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MASTER THESIS**

Finansinių Technologijų ir Verbavimo Lietuvos Bankuose Ateities Prognozė	Future Forecast of Developing Financial Technology and Recruitment in Lithuanian Banks
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FUTURE FORECAST OF DEVELOPING FINANCIAL TECHNOLOGY AND RECRUITMENT IN LITHUANIAN BANKS

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SUMMARY

72 pages, 7 figures, 30 table, 42 references.

The main purpose of this master thesis is to evaluate the percentage changes in the recruitment of banks due to the increasing use of financial technology in banks in Lithuania and to make predictions for the coming years.

The Master thesis consists of three main parts; the analysis of literature, the research and its results, a conclusion and recommendations.

Literature analysis reviews definition and history of financial technology, fintech ecosystem, determination of banking systems and the development of systems are examined. Furthermore, analysis of scientific problems in academic literature and the analysis of methods applied in academic research are mentioned in this section.

Following the literature analysis, 7 different variables are used, including the total number of banks, branches, employees, ATMs, total number of payment cards, registered internet and mobile banking users and cards pos-terminals. The variables for which Pearson correlation analysis was made were then estimated for the values between 2022 and 2028 using the gray system method. In the last section, the results of the research were evaluated.

In line with the results, the number of the total number of ATMs, payment cards, branches, employees and cards pos-terminals are expected to decrease in the coming years. On the other hand, it is estimated that there will be an increase in the number of banks, registered internet, and mobile banking user.

The conclusions and recommendations contain the conclusions of the research conducted as well as recommendations for future analysis.

Forecasts are based on data up to 2021; actual figures for later years were not included, as validation was beyond the scope of this research.

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INTRODUCTION

Fintech companies are transforming the financial services industry by providing customer-centric services that combine speed and flexibility, while mostly startups, backed by forward-looking strategies and cutting-edge business models. Fintech is fast becoming a global phenomenon, driven by entrepreneurs and academics, and catching the attention of regulators.

Fintech is a broad term that encompasses innovative technology-enabled financial services and the business models that support them. In its most basic form, it refers to any innovation aimed at improving the process, delivery, and use of financial services by businesses. In this case, when it comes to financial technology, which is far from stagnation and includes instant developments, the first thing that comes to mind is banks, or rather the change in banks.

The banking sector plays an important role in the economy and is an industry that heavily uses all three of marketing, technology, and human resources. The working strategies of banks are shaped by the effect of this triple structure, among other factors. Until recently, when "alternative distribution channels of banks" were mentioned, we thought of telephone banking, automatic money machines (ATM), and internet banking, while mobile banking applications, which are currently used with internet infrastructure and are functional on mobile devices, have started to be used.

In addition, it has been observed that the marketing activities of banks are also oriented in this direction, and they highlight new mobile banking advantages through channels such as print and visual media and social media in order to stand out in a tough competitive environment.

As mentioned before, intense interest continues in this rapidly developing sector and it is possible to see the effect of this in the academic field. Research on financial technology is increasing day by day. Some of them are as follows. As, *the diffusion of fintech, financial inclusion and income per capita* (Désiré Kanga,2021), *FinTech, terrorism-related fund transfers and behavioral finance* (Benjamin McDermid,2020), *Consumer-lending discrimination in the FinTech Era* (Bartlett,2020), *Fintech and banking: What do we know?* (V. Thakora,2020), *A survey on FinTech* (Sun,2018,) *Enhancing the security of FinTech applications with map-based graphical password authentication* (Meng,2019), *Fintech: Ecosystem, business models,investment decisions, and challenges* (Shin,2018) it has been seen that studies have been carried out on subjects belonging to different disciplines. However, there is a lack of any research on the employees who feel the impact of the developing technology the most. However, there is a lack of any research on the employees who feel the impact of the developing technology the most. Since such a study is a sector with close to 30,000 employees, it is obviously important that it is a

foresight for those who continue their career or who want to make a career in this sector. It will also help people in the industry how to develop themselves in order to move forward on more solid foundations in financial technology.

Aim of the research. The aim of this thesis is to evaluate the percentage changes in the recruitment of banks due to the increasing use of financial technology in banks in Lithuania and to make predictions for the coming years.

The main objectives of the research:

1. To theoretically analyze financial technology in the literature.
2. Determining the technic implementation steps for the methods to be used in the research.
3. Concluding empirical research and interpreting the results.

Research methods. To investigate the contribution of already established means and findings, related studies were gathered and systematized. As a result, literature analysis was used as part of the methodology to support empirical models. After literature review, Grey Model First Order One Variable was selected as the research method to estimate future values which is developed by Prof. Ju Long Deng.

Structure of the research. The thesis is divided into three main sections. The first part covers the definition and history of financial technology, determination of banking systems and development of systems and importance of recruitment in banking. This section also shows us the importance and impact of financial technology on the world. Furthermore, the chosen methodology is mentioned in the first section. The second part is methodology which is include one quantitative research model, variables, data collection as well as estimates. Moreover, this part covers research limitations. The last part will cover result analysis of impact on the banking system, estimate for future years and, their analysis. Finally, conclusions and recommendations are introduced.

1 FINANCIAL TECHNOLOGY: THEORETICAL BACKGROUD

Knowing how fintech came about and its definition plays a big role in understanding the importance of fintech. For this reason, in this section, the meaning of the concept of Fintech will be examined and its history will be emphasized. Then, the situation of Fintechs in the world, which has attracted everyone's attention recently, will be discussed. Fintechs, which are increasing in number and touching everyone's life, will examine the funds they receive from solid companies and the new technological developments they bring to banks. Finally, human resources management, which has been an important building block of banking until recent years, and why it is so important will be discussed.

1.1 Finance Sector and FinTech Concept

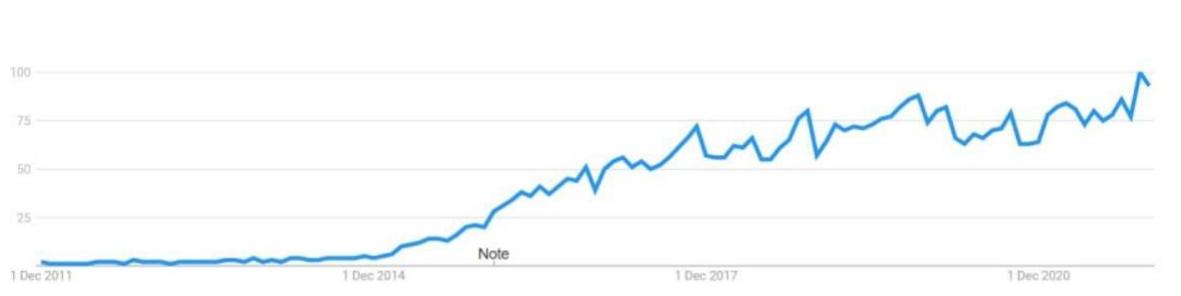
The 2008 financial and economic crisis triggered a series of major upheavals in the financial services sector. The first was the realization that the activities of the major financial institutions can generate systemic risk. This led to the development of different measures designed to quantify that risk. Regulation gave directions and forced actions to mitigate them. In particular, the notion of a financial entity's contribution to systemic risk led to the definition of systematically important financial institutions (SIFIs). The Basel Committee on Banking Supervision (BCBS) increased banks' regulatory reserve requirement in order to take account of individual contributions to global risk (Sylvain Benoit, 2017). Similarly, regulators asked many companies to verify and improve their solvency. This regulatory tightening placed a dual burden on financial institutions: directly, by forcing them to set aside greater reserves and therefore scale back their activities and, indirectly, in that the public opinion considered them the main culprits behind the financial crisis. As the global economy emerged from the crisis, it became clear that many customers, and especially the younger generations, the so-called millennials, had lost faith in the traditional financial services. From their point of view, financial institutions were the root cause of the financial and economic crisis. To make matters worse, those agents had only managed to avoid bankruptcy thanks to continuing massive injections or support of public money (Sorkin, 2010). Why should anyone take their advice or trust them with their savings if the banks themselves are incapable of managing the risks they take? Customers of both old and new generations are willing to abandon the traditional players. They want to see new companies emerge that were not involved in the recent financial crisis and could provide innovative financial services solutions.

Definition Of Fintech. The word fintech derives from the coupling of two complementary areas: financial services and solutions based on advanced technology. The economic literature does not agree on a single definition of fintech due to the overall diversity of the business. The word "fintech" has made its way into the Oxford Dictionary as: "Computer programs and other

technology used to support or enable banking and financial services.” Wikipedia defines “FinTech” as: “Financial technology, also known as Fintech, is a line of business based on using software to provide financial services. fintech companies are generally startups founded with the purpose of disrupting incumbent financial systems and corporations that rely less on software.” (Nicoletti, 2017). In general, Fintech is a word used to describe almost any type of startup that uses a certain level of technology to create a financial product or service. In addition to providing technology-supported financial services in order to increase the efficiency of existing processes or systems, Fintech startups can create new solutions for a specific service activity by using technology.

Figure 1

Popularity of the search term “fintech” at Google



Source: Google database, 2021

According to Google, the term Fintech's search popularity is increasing year after year. On a scale of 0 to 100, we can see a significant increase in interest in the term Fintech over the last ten years when we normalize the scale between the fewest search entries and the most search requests. It has risen from a low of near zero in 2011 to a high of 100 in 2021. Figure 1 depicts this trend. Hence, the term Fintech has long past the test of popularity with the broader business world. It has gained acceptance worldwide and has taken its place in dictionaries.

1.2. History Of Fintech

FinTech has become a hot topic in recent years, but the concept is not new. It can be dated back to the first half of the nineteenth century with the introduction of the telegraph (1838) and later with the successful construction of the first transatlantic cable in 1866. Together, these two technological innovations put the basis for the financial globalization of the late 1800s. Nowadays, in the era of Internet of Things, it can be difficult to think about an unlinked world, where information flows with great difficulties over regions and continents. Before the transatlantic cable was successfully Completed, communications between Europe and the Americas took place only

by ship. Apart from the duration of the trips, there was a considerable risk of having delays due to possible storms and shipwrecks. The significance and the scope of that innovation, even for financial uses, are clear.

Banking as an industry was one of the early adopters of computers. The first mainframe for commercial use was built for a bank. Banks themselves used computers to enhance and speed up legacy processes that already existed (Nicoletti, 2017). This important development is also considered as Fintech 1.0.

Following that, Barclays Bank's introduction of the Automatic Teller Machine (ATM) in 1967 (Lerner, 2013) arguably marks the start of the modern evolution of today's FinTech. The ATM was one of the first technological applications in the financial sector, allowing financial institutions to save money by automating interactions between customers and financial institutions rather than relying on human labor. The impact of ATMs prompted Paul Volcker, former chairman of the US Federal Reserve (1979-1987), to famously say in 2009, in response to a question about the role of financial innovation in the Global Financial Crisis of 2008: *“The most important financial innovation that I have seen the past 20 years is the automatic teller machine, that really helps people and prevents visits to the bank and it is a real convenience.”* (Volcker, 2009)

Until the end of the 1980s, this industry remained, at least from a consumer perspective, largely an industry based on analog technologies. (Nicoletti, 2017) .The financial services industry began to transition from analog to digital technologies in the 1990s. This decade was marked by the development of the World Wide Web and the first Internet banking experiments from Well Fargo in the United States and ING in Europe. Furthermore, the replacement of the telegraph with the fax and later with email/instant messages improved global communications, paving the way for stronger financial relationships.

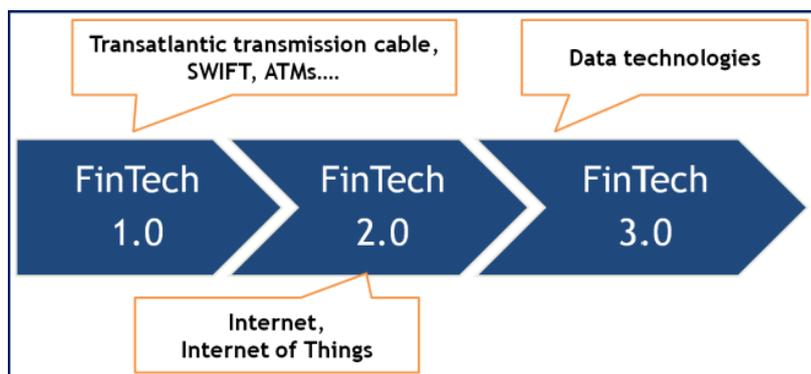
The financial services sector's internal and external processes have moved to full digitization since the twenty-first century. The importance of investments in the ICT sector demonstrates the importance of this sector in the financial services industry.

Fintech startups compete directly with traditional financial institutions. Many customers' banking habits have radically changed because of the mobile phone. In some parts of the world, it has even enabled people to have a bank account, albeit a rudimentary one.

Fintech initiatives are increasingly growing, affecting new areas and branches of the economy. In 2009, Satoshi Nakamoto (a pseudonym) introduced a new type of money called Bitcoin (Skinner, 2016). It is a decentralized digital currency.

Figure 2

The development of FinTech and key technologies in each stage



Source. *Compiled by an author in accordance to Leong, 2018.*

The Trans-Atlantic transmission cable and mainframe computers, for example, were key enabling technologies in FinTech 1.0. These technologies give rise to financial technology products like SWIFT and ATMs. The Internet and the Internet of Things were among the related technologies developed during FinTech 2.0, whereas more and more data technologies will be developed during FinTech 3.0. We are currently in a period of transition between FinTech 2.0 and FinTech 3.0. Figure 2 shows the development of FinTech and key technologies in each stage.

Fintech 1.0 (1886-1967). Finance and technology have had a long history of mutual reinforcement. Financial transactions were aided by the emergence of early calculation technologies, such as the abacus. Finance evolved alongside trade, and double entry accounting emerged as a result in the late Middle Ages and Renaissance. the late 1600s saw a European financial revolution featuring the rise of joint stock companies, insurance, and banking—all based on double entry accounting—which was essential to the Industrial Revolution. The relationship between finance and technology laid the foundations for the modern period.

In the late 19th century, technologies such as the telegraph, railroads, and steamships helped forge financial connections across borders. In 1866, the fundamental infra-structure that enabled a period of strong financial globalization (stretching from 1866 to 1913) was the laying of the transatlantic telegraph cable,¹³ followed by rapid post–World War II technological developments. By the end of this period, a global telex network had been implemented, which provided the communications foundation on which the next stage of FinTech would unfold. (Douglas W. Arner, 2017).

Fintech 2.0 (1967–2008). The late 1960s and the 1970s saw rapid advances in electronic payment systems. Indeed, the basis of modern automated clearing services was formed by the establishment

of the Inter-Bank Computer Bureau in the United Kingdom in 1968. The US Clearing House Interbank Payments System followed in 1970, and Fedwire was introduced soon after. Reflecting the need to link domestic payment systems, the Society of Worldwide Interbank Financial Telecommunications (SWIFT) was established in 1973, followed shortly thereafter by the 1974 collapse of Herstatt Bank—an event that highlighted the risks of increasing international financial links. This crisis served as the catalyst for the first major regulatory initiative: the establishment in 1975 of the Basel Committee on Banking Supervision of the Bank for International Settlements, leading to a series of international soft-law agreements.

In 1987, “Black Monday” saw stock markets crash globally. The effects were a reminder that global markets were technologically interlinked. “Circuit breakers” were introduced to control the speed of price changes, spurring securities regulators to create mechanisms to facilitate cooperation. The foundations for the full interconnection of EU financial markets were being laid, including the Single European Act of 1986, the 1986 “big bang” financial liberalization process in the United Kingdom, and the 1992 Maastricht Treaty.

Advances in the mid-1990s underscored the initial risks of computerized risk management systems, as evidenced by the collapse of Long-Term Capital Management after the Asian and Russian financial crises of 1997–1998. But the next level of development continued with the provision of online consumer banking by Wells Fargo in 1995. The emergence of the internet in the 1990s provided the foundational change that made FinTech 3.0 possible a decade later.

During FinTech 2.0, e-banking presented new risks for regulators. For one thing, electronic bank runs were a possibility because technology facilitated instant withdrawals. Regulators expected that e-banking providers would be authorized financial institutions—typically, the only entities allowed to describe themselves as “banks.” But FinTech 3.0 called for a radical rethinking of that view. (Douglas W. Arner, 2017).

Fintech 3.0 (2008- Present). Between 2007 and 2008, a confluence of factors provided the impetus for FinTech 3.0 in developed countries. The brand image of banks was severely shaken. A 2015 survey reported that Americans trusted technology firms far more than banks to handle their money. Today, the same phenomenon exists in China, where over 2,000 peer-to-peer (P2P) lending platforms initially emerged outside any established regulatory framework; and yet lenders and borrowers—because of lower costs, higher potential returns, and increased convenience—remain undeterred.

The key differentiating factors of FinTech 3.0 are the rapid rate of technology development and the changing identity of the providers of financial services. Startups and technology firms have

challenged established financial institutions by offering specific, niche services to consumers, businesses, and incumbent financial institutions. (Douglas W. Arner, 2017).

