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The association between the corporate governance and artificial intelligence (AI) in the banking sector in ASEAN

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Abstract

Nowadays, the presence of technology in our life is undeniable when it is used in every industry. Especially in the time of the pandemic, the role of technology is becoming more obvious. The banking industry has followed technology 4.0 to stay competitive and sustainable with many changes in operations and services thanks to technology. One of the most outstanding technology is artificial intelligence. In terms of using AI and technology, banks in ASEAN are proving themselves to be top competitors with high growth in revenue and in the quality of technology system.

In this research, the author focused on defining the relationships between three factors: the board of directors, the investment in AI of banks in ASEAN, and the profitability. Besides, the author explored the relationship between Human Resources and AI - two capital of banks that might have conflicts. The author used secondary data of 43 banks in ASEAN collected from their annual reports and financial statements. Descriptive statistics, single and multiple linear regression were applied in Excel software.

The empirical findings revealed that the board of directors has influenced the investment in AI and the investment in AI has impacts on the profitability of banks. The results can be used for further researches on the practical benefits of using AI and for banks, the boards of directors can read to decide their future AI plan.

Keywords/tags (subjects)

Corporate governance, the board of directors, artificial intelligence, ASEAN, fintech, technology, technology cost, profitability, number of employees.

Miscellaneous For example, the confidentiality marking of the thesis appendix, see Project Reporting Instructions, section 4.1.2

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1 Introduction

In modern society when people are demanding fast and accurate services, all service industries are forced to update with the latest technology. Of all the current trending technology terms, artificial intelligence (AI) is the most popular word. With all the news about the ability of artificial intelligence in people's daily life and work life, people are curious to try AI applications in various fields including the banking industry.

We have seen that the banking industry is continually updating its system with the latest technology so that customers can do banking services as fast as possible. The banks have to change and renovate themselves to compete with both traditional and modern competitors such as Fintech companies. Therefore, using AI in banking is an inevitable future. But how to use AI to optimize the operations while preventing risks is a challenge for many bank's board directors- the group of people have the highest level of power at banks.

One of the fastest-growing associations in the world- ASEAN has radically changed itself into a modern, technological continent. Its banking sector is a prominent representative of its incredible growth. And, technology is a vital contribution to that growth.

In this research, the author will research the association between AI and corporate governance in the banking sector in ASEAN countries. Moreover, because corporate governance 's ultimate goal is to bring profits for stakeholders, the author will do more analysis to explore the relationship between the profitability of banks and the use of AI in banks.

2 Literature Review

2.1 Association of Southeast Asian (ASEAN)

2.1.1 Geographical information

Southeast Asia is a sub-region of Asia, composing of 11 countries: Brunei, Myanmar, Cambodia, Vietnam, Indonesia, Malaysia, Philippines, Singapore, Thailand, and East Timor. The area is famous for its long history and culture and financial potential. Now, Southeast Asia

has become one of the fastest economically growing areas in the world. Thanks to the geographical location, Southeast Asian countries have access to many different continents and become the center of traveling and transporting. Except for East Timor, other countries have united and founded ASEAN – the Association of Southeast Asian Nations- an intergovernmental organization that promotes and stabilizes the regional economy.

2.1.2 Economic situation

ASEAN is estimated as the world's fastest-growing market by McKinsey thanks to the united power. 10 out 1of 1 countries in South East Asia have formed "an economic powerhouse". With a large number of laborers, high consumption, and macroeconomic stability, these countries have developed their economy remarkably since 2000 and attracted international companies from big developed countries. The total population of this area is more than 630 million people and more than half of them are young people. This is a huge advantage for this region in the situation when the aging population is a tough challenge for many developed countries.

GDP 2013, current prices $ trillion		**Real GDP growth, 2000–13** %		**GDP growth volatility,[1] 2000–13** %		**Share of debt to GDP, 2013** %		**Inflation rate, 2013** %, GDP deflator	
United States	16.8	China	10.0	Russia	4.2	Japan	243	India	7.0
China	9.3	India	7.0	India	2.4	Italy	133	Russia	6.5
Japan	4.9	**ASEAN**	**5.1**	United Kingdom	2.3	United States	105	Brazil	6.5
Germany	3.6	Russia	4.4	Italy	2.3	France	94	**ASEAN**	**2.8**
France	2.7	Brazil	3.2	Germany	2.3	United Kingdom	90	Germany	2.3
United Kingdom	2.5	Canada	1.9	Japan	2.2	Canada	89	United Kingdom	2.1
ASEAN[2]	**2.4**	United States	1.8	Brazil	2.2	Germany	78	China	1.7
Brazil	2.2	United Kingdom	1.5	China	1.8	India	67	United States	1.5
Russia	2.1	Germany	1.1	United States	1.7	Brazil	66	Canada	1.5
Italy	2.1	France	1.0	Canada	1.7	**ASEAN**	**47**	Italy	1.4
India	1.9	Japan	0.8	France	1.6	China	22	France	1.1
Canada	1.8	Italy	0.0	**ASEAN**	**1.5**	Russia	13	Japan	–0.6

[1] Standard deviation of GDP growth rate.
[2] Association of Southeast Asian Nations.

Source: IHS; International Monetary Fund, *World Economic Outlook*; McKinsey Global Institute analysis

Figure 1 GDP of ASEAN countries in 2013

In addition, thanks to the cooperation among countries, ASEAN's economy now is only behind China and Japan in Asia. Nations have access to the free flow of goods, service, investment, capital, and skilled labor which makes South East Asia more competitive and attractive to investors (Gray A., 2017)

2.1.3 Innovation stages in South East Asia

With the high number of young people, South East Asian countries have a quarter of the total population having a bank account (The ASEAN post, 2017). This shows how big and promising the banking market is but also the challenges for continual updates in technology. In the banking sector, FinTech is witnessing a visible escalate when the investment in this field is 45% more than in 2017 (Bellens ,Liew &Thung, 2020).

Banks to attract more customers, especially young people, are already using AI applications in operations. Although the levels of AI integration among countries are different, they are all trying to optimize the operation and create conveniences for customers. The top countries that have made big progress in applying AI in the banking sector are Singapore, Malaysia, and Indonesia.

