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TECHNOLOGY IN FINTECH - HOW TRENDS SHAPE FINANCE

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Abstract

The finance and banking industry has been reshaped due to the new digitalization trends. FinTech becomes a common concept in the finance field, representing outstanding innovations taken by organizations engaged in financial activities. This word encompasses various strategies, from customer' security to the distribution of technology in financial services. Besides, the current technology that has a huge potential for implementation in various sectors is blockchain technology. The study aims to analyze blockchain as a foundation technology, which is already known as a part of Bitcoin, can also be the "new Internet".

This thesis is a literature review that provides a theoretical framework to examine how FinTech technology affects the financial industry. The objective of the thesis is to define the concept of FinTech. The goal was to determine a report about highlighted technology first, then the evolution of the most significant FinTech' innovations: blockchain and cryptocurrency, and finally developed a demo of them. Quantitative research is used to identify the working principle of these technologies, security threats, and their effect in the banking and financial industry.

Keywords

Finance, Banking, FinTech, Blockchain, Cryptocurrency

CONTENTS

1 INTRODUCTION

The financial technology industry includes technology-friendly businesses that provide financial services, and companies specifically offer technology services to financial institutions. Additionally, FinTech is rapidly becoming a global movement headed by developers and closely pursued by academics. FinTech is term includes the creative financial institutions that support technologies and business models surrounding these services. FinTech can be used to explain how organizations aim to change the financial services operations and their distributions. The new wave of FinTech start-ups and investors are encouraging established financial companies to invest in technology and pay attention to evolving consumer trends.

Undoubtedly, the standards and commitments of consumers are evolving dramatically. Customers increasingly appreciate a new viewpoint that has almost complete immediateness. Besides that, they can quickly get access to information, technology gadgets like smartphones and tablets, and other developments such as the Internet of Things (IoT).

In FinTech's start-up world, companies are trying their best to improve financial services and activities. For instance, Affirm aims to eliminate credit card businesses from online payments by giving customers a way to obtain short-term instant credits for purchases. In the last decade, the variety and scope of FinTech start-ups have increased significantly. Five years ago, $12 billion was raised in funding by the FinTech industry; in 2018, over $31.85 billion is individually raised by the top 250 FinTech companies. According to the CB Insights (2018) report, FinTech start-ups earned $17.4 billion in 2016 and on target to double the number by 2017. The majority of FinTech start-ups are found in North America and Asia. In the first quarter of 2018, global FinTech investment reached a new height as this industry grew rapidly in North America. Also, Asia saw an upward trend. Funding investment in Europe was poor but increased in the second quarter.

Based on the terms digitization and digitalization used in Gobble (2018), FinTech is more and more incorporated into daily economic transactions. The penetration index of Ernst & Young (2017) found that almost 1/3 of customers in 20 surveyed markets were using at least two FinTech platforms, with 84% aware of FinTech. The finance industry has already recognized the promise of FinTech. In addition, the FinTech Pulse study reports that global FinTech investments have grown by more than twice the number of multi-channel agreements from $50.8 billion in 2017 to $111.8 billion in 2018.

The growth story of FinTech has gained attentions from well-established financial institutions. Big banks have already spent capital in this market (CB Insights 2018). Companies such as Goldman Sachs and JPMorgan are creating and pushing innovative projects by supporting FinTech entrepreneurs and exchanging expertise with FinTech companies and stakeholders.

However, some FinTech companies have already faced some tough realities. They cannot provide a consistent value plan for their services and customers. In fact, financial activities are one of the world’s highly most regulated sectors. Moreover, FinTech is frequently conducted in areas with little regulatory guidance since it targets emerging industries and delivers financial resources to new communities.

For a long time, the banking industry has difficulty approaching client satisfaction (e.g., credit cards). It also includes all the items and services used by the client: retail bank, company bank, product services such as insurances and savings. Collaborative work is a central factor of FinTech's future. According to statistics, up to 95% of FinTech businesses struggle without strategic partnerships. The main reason is that most of these companies have trouble incorporating and deploying solutions across regional and country-specific regulatory borders. Therefore, they cannot reach the consumers. FinTech start-ups also struggle to secure organizational ability, particularly the considerable investment in IP (Lee and Shin 2018). For them, this is compounded because they often can't show their established business model and fail to identify the required market.

This study is an overview of FinTech's theoretical research and its connection with the banking and finance industry. It describes FinTech, discusses some statistics and stylized data, and examines the academic and scientific literature. Five key study topics are discussed in the study.

In order to complete the thesis, quantitative method is used throughout the study. The structure of the thesis is as follow:

- **Chapter 1** (Introduction) introduces the meaning of FinTech and the current effect of those technologies on to finance industry.
- **Chapter 2** (About FinTech*)* includes the research about technology contributed to FinTech such as the present and new trends that shape financial technology.
- **Chapter 3** (Privacy and Security Issues in FinTech) introduces the security threats and risk mitigation suggestions to reduce the losses of money and customer's personal information.
- **Chapter 4** (FinTech through COVID-19 and the future of FinTech) gathers the difficulties of FinTech companies in the pandemic and show predictions of this industry.
- **Chapter 4** (BlockChain and Cryptocurrency) includes theory gathering about one of the most successful technology of FinTech.
- **Chapter 5** (Implementation) describes the process of using sample codes to create a demo of blockchain and a cryptocurrency.
- **Chapter 6** (Conclusion) summarize the contribution of FinTech.

Let's start the literature study with chapter 2, the overview of FinTech.

2 THE OVERVIEW OF FINTECH

Nowadays, FinTech expands to numerous industries and businesses such as education, retail banking, sponsorship, non-profit administration, wealth management. With the growth of FinTech, chatbots and artificial intelligence have become very popular for the media in recent years, as well as blockchains and crypto properties. Worldwide, Eastern technology firms introduced super-app messaging systems with hundreds of millions of users and built-in financial services that outstrip the capacity of western jurisdictions. American tech companies have also deeply explored ways of supplying financial products

without affecting the third rail of regulation. In this chapter, I will discuss the evolutions and technologies of FinTech.

2.1 FinTech Evolutions

New technologies like machine learning/AI, predictive behavioral analytics, and data-driven marketing will take the “guesswork” out of financial decisions in today’s world. “Learning” apps will not only learn users’ habits but also engage users to improve their automatic, unconscious spending and saving decisions better. FinTech provides automatic customer services technologies like chatbots and AI interfaces to assist customers with basic tasks, cutting down staffing costs. Furthermore, FinTech is also being used to fight fraud by leveraging information about payment history to flag transactions outside the norm (Zetzsche et al. 2017). Figure 1 shows the technology evolution of FinTech.

These are several of most successful fields in FinTech:

- Digital cash and cryptocurrencies.
- Blockchain technology (including Ethereum), which keeps information on a computer network but has no central ledger.
- Intelligent contracts that use computer programs to execute contracts between buyers and sellers (often using the blockchain) automatically.
- Open banking is a blockchain-based concept where third parties can have access to banking data to create apps that build a linked network between financial institutions and third-party providers.
- Insurtech, which attempts to automate and streamline the insurance sector by leveraging technology.
- Regtech, which strives to assist financial service providers to comply with business laws, particularly those relating to anti-money laundering and the protocols on fraud battling with the client.
- Robo experts, such as Betterment, use algorithms to simplify investment recommendations to reduce their costs and improve usability.
- Unbanked are programs intended to represent poor or low incomes that, by conventional banks or large financial services firms, are neglected or under-served.
- Cybersecurity is interconnected with cyber defense amid the prevalence of decentralized data storage.

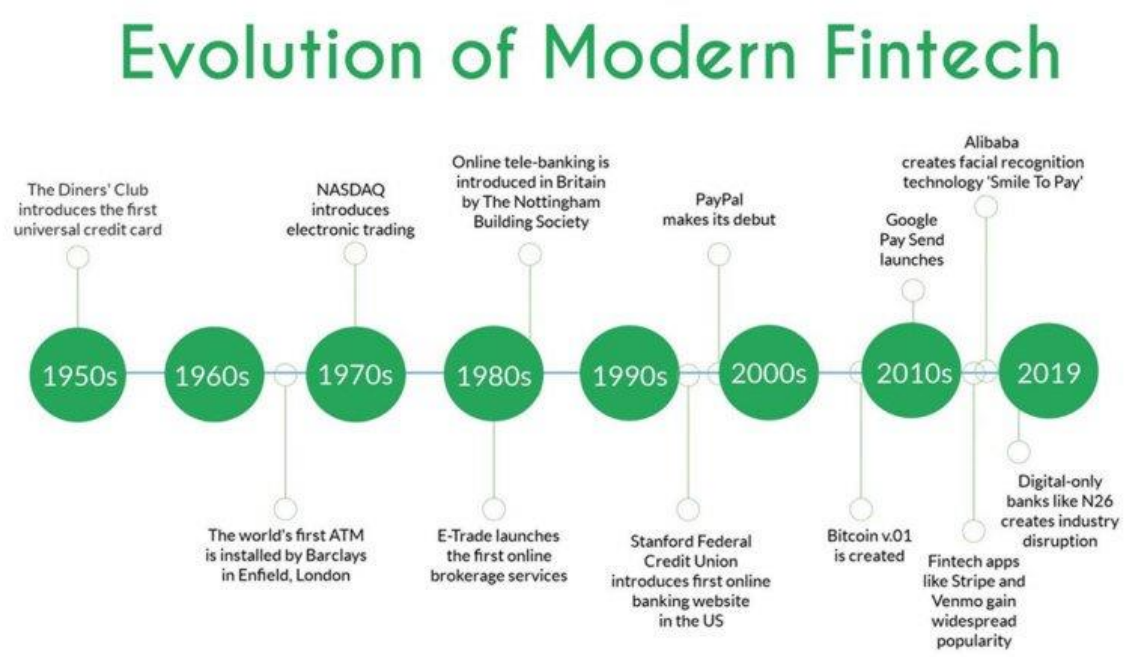


Figure 1. FinTech evolution

2.2 FinTech Trends

There is no question that technology developments progress rapidly regardless of which industry you look at as well as consumers demand more as they are increasingly technologically knowledgeable. When businesses struggle to fulfil those requirements, they will have fewer resources to accomplish the important corporate targets. In order to keep an eye on the growth of financial market, what development and innovations are important? In recent years, technological disruption has undeniably been the most disruptive factor in today's financial service ecosystem. As a result, the global investment in new digital capabilities is growing by financial services organizations. They are digitalized to serve the different roles from regulatory adherence to consume service and product growth, which have disturbed their businesses (Dostov et al. 2017). Figure 2 shows the latest FinTech trends.

