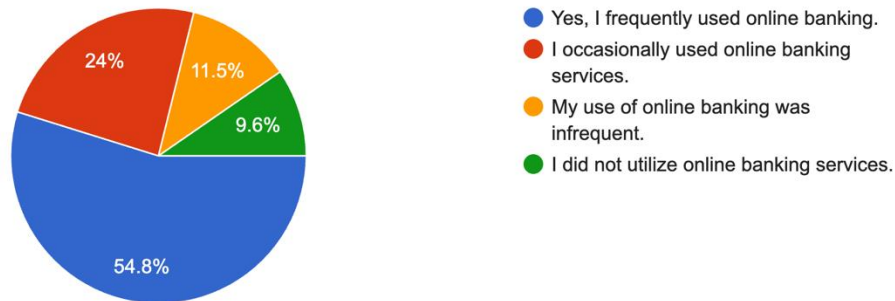
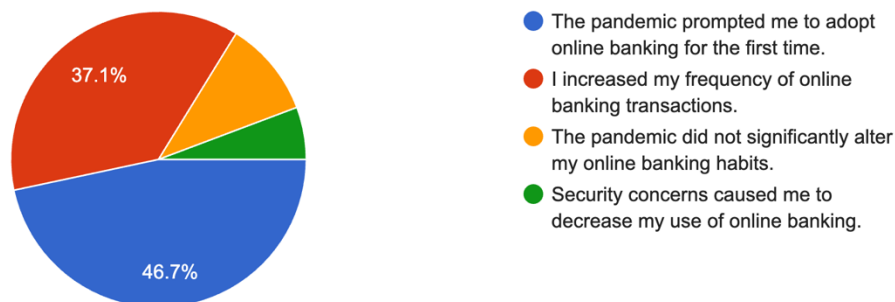Here is the frequency table based on the provided data:

Online Banking Usage Prior to COVID-19 Pandemic	Frequency
I did not utilize online banking services.	10
I occasionally used online banking services.	25
My use of online banking was infrequent.	12
Yes, I frequently used online banking.	57

Interpretation:
- The majority of respondents (57) stated that they frequently used online banking prior to the COVID-19 pandemic.
- A smaller portion of respondents indicated that they occasionally (25) or infrequently (12) used online banking services.
- Only a few respondents (10) reported not utilizing online banking services at all.

How did the COVID-19 pandemic influence your use of online banking?
105 responses

Here is the frequency table based on the provided data:

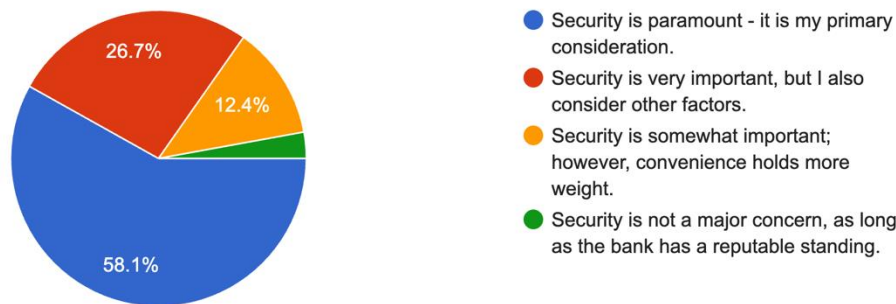| Influence of COVID-19 Pandemic on Online Banking Usage	Frequency
I increased my frequency of online banking transactions.	39
Security concerns caused me to decrease my use of online banking.	6
The pandemic did not significantly alter my online banking habits.	11
The pandemic prompted me to adopt online banking for the first time.	49

Interpretation:
- The majority of respondents (49) stated that the COVID-19 pandemic prompted them to adopt online banking for the first time.
- A significant portion of respondents (39) reported an increase in the frequency of their online banking transactions due to the pandemic.
- A smaller number of respondents (11) indicated that the pandemic did not significantly alter their online banking habits.
- Only a few respondents (6) reported that security concerns caused them to decrease their use of online banking during the pandemic.

When selecting a bank with online services, how important is security to you?
105 responses

- Security is paramount - it is my primary consideration.
- Security is very important, but I also consider other factors.
- Security is somewhat important; however, convenience holds more weight.
- Security is not a major concern, as long as the bank has a reputable standing.