2.2 Banks

The bank is one of the most important financial institutions in an economy, influences the national money flow. All economic areas can be affected by disorders in the banking industry. To understand what a bank is, many definitions have been given based on different perspectives. In one definition, a bank is an institution whose current operations consist of granting loans and receiving deposits from the public (Freixas & Rochet, 2008). Banks keep the money for account holders and lend it to people who are in need. They accept money and its substitutes for its transaction and take profit from the difference in the interest rates paid and charged (Britannica, n.d). Also, a bank can be considered as a high leveraged firm and a key element in any payment system.

Banking is one industry included in the financial sector which provides financial service to individual and organizations and acts as a financial intermediary. Besides banks, investment companies, insurance companies, and real estate firms also belong to the financial sector. Based on the different needs of the economy, banks are divided into many types. The most common types of banks are retail banks, commercial banks, investment banks,

central banks, credit unions, online banks, mutual banks, and savings and loans (The balance, 2020)

The impacts of banks spread to not only the overall economic development but also individuals and organizations. Banks perform different roles in the economy, for example, *ameliorate* the information problem between investors and borrowers and protect depositors from unexpected shocks (Allen, Carletti & Gu, 2014) .

Disorders in the banking industry can affect all economic areas from big entities like the industry to smaller groups such as companies. According to Eugeniu Turlea, Mihaele Mocanu and Carmen Radu, the roles of banks include:

- *Banks significantly impact industrial expansions, CG of firms and capital allocation*
- *Banks influence the money supply of an economy and the price stability*
- *Banking industry is a key element in payment system*
- *Banks are an important source of liquidity, creating liquidity by holding illiquid assets and issue liquid liabilities.*

Risks from banks can be triggered by external or internal factors. Under the impacts of external factors which are customers, borrowers, or the market, major risks for banks are credit risk and market risk. On the other hand, operational risk and liquidity risk are the main threats coming from mismanagement of the banking operation system.

Compared to other financial firms and non-financial firms, banks have their own characteristics. First, banks have different capital structures and equity ownership. Second, the distribution of information plays a pivotal role in banks' operations. Third, a bank's instability and systematic risk can spread to other banks. (Turlea, Mocanu & Radu)

Based on the aforementioned information, banks are important in maintaining the stability of the market, yet they face many challenges from outside and inside factors. Due to the complexity and broad effects of the banking industry, governments and regulators impose more intense laws and regulations on banks than on other industries. There are both international and national rules and laws to guide banks to operate properly and avoid risks.

In 2020, according to the report from Deloitte, banks are facing many new disruptions: technology revolution, low-growth economy, aging population and social impact. Banks will need deeper customer insight to maintain existing customers and reach new potential ones.

However, the role of banks will still be the same as financial intermediaries, managing risks and financial issues and protecting customers' assets. In the nutshell, banks are required to be more open, transparent, real-time, intelligent, tailored, secure, seamless and deeply integrated into customers' behaviours (Deloiite, 2019).

2.3 The banking sector in South East Asia

The banking sector in each area has different characteristics besides international rules that are effective in the worldwide spectrum.

Like other parts of the world, ASEAN has gone through financial crises. After the financial crisis in 1997, finance policymakers in South East Asia have reformed the system to strengthen bank capital requirements. Besides working alone in recovering the economy, South East Asian nations have been together in growing regional financial situations.

The result is that these countries have achieved in establishing regional liquidity support for future crises. Also, some countries have their own project to work with developed nations in Asia – Pacifiareasea like China, Korea, Japan, Australia and New Zealand. ASEAN also founded ABIT – ASEAN Banking Integration Framework- to extend the market and qualifying regional banks. The integration in the Finance sector is a promising opportunity but also a big challenge for South East Asia. The regional policy must be made in harmony to reduce the differences in financial regulations, prevent risks in regional level. (Hiebert M., 2018)

2.4 Banking sector and its corporate governance

An organization's administration decides its business strategy and future targets. Corporate governance has usually been thought of when mentioning business administration.

2.4.1 Corporate governance

Corporate governance (CG) has been defined differently by different authors. The context of corporate governance has evolved over time, for example, from being very narrow

scope (only shareholders oriented) to the much wider horizon (stakeholders oriented). Parkinson (1994) gives a very narrow definition of corporate governance, solely from the shareholders' perspective. He defines "*corporate governance as the process of supervision and control intended to ensure that the company's management acts in accordance with the interests of shareholders".* Studying from the broader perspective CG relates to shareholders, board of directors, debt holders, employees, government, communities and media. In the wider definition, stakeholders play important role in CG.

To explicitly define, stakeholders are divided into external stakeholders and internal stakeholders. Therefore, CG is "the interaction among internal stakeholders, external stakeholders and the board members in directing a firm for value creation (Huse M., 2005). From a relationship perspective, according to the Corporate Library (now GMI ratings), corporate governance is the relationship among the shareholders, directors and management of a company (Tricker B., 2015). The Corporate Library Governing corporations have two main agenda: the roles of board of directors and the relationship of the board of directors with its owners. Normally, shareholders will choose the board of directors and auditors. The board of directors administrate the organization while auditors' job is to check the work of executives. There will be internal and external auditors to ensure the fairness.

There are many theories that have been written to clarify the relationship among stakeholders, especially between shareholders and board of directors. These theories are made to prevent mismanagement that negatively affects employees and ensure fair and loyalty of board of directors with shareholders. Some popular theories include agency theory, resource-dependency theory, stewardship theory and stakeholder theory.

In specific, corporate governance includes the followings: directing the business strategy, overseeing and controlling the actions of the corporate management (Tricker, 1984). The board of directors will set the structure of an organization and the business targets. Senior management will be selected by the board of directors to operate daily activities with the organization's structure to reach the established goals. The board and audit committee have responsibilities in supervising the work of senior managers to reach both long-term and short-term goals in sustainable ways. The benefits of all stakeholders are equally vital,

and the oversight is conducted from both inside and outside factors to upper and lower levels.