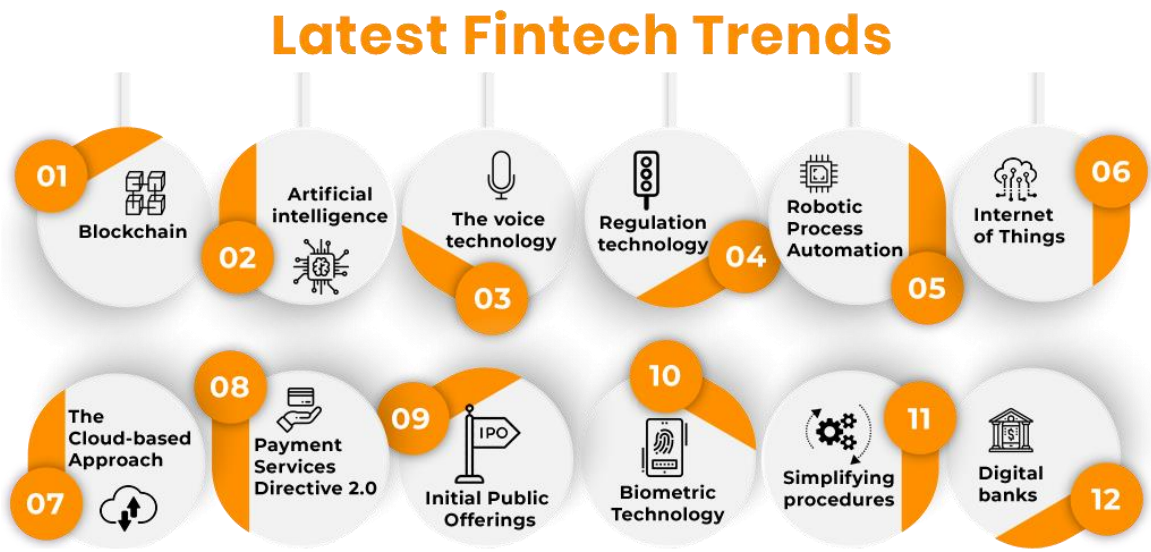


Figure 2. FinTech Trends

2.2.1 DARQ Powers

In reality, this pattern consists of four innovations that will influence the industry to a different degree. The main emerging technology is DARQ: DLT, artificial intelligence (AI), extended reality (XR), and quantum computer technology. Accenture has carried out some analysis on DARQ, which has shown that 89% of companies that are researching DARQ technology, predicting that they will be the main differentiators, and are growing their DARQ investments considerably. This is a scientific advance. Figure 3 shows the experiment of businesses using DARQ technologies.

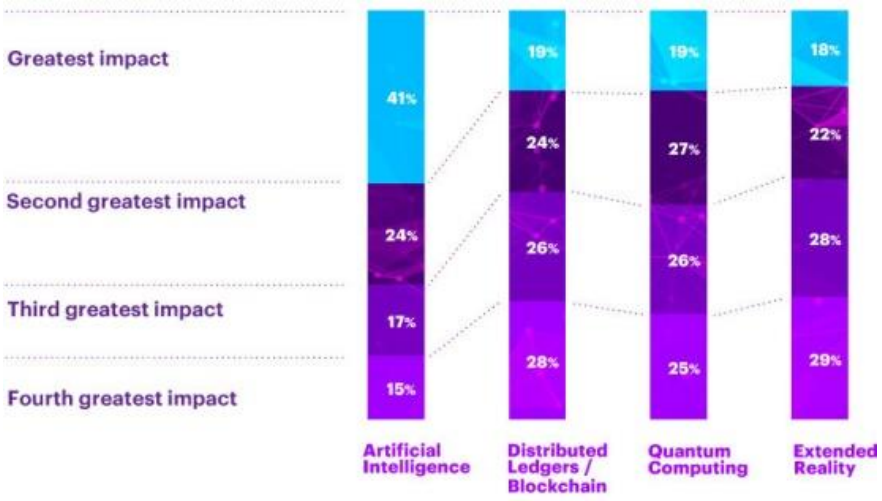


Figure 3. Good impacts of DARQ Powers (https://www.accenture.com/us-en/insights/technology/new-emerging-technologies-darq)

2.2.2 Distributed Ledger Technology (DLT)

Mainly a cornerstone of cryptocurrency and blockchain, DLT permits customers and companies to search their data and uncertainly execute transactions. This ensures that individuals can exchange goods on the Internet without, e.g. a bank verifying the transaction. Most organizations move into a centralized database in a fixed place - the entire system is involved if there are errors in the central database. DLT uses a wide range of decentralized databases, eliminating threats. In the future, some believe it can be used in tax collection, social benefits distributions and voting.

The technology also can efficiently reduce the expense of banking paperwork and transfers. It is also obvious that DLTs will speed up the procedures involved in trade settlement. In a partnership called R4, five of the biggest banks in the world are jointly investigating the possible application of technology in the financial industry. In 2022, Santander, one of the banks in R3, predicts future savings of USD 20 trillion per year as they apply to Bitcoin transfers, real estate, and so on. Also, Deutsche Bank analysts predict that Bitcoin can become a term of asset in the future.

2.2.3 Artificial Intelligence (AI) and Machine Learning (ML)

AI is evolving fast, and we already use this in our everyday lives. For example, in our smart speakers, email filters, chatbots, LinkedIn work features, search engines, etc. At the entire level, AI is a learning machine and business logic algorithm (regular programming code that says "if that is done"). Machine learning is a data processing tool that automates the creation of an analysis model. It is based on the premise that systems can learn from knowledge, recognize patterns and make decisions with no contact between human beings. Data collection and AI facilitate the production, as a basis of customer support, of goods that satisfy and foresee customer requirements and actions. This is relevant because banks, financial institutions, and insurance providers aim to personalize the individual customer's interactions.

Companies will offer a greater user service in all customer contact areas with personalization capabilities built into digital solutions. This is also affecting the market. Some friendly-user and popular example are Siri and Alexa – they are real applications of AI in our daily life. On the contrary, Al are now facing some unsolved threads:

Figure 4. Al Threat Landscape (https://www.enisa.europa.eu/news/enisa-news/enisa-ai-threat-landscape-report-unveils-major-cybersecurity-challenges)

2.2.4 Extended Reality

For a variety of technology, XR is a paragraph word, AR, VR, MR, etc. The influence this would have on the finance sector ranges from one viewpoint to another. The general agreement is that it would have any effect on it, especially as 5G is increasingly common.

It may be too difficult to thrive in the VR system for interactive advice and gamification of services. Examples of AR already used in the industry are available. One example is the CBA: prospective buyers can walk past a house for sale and get information and look inside the house. The closest ATM to conduct

simulated meetings etc., can be found for other functions. Yet, in the next few years, we will see even more applications of AR.

2.2.5 Quantum Computing

Quantum computers can more effectively handle vast and dynamic databases than traditional computers. They use the basic concepts of quantum mechanics to speed up the solution of complicated equations. While the quantification market remains in the early stages, several major technology firms, including Google, use it in their ability to crack encryption and encrypt electronic correspondence to rethink problems of computer security. With greater affordability, businesses will benefit from Quantum computers in many fields, including banking, to transform value chains.

In particular, quantic computing fields that have the greatest opportunities in financial services solve difficult problems of optimization like maximizing portfolio risk and detecting fraud. Concerning financial analysis, this will help to remove blind spots in data and stop the development of baseless financial conclusions. Nevertheless, we have not yet discussed many other applications for quantum computing.

2.2.6 Robotic Process Automatic (RPA)

The automation of RPA or Robotic Method is here to eliminate human errors and to simplify human efforts. 70% of financial sector firms are said to start using their company using RPA tools by the end of 2021. One of the key advantages of RPA is that non-developers can quickly adapt workflows, even people with no technical knowledge. For the same reason, in 2021, we have to see technological developments that use process architecture, bots, and the automation of workers' duties.

2.2.7 Other Technologies

- Voice technology

The number of people using Siri, Alexa, and Google Assistant is the and keeping this pattern in mind, the today's banks are taking steps forward and using AI-driven voice technology that can enable them to protect their banking transactions and boost their customer service. In 2021 we can also see that the bank account is validated securely using speech recognition technologies. The added value of voice technology would be that it allows consumers to move capital, pay mortgages and check recurrent balances.

- Regulation technology

FinTech is a fully financed industry, but it needs to comply with regulatory legislation at all costs, and that is the value of regulatory technologies. It will help financial firms cover both the risk control and regulatory paradigm. The investments in RegTech are predicted to rise by 500 percent by 2021 based on Crowd Learning Hub forecasts. Now it means that over three years from 2017, this number is rising from 106 million to 53 billion dollars.

The European Securities and Markets Authority said that the growth in man-made intelligence and machine learning software would make RegTech accessible during its speech on the growth of RegTech and SupTech. Algorithms for machine learning allow bankers, and even banks, to meet and review the rules that the latest ones will obey.

- Biometric technology

Customers are commonly used in biometric applications to have better safety controls. Nevertheless, it is often used for fast account verification and tests so that users can securely and quickly login. This FinTech sector aims to reduce fraud and vulnerability and to strengthen protection by prioritizing the fight against cybercrime.

2.3 FinTech Application

FinTech technology growth has changed the banking and finance market in a variety of ways. FinTech applications types include digital transfer, control of savings and resources, loan/lending, trade, human banking and InsurTech.

FinTech industry can turn the essence of the market into technology and trends, which create a closer partnership between retailers and consumers. All of these resolve the issues of financial inclusion. Without hesitation, market executives are motivated to integrate FinTech culture in their business strategies of blockchain, big data, AI, ML, and so many other leading-edge innovations.