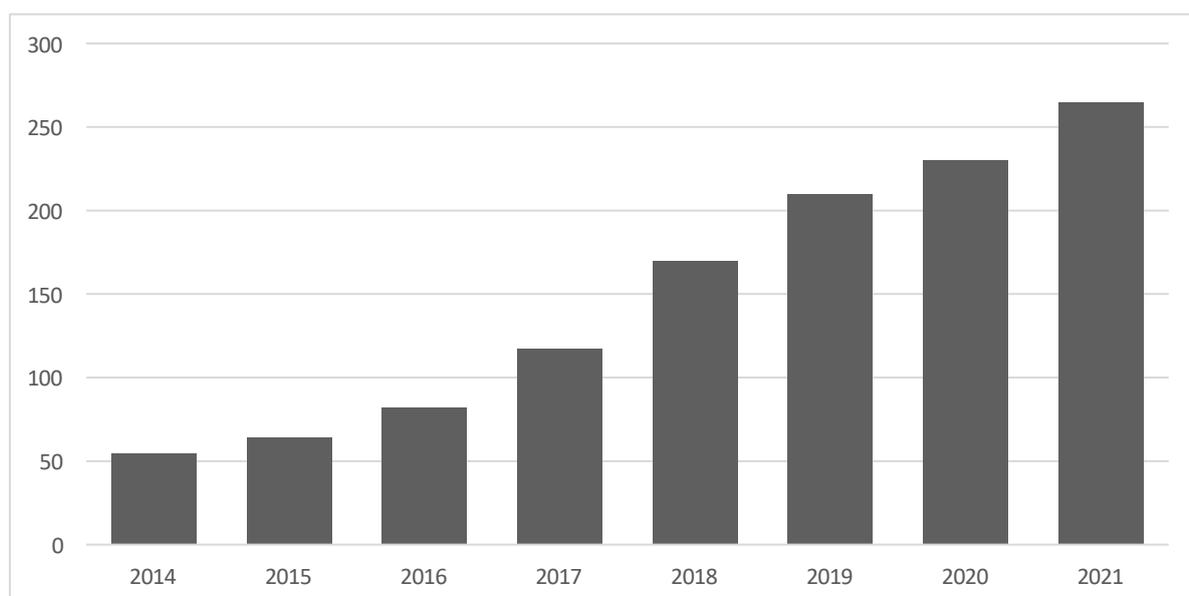
1.3. Fintech In Lithuania

In recent years, Lithuania has become increasingly noticeable among FinTech start-ups. In the inter-national FinTech ranking prepared in the United Kingdom, which evaluates various elements of the FinTech ecosystem, Lithuania was ranked the 4th among various 65 countries in the world in 2019 (a rise by 14 positions during the year), whereas payments, lending and bank-ing were considered to be areas that are the most developed in Lithuania (Findexable, 2020). Year later, Lithuania maintained its leadership in FinTech and was ranked the 10th among 83 countries in the world in 2020 (Findexable, 2021).

According to report of The Fintech Landscape in Lithuania made by Invest Lithuania, despite a troubled global economy, the Fintech industry demonstrated its resilience in 2020 and continued to grow strongly, a trend which was in full evidence in Lithuania. In 2020, Lithuania’s Fintech hub saw 40 new companies set up operations, with the overall sector growing from 210 to 230 over the year. Almost half of these newcomers were international Fintech brands opening offices in Lithuania. The remainder were recently established startups founded either by local or international entrepreneurs. (Baciuliene, 2021). Table 1 shows number of Fintech in Lithuania.

Table 1

Number of Fintech in Lithuania



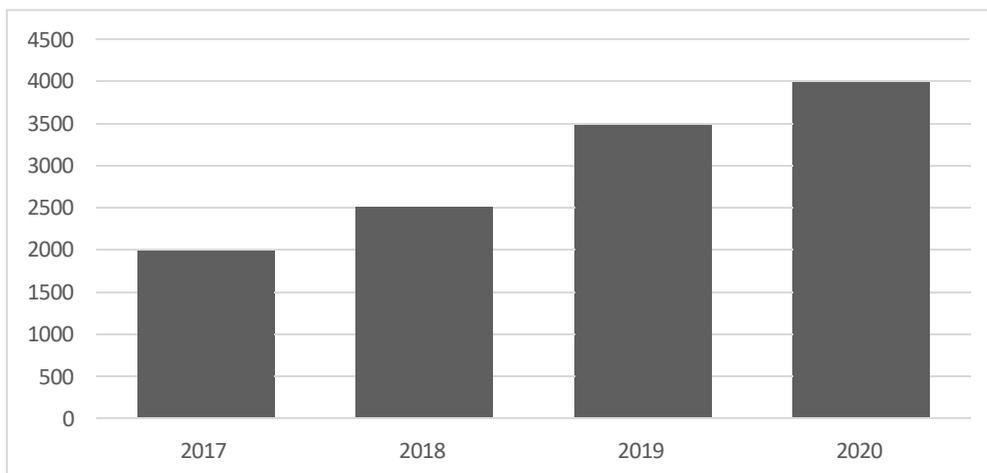
Source. Compiled by an author in accordance to (Baciuliene, 2021)

2021 was indeed a record year for the Fintech sector in Lithuania: the number of employees and revenues smashed previously set records, and 265 fintech companies are already calling Lithuania home.

When it comes to licensed entities (payment institution, electronic money institution and special banking license holders), Lithuania ranks 1st in the EU, with a total of 147 licensed fintechs. Second ranking France has 90 licensed entities, Germany – 86, and Netherlands have 84.

Table 2

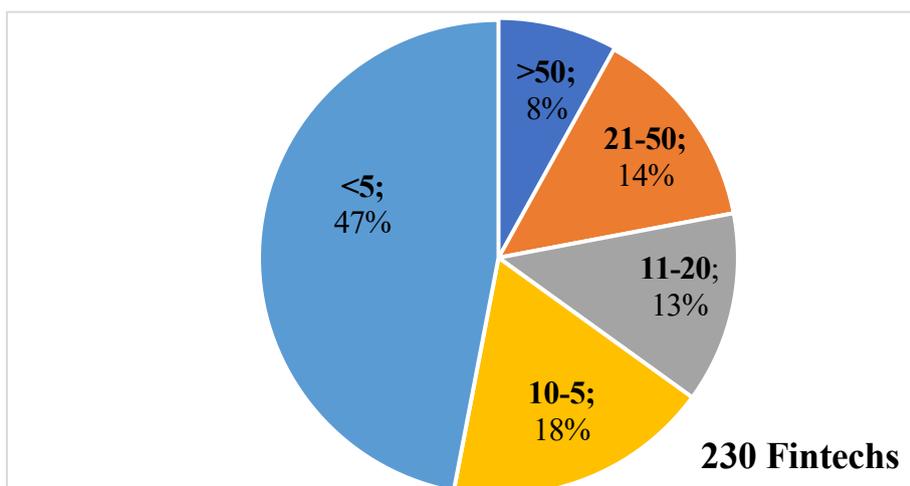
Number of people employed by Fintechs in Lithuania



Source. Compiled by an author in accordance to (Baciuliene, 2021)

Table 3

Fintechs in Lithuania by team size



Source. Compiled by an author in accordance to (Baciuliene, 2021)

The number of specialists employed in this sector grew by 18% in 2020. This represents a similar rate of increase in full-time employees (FTEs) as in previous years, despite the disruption

and uncertainty experienced last year. The growth in the number of FTEs was mainly caused by multiple companies scaling their teams in order to keep up with increased demand for their services or products. Many of these companies experienced triple digit revenue growth. Several new arrivals to the ecosystem were able to ramp up their operations within a year, growing their headcount to as high as 40 FTEs. While the share of young Fintechs with small teams remains similar to last year, the more established Fintechs were able to successfully scale even through the disruption caused by Covid-19 (Baciuliene, 2021).

As mentioned before, a lot of research has been done about Fintechs and one of them has revealed the future of Fintechs in 5 different scenarios for Lithuania. According to the optimistic forecast, if Lithuania continues to put efforts to the improvement of the FinTech ecosystem, the creation of an innovation-friendly environment, and the legal framework for resolving various disputes will continue to improve, the number of FinTech companies can continue to grow rapidly (Taukanskaite, 2022).

1.4. Banking

A large part of the country's economies, moreover, a significant part of the service sector consists of the banking sector. Therefore, breakthroughs in banking have a direct impact on the economy. For this reason, the low or high function of banking affects all economic units. Banks, which correspond to the most important unit of the economy, provide commercial enterprises with many opportunities such as financial resources, the provision of main financial services and access to payment schemes. In addition to these, some banks also provide liquidity and loan facilities in negative market conditions. Moreover, they also provide access to the state's safety net in certain matters. For this reason, banks need a strong corporate governance (Yazıcı & Göker, 2019).

Banking, with its important position in finance, is also important for economic development and development. Banking both attracts the attention of governments and plays an intervening role in order to develop the economy.

The roles that bank take in economics while assuming risks can be listed as follows: (Sayılğan, 2003)

- To reduce national and international disparities by directing resources from places with a large amount of funds to those with a shortage of funds.
- To convey the abundance of funds in economics to those who want it.
- Obtained resources; to play a role in development by shifting it to yield, profit and socially important sectors.

- Transforming maturity and scale by transforming short-term and partially small-rate funds for individuals into long-term and high-rate funds needed to finance investments.
- Generating cash.
- To increase its activities with the monetary policy preferred by the Central Banks.
- To play a role in the development of international commercial relations with the payment and lending methods it offers.

It is to take actions such as influencing the distribution of income and wealth with the credit policies followed.

Traditional Banking Industry in the 21st Century

According to Edward and Mishkin (1995, p. 1), “The traditional banking is to make longtime loans and back them by giving short-time deposits, a process which generally introduced as borrowing short and lending long.”

According to Freixas and Rochet (2008, p. 3), “a bank is a place where existing services comprised of giving credits and collecting deposits from society.”

Services presented by banks distinguish six categories (Dermine, 2015): “payments, portfolio management, risk-sharing, monitoring, underwriting, and advisory services.”

Banks are attempting to keep track of the maturities of funds collected from depositors and allocated as loans. Deposits are made by individuals or businesses who expect a return on their investment. Individuals or businesses who require short-term funding for cash flow activities or long-term investments are eligible for these loans. Individuals or businesses serve as customers for banks on both sides.

For banks, maturity management is a critical activity. This activity is the foundation for other services. Banks must organize customer relationship processes and provide other products to manage these relationships in a customer-based approach. Information management, portfolio management, risk-sharing, and advisory services are all included. Payment services are information sources. Underwriting, placement, and monitoring services are all part of the loan granting process.

One of the most important aspects of bank sustainability is information management. Customers are the primary source of the above-mentioned data. However, information asymmetry poses a significant threat to long-term viability. To overcome the information asymmetry, banks invest in relationship-oriented activities. As a result, relationship-oriented banking aims to build a bond with the customer.

Customers are examined by relationship managers and underwriting teams using methods that are consistent with the banks' internal policies. Both banks are attempting to reduce risk and establish an advisory role for themselves in the presence of customers by doing so.

When the waters are calm, traditional banks prefer relationship-oriented banking (i.e. when banks have access to cheap capital, more stable economic conditions exist, and low levels of non-performing loans realize). The banking industry, on the other hand, operates in a highly competitive environment. When the economy is in a state of flux, banks are more likely to take a position in transaction-oriented banking. Digitalization has played an increasingly important role in the expansion of transaction-oriented banking in recent years. Transaction-oriented banking places a premium on profit, and as a result, the primary goal is to reduce risk.

Traditional banks have physical presence in the form of headquarters, branches, and ATMs. In addition to their physical presence, these tools serve as a point of contact for customers and information providers. To put it another way, the price of these tools is proportional to the cost of reducing information asymmetry.

1.4.1. Digitalization In Banking Industry

Over the last four decades, technological innovations have a direct effect on every division in every industry. The fact reminds us that advancements in innovations sharply increased in recent years. The banking industry also got its share. Technological progressions in the banking industry presented from a historical perspective.

According to Dermine (2016); "...the technological discoveries and their impression on the industry: leveraging data, mobile banking, blockchain, cloud technology, and uses of AI among robo-advisors..." (Akbulut, 2019)

In the restructuring of banks from the 1960s, information technology has a chief function. Data processing is the method to make arrangements of reasonable and serviceable information from data stacks. The main objective of this process is the creation of useful information for every party. By doing so, more classified products can engage the appropriate person or company directly. For those reasons, every corporation seeks effective data processing systems. Electronic data processing is evaluating data by digital applications in an automated way in an electronic environment. This type of processing is not only speedy, cost-effective, feasible, and also outdo for a very large scale of data against conventional manual techniques (Akbulut, 2019).

As the amount and size of the work that banks do with their customers has increased, the paper load has also increased after a certain period of time. Thus, the money spent for the employee and

the branch increased and it was understood that the money in question corresponds to 80% of all expenses on average.

The transformation of the services offered by banking has been with the transition to the digital world. In the 1950s and late 1960s, the digitalization process accelerated and many banks started to work on computer-related infrastructure in this process. These developments started to attract the attention of computer manufacturers Xerox, IBM and Burroughs. But the most important problem is the lack of necessary software. Therefore, the use of computers has increased with the development of software (Batiz-Lazo, 2002).

While banks are trying to respond to customers' requests through their branches, they have also started to prefer digital technologies. But one of the key requirements has been to include branch-wide customers and services in digital transactions. Although there have been developments in order to respond to the increasing customer demand and transaction amounts, service criteria have been determined with the widespread use of digital. Afterwards, banking intensified digital investments and customer-bank jobs started to be done on the computer. Thus, a new competitive environment in banking has changed with technological investments (Batiz-Lazo, 2002).

Internet banking can also name as online banking or web banking. This type of banking provides ease of access to customers, through the Internet, for almost all kinds of financial transactions which only accessible to consumers when actually within a bank branch. The transactions in New York have accepted the initial version of internet banking in 1981. In 1983, the Scotland Bank has been placed the first internet banking service in England as Homelink. Individuals connect to the internet by telephones or televisions for financial services. The basics of the modern digital banking system lay at this time (Davis, 1989).

The banking sector is one of the leaders in adopting open innovation and setting up accelerator programs. These programs are setup with the strong notion that banks must quickly address the threat of disruption and engage with startups (Desai, 2021).

Banks, which mostly do not have a direct impact on the development of technology, benefit from various opportunities by making the advancing technology work in production and distribution channels. It is possible to list these possibilities as follows:

In addition to the cost for the transaction, the obligation to apply to the branch is eliminated by performing non-branch banking transactions.

It can significantly reduce the cost for the work performed.

With the simultaneous works carried out in global markets, the market shares of banks can easily increase.

It has been made possible to provide private banking services for consumers based on their needs and habits.

The increase in the speed of technological developments and their desire by consumers are among the most important reasons for the banking sector to follow them closely. Along with the transforming economic and social structure, the transformation of the political and technological structure plays a role in improving the services of banks, which are under the pressure of competitiveness and consumer demands.

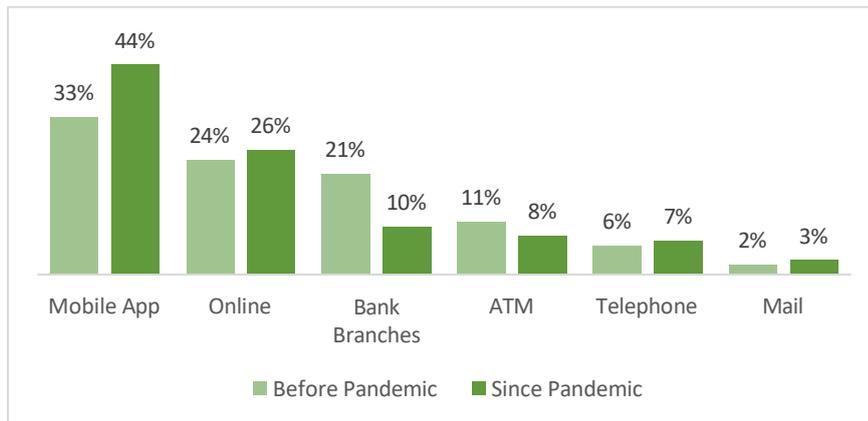
Electronic Banking. The process that emerged with the use of cash as a payment instrument continues with the creation of the core rules of technology in our age. How these rules will take shape, what they will consist of and what they will cover becomes clear over time. As emphasized in the literature, technological advances have accelerated recently, the use of digital communication tools has become widespread, and trade transactions have become digital.

As a result of all the advances, electronic banking gradually differs from banking, which has become widespread in branches in the traditional sense. In other words, a banking system without branches is developing, and its use is becoming widespread in Lithuania as it is everywhere.

As a result of the resource studies carried out, it is seen that different types of electronic banking are emerging, and new technologies create a separate field. Banking establishes Information Technologies units within itself and is divided into various branches in electronic banking by the units established. In general, these regulations; automatic teller machine (ATM), internet, telephone, and mobile banking. According to a study carried out by the American Banks Association, the majority of banking consumers use internet banking. Table 4 shows the usage rates of American banks before and after the pandemic.

Table 4

How Americans Bank: Before and During Covid-19



Source Prepared by Sykes Report, 2021.

As it is clearly seen in the table, the rate of using bank branches decreased by 11%, especially with the pandemic process, while the rate of mobile banking increased by 10%.