The abovementioned scope of CG can impact performance of the entity, responsibilities and accountabilities of the corporate executives and mutual relationships between various stakeholders. Many researches about the relationship between corporate governance and organizational performance have been studied such as Byrd and Hickman (1992), Brickley, Coles and Terry (1994) or Yermack (1996) (Larcker D., Richardson S. A.&Tuna I., 2005). It can be seen that the importance of corporate governance is vital, and it is of utmost crucial for any organization to have effective governance to function properly and efficiently. Governance framework is different among organizations due to the distinguished business models and ethics. There is no standard model of organizational governance that is proven to be effective in all industries. For good corporate governance, the contribution of political responsibilities of shareholders and debtholders and the development of the legal system is considerably needed (Yusoff W. & Alhaji I., 2012).

2.4.2 Corporate governance in banks

Several kinds of research have shown that the weak and inefficient governance of bank distributed largely to the financial crisis in 2008. After the global crisis in 2008, banks have changed their laws and regulations and scrutinized customers' profiles more carefully to avoid non-performing loans and keep enough liquidity.

As banks are also considered as firms, their corporate governance has the same importance as those of other organizations. Nevertheless, the role and responsibilities of banking governance require more complex work because of its business nature, the complexity of organizations and the systematic risks it might cause in case of failures.

Therefore, CG in a bank has unique duties and responsibilities. To help banks' corporate governance work with clarity and efficiency, the Basel Committee on Banking Supervision made a guideline about the corporate governance for banks in 2015 based on the principles published by the Organisation for Economic Co-operation and Development (OECD). The committee stated that the ultimate goal of corporate governance is to protect stakeholders' benefits along with public interest in a sustainable way.

The committee has set a total of 11 principles suggesting how corporate governance in a bank works and behaves.

To meet these above requirements, corporate governance in the banking sector requires high level of experience, knowledge and agility to cope with challenges. Any decisions made by the board of directors affect directly to the bank's performance as well as many characters in the economy which includes individuals, companies and other banks. It's mainly the responsibility of bank's board of directors to structure the operating mechanism to increase the quality of projects and prevent losses.

The need for an optimal governance structure in order to increase the profit of stakeholders, maintain the stability of the economy and be active to social responsibility is always in high demand.

2.4.3 Board of directors and the role of independent directors in banks

The board of directors are on the top of banks' structure. In Investopedia, the board of directors is defined as " *an elected group of individuals that represent shareholders*". The roles of the board of directors varied depending on the perspective of the authors. According to Mintzberg, the board of directors has seven roles: selecting the CEO, control the organization during the crisis time, monitor and supervise management performance, select external resources, raise funds for the organization, enhance the organization's name and reputation and giving advice. Another definition of the board's responsibility was stated by Hung in 1998. In his opinion six main responsibilities of the board are linking, coordinating, control, strategic, maintenance and support. Both set of roles present a strategic, impactful and broad role of the board of directors.

The quality of the board of directors is determined by several factors such as independence of boards, human resources, relational capital and board diversity (Hundal S, & Eskola A., 2020). Of all the factors, independent directors have a crucial position in monitoring organizations. To ensure the board of directors works efficiently, properly and follow the benefits of all stakeholders, Jonathan Charkham in his guidance for the directors of banks said that it was important to have a balance between the executive and non-executive directors. This balance is partly made when the board included independent directors.

The independent director is believed to help the corporate governance work better and prevent any mismanagement behaviours made by the executive directors.

According to the IFC, Independent directors are defined as directors with no direct or indirect material relationship with the company other than the board and have these following conditions:

- *in the past 5 years have not been employed by the company or its affiliates;*
- *in the past years do not and have not had any direct or partnership business association with the company or its affiliate (other than to the extent to which shares are held by such Director pursuant to a requirement of Applicable Law in the Country relating to directors generally) or are not a director, officer or senior employee of a person who had that relationship*
- *are not affiliated with any non-profit organization that receives significant funding from the Company or its Affiliates*
- *in the past 5 years directors do and haven't received any additional remunaration from the company or its affiliate and the received directors' fees does not cover a big percentage in the directors' annual income*
- *do not take part in any share or pension plan of the company or its affiliate*
- *do not work as an executive for another company where any of the Company's executives serve on that company's board of directors*
- *do not work for a present or former auditor of the Company o rits Affiliates in the last 5 years.*
- *do not possess any money materials in the company or its affiliates (either directly or as a partner, shareholder, director, officer or senior employee of a Person that holds such an interest)*
- *are. not a member of the immediate family*
- *are stated in the annual reports as an independent director*
- *have not served on the Board for more than 10 years*

2.5 Technological development in the banking sector.

It is inevitable that technology has been emerged in almost all activities of human in recent years. People are getting used to the existence of technology in different kinds of services from public types to personal types. The financial industry, especially with a traditional sector like banking, is requested to adapt to the trend by changing radically and actively.

2.5.1 Fintech

The digital era has changed life radically in many fields. Its impact on the banking sector is not an exception, which improves financial service and creates new customer habits in financial activities. The application of technology in finance has accelerated the efficiency of financial services but also challenged the current financial system.

To call the technology applications that are used for finance, the word "Fintech" was created. According to the Financial Stability Board,
Fintech is a technologically enabled financial innovation that could result in new business models, applications, processes or products with an associated material effect on financial markets and institutions and the provision of financial service.
The development of digital technological advancement has introduced new type of finance, which is more convenient, less time-consuming and full of breakthroughs (Giorgio, Glacomo&Alberto, 2017).

FinTech itself can be a big competitor but also a helpful partner for traditional financial institutions like banks. Recently, the latter position is being invested to enhance the role of banks in the market. The cooperation between banks and FinTech firms is no longer rare. Some outstanding US banks such as Goldman Sachs, Citigroup and JPMorgan Chase made 24 Fintech investments in 2019 (Verhage J., 2019). Through investments, banks will buy technological solutions from Fintech firms and/or cooperate with Fintech firms to develop R&D in banking and get the consultancy to understand the technology market more thoroughly. These investments assist banks in optimizing customer service, reducing fraud and filtering clients' profiles.