2.3.1 FinTech Applications

FinTech is the fusion of finance and technology, as the name suggests. Any company that uses IoT (Internet of Things), i.e. smartphone, Internet, cloud, and financial support technologies, is called FinTech. The way they conduct their activities has brought a big revolution to conventional banking and financial services. FinTech technology growth has, in a variety of ways, changed the banking and finance market. Additionally, some research found that India was the fastest-growing ecosystem in this field between 2015 and 2018, with more than 1,500 FinTech startup companies overtaken Germany, United Kingdom, and Singapore. It was originally confined to backend applications but is now used extensively for online purchases, mobile payments, money management, inventory, etc. In other words, the financial ecosystem has evolved, and the central payment mechanism has been digitally converted. Financial companies, banks, and couriers are adapted to the public demand and are dedicated to digitalizing data, Bitcoin, blockchain, and AI usage to draw and maintain consumers (Artificial Intelligence). The use of FinTech software and tooling has made all this possible. Figure 5 shows four major applications of FinTech.

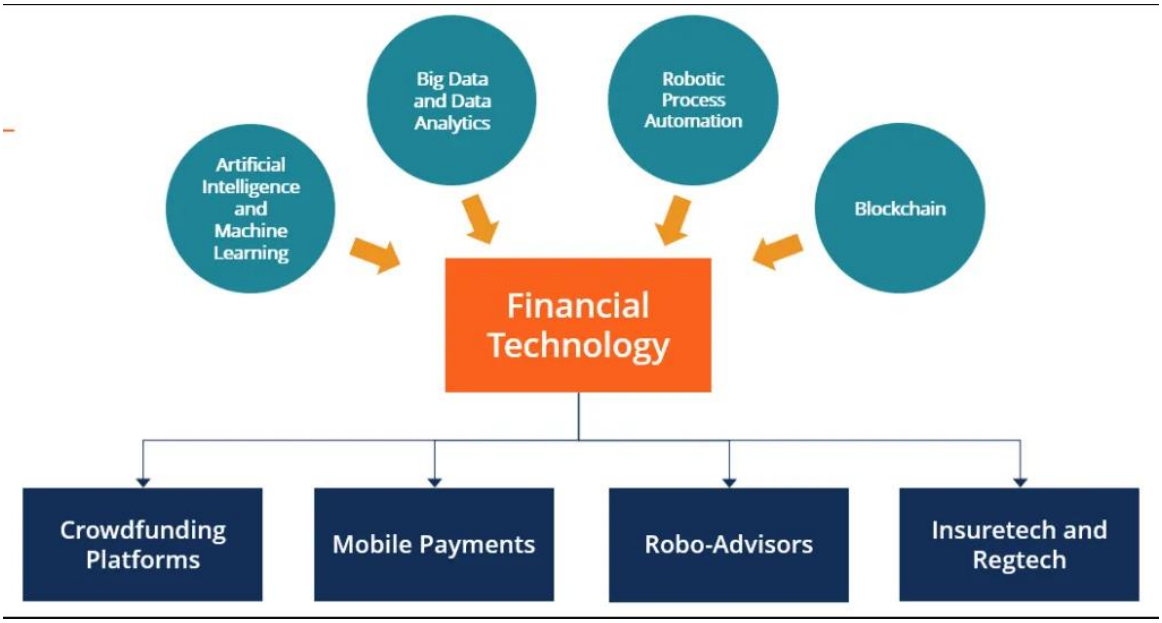


Figure 5. Applications of FinTech

Firstly, let's talk about Crowdfunding Platforms. There are several websites such as Kickstarter, GoFundMe and Patreon. These websites authorize founders and start-ups to collect funds from worldwide and give them a chance to meet foreign audiences and investors.

The next one is Mobile Payments. Mobile payment has been one of most FinTech's essential uses in mobile systems and gateways. These apps allow users to do banking without visiting a branch. For example, in Finland we have MobilePay, Siirto enable customers to send and receive money on smartphones at minimum transaction fees.

Thirdly, Robo-Advisors are robot consultants that use algorithms to customize asset distribution and generate client portfolios. They encourage consumers of all age groups to participate with limited manual effort in low-cost investment activities.

In the other hand, the term Insuretech refers to the use of technologies in the insurance model that enable businesses to supply tailor-made insurance and data protection services. Insuretech helps to streamline the process of insurance by filing and handling online requests.

Finally, Regtech provides cost-efficient and straightforward handling of vast volumes of material, including transaction reports and conformity documentation, including corporate tax returns.

FinTech is now revamping the trade market. These solutions are targeted at reducing foreign trading prices, improving trade openness and promoting trade financing. We have seen many of the most impressive applications that enable international trade through IT networks and intelligent delivery channels to date. Besides, solutions like robot consultants may support start-up investors in risk management.

Loaning service focuses on designing software that provides corporations and customers with lending solutions. The key idea is to simplify the method and make it more human and precise. Intelligent platforms using AI and deep learning algorithms can process and validate identity credentials to prevent any mistakes. These tools are now helping to estimate income prospects, evaluate the track record of the creditor, assess collateral worth and predict how their skills will shift. FinTech technologies' wealth management area concentrates on optimizing enterprise and individual customer wealth management processes. Personal wealth apps are smartphone applications that provide a wide variety of functions that help users safely and efficiently handle their finances. Consumers and businesses use them to manage financial processes and investments. Figure 6 shows the effect of FinTech trends through the area (Stulz 2019).

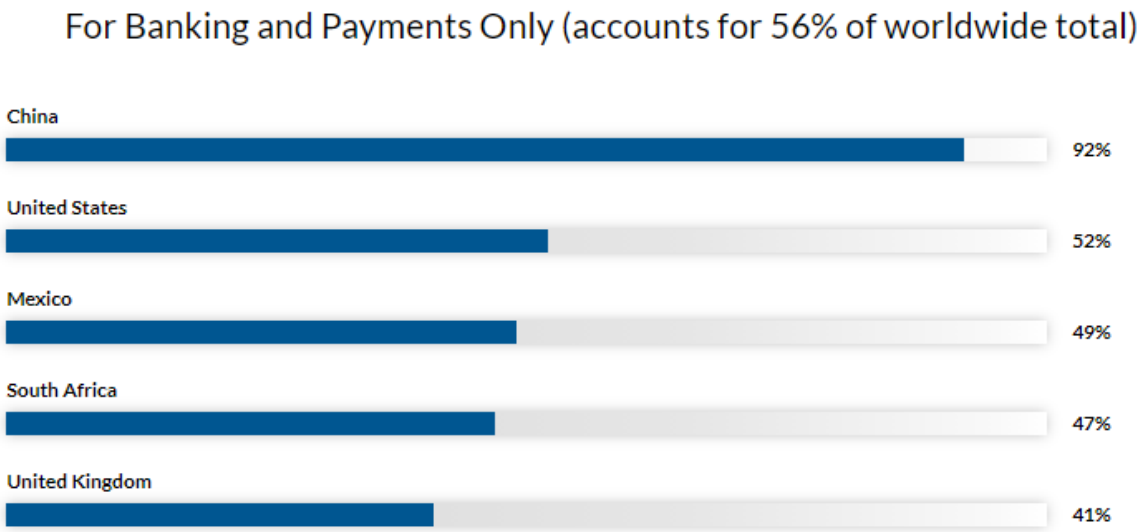


Figure 6. The effect of FinTech trends through the area.

People still spend hours measuring their costs and make budgets at home. Financial tracking typically involves navigation by phones, paper receipts, and checks. Today's budgeting apps allow it simpler and more effective to track expenditures and planning budgets. Indeed, a smartphone budgeting app is one of the most used FinTech services to date. Budgeting applications allow anyone to track their costs, sales, and other finances quickly and efficiently for personal and commercial purposes. These marvelous applications have modified the way customers see and carry out their financial practices.

2.3.2 FinTech Applications' Functional Dimension

About personalization: using technologies such as artificial intelligence and engineering, financial systems are now able to interpret better the needs and desires of consumers of actual data. Seeking a means of adjusting demand for financial services to the customer's needs would make purchases more pleasant.

About integration: it is the ability to merge and synchronize cross-platform structures. Services such as mobile payment, crowd-sourcing, or financial capital management are required for both individuals and entrepreneurs.

About authentication: because money is a sensitive topic, customers want to use stable and protected software as well as they feel suspicious when using a brand

new product that has no special security measures. The right way to protect digital accounts is two-factor authentication. The most commonly used security measure for these applications is two-factor authentication. Services offered by third parties, including Google Authenticator, Digi Pass, etc., allow you to verify via SMS or a particular app installed by the user on your smartphone.

About data tracking and analysis: when consumers use any FinTech mobile apps, they want their financial activities and transaction history to be monitored and analyzed. Nowadays, consumers can track their economic shifts and quickly view their history of purchases. The customer still has an excellent web interface for the data available in a single dashboard and graphic or visual representations to help them quickly understand fluctuations in financial behaviors and trustworthy perspectives (Arner et al. 2017).

2.3.3 Applications' Challenges

Even though FinTech companies have grown in recent years, they are still facing several complex difficulties.

About data protection: with the rising of cyber-crime, every financial company is trying to secure its records. Because of that, FinTech companies use blockchain technology to support commercial businesses in managing their problems. Blockchain technology must find the most viable options as modern businesses arise every day (Arner et al. 2017).

Alluring the customers: FinTech companies are excellent in raising their investments. Nevertheless, potential investors are threatened when every new bank creates its FinTech application, eliminating reliance on other firms. Financial businesses have to use FinTech tools such as a smartphone interface to appeal to new clients (Arner et al. 2017).

3 PRIVACY AND SECURITY ISUSSES IN FINTECH

In recent years, FinTech's conventional financial services products and services have been dramatically changed. However, there are still some unknown risks in the above-mentioned sector.

Nowadays, cyber fraud is sophisticated and some of the hackers' favorite targets are FinTech firms. This is not unexpected since people rely more on digital money management, so FinTech firms have more valuable data than ever before to protect them. For example, in August 2020, Pepperstone – a top Australian brokerage, openly admitted that they had been stolen their clients' information (Andrew Saks- Mcleod 2020). Seriously, entities like the national credit offices and major forex brokers (FBS Markets) have data leaks on occasion (Stuart Fieldhouse 2021). Besides, the exponential rise of digital networks also uniquely made FinTech sector and its clients vulnerable to many IT safety network breaches. Therefore it is critical for FinTech services to know about different hidden threats. Now, let's discuss some of them.