Mobile Banking. Another area of electronic banking is mobile banking. The rapidly developing mobile technology makes its impact felt not only in the field of telecommunications and entertainment, but also in the field of finance. The most important feature of mobile services is that they are preferred by large masses and offer individual services. The issue that distinguishes the technology of phone applications from other systems is the rapid spread of mobile. This has caused the said technology to be important in commerce as well. Other factors in the intensive use of mobile banking are; unlimited access in terms of time, not being tied to a specific location and being able to carry out effortless transactions (Cudjoe, Anim, & Nyanyofio, 2015).

According to the academic model presented by Tiwari and Buse (2007, pp. 73–74), mobile financial services “refer to the provision and availability of banking and financial services with the help of mobile telecommunication devices. The scope of offered services may include facilities to conduct bank and stock market transactions, to administer accounts, and to access customized information.” (Nicoletti, 2017).

In simpler words, mobile financial services are services delivered by a financial institution which allows its end-users to perform financial transactions by means of two specific components:

A mobile device, such as a tablet or a smartphone; and

A software designed for being executed on mobile devices, usually with an “App”.

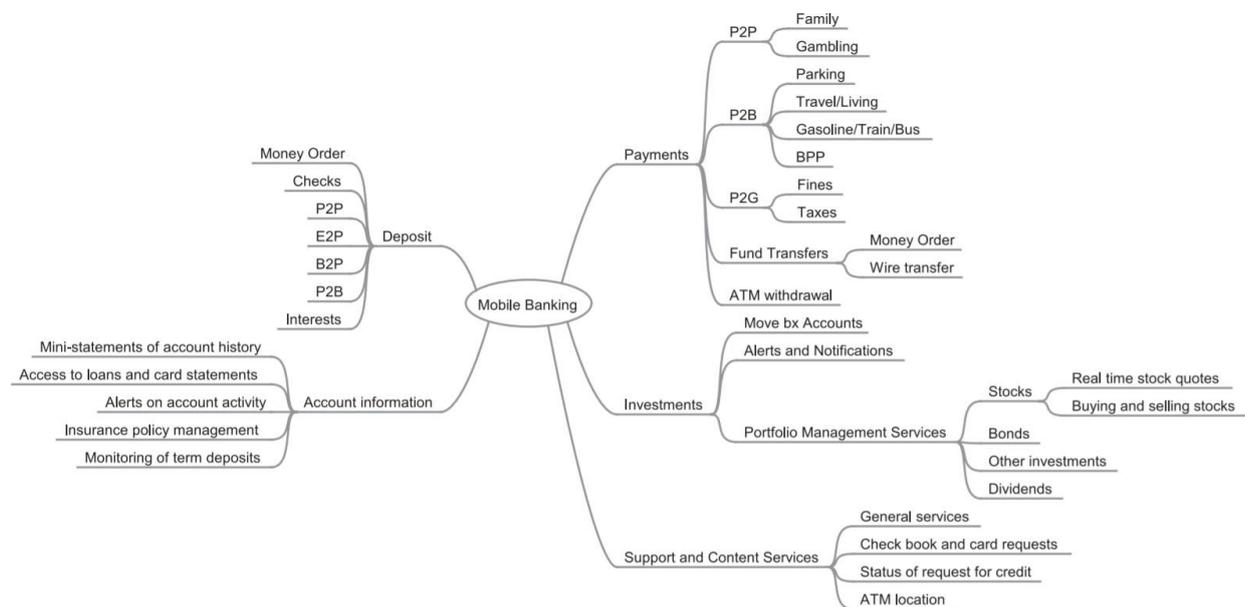
Handling transactions may be expensive for a financial institution: the need of physically visiting a branch is reduced by allowing customers to perform a set of financial transactions

directly through their online or mobile devices. Speed of access is an important element of value for the customers too. Even though companies are moving toward a full digitalization of their internal processes, it is difficult to imagine the world where phones act as ATMs; indeed, banks and some of their branches are still a relevant reference, especially for complex financial transactions, such as mortgages or large investments.

Figure 3 shows the categories of services that mobile banking can provide to its users, from a broader perspective (Nicoletti, 2017).

Figure 3

Services in mobile banking



Source. Compiled by an author in accordance to Nicoletti, 2017.

The Classification based on product innovation includes five areas:

- Account information
- Payments
- Deposits
- Investments
- Support and content services

Currently, most of the financial services provided are transactional: making payments and transferring money are the main scopes for the transactions.

1.4.2. Banks in Lithuania

The financial sector is a part of the Lithuanian economy. In order to be an effective financial sector, it has to invest national and foreign savings into productive industrial and service spheres which can enhance the scope and quality of production and services in the country. In this way the financial sector influences the rise of the gross domestic product of the country. Nowadays, it is widely accepted that the development of the financial sector influences the rate of the country's economic growth. (Filomena Jasevičienė, Vaida Valiulienė, 2013)

The beginning of the contemporary domestic banking in Lithuania dates back to the years of "perestroika" (1988-1989). In the period of National Revival, the issue of the establishment of the Lithuanian banking system became an integral part of the concept of Lithuania's economic sovereignty. In accordance with the concept of national banking, a plan was drawn to restructure the Soviet mono-banking system into a two-tier banking system, with the traditional functions of the central bank entrusted to the Bank of Lithuania (Lietuvos Bankas) established (re-established) in March 1990, i.e. shortly after the restoration of independence had been proclaimed. The creation of a contemporary banking system in Lithuania was delayed by an economic blockade launched by the Soviet Union in April-June 1990 and the absence of international recognition of the State of Lithuania, which ended along with the failure of the *coup d'etat* in Moscow in August 1991 (Jonas Cicinskas, Linas Sadzius, 2006).

Although some changes (towards commercialization³) took place before the restoration of independence, the more profound transformation began on the ground of resolutions passed during 1990. The banking reform was accelerated by adopting legal measures narrowing the scope of activities of some state-owned specialized banks at the same time, and the material basis of the Bank of Lithuania was developed from two formerly specialized banks. After nationalization of Soviet banks, their commercial functions and customers were inherited.

In the process of development of the contemporary banking system in Lithuania, opinions of the representatives of two economic schools advocates of Lithuanian banking pattern in the pre-war period and those of the contemporary free market model clashed. This affected the development of both the Bank of Lithuania and of domestic banking in general. As the first view prevailed during the first phase, creation of modern banking was delayed in Lithuania.

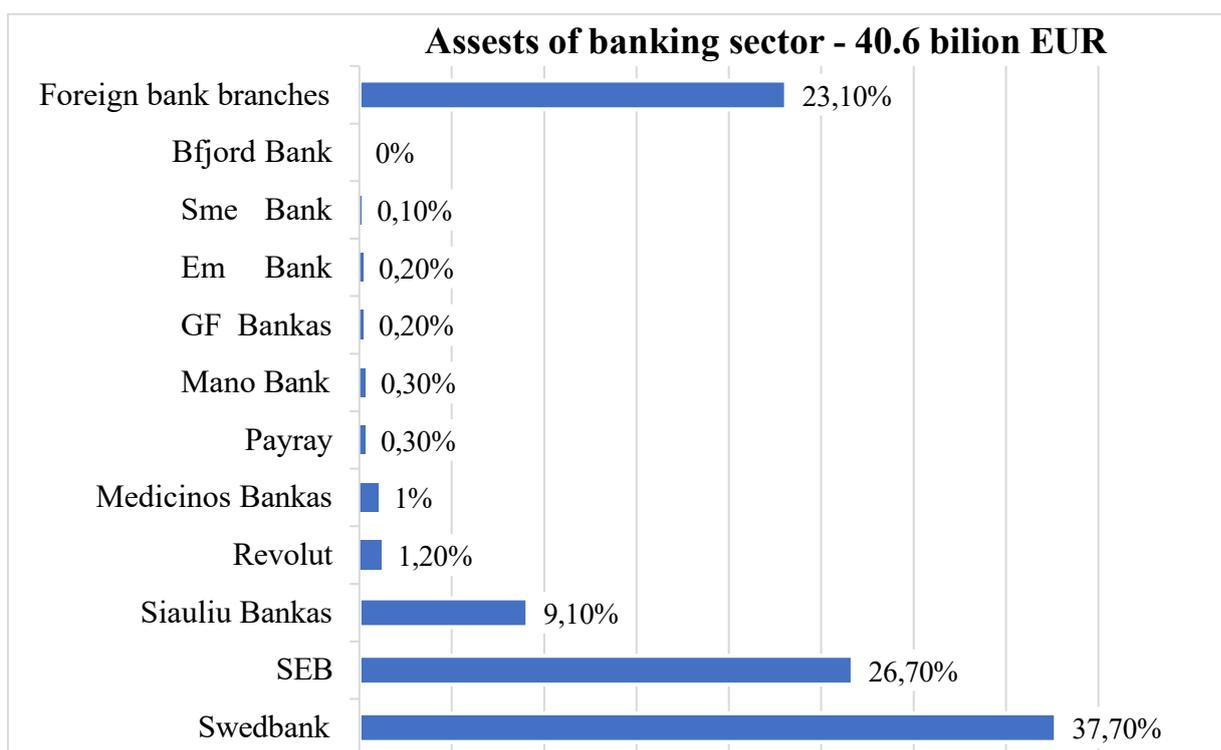
The following tasks of utmost importance were solved at the initial stage of the banking reform: Lithuanian banks were separated from the banking system of the Soviet Union and nationalized, the Bank of Lithuania was established and started operating, foundations were laid for the

activities of state-owned and private commercial banks. By the end of 1993 there were 28 banks in the country (Bankų statistikos metraštis 2002, 2003, 11).

One of the most serious problems during the original period was that, with minor exceptions, domestic specialists in finance had been trained for the planned economy. Most banks employed staff of low qualification and competence who, in extending credits, failed to perform a comprehensive analysis of the activities of their customers. Many new bankers and businessmen failed to adequately respond to the changes of the situation in various business areas, in the development of the national economy when many economic entities became insolvent. By the end of 1995, 27 commercial banks were registered by the Bank of Lithuania, but only 12 of them actually functioned. This may be related to both the lack of competence, experience and qualified staff and the intended activities being based on unclear selfish reasons and goals as well (Jonas Cicinskas, Linas Sadzius, 2006).

Table 5

Assets of banking sector in Lithuania (Bankas, 2022)



Source. Compiled by an author in accordance to Lietuvos Bankas, 2021

Currently Lithuania supervises 12 banks and 6 foreign bank branches. As can be seen in figure 8, Swedbank owns 32.5% of the total assets with 15,312 million euros. This is followed by SEB with its assets of 10,580 million euros and a share of 26.7%.

1.5. Recruitment

The process of obtaining superior human resources must be created a mechanism or system to hire the best candidates. Human resource management organize a mechanism or system whereby company is able to hire desired candidate for the success of business achievement. The process of obtaining candidates according to the needs of the organization is called recruitment. Dessler (2013) explains that recruitment is the process of collecting relevant information about work-related tasks and human characteristics needed to do the work so as to help managers determine the qualifications and types of skills needed in the recruitment process. Then continued Mathis and Jackson (2010) argue that recruitment is the process of generating a pool of qualified applicants to perform an organization's work. Recruitment is an early process in which the organization must be able to formulate human resource requirements including qualifications and competency needs.

Competence of human resources must be tailored with the needs of company. Competence of human resources must be formulated precisely how the company should be able to hire the best people for realizing achievement of business targets. Initial process should be done by the company how to formulate the work plan, qualifications, responsibilities, and work process. Brannick and Levine (2002) explain that job analysis is an organized process where companies are able to formulate the nature of the work to be performed by employees. The process of this company as a business organization must make the formulation of work and the process that will be performed by employees. After determining the type of work and the process, the company must determine the qualifications that must be able to perform the work with the best performance.

The recruitment and selection process are one of the most important human resource managements used by banks as it is the point of entry into the banks and where the banks recruit talents that drive their goals and interest (Walker, 2001) The recruitment of candidates for a position in organizations through headhunting in human resource strategy is critical to the company's success (G Deepakshi , C Sheetal). Smith and Rupp (2004) cited in Deepakshi and Sheetal (2014:2-3), are of the view that the internet has drastically changed the face of recruitment. Employers must market themselves by instituting a well-implemented e-recruitment program t o find better quality candidates to occupy a sensitive position at lower-cost through the recruitment strategy of head-hunting.

It is the process to discover sources of manpower to meet the requirement of staffing schedule and to employ effective measures for attracting that manpower in adequate numbers to facilitate effective selection of an efficient working force.

Recruitment of candidates is the function preceding the selection, which helps create a pool of prospective employees for the organisation so that the management can select the right candidate for the right job from this pool. The main objective of the recruitment process is to expedite the selection process.

Recruitment is almost central to any management process and failure in recruitment can create difficulties for any company including an adverse effect on its profitability and inappropriate levels of staffing or skills. Inadequate recruitment can lead to labor shortages, or problems in management decision making.

The Consequences of Hiring Mistakes. Poor hires are not apparent because the problem does not become noticeable until later: they are the clock-watchers, the incapables who get their work done by others, or the marginal workers who have found a way to beat the system (Cynthia Sandico, Brian H. Kleiner, 1999).

These are the “false positive” employees, the people who were hired but should not have been. An example would be the person who does not get along well with others but is placed in customer service and alienates many customers resulting in lost future sales (Cynthia Sandico, Brian H. Kleiner, 1999).

The less visible problem of an ineffective hiring process is the “false negative,” the candidate who could have been effective on the job but was not hired. If this individual should work for the competition and makes valuable contributions there, the company not only lost a valuable employee, but the competition has gained an edge (Cynthia Sandico, Brian H. Kleiner, 1999).

The cost of bad hiring is difficult to measure because the grossly mis-hired are only a small fraction of the total picture. If you think about the costs of the salary, wasted benefits, training costs, wasted time of the interviewers, effects on fellow employees, and the efficiency and opportunities lost due to the inferior work of the bad hire, it is not hard to see that the mistake can be measured in terms of tens to hundreds of thousands of dollars per hire (Cynthia Sandico, Brian H. Kleiner, 1999).

The Summary of Literature Regarding Financial Technology. Financial technology has become an important part of our daily lives in the last six years, as mentioned in the previous sections. With this change came a slew of new challenges that the academic literature was grappling with. The number of empirical studies on FinTechs is rapidly increasing, and the authors have already compiled a number of useful insights. The research mostly analyzed

aspects relating Fintech hazards and opportunities, Fintech returns, regulations for Fintechs, differences and similarities with traditional banking.

Appropriate methodology must be prepared, and appropriate variables must be selected, in order to produce comprehensive analyses of the research. As a result, scientific literature is examined not only for relevant insights into the topic, but also for the methods and predictors used to solve a specific problem. The following section summarizes the methods and variables used in the literature in relation to Fintechs.

1.6. Scientific Problems Analyzed in Academic Literature

This section provides an overview of the main problems that have arisen in recent literature and the results of research that has already been completed. The summary of this study is as seen in Table 6.

Table 6

Summary of literature analysis of Fintechs

TOPIC	RESULTS	YEAR	AUTHOR
Can Fintech development pave the way for a transition towards low-carbon economy: A global perspective	(1) The higher the level of financial innovations in a country, the lower will be the carbon emissions after controlling for exports, GDP and capital formation.	2021	Ran Tao, Chi-Wei Su, Bushra Naqvi, Syed Kumail Abbas Rizvi
The diffusion of fintech, financial inclusion and income per capita	(1) The extent of fintech diffusion increases with financial inclusion, human capital and GDP per capita. (2) The extent of fintech diffusion (ATMs and mobile phones and payments systems) increases financial inclusion	2021	Désiré Kanga, Christine Oughton, Laurence Harris & Victor Murinde
Givers or Receivers? Return and volatility spillovers between Fintech and the Traditional Financial Industry	(1) A policy change can induce market volatility and co-movement over time. (2) Financial service ETF has a greater effect on the Fintech ETF, and the business development ETF is affected more significantly by Fintech. (3) Fintech does not lead to greater volatility and financial instability in most of the traditional financial industries.	2021	Yuxuan Chen, Junmao Chiu, Huimin Chung

Fintech development and savings, borrowing, and remittances: A comparative study of emerging economies	<p>(1) Respondents living in countries with more developed fintech ecosystems are significantly more likely to have a financial account but less likely to have a mobile money account (MMA).</p> <p>(2) More developed fintech ecosystems are not necessarily associated with increases in individuals' savings behaviors.</p> <p>(3) Having access to online and mobile financial services is related to greater financial inclusion.</p>	2020	Angela C. Lyons, Josephine Kass-Hanna, Ana Fava
Fintech: what's old, what's new?	<p>(1) Recent innovations render communication advantages a key competitive factor in financial services by reducing barriers to entry and weakening banks' traditional role as the "first point of contact" for financial services.</p> <p>(2) The key new development is the abundance of non-financial data, including from digital footprints, which can be used in financial services provision.</p>	2020	Arnoud Boota, Peter Hoffmann, Luc Laeven, Lev Ratnovski
Integrating the 'Troublemakers': A fintech taxonomy for cooperation between banks and fintechs	<p>(1) In a collaboration, the fintech can either keep the innovation or the bank can fully integrate it.</p> <p>(2) Some banks have been observed acting as investors and holding shares in fintech companies.</p> <p>(3) Despite the fact that most fintechs lack a full banking license, a banking license is important in bank-fintech collaboration because it defines a fintech's ability to offer and process financial products without the involvement of a bank.</p>	2018	Benedict J. Drasch, André Schweizer, Nils Urbach

Source Compiled by an author

As can be seen from the summary (Table 1), Ran Tao, Chi-Wei Su, Bushra Naqvi, Syed Kumail Abbas Rizvi (2021) conducted a study to address the question of whether fintech development is helping economies make a smooth transition towards lower carbon and greenhouse gas emissions. As a result of this research, they concluded that the carbon emission rate will be low in countries with high development in financial technology. Désiré Kanga, Christine Oughton, Laurence Harris & Victor Murinde (2021), proved that there is a positive relationship between developing financial technology and GDP in their research based on the question "What is the impact of financial technology on GDP?". An empirical network model was used by Yuxuan

Chen, Junmao Chiu, Huimin Chung (2021) to investigate the return and volatility spillovers between a Fintech ETF and traditional financial industry ETFs. They found that a policy change can trigger market volatility and concerted action over time. They also proved that the financial services ETF has a greater impact on the Fintech ETF and is more influenced by the business development ETF Fintech. Angela C. Lyons, Josephine Kass-Hanna, Ana Fava (2020) explored the relationship between fintech development and various measures of financial inclusion. Additionally, in the same year Arnoud Boota, Peter Hoffmann, Luc Laeven, Lev Ratnovski(2020) published their research on key dimensions of innovation in the provision of financial services. Last but not least, Benedict J. Drasch, André Schweizer, Nils Urbach (2018) explored the link between the bank and Fintechs, revealing in a collaboration that fintech can either maintain innovation or the bank can fully integrate it, and the same research also found that some banks act as investors and own shares in fintech companies. has proven.