Moreover, since the role of bank is unchangeable and its market is stable, it is hard for Fintech firms to take bank's market share. Instead, cooperation is a win-win situation for both sides at the moment and through banks' network, these companies can reach to new customers such as banks' partners or banks' customers.

2.5.2 Artificial Intelligence

Of all FinTech solutions, Artificial Intelligence (AI) is the most popular process or product that is hyped all over the world. The global spending in AI has reached 41.1 billion in 2018 and the financial industry has actively contributed to this number (Padhi U, 2019).

Similar to corporate governance, there is no official definition of Artificial Intelligence, but they all have same meaning which is the ability of a computer to imitate or do better at human's work.

(Kumar C., 2018). In one example of definition, the term "Artificial Intelligence", according to the dictionary Merriam – Webster, is a branch of computer science developing intelligent behaviors in computers. The goals of using AI are to enhance working efficiency by reducing errors and saving time for any products or services using it.

AI is an umbrella term that includes many small parts or subfields. Neota Logic, a no-code AI automation platform which provides intelligent software to optimize working performance for companies, has made the below map of AI subfields. These subfields are underlying methods that create nowadays AI applications. These subfields can be used alone or combined to improve the efficiency and performances of
users.

AI can do tasks at different levels of difficulties and based on these levels, there are three types of AI: Narrow AI (ANI), Artificial General Intelligence (AGI) and Artificial Super Intelligence (ASI). Narrow AI implies systems that is used for one specific task and its capabilities are not easily transferrable to other systems. ANI turns data into useful information by detecting patterns and making predictions. Examples of ANI are self-driving car, Apple's Siri and Amazon's suggested purchases. Artificial General Intelligence, which is also called strong AI, describes machines with the intelligence like humans or be smarter. It is capable of dealing with abstract concepts and move information and data among domains. In a more simply explanation, AGI is the ability of a machine to perform any task that a human can (Forbes). Although machines are superior in automating reasoning, analysing and interpreting data, the road to successfully achieve AGI is still unclear challenging.

With AGI, machines are expected to solve problems and make decisions under different circumstances, use the past collected knowledge and be innovative and creative. To behave, think and react as human, machines need to contain consciousness. One of the most challenging features that make humans be superior to machines is the ability to think and act Human beings are more superior to machines because of the ability to think theoretically and strategically, then and use own thoughts and memories to make informed decisions or come up with creative ideas. This type of intelligence is hard to imitate and does not has a common formula to build AI by it because it belongs to human' sentient . (Medium)Moreover, our understandings of our brain and its functioning are not comprehensive enough for us to model and replicate it. Therefore, it is very challenging to build a machine with the general intelligence of the human.

The last type is Artificial Super Intelligence. This is the most superior intelligence that allows machines to exceed human intelligence and do what human cannot do. Philosopher Nick Bostrom defined ASI as "any intellect that greatly exceeds the cognitive performance of humans in virtually all domains of interest". This is the type that makes people worry about human extinction. However, it will take a long time until we can reach to the highest level of artificial intelligence and no practical work using ASI has been made at this moment.

Of all three types, ANI has been used in almost every field from entertainment, education to medical, finance. The modern life is surrounded by ANI applications and sometimes people do not recognize them. By the ability to interpreting data, ANI applications make our lives become easier and more convenient. They also provide researchers a deep and wide understanding of human's behaviors. With a tremendous amount of data, researchers can assess the past, forecast the future and predict the potential risks.

With any business, these abilities are exceptionally precious in developing markets and increasing revenue, which is the main reason why AI is hyped all over the world.

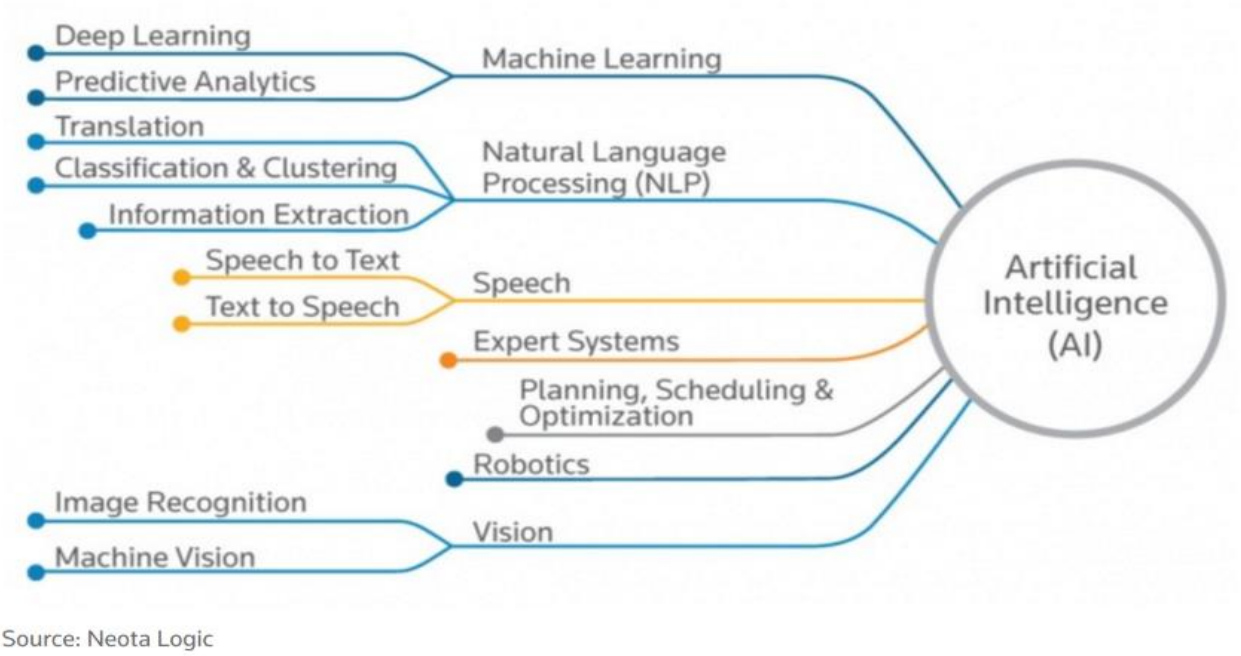

Figure 2 AI sub-field map

2.6 Artificial Intelligence in the banking sector

Many products or services in banking sector have applied AI into their operations. Banks are using big data analysis to collect customers' information and use algorithms to produce better and more correct strategies (Vedapraha & Hariharan, 2018). Some familiar names are chatbot, anti-money laundering and fraud detection. With the enter of AI, the scope and nature of banks is rapidly changing. A Basel Committee has stated that banks are facing more risks, forcing them to modify the activities to meet the demand from the strongest and most vivid factors which are AI and big data in financial sectors (Wuermeling, 2018).