3.1 Security threats

Third-party security threats: banks or other financial institutions use a FinTech service from an untrusted service provider and end up losing their data, faulting their service, and may suffer credibility even due to insufficient data. Such disruption happens as a result of security threats from third parties. FinTech's risk management evaluation should identify FinTech-related risks and address the risk of third parties interested in FinTech services, banks, and financial institutions.

Malware attacks: the key forms of security problems in the global industry are ransomware attacks and hacking. The hackers now target the Global Financial Telecommunications Interbank Society (SWIFT). Nearly all the banks and leading financial institutions use Fast networks to share important financial information. The new cyber assault on the SWIFT networks, however, has shown that hackers and malware criminals are advanced. Banks and financial institutions

have vulnerabilities, and hackers use these vulnerabilities to initiate ransomware attacks.

Data breaches: data plays a crucial role in every sector, regardless of its domain. And data immediately becomes an incredibly relevant matter when it comes to banks and other financial institutions. But the issues of data splits have escalated considerably with the advent of inefficient FinTech platforms in the financial sector. Customers who are vulnerable to data fraud online purchases and the details of credit cards, user identification can be easily accessible by hackers. Then, data errors will occur because of inefficient final-tech services from the financial institution with third parties.

Application security threat: many banks use FinTech apps to view their customers' real-time financial records. They use this information to conduct transactions and to conduct other banking activities in real-time. However, if there are no fault-resistant authentication modules and powerful codes in a software program, cyber fraud is increasingly possible. The attackers use lax device protection to steal user information and other essential information. Therefore, if an entity plans to create a technological solution for FinTech, it must be certain that the program has all the vital safety features.

Money laundering threat: FinTech-driven banks are also used for financial transfers using cryptocurrency. These digital coins are a part of the FinTech community and do not have formal rules and guidelines. The widespread use of non-regulated currencies thus contributes to the illicit laundering of money and even terrorist financing. Since it is not possible to trace the receiver in any of FinTech's transactions due to the pseudonym nature of FinTech, financial laundering is facilitated sufficiently by FinTech's operation.

Digital identity threat: the use of single-password mobile networks and authentication codes has significantly improved with the advent of automated technologies in the banking and financing industries. These encryption codes and passwords are not as secure and convenient for a hacker to enter. Due to the

poor FinTech infrastructure offered by some service providers, the personal details of banking customers could be stolen. Consequently, when preparing for the introduction of FinTech, financial institutions should review their online security infrastructure to comply with these risk factors.

Cloud-based security threat: cloud storage platforms deliver everything in the FinTech world, from payment gateways and digital wallets to secure online payments. While cloud-based services are considered a safe storage system, a lack of appropriate security measures will lead to confidential financial information becoming corrupted (Lim et al. 2019). In certain situations, the organization works with a cloud-based, reliable solutions vendor to fix major data errors.

Al fuzzing: FinTech firms use a technique known as “Al fuzz” to detect program bugs like unreliable APIs and use artificial learning to prevent hackers from identifying future exploits. Sadly, this technique is often used by digital robbers. FinTech businesses are concern about that, so they hire good security engineers with very high salaries.

Skyrocketing traffic: FinTech service has expanded its use since the beginning of the pandemic by 72% in Europe. This means more files to handle and more storage places to cover. The preservation of records is a greater challenge than it would seem. Either FinTech firms must handle more servers themselves or focus on a cloud computing platform such as Amazon Web Service.

3.2 Risk mitigation suggestions

When an organization is hacked and loses its consumer records, consumers and their assets are at risk. After any cyber assault, companies will lose their credibility and customers. To prevent that, they use cryptograms to protect their customers’ privacy and trace data obtained to see if the data genuinely came from the users. But this is not enough to protect them, and every imperfection in the platform code can be taken advantage of.

This is why corporations use AI floating, which is an AI that detects troubles in the applications. This machine learning approach lets the IT department fix the problems before cybercriminals find them out. For instance, Al fuzz is both used by hackers and security engineers. This becomes an endless race – whoever discovers the vulnerabilities first wins. In order to solve this problem, FinTech companies should grow and organize an outstanding security team to manage every matter arising.

4 SERVICE DIVERSITY IN FINTECH

Companies also realize the value of networking and internet networking, especially as marketing and advertising platforms. Because of this, the financial services sector forecasts a substantially high investment return on a wide range of rapidly expanding web-based and social media platforms, with annual sales growth in this sector at an average of 31%, although new and exciting challenges lie in the possibilities provided by social media. The advent of alternative means of contact for the marketing of the product by financial institutions and the appeal to new customers have naturally produced strong regulatory responses, with enforcement teams having substantial record-keeping requirements. Technology is a crucial factor in overcoming these problems. Both big and small financial institutions need to look at regulatory innovations to help them meet those criteria and reduce the record-keeping burden (Hu et al. 2019).

To improve operating efficiency, accelerate commercialization, and superior client service, the industry tends to concentrate on digitizing and embracing new and evolving technologies. Banks are cutting spending on branches to invest in new self-service platforms because consumers get more smartphones and online banking. Mobile portable systems that pack the strength of smartphones make it easy for banks to deliver customer-specific services. Many banks plan to take advantage of digital opportunities by using in-house technology or collaborating with companies from FinTech. Initially, these firms were seen to contend for the vacuum created by the failure of the BFS industry to sustain technical advancements. However, banking-FinTech alliances are becoming more popular and promotion and management for the latter. Bank-FinTech collaborations are

now discovering other opportunities of proximity to funds and clients. These collaborations start to reorganize the world of financial services (Gomber et al. 2018).

4.1 Catalyze diversity in FinTech

At present, there are many problems for financial service businesses, from an increasingly complicated regulatory climate to a rising danger of cybercrime and the growing competition among technology companies. Companies must be creative and agile to overcome these challenges and be successful. With digital advancement, several financial services firms have faced these difficulties. Members of their boards and management committees toured Silicon Valley to meet business executives and learn to become more technologically knowledgeable.

Others also implemented "jam sessions" between thinkers and experts from diverse industries and competition for marathon coding and set up incubation centers and independent technology hubs. However, these methods alone are not adequate. Overall, with the new revolution being accepted in the financial industry, it risks getting worse.

Banks, wealth managers, and insurances are amongst those with the least diversity in the industry, and their gender pay differences reflect this. Their boards and executive teams have been struggling for a long time from a collective mentality, which played a part in the latest financial crisis. And as things stand, both women and men have had a negative influence on the industry's appeal by combining a poor name with a controlled male society. In the meantime, the tech community on the diversity front is maybe becoming more threatened. As these two industries become more closely linked, the market will reward organizations that promote diversity and customer loyalty as a critical component of good governance. Businesses in financial services must adapt to and begin now with the demands of a new era. Both CEOs in financial services discuss short-term goals in regulatory reporting, lowered fee pressures, expense control, and shareholder outcomes. But suppose the leaders do not prioritize diversity and

corporate inclusion. In that case, their businesses will lose in the long run, failing to accommodate top talent and failing to change business models fast enough to stay competitive. Company diversity is not psychological but a financial challenge.

4.2 Current regulation state of FinTech

A set of new rules and regulations was developed after revising the financial services sector in the post-Great Financial Crisis era. Financial firms must respect these criteria when contending with rapid technological advances. Although such developments posed huge regulatory problems for financial institutions, which were changing their everyday activities and actions, they coincided with a separate, prominent revision, namely the implementation of emerging technology by regulators (Arner et al. 2017).

FinTech is taking a more constructive path to better, trouble-free delivery with the ongoing antagonistic regulatory system. The regulatory technique (or RegTech) works to enhance enforcement by IT-based industries like Fintech. RegTech operates not only to reduce the financial challenge of Fintech against money-laundering – but also to exploit AI technologies and Big Data. RegTech systems are also used to track financial transactions in real-time to deter problems or criminal abnormalities.

Although FinTech companies remain a leader in digital finance, they have to face ancient regulatory hurdles ironically. The root cause is that these companies have to work in a legal market to advance their existence. Using regulations for banks that existed during the 1970s in the US, FinTech was called 'banking.' That alone captures perfectly the ongoing clash between the new technical community and the traditional, risk-opposed financial sector. The industrial spread of cryptocurrency is a prime example of this. Unregulated are ICOs or initial coin deals used by startups to gain money. These ICOs were also vulnerable to theft and fraud.

The financial services business is continuously emphasizing digitizing and incorporating new and innovative innovations to generate efficiencies, pace up the market, and superior consumer support. Banks are reducing branch investment in digital self-service platforms as consumers become more popular for smartphone and online banking. Mobile portable systems that pack the strength of smartphones make it easy for banks to deliver customer-specific services.

5 FINTECH SITUATION DURING THE PANDAMIC AND THE FUTURE OF IT

FinTech is expanding to the new customer market. FinTech companies have tried to access and leverage under severed markets such as Asia and the southern hemisphere. In the 1990s and 2000s, banks and financial companies in these countries began developing the infrastructures and now enjoying the rewards. For starters, China's electronic payments are now used more than cash payments, with apps paid $5.5 trillion last year and mobile payments in the US dwarfing $112 billion in 2016 (Iqbal et al. 2021). On the other hand, the economies in the southern hemisphere like the Philippines, Indonesia, part of Latin America, and countries around Sub-Saharan Africa have convenient access to smartphones that allow digital transactions due to telecommunication networks. Mobile revenues are predicted to expand quickly in these territories.

FinTech has transformed the way people in a cashless digital society conceive about currency and value exchange in real-time, pushing hesitant customers to take the habit of digital trades and policymakers to debate whether it is racist or progressive. It is only the first step that consumers are required to pay electronically for goods and services rather than cash. For instance, Amazon takes the lead in integrating an internet retail account into nine cashiers' fewer convenience stores with conventional brick and mortar experience to try the new template. Customers quickly collect the items they need, exit the shop, and automatically charge the items to their Amazon account. These ideas would undoubtedly shape the retail future. The growth of digital currencies such as Bitcoin and the record-keeping technology known as blockchain is much less recognized but more definitely more revolutionary in the long term.