1.6.1. The Analysis of Methods Applied in Academic Researches

In order to select the most applicable and plausible methodology for the analysis of financial technology, similar researches have been examined. As a result, this chapter provides an overview of the main methods and most commonly used variables in recent research.

Methods. The most used methods among academic researches are shown in Table 7. According to the research, regression analysis has been the most used method.

Table 7

Methods used in researches that analyses financial technology related.

		METHODS						
		Regression Analyses	Vector Autoregression (VAR)	Panel Data Regression	Taxonomy	Grey System Theory	Normalization and Aggregation	2SLS
AUTHORS	Ran Tao, Chi-Wei Su, Bushra Naqvi, Syed Kumail Abbas Rizvi	X						X
	Désiré Kanga, Christine Oughton, Laurence Harris & Victor Murinde	X		X				
	Yuxuan Chen, Junmao Chiu, Huimin Chung		X					
	Angela C. Lyons, Josephine Kass-Hanna, Ana Fava	X					X	
	Eyüp Şahin & Buğra Bağcı					X		
	Benedict J. Drasch, André Schweizer, Nils Urbach				X			
	Nguna Kıtlu	X						
	Selim Taştan	X						

Source Compiled by an author

The authors who applied the regression analysis mostly examined the relationship of financial technology with other subjects. For example, Tao, Su, Naqvi, Rizvi (2021) used this method to examine the relationship with carbon level. Another example is the relationship between GDP and financial technology by Kanga, Oughton, Harris and Murinde (2021). In this research the author has also used the panel data regression method. Most used methodologies are indicated Figure 12. Moreover, many other specific analysis methods were used in recent studies as well. For instance, Şahan D. (2017) Şahan D.(2017) conducted a research on how FinTechs will change the banking sector by using the interview technique, which is a qualitative research method. Akbulut M. (2019) published the study used qualitative research, in which he did aim to understand the future of banking and develop a strategic approach to the existing traditional banking system against FinTech startups, based on secondary data obtained from various sources such as books, previously published articles, articles, reports and websites. Akbulut used various methods for the strategy part, such as LCAG model, value chain analysis, VRIO framework, Porter's five forces and general strategies, SWOT analysis, blue ocean strategies and balance scorecard method. Unlike all these studies, Şahin & Bağcı (2020) used the grey system theory to predict the prices of cryptocurrencies.

Variables. In order to understand fintechs and predict their future, the authors investigated the relationship between many different variables. While investigating this relationship, the most used method is the regression method, as mentioned before. Table 8 shows the most commonly utilized variables by financial technology researchers.

Table 8

Variables used in the researches

AUTHORS	VARIABLES
Selim Taştan	Number of FinTech startups, GDP per capita, Labor market efficiency, ATM count, Innovation, Mobile phone usage
Rabia Durhan	Reliability, Convenience, Accessibility, Efficiency
Nguna Kulu	Profitability, Years in business, Size, Ownership
Angela C. Lyons, Josephine Kass-Hanna, Ana Fava	Actual deposit/balance in the account, Geometric GFI score of country, Employment status, Government transfers, Individuals' usage of digital technologies
Ran Tao, Chi-Wei Su, Bushra Naqvi, Syed Kumail Abbas Rizvi	Emissions, Fintech Development, Gross Domestic Product (GDP), Gross Capital Formation (GCF), and Exports (EXP)

Alexandre Croutzet, Amal Dabbous	Renewable energy consumption, the natural logarithms of renewable energy consumption, gross domestic product per capita., consumer price index, foreign direct investment and financial institution depth index, gross domestic product per capita growth.
Dario Salerno, Gabriele Sampagnaro, Vincenzo Verdoliva	Underpricing, FinTech IPOs, Market capitalization, Number of listed domestic companies, Enterprise value multiple, Return on Assets, Underwriter Syndicate

Source Compiled by an author

The dependent variable was chosen by Selim Taştan (2021) as the number of FinTech startups to investigate the economic and technological determinants of new ventures emerging in the financial technology sector as seen in Table 2. GDP per capita, labor market efficiency, ATM count, innovation, and mobile phone usage were the independent variables. Durhan R. (2021) used reliability, convenience, accessibility and efficiency variables in order to determinate the use characteristics of individuals benefit from digital services in financial technologies. Kılıu (2018) investigated the effect of Fintech firm on the financial performance of the banking sector with the variables of profitability, years in business, size and ownership.

1.6.2. The Forecast Analysis of Non-deterministic System

Probability and statistics, fuzzy mathematics, and grey systems theory have been the three most-often applied theories and methods employed in studies of non-deterministic systems. Even though they study objects with different uncertainties, the commonality of these theories is their ability to make meaningful sense out of incompleteness and uncertainties. It is the differences among the uncertainties studied in these theories that three areas of scientific study, each of which has its own characteristics, on uncertainties have been established.

Fuzzy mathematics has its strength in the study of problems with “precognitive uncertainties.” All objects studied using fuzzy mathematics possess the characteristic of “having a clear intension without a clear extension”. For example, the concept of “young men” is a fuzzy concept. It is because all people know the intension of being a “young man”. However, it will be extremely difficult to define such a definite range of age that within the range a man is young and out of range a man is not young. The very reason why it is so difficult to introduce such a definition for the concept of “young men” is that the extension of this concept is not clear. When faced with this kind of unascertained problem with clear intension and unclear extension, fuzzy mathematics is the theory and method to use. The main idea of fuzzy mathematics is based on the so-called membership functions established based on experiences.

With fuzzy mathematics, probability, and statistics described earlier, what we can say here is that grey systems theory is developed to study problems of “small samples and poor information.” These problems studied by grey systems theory cannot be handled successfully by using either probability or statistics. Through coverage of information and generations of series, grey systems theory looks for realistic patterns based on modeling based on a few available data. Different from fuzzy mathematics, grey systems theory focuses on such research objects that have clear extension and unclear intension. Based on our discussion above, let us summarize the comparison of these three theories in the following (Sifeng Liu; Jeffrey Yi-Lin Forrest, 2006)

Table 9

Comparison between grey systems theory, probability, statistics, and fuzzy mathematic

	Grey Systems Theory	Probability Statistics	Fuzzy Mathematics
Objects of the Study	Poor information	Stochastic	Cognitive
Basic Sets	Uncertainly	Uncertainly	Uncertainly
Methods	Information coverage	Probability distribution	Function of affiliation
Procedure	Grey series generation	Frequency distribution	Marginal sampling
Requirement	Any distribution	Typical distribution	Experience
Emphasis	Intention	Intention	Extension
Objective	Laws of reality	Laws of statistics	Cognitive expression
Characteristics	Small samples	Large samples	Experience

Source Compiled by an author in accordance to Liu and Lin, 2006

The main feature that distinguishes the gray estimation method, which is one of the main fields of work of gray system theory, from traditional estimation methods is that it needs a limited number of data to predict the behavior of uncertain systems. Traditional forecasting methods such as time series require large amounts of historical data and known statistical distributions to make accurate assessments. Unlike traditional estimation methods, the main feature of the gray estimation method is that it does not need strict assumptions about the data set and can be successfully applied in the analysis of systems with limited data.

2. METHODOLOGY FOR FUTURE FORECAST OF THE IMPACT OF FINANCIAL TECHNOLOGY ON RECRUITMENTS IN BANKS

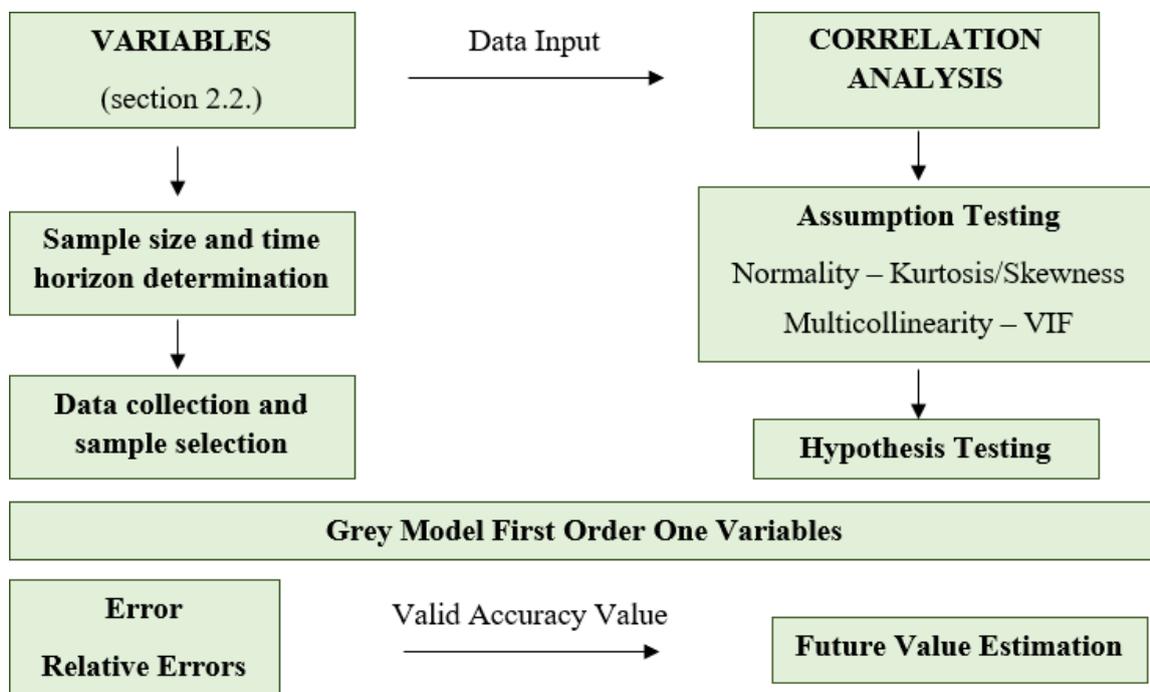
The second chapter of research describes the structure and the process of a quantitative statistical research model by providing a detailed plan of methodology. The construction and substantiation of the methods used are covered in this section. As a result, a significant effort has been made to develop a methodology for conducting sound and reliable analysis. As a result, while developing methodology for this study, various methods and variables that were commonly used by researchers in related scientific literature (section 1.7) are heavily considered. Based on data availability, examined literature and trends in empirical financial studies, Grey Model First Order One Variable is considered as the most suitable way to estimate values from 2023 to 2028. This chapter begins by introducing the overview of the research structure and by providing visual scheme of prepared methodology. Section 2.2 provides justification, formulas, variables, samples, time horizons, and hypotheses for the construction of research model.

2.1. The Overview of the Research Structure

The methodology of this research includes three parts which are shown in the Figure 4. Each part of the methodology is briefly present further below.

Figure 4

Structural Visualization of the Research Analysis



Source Compiled by an author

In the first part of the analysis, it was decided to use the normality and multicollinearity tests and the correlation test that should be applied. A Variance Inflation Factor (VIF) analysis for multicollinearity was performed using the SPSS application. The normality test was decided according to kurtosis and skewness values. As a result of the analysis, the Pearson correlation analysis was again performed on the SPSS application. In addition to all these, standard deviation and mean values were also calculated.

In the second stage, the margin of error and relative error rate were found. After it was seen that the error rates were at an acceptable level, it was aimed to understand that the model established was reliable and could be used in the forecasts for the next period. Future predictions were made for the variables whose tests gave positive results.

2.2. Sample Size, Time Period, Variables, Assumptions and Hypothesis

In this section, sample size, time frame, variables, assumptions and hypotheses are explained and detailed explanations are given under the relevant headings.

Variables. The research is composed of eight variables. All variables are identified in Table 9. All the variables were selected in accordance with the purpose of the research and considering the accessibility of the data. The variables of the total number of ATMs, the number of registered internet banking users, the number of registered SMS banking users, the number of Card POS terminals, the number of payment cards are the financial technology products seen in the banks.

Table 10

Variables for GM (1,1)

VARIABLE	DESCRIPTION
BA	total number of banks,
BR	the total number of branches,
ATM	the total number of ATMs,
AIB	the total number of registered internet banking users,
AMB	the total number of registered SMS banking users,
POS	the total number of Cards POS-terminals,
CAR	the total number of payment cards,
TE	the total number of employees,

Source Compiled by an author

The above eight variables have been chosen because they are thought to be the units most affected by the developing financial technology in Banks.

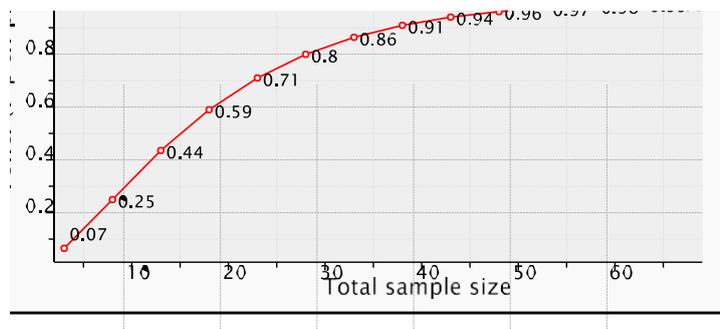
Time Horizon. As mentioned in the literature review section, it is possible to accept the beginning of financial technology as 2015 in banks. Therefore, in the selection of the samples, the values between 2005 and 2021 were chosen, with a minimum of 2015 to 2021.

Sample Size. The amount of the observations in the dataset was calculated by using G*Power software. Under the confidence level of %95 (as this is the standard of empirical research), the minimum required sample size was calculated to be 46 (Figure 11).

However, in order to conduct more reliable research model, 50 observations were included correlation analyses. The number of the banks (BA) did not include the correlation analyses due to has totally 28 observations which are under the threshold.

Figure 5

Total sample size



Source Prepared by author according to GPower Software output

As calculated minimum sample size was 46 out of 68, in the sample, the values between the 4th quarter of 2007 and the 2nd quarter of 2020 were taken in the years when the variable "Number of registered SMS banking users (AMB)", due to which has the smallest number of observations, was found.

Assumptions. In statistical model, parametric indices deliberate some certain characteristic about the data, model suitability as well as reliability. The nonconformity of assumptions could cause inaccurate interpretation of the findings. In some cases, exceptions might made but must be highly substantiated. In accordance with the analyzed literature, assumptions tested are underlined and explained below (Zaid,2015; Pallant 2010; Whitcomb 2012):

1st Assumption. Normal distribution. Normal distribution of data is a prerequisite for many statistical analyzes. In addition, in order to use parametric tests, the data must be normally distributed. The values of kurtosis and skewness between ± 2 indicate that the data are normally distributed.

2nd Assumption. No multicollinearity. The variables are not highly correlated with each other. If the analysis includes more than one independent variable, it could cause concern of multicollinearity, when there is a strong correlation between two or more variables. When you fit the model and interpret the results, a high degree of correlation between variables can cause problems.

Also, multicollinearity refers to the linear relationship among two or more variables, which also means lack of orthogonality among them. When correlation exists among predictor's the standard error of predictors coefficients will increase and consequently the variance of predictor's coefficients is inflated. The VIF is a tool to measure and quantify how much the variance is inflated. To interpret the value of VIF the following rule is used in the figure below (Daoud, 2017):

Figure 6

VIF interpretation

VIF -value	conclusion
$VIF = 1$	Not correlated
$1 < VIF \leq 5$	Moderately correlated
$VIF > 5$	Highly correlated

Source Prepared by a (Daoud, 2017)

Hypotheses of the study. Hypotheses belonging to each variable were expressed theoretically. Below are 3 different hypotheses variables.

H_1 : There is a strong positive relationship between the total number of branches and the number of employees.