While AI covers many areas in computer science, in banking services, not all subfields are developed to improve banking activities. There are some topics that have already been used and others that are being developed to integrate into the finance and banking sector. The most prominent topic is machine learning. This technique helps banks to improve analytics progress, interact with customers by the chatbot and automate repeated daily operations. Predictive analysis and voice recognition – two applications of AI - are used by 32% of financial services providers according to joint research of the National Business Research Institute and Narrative Science,

When mentioning AI, a familiar term is machine learning. Machine learning is defined as the ability of computers to independently learn to solve a task. With machine learning, people don't have to program clearly for every task. It is a field in computer science and operates based on computational statistics and data mining. The core competencies of machine intelligence are data and algorithms. Data from consumers is collected by companies and analyzed by algorithms. The results will describe data patterns and make interpretations. Many advanced machine learning techniques are founded or supported by statistical techniques even though statistics is generally not considered part of AI. There are four ways how machine learning is applied: supervised learning, unsupervised learning, semi-supervised learning, reinforcement learning. In banking, machine learning is used in 4 main areas: automation, personalization, human-machine interactions, and security. Banks establish tailor-made services to satisfy each individual customer based on data interpretation from machine learning. Better capability to process large data sets helps banks create more innovative solutions for customers' needs. More importantly, banks can reduce uncertainty by finding default borrowers and detect fraud by using algorithms to analyse data.

Besides, natural language processing or NLP is often mentioned in AI applications in the banking industry. Exactly like the name, NLP is the system used to understand and use human language by analyzing and generating documents or speeches. NLP allows machines to interact with human's speech and text. According to Emerji, NLP-based products sold to banks make up 28.1% of the total AI approaches that are offered by technical companies. NLP's products are Information Retrieval and Intent Parsing. It helps banks in customer service and document search (Bharadwaj, 2019).

In 2018, Banks for International Settlements stated that AI is a great tool to develop multi-channel customer access, reach customers with a deeper understanding and improve the overall services.

By understanding customers more thoroughly, reducing cost, risk mitigation and revenue increase are three main basic benefits that most institutions can gain from AI applications (Latimore D., 2018). The working area of AI applications are considerably wide. Banks are getting benefits from AI applications in all levels: front office, middle office and back office.

The level of integration might be different due to the different level of complexity and sensitivity. An extensive application of AI in banks hasn't available at the moment since the complexity of the banking system requires flexibility and transparency. The human resource and technological resource of banks are still on the way to prepare for it. Banks need to train and develop their employees so that they can understand the tools and the results generated by AI applications. Moreover, upgrading technological system cost a big investment to operate and to protect it from harms. Hence, the process of applying AI in banking operations should be done gradually and step by step to ensure that it aligns with banks' business strategy.

2.7 Concerns over AI application

AI is efficient for automated and analysis tasks when it can process many times faster and more precisely than human do. However, these jobs that AI is integrated still need human supervision to quickly handle complicated situations and prevent technical errors. (Latimore D., 2018)

The quality of data determines the quality of the machine process to analyze customers' behaviors for banks. Requirements for a large quantity of qualified data are set in every bank applying AI in daily tasks. People worry that data manipulation could happen if the sources of data are not clear and instead of preventing fraud, AI applications neglect suspicious cases.

As mentioned above, human supervision is needed while using machine programs, and more importantly, directors and managers also need to understand clearly about these programs to detect faults and solve problems in a timely manner.

2.8 Corporate governance responsibility in applying AI

Although AI technologies are great tools to create competitive advantages for banks, they are disruptive when being applied unproperly. As the role of board of directors and shareholders are impactful, they will be one of the main reasons deciding the future of bank. Because the role of the board of directors in providing business strategies and manage the operation, when banks bring AI into their operation, the board of directors will have to take the responsibility for any problems happening.

(Wuermeling, 2018).

Many problems will appear if the understanding of AI of banks' leaders is not enough. Banks' governors themselves must have enough knowledge about AI so that their decisions are made based on rational and logical background. Some of them are market distortion, monopoly power, system vulnerabilities or regulatory risks. These problems affect banks at macro level, but at the same time, many issues at micro level will cause troubles for banks instead of delivering benefits.

To enhance safety, soundness and financial stability, the bank's leaders should implement supervisory programs to build suitable governance structures and risk management which is dealing with new technological threats. The threats might come from the process of using fintech applications. (BIS, 2018)

Banks' corporate governance must consider the stages to adopt these advanced technologies to avoid the mismatch between machine and human technology.

AI must be introduced with correct and enough understanding to embrace responsible innovation at banks (Duhaime C., 2018). The adaptation to FinTech and AI must be done in a reasonable way and executed in steps to avoid overwhelming in operational systems for both bankers and customers.

The following study focuses on these hypotheses

H1: The AI investment influences the profitability of banks

H2: The AI investment influences the number of official employees.

H3: The board of directors' education impacts the AI investment .

H4: The number of directors with technology degree impacts the AI investment

H5: The number of independent directors affects the AI investment .

3 Methodology

Research methodology, according to the definition of Buckley J. W., M. H. Buckley and H. Chiang in 1976, is "the strategy or architecture design by which the researcher maps out an approach to problem-finding or problem solving". To start any studies, the first step is defining the purposes and the targets that the studies aim. From then, the authors continually define the problems and find the answers through collected data.