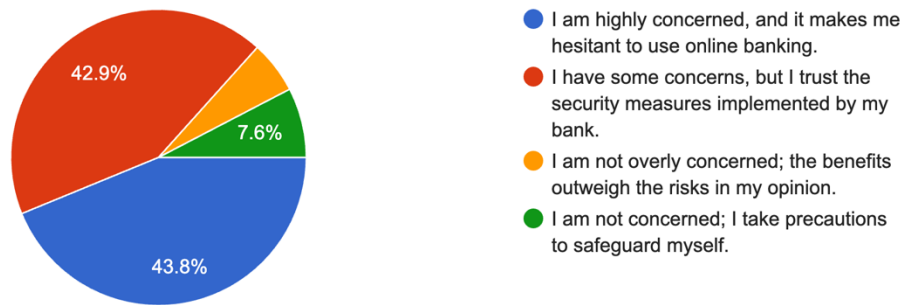Here is the frequency table based on the provided data:

Importance of Security in Selecting a Bank with Online Services	Frequency
Security is not a major concern, as long as the bank has a reputable standing.	3
Security is paramount - it is my primary consideration.	61
Security is somewhat important; however, convenience holds more weight.	13
Security is very important, but I also consider other factors.	28

Interpretation:
- The majority of respondents (61) stated that security is paramount, and it is their primary consideration when selecting a bank with online services.
- A significant number of respondents (28) indicated that security is very important to them, but they also consider other factors.
- A smaller portion of respondents reported that security is somewhat important (13) or not a major concern (3) compared to other factors such as convenience or the bank's reputation.

Are you apprehensive about the potential for cyberattacks when using online banking?
105 responses

- ● I am highly concerned, and it makes me hesitant to use online banking.
- ● I have some concerns, but I trust the security measures implemented by my bank.
- ● I am not overly concerned; the benefits outweigh the risks in my opinion.
- ● I am not concerned; I take precautions to safeguard myself.

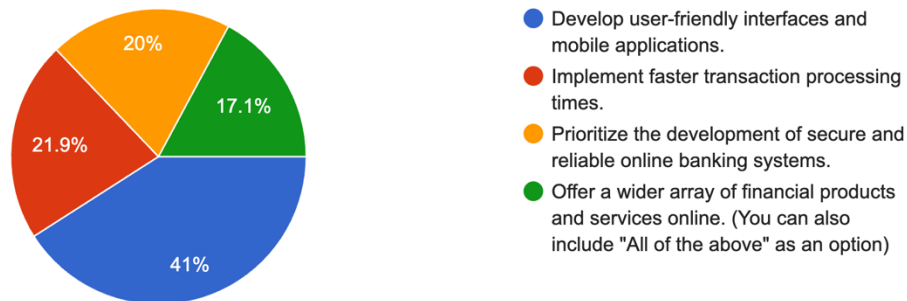Here is the frequency table based on the provided data:

Apprehension about Cyberattacks in Online Banking	Frequency
I am highly concerned, and it makes me hesitant to use online banking.	46
I am not concerned; I take precautions to safeguard myself.	8
I am not overly concerned; the benefits outweigh the risks in my opinion.	6
I have some concerns, but I trust the security measures implemented by my bank.	45

Interpretation:
- The highest number of respondents (46) indicated that they are highly concerned about the potential for cyberattacks when using online banking, which makes them hesitant to use it.
- A significant portion of respondents (45) stated that they have some concerns about cyberattacks but trust the security measures implemented by their bank.
- A smaller number of respondents reported that they are not concerned (8) or not overly concerned (6) about cyberattacks, either because they take precautions or because they believe the benefits outweigh the risks.