Due to the COVID-19 crisis, the FinTech industry has faced several problems (Syah et al. 2019):

- Robinhood's customers encountered outages, stopping them from dealing on three unpredictable exchange days: 4 March, 9 March, and 18 May. The corporation has been sued in these crashes and accused of giving consumers a "$75 loan of goodwill" to forfeit their right to the constitution.
- Revolut bank Challenger lost eight top team members from March to May 2020. In 2019, the bank was called upon to follow shady recruiting methods and toxic work environments. It was accused of ad fraud, data production, money laundering, cultivation of a system of abuse, and transferring £70,000.
- In April, Kabbage slashed its small-business customers' loans and filled out a substantial portion of its 500 employees in the US. Moreover, Lending Club reported 460 workers, about 30 percent of its employees.
- In a review of bank consumer complaints, the UK Financial Conduct Authority released. In 1,000 bank/credit card accounts, consumers reported 4.0 grievances. By contrast, there were 3.3 of the Co-op Bank, 3.5 of the Lloyd, and 0.2 of the Cumberland Building Society.

6 BLOCKCHAIN AND CRYPTOCURRENCY

The pace of business and technological innovation has increased rapidly in recent decades, making it challenging to develop a sustainable business model over time. On the order hand, users always want something new and better to protect their privacy and identity. This is also the foundation of blockchain and cryptocurrency.

6.1 Blockchain

Blockchain is a technology that guarantees security and ease of access, thus allowing information or value transaction to be performed without the need of a trusted third party like governments or banks. In this way, blockchain brings a new website that moves from the Internet of information to value. It is considered to change and modify business processes and models.

It is a reality that a lot of blockchains have in the past been addressed, but FinTech has succeeded in getting the most out of this platform. According to PwC's report, some 77% of FinTech are predicted to continue and implement

blockchain by 2021. The primary explanation for the widespread advancement of this technology is the protection it provides. Without enabling anyone to view the stored information, blockchain will automatically upgrade the digital directory online and document transactions. We know that 2018 was a tough year when we look at the situation at blockchain. There is still a considerable downfall of other systems that operate with blockchain. Still, analysts agree that several businesses will present themselves in 2021 to introduce blockchain services (Bofondi & Gobbi 2017). Figure 7 show the usage of blockchain in FinTech from 2013 to 2018 (Mention 2019):

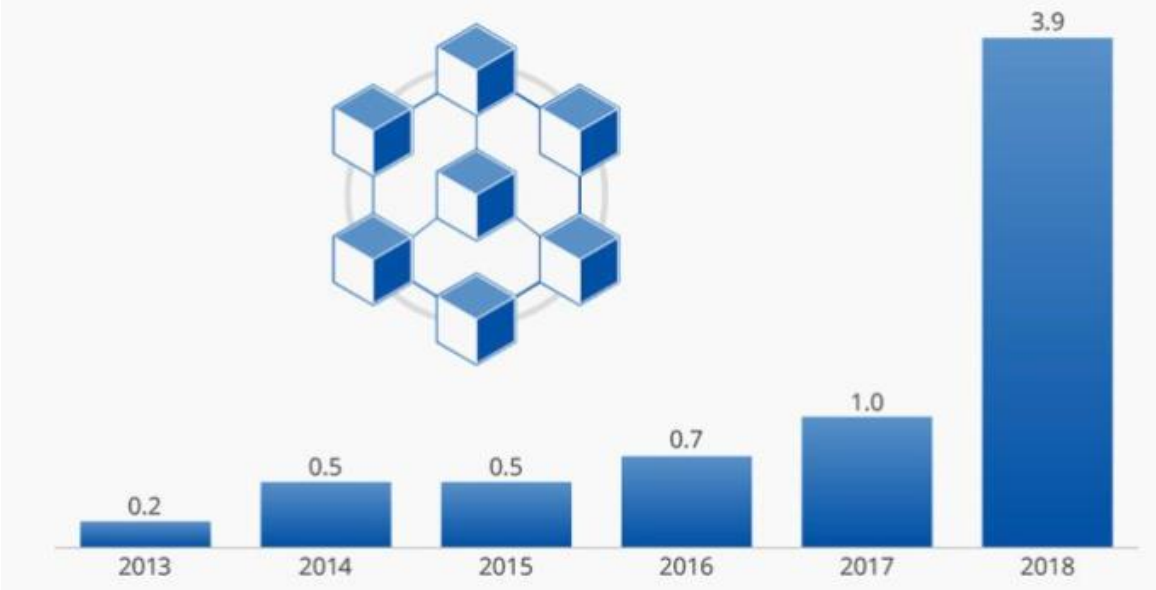


Figure 7. Usage of blockchain in FinTech (Mention 2019)

6.1.1 What is blockchain?

The blockchain is fascinating for its potential to create an environment of trust between brands. If its influence is still uncertain, it should be noted that the technology is based on the management of a list of records, certified and protected against falsification, and based on a peer-to-peer trust system. Clément Jeanneau, who is the co-founder of Blockchain Partner, a blockchain technology consulting firm, summarized: "The blockchain which wants to be decentralized, transparent, readable by the stakeholders, is tomorrow a response to those who introduce "false" in the registers, because it is possible, by the blockchain, to go back in the history and to know who entered false data. Some large groups, such

as Thales, Accenture, Microsoft, or HSBC, have, for example, piloted a blockchain process for traceability (history of a product's journey, for example) and authentication (of digital content, in particular), contributing to the maturity of this trend.

In the technical feature, blockchain is a database that stores data in blocks that are chained together. A chain contains the first block (known as the genesis block), the following blocks, and the final block. The second block must include data from the previous block to connect the second block to the first block. The transaction process is similar to figure 8:

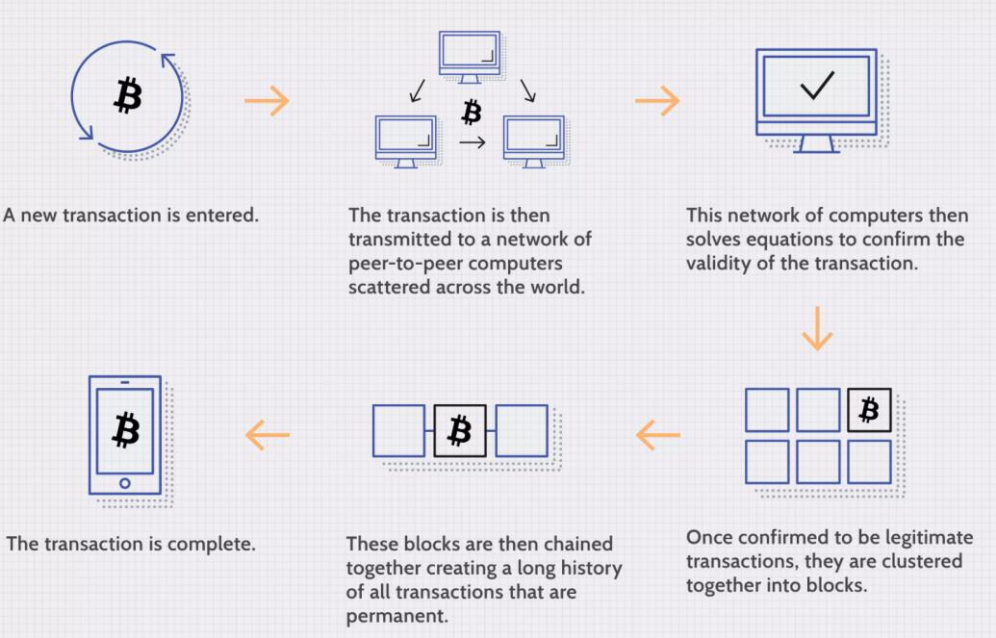


Figure 8. Blockchain transaction process (investopedia.com)

The first blockchain appeared at the end of 2008 with the digital currency Bitcoin, developed by an unknown person under the pseudonym of Satoshi Nakamoto. The history of blockchain can be divided into three generations. The first mark of blockchain technology is the creation of Bitcoin in 2008. In the earliest stage, blockchain worked as a shared public ledger that supports cryptocurrency networks. After that, Ethereum, one of the most valuable digital coins, currently represented smart contracts – the second generation of blockchain. Smart contract is a term describing a unique set of protocols capable of automatically executing terms and agreements between the parties of the contract (in this case

is machine system) thanks to the support of blockchain. Smart contracts also have been using in financial, insurance, healthcare, games (cryptokitties), and government administration in Estonia. The third stage of the development is the scalability of blockchain. Scaling is currently a significant problem for blockchain platforms, with almost all platforms performing relatively slow transactions depending on the consensus algorithm of each platform. Furthermore, Ethereum is developing a solution called Ethereum Plasma:

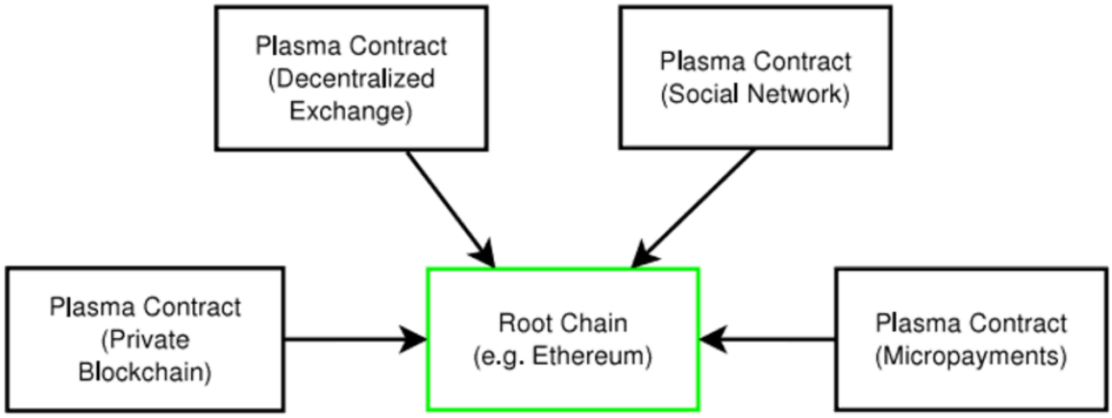


Figure 9. Image from https://www.plasma.io/ show the part of Ethereum Plasma

6.1.2 How does blockchain work?

With its properties that allow it not to depend on a trusted third party, blockchain promises benefits for the community, motivating interest in the collaboration. This ideology fiercely rejects democracy and promotes authoritarian forms of government. Although Bitcoin is a political project and a blockchain product, the simple technology that made this project possible is still assimilated to Bitcoin and cryptocurrencies. This confusion perfectly illustrates the ambivalence of this technology. Indeed, the blockchain can be considered the embodiment of political and social values, such as transparency and the redistribution of power, and as the embodiment of ultraliberal values, which refuse any control, however democratic it may be. It is in this ambivalence that lies the complexity of blockchain technology, both an opportunity and a threat to the social economy and the vision of the society it defends. (Chen & Wang 2018).