To help authors build their research methodology efficiently and correctly, Saunders had invented the research “onion” that has been used popularly since 2007. In this study, the author also based on this model to execute the planning process.

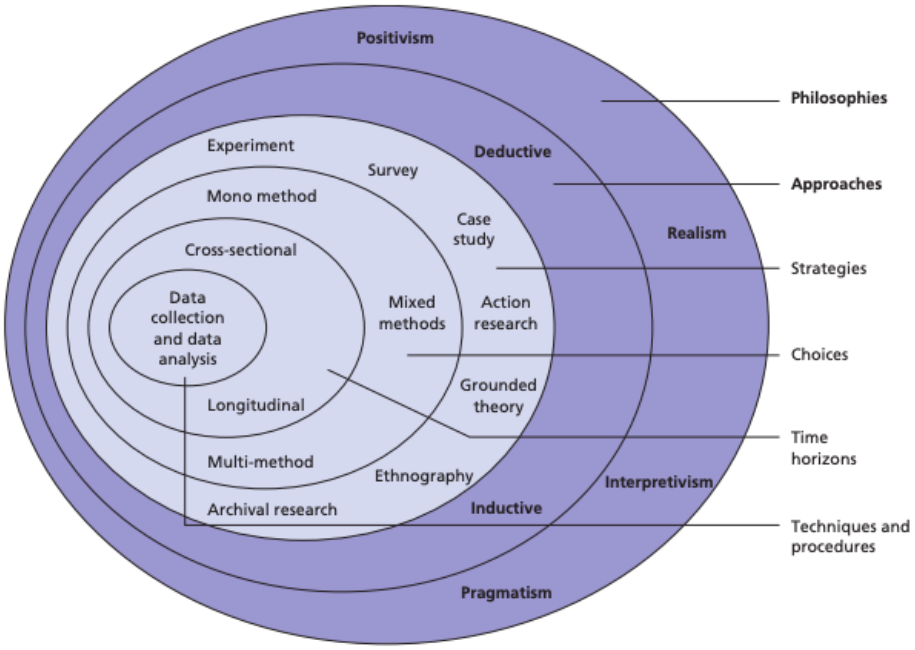

Figure 3 The research onion by Saunders (Saunders M., Lewis P. & Thornhill A., 2008)

3.1 Research design

In this research, 43 listed banks from 5 countries representing for ASEAN (Vietnam, Malaysia, Indonesia, Singapore, Philippines and Thailand) was selected to test the hypotheses. There are twelve banks from Vietnam, six banks from Malaysia, four banks from Singapore, six banks from Indonesia, eight banks from Thailand and seven banks from the Philippines. The data set is from 2015 to 2018 with an unbalanced amount of information within banks. The total data contains a sample of 258 bank years. All the information is collected from the bank's annual reports and financial statements.

There are two main ideas behind this research. First, the author wants to understand the real benefits of artificial intelligence in the banking industry by analyzing its relationship with the profitability of banks. Using and applying AI in any bank requires tremendous investment and modification in the working process. Therefore, bank managers must see how much AI applications affect profit positively.

The board of directors is responsible for setting the business target of banks and the technological change belongs to their responsibility. The structure of the board and the educational level of both non-independent and independent directors might influence the decision to invest in Fintech and AI specifically. Furthermore, to properly bring AI into practice, directors are required to have a deep understanding of how it works and changes their organizations. In some situations, a technology background will be beneficial for directors in operating AI software and applications.

This study required accuracy in numbers, therefore, a deductive approach was chosen as it is typically suitable for scientific investigation. The steps of a deductive approach presented the real reasons for the start of this research.

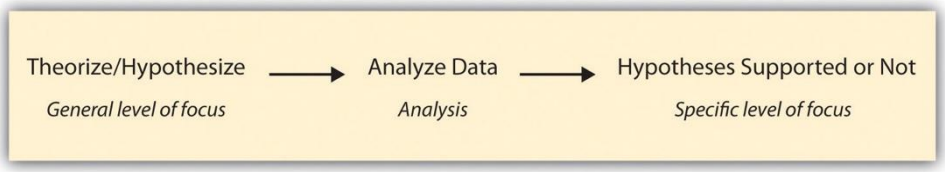

Figure 4 Deductive approach process

This study is purely based on quantitative data to acquire a high level of accuracy in numbers. The OECD defines quantitative data as data expressing a certain quantity, amount, or range and measured by a unit. To have an overall view of the research problems, the data set is cross-sectional to allow the author to see the change of banks before and after the appearance of AI in their operation in 6 years from 2015 to 2020.

3.2 Data collection

Due to the nature of this research, all the data must be official, correct, and have been audited by auditors to avoid fraud. The correctness of data will confirm the reliability of the research results. In this regard, the author picked the option to use secondary data published by banks on their official websites. The data includes information about the time banks start using AI, the board of directors' characteristics, number of employees and financial numbers from 6-year annual reports and financial statements of banks. Annual reports are documents

public companies published every year to provide annual shareholders about their operations and financial conditions (Hayes 2020). The financial statements are usually placed at the end of the annual reports and include three different reports: income statement, balance sheet and cashflows. To help readers understand clearly any expenses or income, the notes are used to clarify each section separately.

First, to extract information about when the company started using AI, keywords related to AI were used. These include artificial intelligence, machine learning, technology 4.0, big data, chatbots, automation, robotics and fintech. When the annual reports mentioned how banks were using AI and AI subfields for the first time, that year will be considered as the start date.

In terms of the board of directors, their profiles about education were listed on the annual reports and the author based on that the calculate the percentage of independent directors, the education score and the number of technology degrees in one board of directors.

- The education score is a formula calculating the education background of the board of directors based on the level of a degree each director has. There are three levels: bachelor's degree(equivalent to score 1), master's degree(equivalent to score 2) and Ph.D. degree(equivalent to score 3)

  Education score of the board of directors = 1* the number of directors with bachelor's degree only + 2*the number of directors with bachelor and master's degree + 3*the number of directors with all three degrees.

Secondly, the author used financial statements to collect numerical financial data. The data the author takes from financial statements consists revenue (Interest income), EBIT(Earning before interest and tax), net income, software costs and total assets.