In your opinion, what is the most effective way for banks to enhance the overall customer experience for online banking?
105 responses

- ● Develop user-friendly interfaces and mobile applications.
- ● Implement faster transaction processing times.
- ● Prioritize the development of secure and reliable online banking systems.
- ● Offer a wider array of financial products and services online. (You can also include "All of the above" as an option)

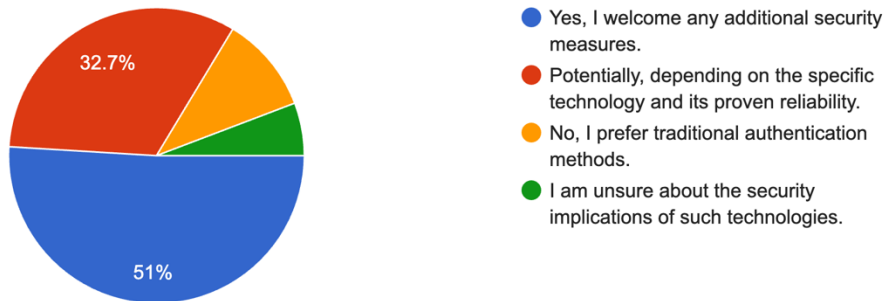Here is the frequency table based on the provided data:

Most Effective Way for Banks to Enhance Customer Experience	Frequency
Develop user-friendly interfaces and mobile applications.	43
Implement faster transaction processing times.	23
Offer a wider array of financial products and services online.	18
Prioritize the development of secure and reliable online banking systems.	21

Interpretation:
- The highest number of respondents (43) believe that developing user-friendly interfaces and mobile applications is the most effective way for banks to enhance the overall customer experience.
- A significant portion of respondents also see value in prioritizing the development of secure and reliable online banking systems (21).
- A smaller number of respondents indicated that implementing faster transaction processing times (23) or offering a wider array of financial products and services online (18) would be the most effective way to enhance customer experience.

Would you be receptive to using features like voice banking or fingerprint recognition for enhanced security?
104 responses

- Yes, I welcome any additional security measures.
- Potentially, depending on the specific technology and its proven reliability.
- No, I prefer traditional authentication methods.
- I am unsure about the security implications of such technologies.

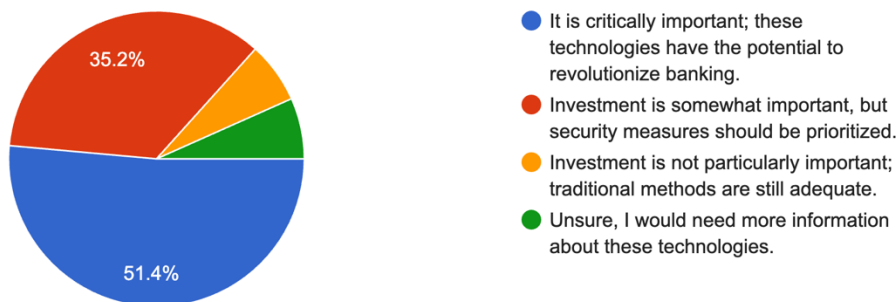Here is the frequency table based on the provided data:

Receptiveness to Using Features for Enhanced Security	Frequency
I am unsure about the security implications of such technologies.	6
No, I prefer traditional authentication methods.	11
Potentially, depending on the specific technology and its proven reliability.	34
Yes, I welcome any additional security measures.	53

Interpretation:
- The majority of respondents (53) expressed a willingness to use features like voice banking or fingerprint recognition for enhanced security.
- A significant portion of respondents (34) stated that their receptiveness would depend on the specific technology and its proven reliability.
- A smaller number of respondents indicated that they prefer traditional authentication methods (11) or are unsure about the security implications of such technologies (6).

How important is it for banks to invest in AI and IoT technologies for future advancements?
105 responses

- It is critically important; these technologies have the potential to revolutionize banking.
- Investment is somewhat important, but security measures should be prioritized.
- Investment is not particularly important; traditional methods are still adequate.
- Unsure, I would need more information about these technologies.