6.1.3 Consensus Algorithms

In Blockchain networks, the two main types of consensus algorithms for reaching consensus in a distributed manner are Proof of Work (POW), Proof of Stake (POS). The main innovation of the blockchain protocol is the data structure on a consensus algorithm, which allows building an open distributed network in which all parties can reach an agreement.

Proof of Work POW (Proof of Work): is a method used to prevent malicious behavior on a system. To do this, miners must perform very expensive work for them, but easy for the rest of the community to verify. This work is computational -informatics- and carrying it out costs them processing power. The algorithms that operate the distributed system reward the miners who solve mathematical problems. The financial incentive for each miner is to be the first to create the new block of transactions that the other machines will take as the new truth state of the network.

Proof of Transaction POS (Proof of Stake): The consensus algorithm is based on owning a stake in the network. In POS systems, the creator of a new block is chosen deterministically, depending on their participation or degree of commitment (wealth) in the network. However, POS systems are perhaps unnecessarily complicated with the levels.

6.2 Cryptocurrency

The foundation of blockchain led to the creation of digital currencies. Some popular and high value cryptocurrencies at present are Bitcoin, Ethereum, Binance Coin, Bitcoin Cash, Litecoin, Ethereum Classic and AAVE.

6.2.1 What is cryptocurrency?

Cryptocurrency is a term that describes digital currency that people can buy and trade online. It is invented by blockchain technology. They can transfer it to real money by selling it to other people. A lot of services accept cryptocurrency as payment now. For example, customers can purchase a Tesla car by Bitcoin.

In addition, the authorities can clarify the legal status of cryptocurrency. This status depends on consumer protection methods (dealing with property rights, theft, and abusive sales) and the use of cryptocurrency by individuals (for example, who is entitled to trade them. Another critical question relating to the legal status of cryptocurrency is whether it should be treated as transferable securities. As negotiable instruments that promise future payment that they represent, they can be used to raise funds.

There are different types of payment systems. There are four-actor payment systems that are the most vulnerable. In this system, one party pays the other party for the transaction. And each party has its bank. The payer goes through his bank, which then pays that of the recipient. In this case, the money goes through two trusted third parties, which may fail. And there are three-factor systems: systems where both parties to a transaction do not only go through a single trusted third party, like PayPal, or if both parties are in the same bank. In this case, only one-third party can fail. Satoshi Nakamoto has, with Bitcoin, succeeded in creating a two-corner payment system where the Trusted Third Party does not exist more because the network replaces it. In this two-ended system, the parts at one end transaction only transact between them without a third party contacting the funds.

To analyze these questions, let’s draw on Auer and Claessens (2018). They have compiled a series of data on announcements made in recent years by regulators, central banks, and international organizations, and standard-setting bodies concerning cryptocurrency markets. Regulatory news is classified according to the three broad categories mentioned above. To do this, we have implemented a simple, binary code, assigning the value +1 to announcements relating to a tightening or better definition of regulations and the value -1 to those indicating more flexible or less well-defined regulations. Besides, we have assigned a code to two subsidiary categories: the first concerning general information and warnings on crypto-assets intended for the general public and the authorities’ declarations on CBDC. We have included all announcements from early 2015 to

late 2018 as published by Reuters, the criterion for inclusion in the sample being dissemination through this news channel. In total, we identified 151 regulatory news items (Bashir 2017).

6.2.2 The history of cryptocurrency

A history of cryptocurrencies brings us to the prehistory of encrypted or encrypted currencies. In 1982, a decade before the development of electronic commerce, David Chaum wrote an article “Blind Signatures for Untraceable Payments” to describe the first encrypted system to allow untraceable payments. It is reported to achieve crypto-backed payments and prevent the third party from knowing who is paying, when, and how much. This system would allow individuals to have proof of payment and help stop using embezzled or stolen means of payment. In 1990, the same David Chaum wrote another paper called “Untraceable Electronic Cash” in which he explained that the use of credit cards had become an act of faith on the part of their holders because they had no protection against them. In his paper, he explains that cash has a distinct advantage over credit cards when it comes to privacy. Based on this observation, he decides to create the first anonymous electronic money system that will not benefit from global acceptance and fail. However, the idea of transactions protecting anonymity, in addition to being born, was implemented for the first time.

In 1996, e-Gold was created, considered an electronic currency to create a digital global currency convertible into gold. This currency facilitates payments on the Internet. It is suspected of being used in illegal activities, so the creators have been indicted for money laundering, illegal transfers, etc. The first electronic money not issued by a state was born that could be exchanged for a store of value commonly accepted around the world, namely gold. In 1998, a cypherpunk named Wei-Dai wrote the “B-money Proposal”, which was published on the cypherpunk mailing list. While explaining not knowing how to set them up, he described two protocols for creating and managing money and implementing contracts for a group of non-traceable digital pseudonyms without needing outside help, trusted third parties, or another fallible person. He also described a system based on proof of work as a mode of money creation, based on the

assumption that all the participants would also be the guardians and the memory of the system.

The Bitcoin system, which operates on the Peer-to-Peer model, is free software developed under the MIT (Open Source) 25 license, allowing digital money to be exchanged without going through the banking network. Bitcoin is based on Peer-to-Peer technology, a “network of peers where each peer, as an independent database, participates in the network to share data with other peers”. Peer-to-Peer is, therefore, a form of system that functions like an organized community. It allows multiple computers to communicate over a network to share files, stream media, do distributed computing, or use a service on the Internet. This technology for exchanging files between Internet users allows Bitcoin to operate without a central authority. The processing of transactions and the creation of bitcoins are therefore collectively taken care of by the community. Thanks to its unique properties, Bitcoin makes possible promising uses that previous payment systems could not cover. (Abadi & Brunnermeier 2018).

7 IMPLEMENTATIONS

For the implementation part, I used the sample code from Udemy online course to create a demo of blockchain and cryptocurrency using Python. Udemy web course has contained the same Python package which is used in the thesis, and now it is quoted, too. The following content is the detail of codes that describe how to do step by step.

The program and framework I had installed: Anaconda, Spider, Flash and Postman.

7.1 Create a blockchain

1. Introduction

A block contains three elements: data, hash and the hash of the previous block. Therefore, this is how the process works: create a genesis block => create a final

block => insert the block data => apply hash function into the block => connect blocks into chain => mine the blockchain => check the result.

2. Build the architecture of the blockchain

At the beginning, I created a class called “Blockchain” and its functions. The first function is to create a genesis block of a blockchain:

```
def __init__(self):
        self.chain = []
        self.create_block(proof= 1, previous_hash = '0')
```

Next, I created a function that is a list that defines each block contains four important keys: the index of the block, the exact time when the block is mined, the proof of mining the new block and the previous hash. After that, I appealed the new block to the blockchain and returned it to display it on Postman:

```
def create_block(self, proof, previous_hash):
        block = {'index': len(self.chain) + 1,
                 'timestamp': str(datetime.datetime.now()),
                 'proof': proof,
                 'previous_hash': previous_hash,
                 }
        self.chain.append(block)
        return block
```

The next function is to create the last block and get it anytime:

```
def get_previous_block(self):
        return self.chain[-1]
```

A “proof_working” is the function that defines pieces of data the miners need to find when mining a new block. They have to find the specific number that will be the “proof_working”. As if the blocks are easy to mine, the cryptocurrency will become less valuable. Basically, I assigned a variable called “new_proof” to 1 and ran a WHILE loop until getting the right proof. After that, I created a

“check_proof” variable to explain what will happen if the result is wrong. In order to solve the problem, i used the hash function:

```
def proof_working(self, previous_proof):
        new_proof = 1
        check_proof = False
        while check_proof is False:
            hash_operation = hashlib.sha256(str(new_proof**2 -
 previous_proof**2).encode()).hexdigest()
            if hash_operation[:4] == '0000':
                check_proof = True
            else:
                new_proof += 1
        return new_proof
```

This hash function takes the block as an input and return 256 cryptographic hashes of the block:

```
def hash(self, block):
        encoded_block = json.dumps(block, sort_keys = True).encode()
        return hashlib.sha256(encoded_block).hexdigest()
```

The final function is to check if each chain is valid and it will return True if everything is correct in the blockchain. It means if each block has a valid “proof_working” and the previous hash of block is equal to the hash of the previous block, the miners find the correct block.

```
def check_if_chain_valid(self, chain):
        previous_block = chain[0]
        block_index = 1
        while block_index < len(chain):
            block = chain[block_index]
            if block['previous_hash'] != self.hash(previous_block):
                return False
            previous_proof = previous_block['proof']
            proof = block['proof']
            hash_operation = hashlib.sha256(str(proof**2 -
 previous_proof**2).encode()).hexdigest()
            if hash_operation[:4] != '0000':
                return False
            previous_block = block
            block_index += 1
        return True
```

3. Mine the blockchain

To start with this, I created a flask based web application and an object “Blockchain”:

```
app = Flask(__name__)

blockchain = Blockchain()
```

Next, to mine a new block, I created a route on the interface and a function to interact with the blockchain. In the end, I returned it back to json format with the HTTP request successful status code 200:

```
@app.route('/mine_block', methods = ['GET'])

def mine_block():
    previous_block = blockchain.get_previous_block()
    previous_proof = previous_block['proof']
    proof = blockchain.proof_working(previous_proof)
    previous_hash = blockchain.hash(previous_block)
    block = blockchain.create_block(proof, previous_hash)
    response = {'message': 'Hurray, you just mined a block!',
                'index': block['index'],
                'timestamp': block['timestamp'],
                'proof': block['proof'],
                'previous_hash': block['previous_hash']
    return jsonify(response), 200
```

I added a “get_chain” function which will be based on GT request to get the whole blockchain and then display in on Postman:

```
@app.route('/get_chain', methods = ['GET'])
def get_chain():
    response = {'chain': blockchain.chain,
                'length': len(blockchain.chain)}
    return jsonify(response), 200
```

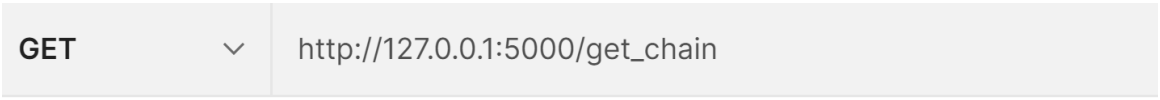
Finally, I created a “if_blockchain_is_valid” function to test if the mined blockchain is correct or not:

```
@app.route('/if_blockchain_is_valid', methods = ['GET'])
def is_valid():
    is_valid = blockchain.check_if_chain_valid(blockchain.chain)
    if is_valid:
        response = {'message': 'Perfect. Blockchain is valid.'}
    else:
        response = {'message': 'We detect a problem. The Blockchain is not
valid.'}
    return jsonify(response), 200
```

4. Test the blockchain

I typed `app.run(host = '0.0.0.0', port = 5000)` and run the code.