To find the information about the investment in AI, the author found based on the software costs or computer costs listed in the balance sheet. They are listed in the intangible assets

section. From then, the data will be used to calculate the profit of banks by profitability ratios. Those ratios are a set of measurements to determine the ability to create income for a firm. Three ratios that were used are ROA(Return on Assets), NPM(Net Profit Margin) and OPM (Operating Profit Margin).

- ROA (Return on Assets): one of the return on investment metrics used to calculate the profitability of a business to its total assets. Through this ratio, shareholders can estimate how well the business is performing. The higher the ratio is, the better resource management the business has.

  ROA= Net profit / Total Assets

- NPM (Net Profit Margin): a financial ratio calculating the percentage of profit a company produces from its total revenue. The ratio uses net profit which is calculated by deducting all the expenses from the total revenue. It is a strong indicator to assess the company's success and a high net profit margin is preferred. NMP of a company should be compared with other companies from the same industry as the ratio is varied among different industries.

  NPM= Net Profit / Total Revenue * 100

- OPM (Operating Profit Margin) : a financial ratio calculating the percentage of profit a company produces from its operation without deducting taxes and interest expenses. The ratio indicates how well the company is managed compared to other competitors. Similar to NPM, OPM is greatly different among industries and it is recommended to compare this ratio within the same industry.

  OPM = EBIT / Total Revenue *100

3.3 Key variables

The table below lists all the variables used in this study to test the hypotheses and where the author collected them.

Variable	Description	Source
ROA	It describes how well a company operates by comparing the profit with the money invested in assets	Net Profit: Income Statement Total Assets: Balance Sheet
NPM	It measures the percentage of profit a company receives from its revenue	Net Profit: Income Statement Total Revenue: Income Statement
OPM	It measures the percentage of operating income a bank receives from its revenue	Operating Profit: Income Statement Total Revenue: Income Statement
Tech Cost	The cost a company spends to develop and possess computer software and technology assets.	Technology cost : Balance Sheet Notes
TCOR	The ratio calculates the percentage of technology investment over the revenue of a company	Technology cost : Balance Sheet Notes Total Revenue: Income Statement

Education Score	The score made based on the education degree directors have	Annual Reports
Tech Degree	The number of directors has degree relating to technology and computer science	Annual Reports
IndeDI	The percentage of independent directors in a board of directors	Annual Reports
Employees	The total number working for a company	Annual Reports

3.4 Data analysis

To identify the relationship among variables, several types of analysis were chosen by the authors.

The author started the research by using descriptive statistics to analyze the data. Descriptive statistics are a method to describe the quantitative data set in several mathematics value. It helps to summarize and simplify the most important ideas behind the data in a sensible way. (William 2006)

In descriptive statistics, there are two main parts: measures of central tendency and measures of variability. The former are presented by the mean, mode and median while the latter include standard deviation, variance, minimum and maximum variables, kurtosis and skewness. In this study, the author focused on the mean and median.

The data set was divided into three groups so that the author can compare the descriptive statistic value before and after banks used AI. The comparison will be within the group

Group 1: Banks have used AI since 2017

Group 2: Banks have used AI since 2018

Group 3: Banks have used AI since 2019

To describe the relationship between variables, the author used inferential analysis. This type of analysis includes regression and correlation. Both models are calculated by Microsoft Excel.

The author used simple linear regression and multiple linear regression to examine whether dependent variables were affected by independent variables. Independent variables are those that a researcher can manipulate, whereas dependent variables are the responses to the effects of independent variables. (Salkind, 2010)

Simple linear regression is calculated as below

$$Y = B0 + B1*X + e$$

Where

Y - the predicted value of the dependent variable for any given value of the independent variable

B0 - the intercept, which is the value of y when x = 0

B - the regression coefficient, which presents how much y can affect x

X - the independent variable

e - the error of the estimate

With multiple linear regression, the formula is

$$Y = B0 + B1*X1 +…+ BnXn +e$$

Where

Y - the predicted value of the dependent variable for any given value of the independent variable

B0 - the intercept, which is the value of y when x = 0

B1X1 - the regression coefficient (b1), which presents how much y can affect x, of the first independent variables

BnXn- the regression coefficient (bn), which presents how much y can affect x, of the last independent variables

n – the number of independent variables

X - the independent variable

e - the error of the estimate

After defining whether there are relationships between variables, the author used a correlation coefficient to measure how strong the relationships. The type of correlation coefficient in this study is Pearson's correlation. The correlation coefficient has a value from -1 to 1.

- The result is 1 – the relationship is positive meaning the variables tend to move in the same direction

- The result is 0 – there is no relationship between variables
- The result is -1 – the variables have negative relationships and tend to move in opposite directions.

The model is calculated as follows:

$$r = \frac{1}{n-1} \sum \left(\frac{x - \overline{x}}{s_x} \right) \left(\frac{y - \overline{y}}{s_y} \right)$$

Where

- r– the correlation coefficient of the linear relationship between the variables x and y
- xi – the values of the x-variable in a sample
- $\overline{x}$ – the mean of the values of the x-variable
- yi – the values of the y-variable in a sample
- $\bar{y}$ – the mean of the values of the y-variable

For inferential analysis, the data set will not be separated but united to assess the relationship of the profitability and investment in AI in the bank. The regression will show whether the Board of Directly strongly affects the investment in AI and whether the number of employees will decrease and be replaced by AI applications.

4 Reliability and validity

To make a good result, the quality of data plays an important role. To assess the quality of the research results, researchers will normally use two measures: reliability and validity. Reliability is. defined as how consistently or dependably does a measurement scale measures what it is supposed to be measuring (Polit & Hungler 1995). The concept of reliability always goes with a degree of error. As data can vary dramatically, the consistency of variables is affected and results can’t present the true characteristics of a problem. Therefore, the less variation an instrument produces in repeated measurements of an attribute, the higher its reliability (Polit & Hungler 1995, p. 347).