H_2 : There is a significant relation with number of ATMs, number of registered internet banking users and number of registered SMS banking users.

H_3 : There is a negative relationship between the total number of employees and the number of registered internet and mobile banking users.

Limitations of Data and Research Models. Short comes should indeed be identified in order to effectively generalize research findings. As a consequence, this section provides an overview of the research's limitations, which are primarily related to methodology and dataset.

The first limitation concerns data collection. Since Lithuania is determined as the study area, data will be obtained directly from banks operating in Lithuania. These are Swedbank, SEB, Citadele Bank, Danske Bank, DNB bank, Handelsbanken, Medicinos Bankas, Nordea Bank, Pohjola Bank, Šiaulių Bankas. The data will be taken from the Lithuanian Banking Association official site.

Data collected between 2005 and 2021 will be used to make future projections. The collected data will be used separately for each year between 2022 and 2028.

However, the limitations noted above have no impact on the reliability of the research models or the interpretation of the findings. The model will be subjected to reliability and robustness tests that will show a reliable result.

The methodology chapter covered the creation of a research model as well as the robustness tests which should be carried out in order to compose a reliable analysis. In addition, this section included a detailed explanation and sequence of methodology application, which was later used in Chapter 3. As a result of the examination and introduction of methods, variables, datasets, and samples, assumptions, robustness tests, and limitations, the practical part can be implemented, results analyzed, and outlook and recommendations proposed.

2.3. The Construction of Grey System Theory

Grey system theory was advanced by Deng in 1982. In this theory, the color “grey” indicates that the information within a system is partially unknown. Since then, the theory has become quite popular, in part for its ability to deal with systems with unknown parameters. In superiority to traditional statistical models, grey models require only a limited amount of data to predict the behavior of unknown systems. Conversely, the color “white” in a grey system denotes that all of the information is definite and complete (i.e., fully known), and “black” indicates that the information within the system is completely unknown. The objective of grey system theory is to transform the “black” (unknown) information of the system into “white” (definite) information from the available information. Consider the following statement: “Tom’s height is almost six feet.” From this statement, the phrase “almost six feet” is not sufficiently accurate to describe Tom’s height, and therefore this statement involves some “grey” information. A grey system would enable Tom’s height to be identified to within an acceptable error tolerance by using some other available data. (Forrest, Liu, & Chen, 2004)

Grey systems have been successfully applied within a variety of fields, including engineering classification and control systems, multi objective management systems, product-shape generation, and image prediction systems, as well as agricultural systems. Grey methods have the powerful advantage of being capable of dealing with complex problems concerning uncertain or fragmented systems by means of a simple process and a reliable analysis technique. (Forrest, Liu, & Chen, 2004)

One of the grey estimation methods, the GM(1,1) model is used to define the grey model, which includes first-order differentiable equations with a single variable.

The GM(1,1) model consists of seven stages. (Forrest, Liu, & Chen, 2004)

Step 1: A raw dataset is created as follows. $X^{(1)} = (x^{(1)}(1), x^{(1)}(2), x^{(1)}(3), \dots, x^{(1)}(n))$ indicates the sequence in which it accumulates.

$$X^{(0)} = (x^{(0)}(1), x^{(0)}(2), x^{(0)}(3), \dots, x^{(0)}(n)) \quad (1)$$

Step 2: It is then referred to as the original form of the model $X^{(0)}k + ax^{(1)}(k) = b$ GM(1,1), where the symbol GM(1,1) represents the "grey model of the first order in one variable".

$$X^{(1)} = (x^{(1)}(1), x^{(1)}(2), x^{(1)}(3), \dots, x^{(1)}(n)) \quad (2)$$

$$X^{(0)}k + ax^{(1)}(k) = b \quad (3)$$

Step 3: Let $Z^{(1)}(k)$ be the sequence generated from $X^{(1)}$ by adjacent means.

So;

$$Z^{(1)}(k) = \frac{1}{2}(x^{(1)}(k) + x^{(1)}(k-1)), k = 2, 3, \dots, n \quad (4)$$

$$X^{(0)}k + ax^{(1)}(k) = b \quad \text{It is referred to as the basic form of the GM(1,1) model.} \quad (5)$$

Step 4: Let $X^{(0)}$, $X^{(1)}$, and $Z^{(1)}$ be the same as above, except that $X^{(0)}$ is not negative. After the $X^{(1)}$ and $Z^{(1)}$ series are formed, if $\hat{a} = (a, b)^T$ is a sequence of parameters,

$$Y = \begin{bmatrix} x^{(0)}(2) \\ x^{(0)}(3) \\ \vdots \\ x^{(0)}(n) \end{bmatrix}, B = \begin{bmatrix} -z^{(1)}(2) & 1 \\ -z^{(1)}(3) & 1 \\ \vdots & \vdots \\ -z^{(1)}(n) & 1 \end{bmatrix} \quad (6)$$

If it is estimated by the least squares method, using the equation $x^{(0)}k + az^{(1)}(k) = b$, the vector \hat{a} showing the parameters of the GM(1,1) model is calculated. $\hat{a} = (a, b)^T$ is calculated as:

Step 5: If;

$$\hat{a} = (B^T B)^{-1} B^T Y \quad (7)$$

The first-order derivatives are obtained as; $\frac{dx^{(1)}}{dt} + ax^{(1)} = b$

$$x^{(1)}_t = (x^{(1)}(1) - \frac{b}{a}) e^{-at} + \frac{b}{a} \text{ is displayed with. So, } x^{(1)}(k+1) = (x^{(1)}(1) - \frac{b}{a}) e^{-ak} + \frac{b}{a}, \quad (8)$$

$k= 1,2,3 \dots n$

Step 6: Then, the reverse cumulative process is applied to the first order differentiable equation and the estimated values are obtained with the model below.

$$\hat{x}^{(0)}(k+1) = a^{(1)} \hat{x}(k+1) = \hat{x}^{(1)}(k+1) - \hat{x}^{(1)}(k) = (1-e^a) (x^{(0)}(1) - \frac{b}{a}) e^{-ak}, \quad (9)$$

$k= 1,2,3 \dots n$

Step 7: Then, the margin of error of the produced forecast values is calculated and it is tested whether the model can be used to predict future values. Any value of the raw dataset $X^{(0)}$ The estimation error for $\epsilon^{(0)}(k)$ is denoted. It is calculated as follows;

$$\epsilon^{(0)} = (\epsilon(1), \epsilon(2), \dots, \epsilon(n)) = (x^{(0)}(1) - \hat{x}(1), x^{(0)}(2) - \hat{x}(2), \dots, x^{(0)}(n) - \hat{x}(n)) \quad (10)$$

If $x^{(0)}$ is the error rate for any element of the raw data set, then Δk .

It is calculated as follows and expressed as a percentage.

$$\Delta k = (|\frac{\epsilon(1)}{x^{(0)}(1)}|, |\frac{\epsilon(2)}{x^{(0)}(2)}|, \dots, |\frac{\epsilon(n)}{x^{(0)}(n)}|) = \{\Delta k\}_1^n \quad (11)$$

The mean relative error is calculated by equation 12.

$$\Delta = \frac{1}{2} \sum_{k=1}^n \Delta_k \quad (12)$$

The accuracy classification of commonly used forecasting models is as shown in Table 10.

Table 11

Accuracy Classification of Forecast Models

Accuracy Classification	Parameters	
	P	C
Level 1 High Confidence	>0,95	<0,35
Level 2 Highly Reliable	>0,80	<0,50
Level 3 Low Confidence	>0,70	<0,65
Level 4 Unreliable	≤0,70	≥0,65

Source (Ju-Long, 1982).

Analyze of Correlation. Normal distribution of data is a prerequisite for many statistical analyzes. For example, in order to use parametric tests, the data must be normally distributed. It is necessary to do a normal distribution research in order to choose which correlation method to use. In our analysis, the normality value of the data will be found by using the Shapiro-Wilk test in SPSS software. If the data distribution is normal in the analysis result, the Pearson correlation method will be used. If the data distribution is not normal, the Spearman correlation method will be used.

3. INVESTIGATION OF THE IMPACT OF FINANCIAL TECHNOLOGY ON RECRUITMENTS IN BANKS

As mentioned in the previous sections, this research was conducted using the grey system theory, which is a qualitative research method, as the main method. Before applying this method, the collected values were subjected to different analyses to test their applicability. First of all, correlation analysis, standard deviation, and mean values of the collected values were found. In line with these results, it was determined that there was no multicorrelation between the values, and the grey system method was applied, and the predictions for the future years were made.

3.1. Investigation of Financial Technology Variables

Correlation analysis was used to determine whether there is a linear relationship between the data, and if so, what is the direction and severity of this relationship. In order to determine the method, normal distribution analysis of the data were performed. All of the analyzes were made on the SPSS application, and the results and interpretations are given below.

In order to determine the normal distribution, which is the first test, Shipara-Wilk test was applied and Kurtosis and Skewness values were checked. Darren George and Paul Mallery explained the results of their research on this issue as follows. "Kurtosis is a measure of the "peakedness" or the "flatness" of a distribution. A kurtosis value near zero (0) indicates a shape close to normal. A positive value for the kurtosis indicates a distribution more peaked than normal. A negative kurtosis indicates a shape flatter than normal. An extreme negative kurtosis (e.g., < -5.0) indicates a distribution where more of the values are in the tails of the distribution than around the mean. A kurtosis value between ± 1.0 is considered excellent for most psychometric purposes, but a value between ± 2.0 is in many cases also acceptable, depending on the particular application. Remember that these values are only guidelines. In other settings different criteria may arise, such as significant deviation from normality. Similar rules apply to skewness."

Figure 7

Normality analyzes of variables

	BA	BR	ATM	AIB	AMB	POS	CAR	TE
Skewness	0,555	0,388	0,83	0,135	-0,933	0,484	0,858	0,48
Kurtosis	-1,753	-1,595	0,055	1,146	-0,52	-0,739	-0,496	-1,344

Source Prepared by an author according to SPSS software outputs

As can be seen in Figure 7 above, all of the values fall between ± 2 , so it can be said that the values are normally distributed.

Descriptive statistics. Table 11 describes variables by involving mean, standard deviation and a total number of observations used in the model. The mean in a normally distributed data represents the central tendency of the values of the data. The standard deviation (or σ) is a statistic that calculates the square root of the variance and measures the dispersion of a dataset relative to its mean. Standard deviation also indicates how dispersed the data is in relation to the mean. Data are clustered around the mean when the standard deviation is low, and data are spread out when the standard deviation is high. A standard deviation near zero indicates that data points are close to the mean, while a high or low standard deviation indicates that data points are above or below the mean, respectively.

Table 12

Descriptive Statistics

Descriptive Statistics		
	Mean	Std. Deviation
TE	8759,32	1764,487894
BR	442,28	197,8790643
ATM	1445,76	332,8000294
AIB	3647575,06	624501,084
POS	3604926,7	409403,9157
AMB	1354849,68	483171,0876
CAR	48363,98	9696,759121

Source Prepared by an author according to SPSS software outputs

Moreover, correlation analysis was performed as the second analysis. The Pearson Correlation method was chosen considering the normal distribution of the values. Pearson's correlation coefficient (r) is a measure of the linear association of two variables. The values of correlation coefficient vary from -1 to $+1$. Positive values of correlation coefficient indicate a tendency of one variable to increase or decrease together with another variable. Negative values of correlation coefficient indicate a tendency that the increase of values of one variable is associated with the decrease of values of the other variable and vice versa. Values of correlation coefficient close to zero indicate a low association between variables, and those close to -1 or $+1$ indicate a strong linear association between two variables (Kirch, 2008). The analysis was performed on the SPSS program and the values are given in Table 12.

Table13

Normality analyzes of variables

Pearson Correlation							
		TE	BR	ATM	AIB	POS	AMB
BR	<i>r</i>	,946**					
	<i>Sig.</i>	0,000					
ATM	<i>r</i>	,339**	,409**				
	<i>Sig.</i>	0,005	0,001				
AIB	<i>r</i>	-,822**	-,881**	-,505**			
	<i>Sig.</i>	0,000	0,000	0,000			
POS	<i>r</i>	,804**	,823**	,604**	-,840**		
	<i>Sig.</i>	0,000	0,000	0,000	0,000		
AMB	<i>r</i>	-,507**	-,460**	-0,210	,623**	-,449**	
	<i>Sig.</i>	0,000	0,001	0,144	0,000	0,001	
CAR	<i>r</i>	-,725**	-,842**	-,330**	,789**	-,505**	,319*
	<i>Sig.</i>	0,000	0,000	0,006	0,000	0,000	0,024

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

Source Prepared by an author according to SPSS software outputs

According to the results of the Pearson Correlation analysis, a significant and positive relationship was found between TE and the total number of branches (BR), $r = 0,946$ $p < 0,01$ Also a significant and positive correlation was found between TE and the total number of ATMs (ATM), $r = 0,339$ $p < 0,05$. Contrary to this a significant and negative correlation was found between TE and the total number of registered internet banking users (AIB), $r = -0,822$ $p < 0,01$. A significant and strong positive correlation was found between TE and the total number of Cards POS-terminals (POS), $r = 0,804$ $p < 0,01$. In addition to these values, a significant but negative relationship was found between TE and the total number of registered SMS banking users (AMB), $r = -0,507$ $p < 0,01$. Finally, there is a significant, negative and moderately difficult relationship between TE and the total number of payment cards (CAR), $r = -0,725$ $p < 0,01$.

As the second variables which called BR has a significant and positive relationship with ATM, $r = 0,409$ $p < 0,01$. A significant but negative strong relationship was found between BR and AIB, $r = -0,881$ $p < 0,01$. Contrary to this a significant and positive correlation was found between BR and POS which is also strong, $r = -0,823$ $p < 0,01$. On the other hand, a significant

and negative correlation was found between BR and AMB, CAR. This value is as follows for the AMB variable, $r = -0,210$ $p < 0,01$ and for CAR variable, $r = -0,330$ $p < 0,01$.

The ATM variable does not have a strong relationship with other variables such as the AMB variable. According to analyses, a significant but negative relationship was found with AIB, $r = -0,505$ $p < 0,01$. A significant and positive relationship was found with POS, $r = -0,604$ $p < 0,01$. On the other hand, a significant and negative correlation was found with AMB and CAR. This value is as follows for the AMB variable, $r = -0,460$ $p < 0,01$ and for CAR variable, $r = -0,842$ $p < 0,01$.

A significant but negative relationship was found between AIB and POS, $r = -0,840$ $p < 0,01$. Also, a significant and positive correlation was found between AIB and AMB, $r = 0,623$ $p < 0,01$. The last significant and positive correlation for AIB is with CAR, $r = 0,789$ $p < 0,01$.

The relationship of another variable, POS, with AMB and CAR is significant and negative for both. The values of this correlation are as follows for AMB and as such for CAR. The values of this correlation are $r = -0,449$ $p < 0,01$ for AMB and $r = -0,505$ $p < 0,01$ for CAR.

Finally, the correlation of AMB variable with CAR is significant and positive, $r = 0,319$ $p < 0,05$. In addition, the results of the SPSS software of Pearson correlation analysis are added as Appendix 1.

Multicollinearity refers to the linear relationship among two or more variables, which also means lack of orthogonality among them. When correlation exists among predictor's the standard error of predictors coefficients will increase and consequently the variance of predictor's coefficients are inflated. The VIF is a tool to measure and quantify how much the variance is inflated (Daoud, 2017). As mentioned in the methodology section, a VIF value below 5 indicates the absence of multicollinearity. The results of the VIF analysis performed on the SPSS application are shown in Table 14.

Table 14

Variance Inflation Factor Test

Coefficients		
	Tolerance	VIF
BR	0,2246	3,6780
ATM	0,4640	1,4421
AIB	0,2246	1,9050
AMB	0,4545	1,2558
POS	0,4295	1,7269
CAR	0,5009	1,9964

Source Prepared by an author according to SPSS software outputs

Along with Jamal I. Daoud, Hair stated the results of his research on this subject as follows. “Multicollinearity occurs when two or more predictors in the model are correlated and provide redundant information about the response. Multicollinearity was measured by variance inflation factors (VIF) and tolerance. If VIF value exceeding 4.0, or by tolerance less than 0.2 then there is a problem with multicollinearity” (Hair et al., 2010).

According to the analysis results, it is seen that the VIF values are below 5. According to both Jamal I. Daoud and Hair, it seems clear that there is no multicollinearity problem.

Finally, the correlation analysis' assumptions were met, and the model was deemed trustworthy and reliable. Hypotheses specified in part 2.3. should be revised if analyzed measures indicated statistical significance of the model. In general, all hypotheses can be confirmed, depending on whether there is a significant relationship between all variables. Therefore, the hypotheses are summarized as follows:

1. There is a strong positive relationship between the total number of branches and the number of employees.
2. There is a significant relation with number of ATMs, number of registered internet banking users and number of registered SMS banking users.
3. There is a negative relationship between the total number of employees and the number of registered internet and mobile banking users.

3.2. The Investigation of Grey System Method

Grey system theory was chosen as the second part analysis, since the main subject of our research was to predict the future. As mentioned in the methodology section, the high reliability level and the small number of data requirements are the main factors in choosing this method. Although there is no application for making the estimation, the process steps are given in the methodology section. In this section, calculations will be made for each variable and the results will be evaluated.