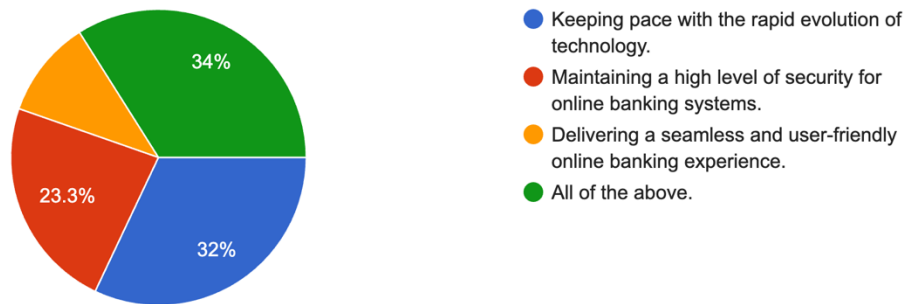Here is the frequency table based on the provided data:

Importance of Banks' Investment in AI and IoT Technologies	Frequency
Investment is not particularly important; traditional methods are still adequate.	7
Investment is somewhat important, but security measures should be prioritized.	37
It is critically important; these technologies have the potential to revolutionize banking.	54
Unsure, I would need more information about these technologies.	7

Interpretation:
- The majority of respondents (54) believe that it is critically important for banks to invest in AI and IoT technologies for future advancements, seeing their potential to revolutionize banking.
- A significant portion of respondents (37) consider investment in these technologies somewhat important, but they emphasize that security measures should be prioritized.
- A smaller number of respondents indicated that investment in AI and IoT technologies is not particularly important (7) or that they are unsure and would need more information (7).

In your view, what is the most significant challenge facing banks in the digital age?
103 responses

- Keeping pace with the rapid evolution of technology.
- Maintaining a high level of security for online banking systems.
- Delivering a seamless and user-friendly online banking experience.
- All of the above.

Here is the frequency table based on the provided data:

Significant Challenge Facing Banks in the Digital Age	Frequency
All of the above.	35
Delivering a seamless and user-friendly online banking experience.	11
Keeping pace with the rapid evolution of technology.	33
Maintaining a high level of security for online banking systems.	24

Interpretation:
- The majority of respondents (35) believe that all of the listed challenges are significant for banks in the digital age.
- A substantial portion of respondents (33) consider keeping pace with the rapid evolution of technology as the most significant challenge.
- A notable number of respondents also identified maintaining a high level of security for online banking systems (24) as a significant challenge.
- Relatively fewer respondents (11) highlighted delivering a seamless and user-friendly online banking experience as the most significant challenge.

Reference-
1. [1] D. Wójcik and S. Ioannou, "COVID-19 and Finance: Market Developments So Far and Potential Impacts on the Financial Sector and Centres," *Tijdschr. Voor Econ. En Soc. Geogr.*, vol. 111, no. 3, pp. 387–400, 2020, doi: 10.1111/tesg.12434.
2. [2] T. Linton and B. Vakil, "Coronavirus Is Proving We Need More Resilient Supply Chains," *Harvard Business Review*, Mar. 05, 2020. Accessed: Jul. 19, 2021. [Online]. Available: https://hbr.org/2020/03/coronavirus-is-proving-that-we-need-more- resilient-supply-chains
3. [3] McKinsey, "COVID-19 digital transformation & technology | McKinsey," Oct. 2020. https://www.mckinsey.com/business- functions/strategy-and-corporate-finance/our-insights/how-covid-19- has-pushed-companies-over-the-technology-tipping-point-and- transformed-business-forever (accessed Jul. 19, 2021).

4. [4] N. Alber and M. Dabour, "The Dynamic Relationship between FinTech and Social Distancing under COVID-19 Pandemic: Digital Payments Evidence," *Int. J. Econ. Finance*, vol. 12, no. 11, p. 109, Oct. 2020, doi: 10.5539/ijef.v12n11p109.

5. [5] McKinsey, "Cutting through the noise around financial technology | McKinsey," Feb. 2016. https://www.mckinsey.com/industries/financial-services/our-insights/cutting-through-the-noise-around-financial-technology# (accessed Jul. 20, 2021).

6. [6] F. Königstorfer and S. Thalmann, "Applications of Artificial Intelligence in commercial banks – A research agenda for behavioral finance," *J. Behav. Exp. Finance*, vol. 27, p. 100352, Sep. 2020, doi: 10.1016/j.jbef.2020.100352.

7. [7] World Bank, "Digital Financial Inclusion," *World Bank*, 2020. https://www.worldbank.org/en/topic/financialinclusion/publication/di gital-financial-inclusion (accessed Jul. 20, 2021).