After that, I went to Postman and inserted a request to connect it with Flask:



When I sent the request, I received the first block of the blockchain:


```
{
    "chain": [
        {
            "index": 1,
            "previous_hash": "0",
            "proof": 1,
            "timestamp": "2021-05-04 22:38:00.397090"
        }
    ],
    "length": 1
}
```


Next, I mined the second block by replacing the GET request from “get_chain” to “mine_block”:

```
{
    "index": 2,
    "message": "Hurray, you just mined a block!",
    "previous_hash": "03cd94a7b83b85b58f76217efff647c2692b31415c8be918bcfc609785edcabc",
    "proof": 533,
    "timestamp": "2021-05-04 23:01:31.751269"
}
```


I tried to mine new blocks by unstoppable pressing a lot of “mine_block”. For example, this is my 7th block in the chain:


```
{
    "index": 7,
    "message": "Hurray, you just mined a block!",
    "previous_hash": "4766796781267f001e1f47fa7c8ef8190297366cba86cfbcaf0b96ba6ccd9d6d",
    "proof": 19865,
    "timestamp": "2021-05-04 23:04:08.209661"
}
```


I reviewed all of the mined blocks with “get_chain” request:

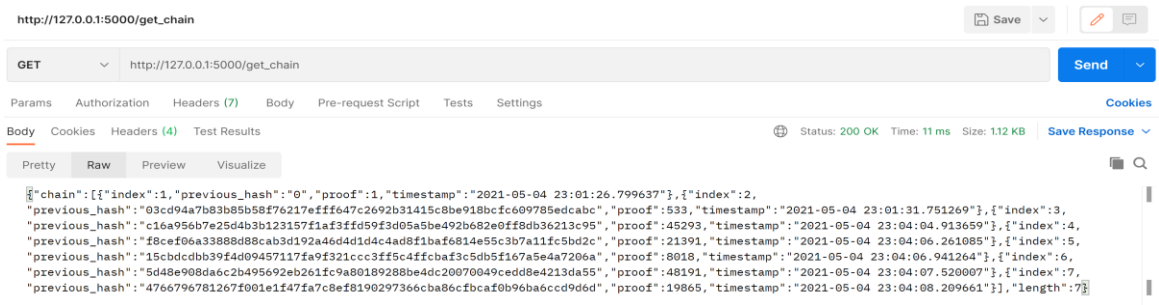


Figure 10. Mined blocks when viewing with get_chain method

For conclusion, I tested if the blockchain is vaild with “if_blockchain_is_valid” request:


```
{
    "message": "Perfect. Blockchain is valid."
}
```


7.2 Create a cryptocurrency

1. Introduction

The process to transform the general blockchain into a digital coin is to decentralizing the blockchain. The principle of cryptocurrency activities is that buyers can exchange these coins through securely added transactions on the mined blocks. Once some transactions are added to a new block and that block is integrated to the chain, the data inside it cannot be modified.

2. Decentralize the blockchain

First of all, I created a crytocurrency called “Maitocoin”.

Secondly, I created a format for the transactions which include data about the sender, the receiver and the amount of coins exchanged. I also returned the index of the block that will receive these transactions:

```
def add_transaction(self, sender, receiver, amount):
        self.transactions.append({'sender': sender,
                                  'receiver': receiver,
                                  'amount': amount})
        previous_block = self.get_previous_block()
        return previous_block['index'] + 1
```

The next step is to create the consensus into the blockchain to make sure that all the nodes contain the same chain at any time. In order to do this, I created a “add_node” function to add any nodes in the set by taking the address of the node. I used the ULR parse function to parse the address of the node:

```
def add_node(self, address):
        parsed_url = urlparse(address)
        self.nodes.add(parsed_url.netloc)
```

After that, I created a “replace_chain” method that will be used to replace any chain that is shorter than the longest chain among all. Here, I used a FOR loop to find which the longest chain is:

```
def replace_chain(self):
        network = self.nodes
        longest_chain = None
        max_length = len(self.chain)
        for node in network:
```

```
            response = requests.get(f'http://{node}/get_chain')
            if response.status_code == 200:
                length = response.json()['length']
                chain = response.json()['chain']
                if length > max_length and self.is_chain_valid(chain):
                    max_length = length
                    longest_chain = chain
        if longest_chain:
            self.chain = longest_chain
            return True
        return False
```

Next, I created a node address. Whenever the miners find some new blocks, they will get the crypto coins. Therefore, there will be a transaction from the nodes to the miners. I used this one to create an address for the node on port 5001:

```
node_address = str(uuid4()).replace('-', '')
```

Thirdly, I added a new transaction to the blockchain using POST method. There would be a list of three keys of a transaction: sender, receiver and amount. If a transaction is missing one of these keys, the system will return a warning or an error saying that something is missing or not right:

```
@app.route('/connect_node', methods = ['POST'])
def connect_node():
    json = request.get_json()
    nodes = json.get('nodes')
    if nodes is None:
        return "No node", 400
    for node in nodes:
        blockchain.add_node(node)
    response = {'message': 'Congrats! All the nodes are now connected. The
Maitocoin Blockchain now contains the following nodes:',
                'total_nodes': list(blockchain.nodes)}
    return jsonify(response), 201
```

The final step is to replace the chain by the longest chain. This time, I used the GET request:

```
def replace_chain():
    is_chain_replaced = blockchain.replace_chain()
    if is_chain_replaced:
```

```
        response = {'message': 'The nodes had different chains so the chain
 was replaced by the longest one.',
                    'new_chain': blockchain.chain}
    else:
        response = {'message': 'All good. The chain is the largest one.',
                    'actual_chain': blockchain.chain}
    return jsonify(response), 200
```

3. Testing the result

First, I created a json file for storing the address nodes that I wanted to have in my decentralized blockchain. Here, I would input three different ports: 5001, 5002 and 5003. I used http://127.0.0.1 to be the main url:

```
"nodes": ["http://127.0.0.1:5001",
          "http://127.0.0.1:5002",
          "http://127.0.0.1:5003"]
```

Next, I created a json file for the format of the transactions. This file contains three keys: sender, receiver and the amount of exchanged coins between sender and receiver:

```
{
    "sender": "",
    "receiver": "",
    "amount":
}
```

Beside that, I created three python files for running three different ports. I copied all the codes in my Maitocoin before and changed the running code into 5001, 5002 and 5003. For nodes 5002 and 5003, I changed the receiver name to Matti and You:

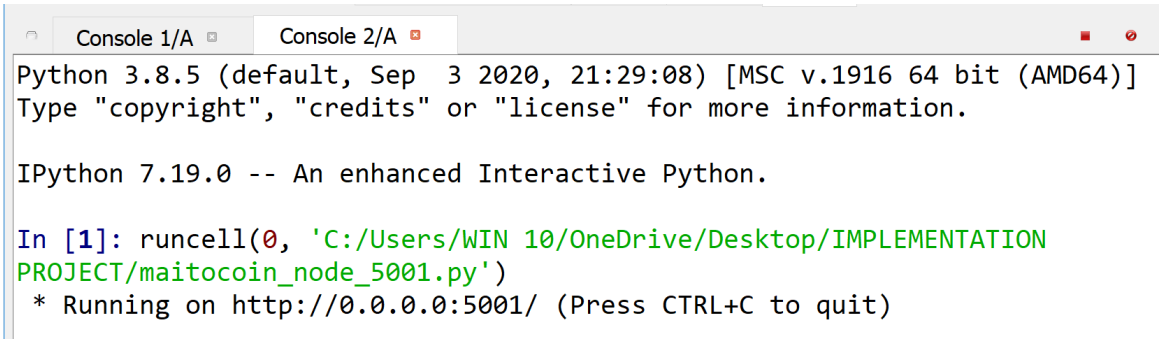
```
@app.route('/mine_block', methods = ['GET'])
def mine_block():
    previous_block = blockchain.get_previous_block()
    previous_proof = previous_block['proof']
    proof = blockchain.proof_of_work(previous_proof)
    previous_hash = blockchain.hash(previous_block)
    blockchain.add_transaction(sender = node_address, receiver = 'Matti', a
mount = 1)
    block = blockchain.create_block(proof, previous_hash)
    response = {'message': 'Congratulations, you just mined a block!',
                'index': block['index'],
```

```
                'timestamp': block['timestamp'],
                'proof': block['proof'],
                'previous_hash': block['previous_hash'],
                'transactions': block['transactions']}
    return jsonify(response), 200
```