The total number of Branches (BR)

Step1:

$X^{(0)} = (643,0; 689,0; 744,0; 758,0; 714,0; 698,0; 418,0; 414,0; 368,0; 356,0; 316,0; 283,0; 268,0; 241,0; 202,0; 191,0; 182,0)$

Step 2:

$X^{(1)} = (643,0; 1.332,0; 2.076,0; 2.834,0; 3.548,0; 4.246,0; 4.664,0; 5.078,0; 5.446,0; 5.802,0; 6.118,0; 6.401,0; 6.669,0; 6.910,0; 7.112,0; 7.303,0; 7.485,0)$

In order for the data to be suitable for estimation, it is necessary to determine the quasi-smooth and semi-exponential values. Quasi-smooth values are shown below.

$$a) \quad P(4) = \frac{x_{(4)}^{(0)}}{x_{(3)}^{(1)}} = \frac{758}{2076} = 0,36513$$

$$b) \quad P(5) = \frac{x_{(5)}^{(0)}}{x_{(4)}^{(1)}} = \frac{714}{2834} = 0,25194$$

Condition for quasi-smooth control: In cases where $k > 3$ the values found must be less than 0.5. When viewed, $X^{(0)}$ conforms to the semi-smoothness rule as it satisfies the $p(4) < 0.5$ condition.

Likewise, the quasi exponentiality check for the $X^{(1)}$ array is done as follows;

$$a) \quad \sigma^{(1)}(4) = \frac{x_{(4)}^{(1)}}{x_{(3)}^{(1)}} = \frac{2834}{2076} = 1,37$$

$$b) \quad \sigma^{(1)}(5) = \frac{x_{(5)}^{(1)}}{x_{(4)}^{(1)}} = \frac{3548}{2834} = 1,25$$

Condition for quasi exponentiality check: In cases where $k > 3$, $\sigma^{(1)}(K) \in [1, 1.5]$ should be, and since $\sigma^{(1)}(4) \in [1, 1.5]$, the sequence $X^{(1)}$ suitable to the quasi exponentiality rule.

Step 3:

$Z^{(1)} = (987,5; 1704,0; 2455,0; 3191,0; 3897,0; 4455,0; 4871,0; 5262,0; 5624,0; 5960,0; 6259,5; 6535,0; 6789,5; 7011,0; 7207,5; 7394,0)$

Step 4:

$$Y = \begin{bmatrix} 689 \\ 744 \\ 758 \\ 714 \\ 698 \\ 418 \\ \vdots \\ [182] \end{bmatrix}, B = \begin{bmatrix} 987,5 & 1 \\ 1704 & 1 \\ 2455 & 1 \\ 3191 & 1 \\ 3897 & 1 \\ 4455 & 1 \\ \vdots & \vdots \\ [7394 & 1] \end{bmatrix}$$

Step 5:

$$\hat{a} = (B^T B)^{-1} B^T Y = \begin{bmatrix} 0,10153 \\ 932,734 \end{bmatrix}, \quad \frac{dx^{(1)}}{dt} + 0,10153x^{(1)} = 932,734$$

Step 6:

$X^{(0)} = (824,87; 745,24; 673,29; 608,29; 549,56; 496,51; 448,57; 405,27; 366,14; 330,79; 298,86; 270,01; 243,94; 220,39; 199,11; 179,89)$

Table 15

Average relative error found as a result of total relative errors for BR

	Raw Data	Estimated Data	Errors	Relative Errors
2005	643	643,00	0,00000	0,00000
2006	689	824,87	-135,87184	0,19720151
2007	744	745,24	-1,23708	0,001662746
2008	758	673,29	84,70958	0,11175406
2009	714	608,29	105,71037	0,148053733
2010	698	549,56	148,43585	0,212658809
2011	418	496,51	-78,50814	0,187818522
2012	414	448,57	-34,57427	0,083512717
2013	368	405,27	-37,26802	0,101271791
2014	356	366,14	-10,14264	0,028490572
2015	316	330,79	-14,79451	0,046818068
2016	283	298,86	-15,85895	0,056038706
2017	268	270,01	-2,00652	0,007487014

2018	241	243,94	-2,93956	0,012197331
2019	202	220,39	-18,38915	0,091035396
2020	191	199,11	-8,11235	0,042473015
2021	182	179,89	2,11035	0,011595348

Source Prepared by an author according to formulas

Step 7: Average relative error found as a result of total relative errors:

$$\Delta = 8,375$$

$$\%100 - \Delta = p$$

$$\%100 - \%8,375 = \%91,625$$

Since the critical p value is >0.80 , the analysis result is 2nd degree-high reliability according to Table 16. In line with this result, prediction values for the future period can be produced by using the forecast model.

Table 16

Forecast Values for the Number of Branches for Future Periods

Years	Estimated Branch Numbers	Estimated Branch Numbers (\approx)
2022	162,52	163
2023	146,83	147
2024	132,66	133
2025	119,85	120
2026	108,28	108
2027	97,83	98
2028	88,38	88

Source Prepared by an author according to formulas

The total number of ATMs (ATM)

Step1:

$$X^{(0)} = (1053,0; 1146,0; 1332,0; 1489,0; 1536,0; 1567,0; 1828,0; 2109,0; 1724,0; 1504,0; 1429,0; 1158,0; 1131,0; 1305,0; 1073,0; 1045,0; 1004,0)$$

Step 2:

$$X^{(1)} = (1053,0; 2.199,0; 3531,0; 5020,0; 6556,0; 8123,0; 9951,0; 12060,0; 13784,0; 15288,0; 16717,0; 17875,0; 19006,0; 20311,0; 21384,0; 22429,0; 23433,0)$$

$$P(4) = \frac{x^{(0)}_{(4)}}{x^{(1)}_{(3)}} = \frac{1489}{3531} = 0,42169$$

$$P(5) = \frac{x^{(0)}_{(5)}}{x^{(1)}_{(4)}} = \frac{1536}{5020} = 0,30598$$

$$\sigma^{(1)}(4) = \frac{x^{(1)}_{(4)}}{x^{(1)}_{(3)}} = \frac{5020}{3531} = 1,42$$

$$\sigma^{(1)}(5) = \frac{x^{(1)}_{(5)}}{x^{(1)}_{(4)}} = \frac{6556}{5020} = 1,31$$

Step 3:

$Z^{(1)} = (1626,0; 2865,0; 4275,5; 5788,0; 7339,5; 9037,0; 11005,5; 12922,0; 14536,0; 16002,5; 17296,0; 18440,5; 19658,5; 20847,5; 21906,5; 22931,0)$

Step 4:

$$Y = \begin{bmatrix} 1053 \\ 1346 \\ 1489 \\ 1536 \\ 1567 \\ \vdots \\ 1004 \end{bmatrix}, B = \begin{bmatrix} 1626 & 1 \\ 2865 & 1 \\ 4275,5 & 1 \\ 5788 & 1 \\ 7339,5 & 1 \\ 9037 & 1 \\ \vdots & \vdots \\ 22931 & 1 \end{bmatrix}$$

Step 5:

$$\hat{a} = (B^T B)^{-1} B^T Y = \begin{bmatrix} 0,019615 \\ 1651,879 \end{bmatrix}, \quad \frac{dx^{(1)}}{dt} + 0,019615x^{(1)} = 1651,879$$

Step 6:

$X^{(0)} = (1615,33; 1583,95; 1553,19; 1523,02; 1493,44; 1464,43; 1435,98; 1408,09; 1380,74; 1353,92; 1327,62; 1301,83; 1276,55; 1251,75; 1227,44; 1203,60)$

Table 17

Average relative error found as a result of total relative errors for ATM

	Raw Data	Estimated Data	Errors	Relative Errors
2005	1053	1053,00	0,00000	0,00000
2006	1146	1615,33	-469,33027	0,409537759
2007	1332	1583,95	-251,95414	0,189154756
2008	1489	1553,19	-64,18745	0,043107755
2009	1536	1523,02	12,98163	0,008451581
2010	1567	1493,44	73,56470	0,046946204
2011	1828	1464,43	363,57315	0,198891222
2012	2109	1435,98	673,01815	0,319117186
2013	1724	1408,09	315,91062	0,183242821
2014	1504	1380,74	123,26132	0,081955664
2015	1429	1353,92	75,08075	0,052540766
2016	1158	1327,62	-169,62075	0,146477332
2017	1131	1301,83	-170,83308	0,151046045
2018	1305	1276,55	28,45370	0,0218036
2019	1073	1251,75	-178,75070	0,166589652
2020	1045	1227,44	-182,43672	0,174580594
2021	1004	1203,60	-199,59502	0,198799819

Source Prepared by an author according to formulas

Step 7: Average relative error found as a result of total relative errors:

$$\Delta = 14,95$$

$$\%100 - \Delta = p$$

$$\%100 - \%14,95 = \%85,048$$

Table 18

Forecast Values for the Number of ATMs for Future Periods

Years	Estimated ATM Numbers	Estimated ATM Numbers (\approx)
2022	1180,22	1180
2023	1157,29	1157
2024	1134,81	1135
2025	1112,77	1113
2026	1091,16	1091
2027	1069,96	1070
2028	1049,18	1049

Source Prepared by an author according to formulas

The total number of registered internet banking users (AIB)

Step 1:

$$X^{(0)} = (2168826,0; 2536191,0; 2661756,0; 3467342,0; 3392852,0; 3597634,0; 3651038,0; 3822908,0; 4044301,0; 4188797,0; 4064673,0; 4227807,0; 4299195,0; 4208146,0; 5673136,0)$$

Step 2:

$$X^{(1)} = (3436921,5; 6035895,0; 9100444,0; 12530541,0; 16025784,0; 19650120,0; 23387093,0; 27320697,5; 31437246,5; 35563981,5; 39710221,54; 3973722,5; 48227393,0; 53168034,0)$$

$$P(4) = \frac{x_{(4)}^{(0)}}{x_{(3)}^{(1)}} = \frac{3467342}{7366773} = 0,47067 \qquad P(5) = \frac{x_{(5)}^{(0)}}{x_{(4)}^{(1)}} = \frac{3392852}{10834115} = 0,31316$$

$$\sigma^{(1)}(4) = \frac{x_{(4)}^{(1)}}{x_{(3)}^{(1)}} = \frac{10834115}{7366773} = 1,47 \qquad \sigma^{(1)}(5) = \frac{x_{(5)}^{(1)}}{x_{(4)}^{(1)}} = \frac{14226967}{10834115} = 1,31$$

Step 3:

$$Z^{(1)} = (3436921,5; 6035895,0; 9100444,0; 12530541,0; 16025784,0; 19650120,0; 23387093,0; 27320697,5; 31437246,5; 35563981,5; 39710221,5; 43973722,5; 48227393,0; 53168034,0)$$

Step 4:

$$Y = \begin{bmatrix} 2168826 \\ 2536191 \\ 2661756 \\ 3467342 \\ 3392852 \\ 3597634 \\ \vdots \\ 5673136 \end{bmatrix}, B = \begin{bmatrix} 3436921,5 & 1 \\ 6035895 & 1 \\ 9100444 & 1 \\ 12530541 & 1 \\ 16025784 & 1 \\ 19650120 & 1 \\ \vdots & \vdots \\ 53168034 & 1 \end{bmatrix}$$

Step 5:

$$\hat{a} = (B^T B)^{-1} B^T Y = \begin{bmatrix} -0,042765575 \\ 2716498,843 \end{bmatrix}, \frac{dx^{(1)}}{dt} + 0,042765575x^{(1)} = 2716498,843$$

Step 6:

$$X^{(0)} = (2870185,07; 2995592,63; 3126479,66; 3263085,55; 3405660,20; 3554464,39; 3709770,31; 3871862,04; 4041036,08; 4217601,87; 4401882,38; 4594214,71; 4794950,64; 5004457,37; 5223118,12; 5451332,86)$$

Table 19

Average relative error found as a result of total relative errors for AIB

	Raw Data	Estimated Data	Errors	Relative Errors
2007	2168826	2168826,00	0,00000	0
2008	2536191	2870185,07	-333994,06663	0,131691212
2009	2661756	2995592,63	-333836,63314	0,125419698
2010	3467342	3126479,66	340862,34263	0,098306525
2011	3392852	3263085,55	129766,44564	0,03824701
2012	3597634	3405660,20	191973,80004	0,053361126
2013	3651038	3554464,39	96573,61212	0,026451002
2014	3822908	3709770,31	113137,69325	0,029594668
2015	4044301	3871862,04	172438,96199	0,042637519
2016	4188797	4041036,08	147760,92451	0,035275265
2017	4064673	4217601,87	-152928,86781	0,037623904
2018	4227807	4401882,38	-174075,38438	0,041173919
2019	4299195	4594214,71	-295019,70618	0,068622081
2020	4208146	4794950,64	-586804,64234	0,139444934
2021	5673136	5004457,37	668678,62634	0,117867547

Source Prepared by an author according to formulas

Step 7: Average relative error found as a result of total relative errors:

$$\Delta = \%0,0704$$

$$\%100 - \Delta = p, \quad \%100 - \%0,0704 = \%92,96$$

Table 20

Forecast Values for the Number of AIB for Future Periods

Years	Estimated Internet User Numbers	Estimated Internet User Numbers (\approx)
2022	5223118,12	5.223.118
2023	5451332,86	5.451.333
2024	5689519,03	5.689.519
2025	5938112,32	5.938.112
2026	6197567,44	6.197.567
2027	6468358,99	6.468.359
2028	6750982,28	6.750.982

Source Prepared by an author according to formulas

The total number of registered mobile banking users (AMB)

Step 1:

$X^{(0)} = (611677,0; 709170,0; 994453,0; 1136873,0; 1245253,0; 1365104,0; 1475395,0; 1579424,0; 1646627,0; 1557099,0; 1618225,0; 1643322,0; 1672081,0)$

Step 2:

$X^{(1)} = (611677,0; 1320847,0; 2315300,0; 3452173,0; 4697426,0; 6062530,0; 7537925,0; 9117349,0; 10763976,0; 12321075,0; 13939300,0; 15582622,0; 17254703,0)$

$$P(4) = \frac{x_{(4)}^{(0)}}{x_{(3)}^{(1)}} = \frac{1136873}{2315300} = 0,49103$$

$$P(5) = \frac{x_{(5)}^{(0)}}{x_{(4)}^{(1)}} = \frac{1245253}{3452173} = 0,36072$$

$$\sigma^{(1)}(4) = \frac{x_{(4)}^{(1)}}{x_{(3)}^{(1)}} = \frac{3452173}{2315300} = 1,4910$$

$$\sigma^{(1)}(5) = \frac{x_{(5)}^{(1)}}{x_{(4)}^{(1)}} = \frac{4697426}{3452173} = 1,3607$$

Step 3:

$Z^{(1)} = (966262,0; 1818073,5; 2883736,5; 4074799,5; 5379978,0; 6800227,5; 8327637,0; 9940662,5; 11542525,5; 13130187,5; 14760961,0; 16418662,5)$

Step 4:

$$Y = \begin{bmatrix} 611677 \\ 709170 \\ 994453 \\ 1136873 \\ 1245253 \\ 1365104 \\ \vdots \\ 1672081 \end{bmatrix}, B = \begin{bmatrix} 966262 & 1 \\ 1818073,5 & 1 \\ 2883736,5 & 1 \\ 4074799,5 & 1 \\ 5379978 & 1 \\ 6800227,5 & 1 \\ \vdots & \vdots \\ 16418662,5 & 1 \end{bmatrix}$$

Step 5:

$$\hat{a} = (B^T B)^{-1} B^T Y = \begin{bmatrix} -0,052106147 \\ 969879,846 \end{bmatrix}, \quad \frac{dx^{(1)}}{dt} + 0,052106147x^{(1)} = 969879,846$$

Step 6:

$X^{(0)} = (1028309,96; 1083311,76; 1141255,46; 1202298,43; 1266606,44; 1334354,13; 1405725,48; 1480914,31; 1560124,80; 1643572,08; 1731482,74; 1824095,53)$

Table 21

Average relative error found as a result of total relative errors for AMB

	Raw Data	Estimated Data	Errors	Relative Errors
2007	611677	611677,00	0,00000	0
2008	709170	1028309,96	-319139,96405	0,450018986
2009	994453	1083311,76	-88858,75633	0,089354405
2010	1136873	1141255,46	-4382,46035	0,003854837
2011	1245253	1202298,43	42954,56820	0,034494651
2012	1365104	1266606,44	98497,55708	0,072153885
2013	1475395	1334354,13	141040,86727	0,095595327
2014	1579424	1405725,48	173698,51875	0,109975864
2015	1646627	1480914,31	165712,69084	0,100637662
2016	1557099	1560124,80	-3025,80412	0,001943232
2017	1618225	1643572,08	-25347,07528	0,015663505
2018	1643322	1731482,74	-88160,73747	0,053647878
2019	1672081	1824095,53	-152014,52661	0,090913375