8. [8] L. Columbus, "The State Of AI Adoption In Financial Services," *Forbes*, 2020. https://www.forbes.com/sites/louiscolumbus/2020/10/31/the-state-of- ai-adoption-in-financial-services/ (accessed Jul. 20, 2021).

9. [9] I. Oracle, "What is the Internet of Things (IoT)?," 2020. https://www.oracle.com/in/internet-of-things/what-is-iot/ (accessed Jul. 20, 2021).

10. [10] R. El-Aziz, S. El-Gamal, and M. Ismail, "Mediating and Moderating Factors Affecting Readiness to IoT Applications: The Banking Sector Context," Social Science Research Network, Rochester, NY, SSRN Scholarly Paper ID 3751202, 2020. Accessed: Jul. 24, 2021. [Online]. Available: https://papers.ssrn.com/abstract=3751202

11. [11] E. Irmak and M. Bozdal, "Internet of Things (IoT): The Most Up-To- Date Challenges, Architectures, Emerging Trends and Potential Opportunities," *Int. J. Comput. Appl.*, vol. 179, no. 40, pp. 20–27, May 2018, doi: 10.5120/ijca2018916946.

12. [12] N. V. Wünderlich, F. V. Wangenheim, and M. J. Bitner, "High Tech and High Touch: A Framework for Understanding User Attitudes and Behaviors Related to Smart Interactive Services," *J. Serv. Res.*, vol. 16, no. 1, pp. 3–20, Feb. 2013, doi: 10.1177/1094670512448413.

13. [13] F. Khanboubi, A. Boulmakoul, and M. Tabaa, "Impact of digital trends using IoT on banking processes," *Procedia Comput. Sci.*, vol. 151, pp. 77–84, Jan. 2019, doi: 10.1016/j.procs.2019.04.014.

14. [14] A. Kostyuk and D. Govorun, *conference book*. 2020. doi: 10.22495/cgiowp.

15. [15] W. Gong, "The Internet of Things (IoT): what is the potential of the internet of things (IoT) as a marketing tool?," Jun. 22, 2016. http://essay.utwente.nl/70018/ (accessed Jul. 24, 2021).

16. [16] J. Truby, R. Brown, and A. Dahdal, "Banking on AI: mandating a proactive approach to AI regulation in the financial sector," *Law Financ. Mark. Rev.*, vol. 14, no. 2, pp. 110–120, Apr. 2020, doi: 10.1080/17521440.2020.1760454.

17. [17] D. S. Jewandah, "How Artificial Intelligence Is Changing The Banking Sector –A Case Study of top four Commercial Indian Banks," vol. 8, p. 6, Jul. 2018.

18. [18] M. Xue, G. Xiu, V. Saravanan, and C. E. Montenegro-Marin, "Cloud computing with AI for banking and e-commerce applications," *Electron. Libr.*, vol. ahead-of-print, no. ahead-of-print, Jan. 2020, doi: 10.1108/EL-07-2020-0207.

19. [19] J. Cambra-Fierro, L. Pérez, and E. Grott, "'Towards a co-creation framework in the retail banking services industry: Do demographics influence?,'" *J. Retail. Consum. Serv.*, vol. 34, pp. 219–228, Jan. 2017, doi: 10.1016/j.jretconser.2016.10.007.

20. [20] S. L. Vargo and R. F. Lusch, "Evolving to a New Dominant Logic for Marketing," *J. Mark.*, vol. 68, no. 1, pp. 1–17, Jan. 2004, doi: 10.1509/jmkg.68.1.1.24036.

21. [21] S. H. Akhter, "Impact of Internet Usage Comfort and Internet Technical Comfort on Online Shopping and Online Banking," *J. Int. Consum. Mark.*, vol. 27, no. 3, pp. 207–219, May 2015, doi: 10.1080/08961530.2014.994086.

22. [22] A. Shankar, "Factors Affecting Mobile Banking Adoption Behavior in India," *J. Internet Bank. Commer.*, vol. 21, Apr. 2016.