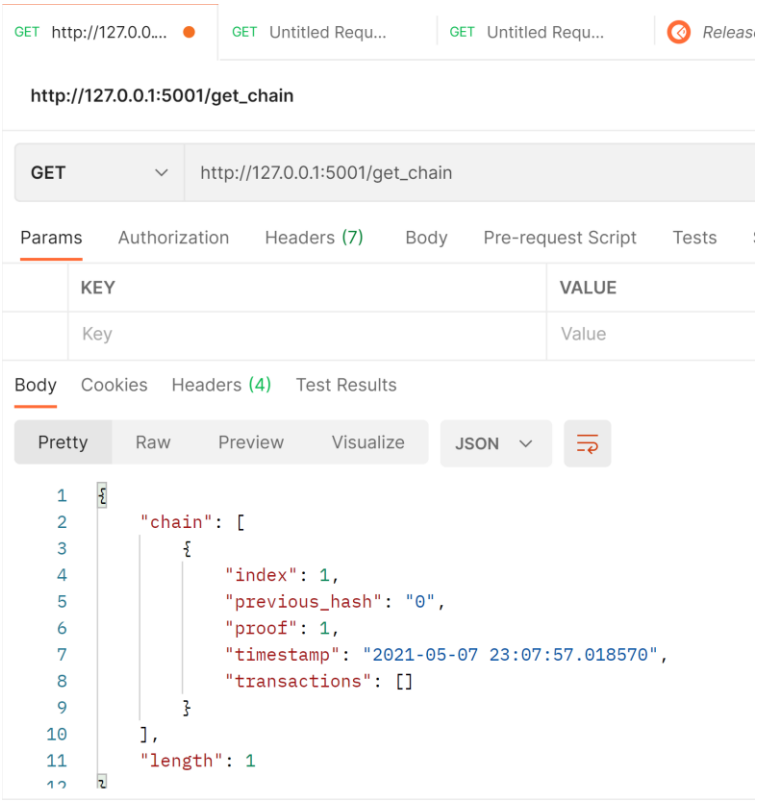
This is the You version:

```
@app.route('/mine_block', methods = ['GET'])
def mine_block():
    previous_block = blockchain.get_previous_block()
    previous_proof = previous_block['proof']
    proof = blockchain.proof_of_work(previous_proof)
    previous_hash = blockchain.hash(previous_block)
    blockchain.add_transaction(sender = node_address, receiver = 'You', amo
unt = 1)
    block = blockchain.create_block(proof, previous_hash)
    response = {'message': 'Congratulations, you just mined a block!',
                'index': block['index'],
                'timestamp': block['timestamp'],
                'proof': block['proof'],
                'previous_hash': block['previous_hash'],
                'transactions': block['transactions']}
    return jsonify(response), 200
```

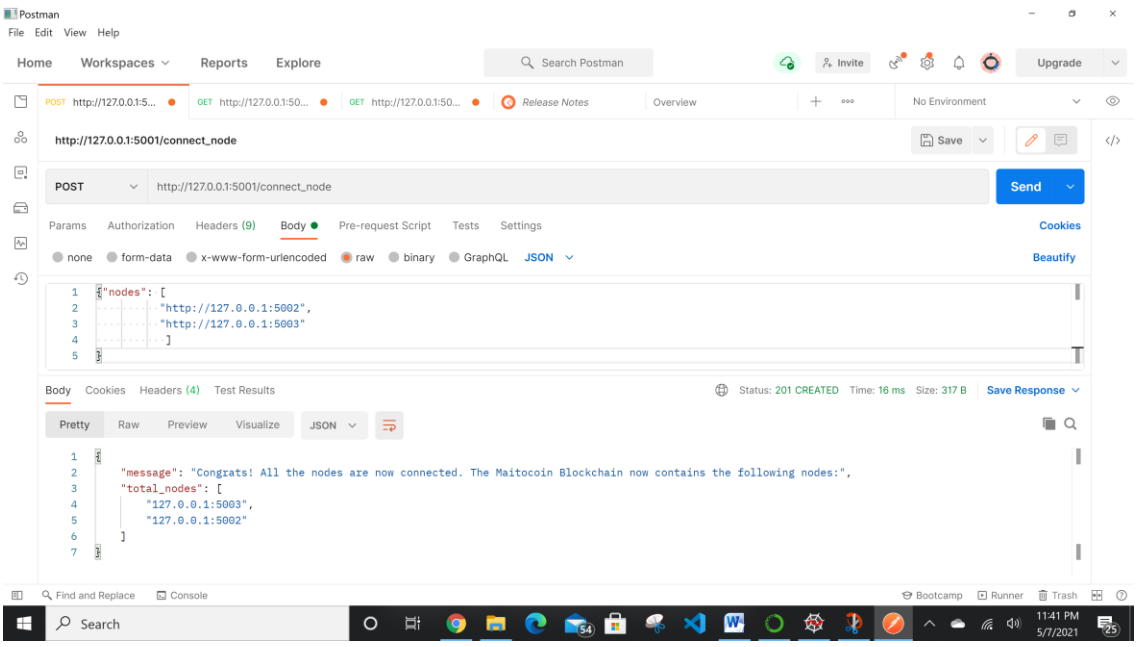
After that, I created the second and third console as a remote computer for node 5002 and 5003:



The blockchain is decentralizing now. Let's open Postman to test the requests. This is the genesis block of port 5001. I did the same thing with node 5002 and 5003:



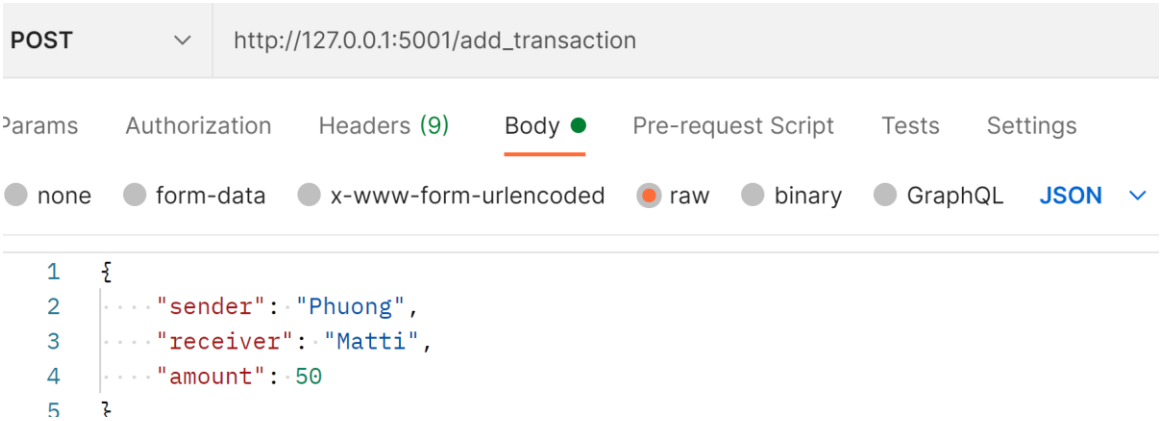
In the next step, I made the first POST request to connect the nodes to each other. In this picture, I connected node 5001 to the 5002 and 5003. I also did the same thing with two remain nodes. This is my result:



All the nodes are connected now. Let's test the consensus to see what happens if on one node, we get the chain which is larger than the chain on the other node. In node 5002 and 5003, I used replace_chain request and got the same chain with node 5001:


```
{
    "index": 2,
    "previous_hash": "410efa94015b03adf6f1209ed894f3e693a61a5d10e92f5ff37852ec56b4eb94",
    "proof": 533,
    "timestamp": "2021-05-07 23:55:56.830843",
    "transactions": [
        {
            "amount": 1,
            "receiver": "Phuong",
            "sender": "06ba53694f524b2f8d084aedb3ab6d18"
        }
    ]
}
```


After that, I tried to send multiple coins via add_transaction request. This is just a demo but in real life we also have to put our public key when transferring the coins:



I got the transaction but the transaction was not in the block yet so I would mine the block to see:

```
"transactions": [
    {
        "amount": 50,
        "receiver": "Matti",
        "sender": "Phuong"
    },
    {
        "amount": 1,
        "receiver": "Phuong",
        "sender": "06ba53694f524b2f8d084aedb3ab6d18"
    }
]
```


Finally, I applied the consensus on these two nodes to make sure every node in the blockchain had the same chain:


```
"index": 6,
"message": "Hurray, you just mined a block!",
"previous_hash": "3ebbe9c3ad55ea25baf7de4e36a438ba33668e25d9d0aa9c3245adc93cf0280f",
"proof": 48191,
"timestamp": "2021-05-08 00:37:48.265414",
"transactions": [
    {
        "amount": 10000,
        "receiver": "You",
        "sender": "Phuong"
    },
    {
        "amount": 1,
        "receiver": "Phuong",
        "sender": "06ba53694f524b2f8d084aedb3ab6d18"
    }
```


In the end, I just finished mining multiple Maitocoin and transferring it to other people.

8 CONCLUSION

This thesis covers a theoretical study on different topics related to FinTech technology and its contribution to the finance and banking industry. It also includes one of the most popular trends at present: blockchain and cryptocurrency. The thesis was successfully completed with the investigation through chapter 2 (FinTech trending technology), chapter 3 (FinTech applications), chapter 4 (FinTech security threats), and chapter 6 (Blockchain

and Cryptocurrency). The theory part of the thesis investigated a deep understanding of the FinTech industry and how bitcoin and cryptocurrency works, which became a solid foundation for initiating the implementation part.

Financial businesses can adjust what their clients offer to help handle their regulatory requirements by seizing the potential of technology. Regulators are trying to change the regulatory environment by incorporating emerging innovations. With technical progress speeds just boosting, 2021 looks like a year of significant scanning prospects for financial services.

Although the problems mentioned remain, FinTech can change the essence of the industry with technology and following developments, including the building of closer ties between merchants and clients and everything to solve the financial incorporation dilemma. Without hesitation, market executives are motivated to integrate FinTech culture in their business strategies of blockchain, Big Data, AI, ML, and so many other leading-edge innovations. This will be the horizon for the Banking and Financial Industry and the face of modernization.

The study represents the importance of understanding blockchain technology as an ecosystem since its potential lies in the adoption and growth of the networks for the benefit of the entire community. Through the research, we can understand the commercial scope of technology and its impacts and therefore, we can gain new business opportunities. It also serves as a guide for further research since it allows us to understand each ecosystem participant. The level of the ecosystem corresponds to end consumers, people, private companies, and governments, who play a fundamental role by indicating their requirements for solving a specific problem, thus generating a market or participating in the community and blockchain alliances development of technology and the ecosystem.

I want to finish this thesis with a note about my working process. When I tried to grasp what the report would look like, it was more challenging to draw actions based on proposals than on a finished document. The value of the research is that it inspires me, as an author, in this case, to discuss new and underexplored

fields. Also, I would like to thank my supervisor and English teacher for helping me complete my thesis.

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LIST OF FIGURES