Source Prepared by an author according to formulas

Step 7: Average relative error found as a result of total relative errors:

$$\Delta = \%0,0931$$

$$\%100 - \Delta = p, \quad \%100 - \%0,0931 = \%90,68$$

Table 22

Forecast Values for the Number of AMB for Future Periods

Years	Estimated Mobile Banking User Numbers	Estimated Mobile Banking User Numbers (\approx)
2020	1921661,95	1.921.662
2021	2024446,96	2.024.447
2022	2132729,69	2.132.730
2023	2246804,20	2.246.804
2024	2366980,28	2.366.980
2025	2493584,28	2.493.584
2026	2626960,02	2.626.960
2027	2767469,71	2.767.470
2028	2915494,91	2.915.495

Source Prepared by an author according to formulas

The total number of Payment Cards(CAR)

Step1:

$X^{(0)} = (3089650,0; 3563308,0; 3881251,0; 4171680,0; 4206651,0; 4163805,0; 3551109,0; 3627009,0; 3496389,0; 3387526,0; 3358061,0; 3365419,0; 3297121,0; 3216806,0; 3201657,0; 3154169,0; 3135155,0)$

Step 2:

$X^{(1)} = (3089650,0; 6652958,0; 10534209,0; 14705889,0; 18912540,0; 23076345,0; 26627454,0; 30254463,0; 33750852,0; 37138378,0; 40496439,0; 43861858,0; 47158979,0; 50375785,0; 53577442,0; 56731611,0; 59866766,0)$

$$P(4) = \frac{x^{(0)}_{(4)}}{x^{(1)}_{(3)}} = \frac{4171680}{10534209} = 0,39601$$

$$P(5) = \frac{x^{(0)}_{(5)}}{x^{(1)}_{(4)}} = \frac{4206651}{14705889} = 0,28605$$

$$\sigma^{(1)}(4) = \frac{x^{(1)}_{(4)}}{x^{(1)}_{(3)}} = \frac{14705889}{10534209} = 1,39601$$

$$\sigma^{(1)}(5) = \frac{x^{(1)}_{(5)}}{x^{(1)}_{(4)}} = \frac{18912540}{14705889} = 1,28605$$

Step 3:

$Z^{(1)} = (4871304,0; 8593583,5; 12620049,0; 16809214,5; 20994442,5; 24851899,5; 28440958,5; 32002657,5; 35444615,0; 38817408,5; 42179148,5; 45510418,5; 48767382,0; 51976613,5; 55154526,5; 58299188,5)$

Step 4:

$$Y = \begin{bmatrix} 3089650 \\ 3563308 \\ 3881251 \\ 4171680 \\ 4206651 \\ 4163805 \\ \vdots \\ [3135155] \end{bmatrix}, B = \begin{bmatrix} 4871304 & 1 \\ 8593583,5 & 1 \\ 12620049 & 1 \\ 16809214,5 & 1 \\ 20994442,5 & 1 \\ 24851899,5 & 1 \\ \vdots & \vdots \\ [58299188,5 & 1] \end{bmatrix}$$

Step 5:

$$\hat{a} = (B^T B)^{-1} B^T Y = \begin{bmatrix} 0,017825042 \\ 4133825,391 \end{bmatrix} \quad \frac{dx^{(1)}}{dt} + 0,017825042x^{(1)} = 4133825,391$$

Step 6:

$X^{(0)} = (4042615,32; 3971193,96; 3901034,42; 3832114,39; 3764411,98; 3697905,68; 3632574,35; 3568397,24; 3505353,95; 3443424,45; 3382589,08; 3322828,48; 3264123,69; 3206456,03; 3149807,20; 3094159,19)$

Table 23

Average relative error found as a result of total relative errors for CAR

	Raw Data	Estimated Data	Errors	Relative Errors
2005	3089650	3089650,00	0,00000	0,00000
2006	3563308	4042615,32	-479307,31605	0,134511896
2007	3881251	3971193,96	-89942,96241	0,023173704
2008	4171680	3901034,42	270645,58188	0,06487688
2009	4206651	3832114,39	374536,60937	0,089034391
2010	4163805	3764411,98	399393,01875	0,095920202
2011	3551109	3697905,68	-146796,67820	0,041338263
2012	3627009	3632574,35	-5565,34972	0,001534419
2013	3496389	3568397,24	-72008,23739	0,02059503
2014	3387526	3505353,95	-117827,94955	0,034782892
2015	3358061	3443424,45	-85363,45479	0,02542046
2016	3365419	3382589,08	-17170,07559	0,005101913
2017	3297121	3322828,48	-25707,48209	0,007796948
2018	3216806	3264123,69	-47317,68593	0,014709524
2019	3201657	3206456,03	-4799,03421	0,001498922
2020	3154169	3149807,20	4361,79641	0,001382867
2021	3135155	3094159,19	40995,80558	0,013076165

Source Prepared by an author according to formulas

Step 7: Average relative error found as a result of total relative errors:

$$\Delta = \%0,0359$$

$$\%100 - \Delta = p, \%100 - \%0,0359 = \%96,40$$

Table 24

Forecast Values for the Number of CAR for Future Periods

Years	Estimated Payment Cards	Estimated Payment Cards Numbers (\approx)
2022	3039494,33	3.039.494
2023	2985795,23	2.985.795
2024	2933044,84	2.933.045
2025	2881226,39	2.881.226
2026	2830323,43	2.830.323
2027	2780319,78	2.780.320
2028	2731199,55	2.731.200

Source Prepared by an author according to formulas

The total number of Cards POS-terminals (POS)

Step 1:

$X^{(0)} = (18351,0; 20987,0; 30408,0; 42986,0; 40939,0; 35974,0; 37094,0; 41665,0; 47542,0; 53153,0; 57298,0; 62470,0; 62697,0; 53689,0; 60050,0; 63232,0; 66671,0)$

Step 2:

$X^{(1)} = (18351,0; 39338,0; 69746,0; 112732,0; 153671,0; 189645,0; 226739,0; 268404,0; 315946,0; 369099,0; 426397,0; 488867,0; 551564,0; 605253,0; 665303,0; 28535,0; 795206,0)$

$$P(4) = \frac{x^{(0)}(4)}{x^{(1)}(3)} = \frac{42986}{69746} = 0,61632 \quad P(5) = \frac{x^{(0)}(5)}{x^{(1)}(4)} = \frac{40939}{112732,0} = 0,36315$$

$$\sigma^{(1)}(4) = \frac{x^{(1)}(4)}{x^{(1)}(3)} = \frac{112732}{69746} = 1,61632 \quad \sigma^{(1)}(5) = \frac{x^{(1)}(5)}{x^{(1)}(4)} = \frac{153671}{112732} = 1,36315$$

Step 3:

$Z^{(1)} = (28844,5; 54542,0; 91239,0; 133201,5; 171658,0; 208192,0; 247571,5; 292175,0; 342522,5; 397748,0; 457632,0; 520215,5; 578408,5; 635278,0; 696919,0; 761870,5)$

Step 4:

$$Y = \begin{bmatrix} 18351 \\ 20987 \\ 30408 \\ 42986 \\ 40939 \\ 35974 \\ \vdots \\ 66671 \end{bmatrix}, B = \begin{bmatrix} 28844,5 & 1 \\ 54542 & 1 \\ 91239 & 1 \\ 133201,5 & 1 \\ 171658 & 1 \\ 208192 & 1 \\ \vdots & \vdots \\ 761870,5 & 1 \end{bmatrix}$$

Step 5:

$$\hat{a} = (B^T B)^{-1} B^T Y = \begin{bmatrix} -0,051680305 \\ 30407,13404 \end{bmatrix} \quad \frac{dx^{(1)}}{dt} + 0,051680305x^{(1)} = 30407,13404$$

Step 6:

$X^{(0)} = (32179,89; 33886,68; 35684,00; 37576,64; 39569,67; 41668,41; 43878,46; 46205,73; 48656,44; 51237,13; 53954,70; 56816,40; 59829,89; 63003,21; 66344,84; 69863,71)$

Table 25

Average relative error found as a result of total relative errors for POS

	Raw Data	Estimated Data	Errors	Relative Errors
2005	18351	18351,00	0,00000	0,00000
2006	20987	32179,89	-11192,89058	0,533324943
2007	30408	33886,68	-3478,68099	0,11440019
2008	42986	35684,00	7302,00209	0,169869308
2009	40939	37576,64	3362,35721	0,082130907
2010	35974	39569,67	-3595,67174	0,099951958
2011	37094	41668,41	-4574,40902	0,123319378
2012	41665	43878,46	-2213,46130	0,053125196
2013	47542	46205,73	1336,26737	0,028107092
2014	53153	48656,44	4496,55981	0,084596539
2015	57298	51237,13	6060,86908	0,105778022
2016	62470	53954,70	8515,30101	0,136310245
2017	62697	56816,40	5880,59574	0,093793893
2018	53689	59829,89	-6140,89163	0,114378953
2019	60050	63003,21	-2953,21146	0,049179208
2020	63232	66344,84	-3112,84111	0,049228889
2021	66671	69863,71	-3192,70759	0,047887501

Source Prepared by an author according to formulas

Step 7: Average relative error found as a result of total relative errors:

$$\Delta = \%0,1178$$

$$\%100 - \Delta = p$$

$$\%100 - \%0,1178 = \%88,21$$

Table 26

Forecast Values for the Number of POS for Future Periods

Years	Estimated Cards POS-terminals Numbers	Estimated Cards POS-terminals Numbers (\approx)
2022	73569,21	73.569
2023	77471,25	77.471
2024	81580,25	81.580
2025	85907,19	85.907
2026	90463,62	90.464
2027	95261,73	95.262
2028	100314,32	100.314

Source Prepared by an author according to formulas

The total number of employee (TE)

Step 1:

$X^{(0)} = (9871,0; 10640,0; 12163,0; 11921,0; 11139,0; 10845,0; 8330,0; 8154,0; 7178,0; 7845,0; 7638,0; 7545,0; 7361,0; 7571,0; 7547,0; 7523,0; 7407,0)$

Step 2:

$X^{(1)} = (9871,0; 20511,0; 32674,0; 44595,0; 55734,0; 66579,0; 74909,0; 83063,0; 90241,0; 98086,0; 105724,0; 113269,0; 120630,0; 128201,0; 135748,0; 143271,0; 150678,0)$

$$P(4) = \frac{x^{(0)}_{(4)}}{x^{(1)}_{(3)}} = \frac{11921}{32674} = 0,3648 \quad P(5) = \frac{x^{(0)}_{(5)}}{x^{(1)}_{(4)}} = \frac{11139}{44595} = 0,2497$$

$$\sigma^{(1)}(4) = \frac{x^{(1)}_{(4)}}{x^{(1)}_{(3)}} = \frac{44595}{32674} = 1,3648 \quad \sigma^{(1)}(5) = \frac{x^{(1)}_{(5)}}{x^{(1)}_{(4)}} = \frac{55743}{44595} = 1,2499$$

Step 3:

$Z^{(1)} = (15191,0; 26592,5; 38634,5; 50164,5; 61156,5; 70744,0; 78986,0; 86652,0; 94163,5; 101905,0; 109496,5; 116949,5; 124415,5; 131974,5; 139509,5; 146974,5)$

Step 4:

$$Y = \begin{matrix} 9871 \\ 10640 \\ 12163 \\ 11921 \\ 11139 \\ 10845 \\ \vdots \\ [7407] \end{matrix}, B = \begin{matrix} 15191 & 1 \\ 24533,5 & 1 \\ 36575,5 & 1 \\ 48105,5 & 1 \\ 59097,5 & 1 \\ 68685 & 1 \\ \vdots & \vdots \\ [144915,5 & 1] \end{matrix}$$

Step 5:

$$\hat{a} = (B^T B)^{-1} B^T Y = \begin{bmatrix} 0,03848613 \\ 12152,3614 \end{bmatrix} \quad \frac{dx^{(1)}}{dt} + 0,03848613x^{(1)} = 12152,3614$$

Step 6:

$X^{(0)} = (11548,80; 11112,78; 10693,22; 10289,50; 9901,02; 9527,20; 9167,51; 8821,39; 8488,34; 8167,86; 7859,48; 7562,75; 7277,22; 7002,47; 6738,09; 6483,69)$

Table 27

Average relative error found as a result of total relative errors for TE

	Raw Data	Estimated Data	Errors	Relative Errors
2005	9871	9871	0,00000	0,00000
2006	10640	10413,82	-908,80499	0,085414003
2007	12163	12247,76	1050,21950	0,086345433
2008	11921	10693,22	1227,78192	0,102993199
2009	11139	10289,5	849,50378	0,076263918
2010	10845	9901,017	943,98315	0,087043167
2011	8330	8590,899	-1197,20451	0,143722029
2012	8154	9202,856	-1013,50542	0,12429549
2013	7178	8855,402	-1643,38676	0,228947723
2014	7845	8521,067	-643,33579	0,082005836
2015	7638	8199,355	-529,85913	0,06937145
2016	7545	7889,788	-314,48206	0,041680856
2017	7361	7591,91	-201,74775	0,027407655
2018	7571	7305,278	293,78338	0,038803775
2019	7547	7029,467	544,53429	0,072152417
2020	7523	6764,07	784,91200	0,104334973
2021	7407	6508,693	923,30814	0,124653455

Source Prepared by an author according to formulas

Step 7: Average relative error found as a result of total relative errors:

$$\Delta = \%0,04,7399$$

$$\%100 - \Delta = p$$

$$\%100 - \%0,04739 = \%95,26$$

Table 28

Forecast Values for the Number of TE for Future Periods

Years	Estimated Employee Numbers	Estimated Employee Numbers (\approx)
2022	7005,45	7005
2023	6997,416	6997
2024	6963,431	6963
2025	6904,862	6904
2026	6873,19	6873
2027	6859,55	6859
2028	6810,696	6811

Source Prepared by an author according to formulas

The total number of bank number (BA)

Step 1:

$$X^{(0)} = (13,0; 14,0; 13,0; 13,0; 16,0; 17,0; 18,0)$$

Step 2:

$$X^{(1)} = (13,0; 27,0; 40,0; 53,0; 69,0; 86,0; 104,0)$$

$$P(4) = \frac{x_{(3)}^{(0)}}{x_{(3)}^{(1)}} = \frac{13}{40} = 0,325 \quad P(5) = \frac{x_{(5)}^{(0)}}{x_{(4)}^{(1)}} = \frac{16}{53} = 0,301$$

$$\sigma^{(1)}(4) = \frac{x_{(4)}^{(1)}}{x_{(3)}^{(1)}} = \frac{53}{40} = 1,3250 \quad \sigma^{(1)}(5) = \frac{x_{(5)}^{(1)}}{x_{(4)}^{(1)}} = \frac{69}{53} = 1,3019$$

Step 3:

$$Z^{(1)} = (20,0; 33,5; 46,5; 61,0; 77,5; 95,0)$$

Step 4:

$$Y = \begin{matrix} 13 \\ 14 \\ 13 \\ 13 \\ 16 \\ 17 \\ [18] \end{matrix}, B = \begin{matrix} 13 & 1 \\ 27 & 1 \\ 40 & 1 \\ 53 & 1 \\ 69 & 1 \\ 86 & 1 \\ [104 & 1] \end{matrix}$$

Step 5:

$$\hat{a} = (B^T B)^{-1} B^T Y = \begin{bmatrix} -0,068060646 \\ 11,38362912 \end{bmatrix} \frac{dx^{(1)}}{dt} + 0,068060646x^{(1)} = 11,38362912$$

Step 6:

$$X^{(0)} = (12,70; 13,59; 14,55; 15,57; 16,67; 17,84; 19,10; 20,44; 21,88; 23,42; 25,07; 26,84; 28,73)$$

Table 29

Average relative error found as a result of total relative errors for BA

	Raw Data	Estimated Data	Errors	Relative Errors
2015	13	13,00	0,00000	0
2016	14	12,70	1,30445	0,093174941
2017	13	13,59	-0,58970	0,045361639
2018	13	14,55	-1,54683	0,118986693
2019	16	15,57	0,42864	0,026789795
2020	17	16,67	0,33194	0,019526007
2021	18	17,84	0,15801	0,008778171

Source Prepared by an author according to formulas

Step 7: Average relative error found as a result of total relative errors:

$$\Delta = \%0,0521$$

$$\%100 - \Delta = p \quad \%100 - \%0,0521 = \%94,78$$

Table 30

Forecast Values for the Number of BA for Future Periods

Years	Estimated Bank Numbers	Estimated Bank Numbers (\approx)
2022	19,10	19
2023	20,44	20
2024	21,88	22
2025	23,42	23
2026	25,07	25
2027	26,84	27
2028	28,73	29

Source Prepared by an author according to formulas

The results of this section, where all the given variables are estimated by the gray system method, are examined in detail in section 3.3. Result Consideration of Grey System Theory Analysis.

3.3. Result Consideration of Grey System Theory Analysis

All variables in the methodology section were tested for their suitability for gray system analysis and positive results were obtained. In addition, according to the Accuracy Classification, the details of which are given in the methodology section, analyzes on all variables except payment cards are in the Level 2 Highly Reliable category, since the p value is >80. Payment cards variable is in Level 1 High Confidence category because its p value is >95.

In general, the analysis predicts that the value of branches, employees, and payment cards will decline until the end of 2028, whereas the value of ATMs, internet banking users, mobile banking users, card-POS terminals, and banks will increase. Card-POS terminals are expected to grow the most, increasing from 66,671 to 100,314 at a rate of 50.46 percent. Branches, on the other hand, are expected to decline the fastest, from 182 to 88 percent.