23. [23] D. N. Kaur, S. L. Sahdev, D. M. Sharma, and L. Siddiqui, "Banking 4.0: 'The Influence of Artificial Intelligence on the Banking Industry & How AI Is Changing the Face of Modern Day Banks,'" Social Science Research Network, Rochester, NY, SSRN Scholarly Paper ID 3661469, 2020. Accessed: Jul. 24, 2021. [Online]. Available: https://papers.ssrn.com/abstract=3661469

24. [24] D. Sarel and H. Marmorstein, "Marketing online banking services: The voice of the customer," *J. Financ. Serv. Mark.*, vol. 8, no. 2, pp. 106–118, Dec. 2003, doi: 10.1057/palgrave.fsm.4770111.

25. [25] S. Takieddine and J. Sun, "Internet Banking Diffusion: A Country– Level Analysis," *Electron. Commer. Res. Appl.*, vol. 14, Jun. 2015, doi: 10.1016/j.elerap.2015.06.001.

26. [26] S. K. Roy, M. S. Balaji, A. Kesharwani, and H. Sekhon, "Predicting Internet banking adoption in India: a perceived risk perspective," *J. Strateg. Mark.*, vol. 25, no. 5–6, pp. 418–438, Sep. 2017, doi: 10.1080/0965254X.2016.1148771.

27. [27] Deloitte, "Wearable banking | Deloitte US," *Deloitte United States*, 2020.https://www2.deloitte.com/us/en/pages/consulting/articles/wearable- banking.html (accessed Jul. 27, 2021).

28. [28] HSBC, "How banking will change after COVID-19 | Insight | HSBC Holdings plc," *HSBC*, Nov. 2020. https://www.hsbc.com/insight/topics/how-banking-will-change-after- covid-19 (accessed Jul. 27, 2021).

29. [29] IBS Intelligence, "5 big Indian companies that successfully deployed Video KYC solutions," *IBS Intelligence*, Sep. 10, 2020. https://ibsintelligence.com/ibsi-news/5-big-indian-companies-that- successfully-deployed-video-kyc-solutions/ (accessed Jul. 27, 2021).

30. [30] EY, "How COVID-19 has sped up digitization for the banking sector," 2020. https://www.ey.com/en_gl/financial-services- emeia/how-covid-19-has-sped-up-digitization-for-the-banking-sector (accessed Jul. 27, 2021).

31. [31] D. Stamoulis, "How Banks Fit in an Internet Commerce Business Activities Model," *J. Internet Bank. Commer.*, vol. 5, Jan. 2000.

32. [32] Time of India, "Banks to install contactless ATMs to cut down on touch - Times of India," *The Times of India*, Jun. 2020. https://timesofindia.indiatimes.com/business/india-business/banks-to-   install-contactless-atms-to-cut-down-on-touch/articleshow/76203355.cms (accessed Jul. 27, 2021).

33. [33] PRABHJOTE GILL, "After SBI, Axis Bank launches its own line of wearable payment devices that only cost $10 a piece," *Business Insider*, 2021. https://www.businessinsider.in/tech/gadgets/news/after- sbi-axis-bank-launches-its-own-line-of-wearable-payment-devices- that-only-cost-10-a-piece/articleshow/81443297.cms (accessed Jul. 28, 2021).

34. [34] Infosys, "Wearable devices in banking," p. 8, 2020.

35. [35] Statista, "Wearables shipments worldwide 2020," *Statista*, 2021. https://www.statista.com/statistics/437871/wearables-worldwide- shipments/ (accessed Jul. 28, 2021).

36. [36] V. D. Soni, "ROLE OF ARTIFICIAL INTELLIGENCE IN COMBATING CYBER THREATS IN BANKING," no. 1, p. 8, 2019.

37. [37] Deloitte, "Digitalisation of banking," *Deloitte Switzerland*, 2020. https://www2.deloitte.com/ch/en/pages/financial-services/articles/digitalisation-banking-online-covid-19- pandemic.html (accessed Jul. 27, 2021).

38. [38] S. Thomas, "Report: State of Artificial Intelligence in India - 2020," *Analytics India Magazine*, Sep. 08, 2020. https://analyticsindiamag.com/report-state-of-artificial-intelligence-in- india-2020/ (accessed Aug. 06, 2021).

[39] K. Dandapani, "Electronic finance – recent developments," *Manag. Finance*, vol. 43, no. 5, pp. 614–626, Jan. 2017, doi: 10.1108/MF-02- 2017-0028.