In more detail, the number of branches is expected to decrease by an average of 9.75% each year. According to this estimation, it is expected to be 163 at the end of 2022, 147 at the end of 2023, 133 at the end of 2024, 120 at the end of 2025, 108 at the end of 2026, 98 at the end of 2027 and 88 at the end of 2028. Despite this decrease in the number of branches, an increase in the number of banks is foreseen every year. Although the average annual increase is 7.35%, it is expected to be 19, 20, 22, 23, 25, 27, 29, respectively, from 2022 to the end of 2028. The decrease in the number of branches, the increase in the number of banks, and the expected decrease in the number of employees indicate a relatively soft change. With an annual average decrease of 3.77%,

the number of employees, which is 7,407 today, is expected to decrease every year until the end of 2028, to 6811.

On the other hand, although the number of ATMs, which is accepted as the first product of financial technology in many sources, seems to show a high increase between 2021 and 2022, it is expected to decrease over the years and almost return to its current value, which is 1049. The Internet and mobile banking have started to become more common, especially in recent years, and it is estimated that these increases will occur in the next 7 years. The number of Internet banking users is estimated to increase by an average of 4.36% each year, reaching almost 7 million by the end of 2028. According to this estimation, it can be said that 1,077,846 more people will benefit from internet banking services in the coming years. In addition, the number of mobile banking users is expected to increase by an average of 5.34% annually, showing a greater change than the number of internet banking users. With these increases, it is estimated that approximately 120,000 people will become new mobile internet service customers every year.

The number of payment cards and POS terminals, on the other hand, revealed that they are two different variables moving in opposite directions from each other, although they are considered linear. Although payment cards have reached high numbers in the past years, the decrease in the current situation shows that this effect will be the same in the future. Although this average is estimated to decrease by 1.76% every year, it is a harbinger of a great change when the total number is considered. It is estimated that at the end of 7 years, it will reach a value of 2,731,200 with a decrease of approximately 404,000 people. In addition, an average 5.30% increase is expected in the number of POS terminals every year. However, the current 66,671 number is predicted to rise to 100,314 by the end of 2028.

Discussion and Outlook of Grey System Theory Analysis. The analysis aspired to investigate the future status of financial technology products, as well as the changes that will occur in banks, through human resources. Thus, this research was designed on the basis of the main purpose created and the problems that emerged by examining the current literature.

The point that should not be forgotten while examining the results of this research is that all of the predictions were made by assuming that today's conditions would proceed in the same way. According to the results of the research, while the number of uses of financial technology products in general increases, the decrease in the number of bank branches and the number of working personnel draws attention. Although there are many different reasons for these decreases, it is impossible not to feel the impact of developing technology. Especially due to the COVID-19 epidemic in recent years, people have started to work from home, and with the curfews, many bank transactions have started to be made only over the phone. While this reduced the number of

branches required, it also resulted in a reduction in expenses for banks. In addition, these changes have reduced the duration of the work done by thousands of people in the past and have almost completely eliminated the need for labor. It is predicted that banks in different countries will start to act more boldly in entering the market in other countries due to decreasing costs. The fact that competition will increase even more will undoubtedly spur new ideas, and the targets of these ideas will always be to be faster and less costly.

Although different aspects of financial technology are investigated in the literature, the lack of these estimates draws attention. Because the research has achieved important results for anyone who wants to plan for the future. It is not only a preliminary preparation for other research in the world of education, but also a preliminary prediction for the decisions that investors, students, and trainers will make. Despite the limitations encountered while developing the research model, the results were reliable and showed statistically significant effects.

CONCLUSION AND RECOMMENDATIONS

The ability of people to complete banking transactions independently of time and place utilizing technology goods, as well as the digitalization of the financial system, is crucial to the changing structure of banking. As mentioned in the previous sections, the future prediction of the changing factors was made in our research. The total number of banks operating in Lithuania, the total number of branches, the total number of employees, and the total number of ATMs, cards pos-terminals, the number of registered internet banking users and SMS banking users, and number of payment cards were included in this study. Grey System Theory estimation was used as the main method of the research.

In the research, data estimation between 2022-2028 was made by using only Lithuanian data between 2005-2021. The data obtained from the official website of the Lithuanian Banks Association belongs to SEB, Citadele Bank, Danske Bank, DNB bank, Handelsbanken, Medicinos Bankas, Nordea Bank, Pohjola Bank, Šiaulių Bankas, which have been active in Lithuania during the mentioned years.

A total of 120 different data were collected from 8 different variables. First of all, the normality distribution test was performed on SPSS, and it was determined that the data was normally distributed. The correlation and intensity information between each variable was shown with the Pearson Correlation test. It was observed that the total number of employees and branches variables had a negative correlation with all other variables investigated except for the card pos-terminals and the total number of ATMs.

It was observed that the total number of employees and branches variables had a negative correlation with all other variables investigated except for the card pos-terminals.

Hypothesis tests were evaluated only according to the analysis results of all variables included in the model. To summarize the result about the accepted hypotheses as a result of the research, there are 2 accepted hypotheses here. These are as follows.

- There is a strong positive relationship between the total number of branches and the number of employees.
- There is a negative relationship between the total number of employees and the number of registered internet and mobile banking users.

When we look at the results of the research, the analysis of which is shared as detailed in Part 2.5, it is concluded that the total number of bank branches, employees, ATMs, payment cards, cards POS-terminals will decrease in the next 5 years. On the contrary, it is predicted that the total number of banks, internet users and mobile users will increase.

The first of the hypothesis accepted in the study; There is a strong positive relationship between the total number of branches and the number of employees. Moreover, the decrease in these two variables in the coming years provides realistic data for the interpretations made.

Many banks have opened branches in different places over the years in order for customers, who have been the most important element of the banking sector for years, to have the best experience, and many employees have been hired to reduce waiting lines. In the following years, this situation has changed due to opening a branch is a costly investment, alternative distribution channels have been adopted by a large segment of customers in the process, and higher business volume and profitability can be achieved with fewer personnel, this understanding has resulted in the closure of existing branches, let alone the opening of new branches.

The second of the hypothesis accepted in the study; There is a negative relationship between the total number of employees and the number of registered internet and mobile banking users. Moreover, it is predicted that while the number of employees will decrease in the future, there will be an increase in the use of internet and mobile banking. Issues such as the rapid increase in smartphone use in society and the provision of the working principle of smartphones with wireless network connections were, of course, effective in this case. As previously stated, the estimation of a decrease in the total number of branches and employees has a significant impact on banks' preference for electronic channels, which are less expensive and require fewer employees.

Because technological advancements are always for the better, more profitable, and less expensive, it should come as no surprise that changings in banks. The relationship between electronic banking and bank employee job security was investigated in Adelani's (2019) research in Nigeria. A questionnaire was used to collect data, which was then analyzed using descriptive statistics like frequencies, means, and standard deviation. In hypothesis testing, the chi-square method was used. The study found that the adoption of electronic banking did not result in job losses in the banking industry. Despite this, the majority of interviewees believe that job losses will be inevitable in the near future as electronic banking becomes more widely adopted.

Recommendations. Only a future estimation method was used in the study. It is recommended to use two different methods for future research and comparison the results. Data can be checked before the variables and the research country are identified because many banks have strict rules for providing data. Research can be recommended for the US, UK and other countries where financial technology ecosystems are strong.

List of References

Akbulut, M. (2019). A Strategic Approach For Traditional Banking System Against Fintech Start-Ups. *Bahcesehir University*.

Baciuliene, G. (2021). *The Fintech Landscape In Lithuania*. Vilnius: Invest Lithuania.

Bankas, L. (2022, 04 10). *Lietuvos Bankas*. Viewed on 2021-12-20 Internet Access: <https://www.lb.lt/en/fs-banks>

Batiz-Lazo, B. (2002). An Historical Appraisal Of Information Technology In Commercial Banking. *Electronic Markets*, 192-205.

Contreras, I. (2021, 12 11). *Fintech Investments Have Hit \$91.5 Billion In 2021, Nearly Doubling Last Year's Total*. Viewed on 2021-12-19 Internet Access: <https://www.forbes.com/sites/isabelcontreras/2021/10/18/fintech-investments-have-hit-915-billion-in-2021-nearly-doubling-last-years-total/?sh=507911714a2e>

Cudjoe, A. G., Anim, P. A., & Nyanyofio, J. G. (2015). Determinants Of Mobile Banking Adoption In The Ghanaian Banking Industry: A Case Of Access Bank Ghana Limited. *Journal Of Computer And Communications*, 42-46.

Cynthia Sandico, Brian H. Kleiner. (1999). How To Hire Employees Effectively. *Mcb Up*, 33-37.

Daoud, J. I. (2017). Multicollinearity And Regression Analysis. *Journal Of Physics: Conference Series*.

Davis, F. T. (1989). The Development And Future Of Home Banking. *International Journal Of Bank Marketing*, 3-9.

Desai, F. (2021, 12 12). *Forbes*. Retrieved From The Fintech Boom And Bank Innovation: Viewed on 2021-12-22 Internet Access:

<https://www.forbes.com/sites/falgunidesai/2015/12/14/the-fintech-revolution/?sh=355aa1d9249d>

Douglas W. Arner, J. B. (2017). *Fintech And Regtech In A Nutshell, And The Future In A Sandbox*. Cfa Institute Research Foundation.

Yazıcı E;Göker İ.K. (2019). The Effect Of Banking Regulations On Risk-Taking Behaviour Of Banks: A Research In The Turkish Banking Sector. *Journal Of International Management*, 123-133.

- Filomena Jasevičienė, Vaida Valiulienė. (2013). Main Risks In The Lithuanian Banking Sector. *Ekonomika*, 98-119.
- Fintechcity. (2021, 12 5). *Fintechcity*. Viewed on 2021-12-22 Internet Access: <https://thefintech50.com/>: <https://thefintech50.com/the-fintech50-hall-of-fame-1>
- Forrest, J. Y.-L., Liu, S., & Chen, M.-Y. (2004). Theory Of Grey Systems: Capturing Uncertainties Of Grey Information. *Kybernetes*, 196-218.
- G Deepakshi , C Sheetal . (N.D.). .A New Recruitment Tool For Human Resource. *The International Journal Of Business And Management*, 2-3.
- Hatice Nilay Gemlik, Özlem Soylu, Gülfer Bektaş, Sema Daniç. (2016). A Qualitative Research On The Human Resources Perception Of The Hospital Staff. *Sağlık Akademisyenleri Dergisi*, 145-154.
- In Lee, Y. J. (2018). Fintech: Ecosystem, Business Models, Investment Decisions, And Challenges. *Business Horizons*, 35-46.
- Insights, C. (2021). *Cb Insights Q3'21 State Of Venture Report*. Cb Insights.
- Insights, C. (2021). *State Of Venture Global 2021*. Cb Insights.
- Jonas Cicinskas, Linas Sadzius. (2006). Evolution Of The Banking System In Lithuania: From State-Owned Mono-Banks To A Modern Banking System (1988-2004). *Ekonomika*, 7 - 20.
- Ju-Long, D. (1982). The Control Problems Of Grey Sytems. *Systems And Control Letters*, 288-294.
- Kirch, W. (2008). Pearson's Correlation Coefficient. *Encyclopedia Of Public Health*, 978-1-4020-5614-7.
- Leong, K. A. (2018). Fintech (Financial Technology): What Is It And How To Use Technologies To Create Business Value In Fintech Way? *Glyndŵr University Research Online*, 74-78.
- Lerner, T. (2013). *Mobile Payment*. Springer.
- Nicoletti, B. (2017). *The Future Of Fintech*. Rome, Italy: Palgrave Studies In Financial Services Technology.
- Orhan Koçak; Zeynep Büşra Erdoğan. (2011). An Application About New Approaches In Human Resources Management In Banking Sector. *Dergipark*, 259 - 283.

- Philippon, T. (2015). Has The Us Finance Industry Become Less Efficient? On The Theory And Measurement Of Financial Intermediation. *American Economic Review*, 1408-38.
- Prakash, O. (2015). Human Resource Management In Banking Sector. *Anusandhanika*, 95-99.
- Sayılgan, Ş. (2003). Bankacılık Sisteminin Güncel Sorunları Ve Çözüm Önerileri. *İktisat İşletme Ve Finans*, 63-76.
- Skinner, C. (2016). *Valuweb: How Fintech Firms Are Using Bitcoin Blockchain And Mobile Technologies To Create The Internet Of Value*. Marshall Cavendish International (Asia) Pte Ltd.
- Sorkin, A. R. (2010). *Too Big To Fail: The Inside Story Of How Wall Street And Washington Fought To Save The Financial System And Themselves*. London, Uk: Penguin Group.
- Sylvain Benoit, J.-E. C. (2017). Where The Risks Lie: A Survey On Systemic Risk. *Review Of Finance*, 109–152.
- Şahin, E. E., & Bağcı, B. (2020). Grey System Theory For Prediction Of Crypto Money Prices: Methodological Comparison. *Anadolu Univeristy Journal Of Social Sciences*, 219-232.
- Tafamel, Andrew Ehiabhi, Akrawah, Dennis Onutomaha. (2019). Recruitment Strategies Of The Banking Industry In Nigeria: The Head Hunting Panacea. *African Journal Of Business Management*, 449-455.
- Taukanskaite, K. (2022). Development Of Fintech Business In Lithuania: Driving Factors And Future Scenarios. *Business, Management And Economics Engineering*, 96–118.
- (2020). *The Global Fintech Index*. Findexable.
- Tomescu-Dumitrescu, C. (2020). Management Of Human Resources In The Financial-Banking System. *Academica Brâncuși*, 71-76.
- Tondre, A. (2015). Human Resource Management In Banking Sector. *Commerce And Economics*, 130-137.
- Volcker, P. (2009, December 13). “*The Only Thing Useful Banks Have Invented In 20 Years In The Atm*”. Retrieved From New York Post. Viewed on 2022-01-05 Internet Access: <https://Nypost.Com/2009/12/13/The-Only-Thing-Useful-Banks-Have-Invented-In-20-Years-Is-The-Atm/>
- Walchek, S. (2015, May 30). *The Unbundling Of Finance*. Retrieved From Techcrunch: <https://Techcrunch.Com/2015/05/29/The-Unbundling-Of-Finance/?Guccounter=1>

Walker, A. J. (2001). Web-Based Human Resources. In A. J. Walker, *Web-Based Human Resources*.

Yang, S. (2015, March 20). *Why Wall Street Is Pouring Money Into Companies That Want To Eat Its Lunch*. Retrieved From Business Insider. Viewed on 2022-01-05 Internet Access: <https://www.businessinsider.com/wall-street-invests-in-fintech-startups-2015-3>

Yüksel, P. Ö. (1998). *Human Resources Management*. Ankara: Gazi Publications.

FINANSINIŲ TECHNOLOGIJŲ IR VERBAVIMO LIETUVOS BANKUOSE ATEITIES PROGNOZĖ

Cahide Citak

Baigiamasis magistro darbas

Finansų ir bankininkystės magistrantūros programa

Ekonomikos ir verslo administravimo fakultetas, Vilniaus universitetas

Prižiūrėtojas prof. Alfreda Šapkauskienė, Vilniaus, 2026

SANTRAUKA

72 psl., 7 paveikslai, 30 lentelės, 42 literatūros šaltiniai.

Pagrindinis šio baigiamojo darbo tikslas yra įvertinti procentalų nuokrypį Lietuvos bankuose dėl didėjančio finansinių technologijų naudojimo ir iškelti prognozę ateinantiems metams.

Šis baigiamasis darbas sudarytas iš trijų dalių: literatūros analizės, mokslinio tyrimo ir jo rezultatų, bei išvadų ir rekomendacijų.

Literatūros apžvalgos skyriuje nagrinėjamas finansinių technologijų apibrėžimas ir istorija, FinTech ekosistema, bankų sistemų apibrėžimas ir raida. Taip pat šioje dalyje yra minima mokslinių problemų analizė akademinėje literatūroje ir metodai, taikomi akademinuose tyrimuose.

Remiantis atlikta literatūros analize, buvo panaudoti 7 skirtingi kintamieji, įskaitant bendrą bankų, filialų, darbuotojų, bankomatų skaičių, bendrą mokėjimo kortelių skaičių, registruotus interneto ir mobiliosios bankininkystės vartotojus bei kortelių terminalus. Pasirinkti Pearsono koreliacinės analizės kintamieji buvo vertinami taikant pilkosios sistemos metodą nagrinėjant 2022–2028 m. laikotarpį. Atlikto tyrimo rezultatai aptariami paskutiniame skyriuje.

Atsižvelgiant į rezultatus, artimiausiais metais turėtų mažėti bendras bankomatų, mokėjimo kortelių, filialų, darbuotojų ir kortelių terminalų skaičius. Kita vertus, skaičiuojama, kad daugės bankų, registruotų interneto, mobiliosios bankininkystės vartotojų.

Išvadose ir rekomendacijose pateikiamos atlikto tyrimo išvados bei rekomendacijos tolimesnei analizei.

Prognozės yra pagrįstos duomenimis iki 2021 m.; faktiniai vėlesnių metų duomenys nebuvo įtraukti, nes jų patikrinimas nebuvo šio tyrimo apimtyje.