In this study, the author chose the data from official and audited sources, which are annual reports and financial statements. The data of each variable are listed in the same form. The comparison between three periods does not include banks with inadequate data. Therefore, the research can be seen as reliable. Moreover, although each country uses different currencies, it does not affect the internal consistency of the data as the variables are made in the form of percentages and there is no direct comparison among banks.

The second measurement is validity. According to Utwin, the measurement scale of variables should be able to confirm as having the ability to measure what researchers want to measure. In other words, the data is considered to validate when the concepts are accurately measured. In this study, all variables have measured with proper measurement. Because the data is quantitative, the measurement is presented in the form of numbers. The profitability is measured by the known financial ratios. The board of directors is calculated by the score based on the factors relating directly to them that can be found on the annual reports. Lastly, the AI cost is directly measured by the currency in each bank's national currency.

5 Research results

Through three different analysis models, the author came up with some conclusions about the relationship between variables. This section includes three parts: descriptive statistics, regression and correlation coefficient.

5.1 Descriptive statistic

In descriptive statistics, the data set was divided into three groups based on the year that banks started using artificial intelligence applications. For each group, the effects of artificial intelligence on their profitability and the impact of the board of directors on the amount of AI investment are different.

GROUP 1: 2017

Year	Variables	Mean	Standard Error	Median	Mode	Standard Deviation	Sample Variance	Kurtosis	Skewness	Range	Minimum	Maximum	Sum	Count
2015-2016	Tech Cost/Revenue	0,081	0,0157	0,0629	#N/A	0,0667	0,0045	0,2774	0,9248	0,2319	0,00002	0,2319	1,467	18
2017-2020	Tech Cost/Revenue	0,108	0,0136	0,0895	#N/A	0,0818	0,0067	-0,6084	0,6640	0,2994	0,0002	0,2996	3,883	36
2015-2016	ROA	0,012	0,0008	0,0110	#N/A	0,0036	0,0000	4,7151	2,0755	0,0143	0,0089	0,0232	0,2186	18
2017-2020	ROA	0,011	0,0007	0,0104	#N/A	0,0039	0,0000	1,9916	1,0351	0,0177	0,0039	0,0216	0,3905	36
2015-2016	Net Profit Margin	0,300	0,0227	0,2776	#N/A	0,0961	0,0092	-0,9345	0,3235	0,3281	0,1559	0,4840	5,393	18
2017-2020	Net Profit Margin	0,276	0,0147	0,2839	#N/A	0,0882	0,0078	-0,5317	0,2432	0,3523	0,1317	0,4840	9,949	36
2015-2016	Operating Profit Margin	0,528	0,0263	0,5453	#N/A	0,1114	0,0124	2,5562	-1,2457	0,4607	0,2617	0,7224	9,511	18
2017-2020	Operating Profit Margin	0,538	0,0214	0,5411	#N/A	0,1285	0,0165	1,5362	-0,5167	0,6208	0,2494	0,8702	19,371	36
2015-2016	Percentage of Independence Director	0,433	0,0499	0,4276	0,3333	0,2117	0,0448	0,2586	-0,5894	0,75	0	0,75	7,788	18
2017-2020	Percentage of Independence Director	0,466	0,0373	0,485	0	0,2236	0,0500	-0,0874	-0,6873	0,75	0	0,75	16,772	36
2015-2016	Educational Score	22,88	1,84	21	19	7,5984	57,7353	-0,1747	0,6520	27	12	39	389	17
2017-2020	Educational Score	22,97	1,08	22	22	6,4829	42,0278	-0,8352	0,5211	22	13	35	827	36
2015-2016	Tech degree	0,278	0,1086	0	0	0,4609	0,2124	-0,9415	1,0849	1	0	1	5	18
2017-2020	Tech degree	0,444	0,0840	0	0	0,5040	0,2540	-2,0635	0,2334	1	0	1	16	36

For group 1, in the first variable – tech cost over revenue, the author has seen an increase in the mean, median and maximum. The annual average investment for technology including AI has increased since banks from group 1 started to apply AI in their operations. The average percentage increased from 8.1% to 10.7% and the maximum amount of investment for technology in this group contributed 29.9% of the revenue after 2017.

Next, the profitability variables including ROA, Net Profit Margin(NPM) and Operating Profit Margin(OPM) had little or no differences before and after the banks used AI. The average of ROA and NPM decreased from 1.2 % to 2% and 2.9% to 2.7% respectively. The last ratio that the author used is OCM received a slight increase from 5.28% to 5.38%. The median and maximum values almost stay the same.

The last three variables which are the board of directors' characteristics have different reactions with AI applications. The percentage of independent directors goes from 2.6% to 3% with the mean and from 2% to 2.36% with the median. However, the maximum value goes down from 0.88% to 0.78%.

The educational score receives a decrease in the maximum value and varies a moderate number in the mean and median. Of all three variables about the board of directors, tech degree has the most obvious change when the mean increased from 0.27 to 0.44 but the median and the maximum value stays the same,

GROUP 2: 2018

Year	Variables	Mean	Standard Error	Median	Mode	Standard Deviation	Sample Variance	Kurtosis	Skewness	Range	Minimum	Maximum	Sum	Count
2015-2017	Tech Cost/Revenue	0,065	0,009	0,050	#N/A	0,071	0,005	4,76	2,13	0,303	0,003	0,306	3,79	58
2018-2020	Tech Cost/Revenue	0,090	0,017	0,042	#N/A	0,130	0,017	16,98	3,55	0,819	0,001	0,820	5,21	58
2015-2017	ROA	0,014	0,001	0,011	#N/A	0,007	0,0001	0,099	1,06	0,026	0,005	0,031	0,792	58
2018-2020	ROA	0,016	0,002	0,014	#N/A	0,011	0,0001	13,05	2,86	0,075	0,002	0,077	0,936	58
2015-2017	Net Profit Margin	0,236	0,015	0,232	#N/A	0,117	0,014	-0,878	0,403	0,425	0,076	0,501	13,66	58
2018-2020	Net Profit Margin	0,364	0,074	0,246	#N/A	0,565	0,319	23,29	4,67	3,59	0,056	3,64	21,10	58
2015-2017	Operating Profit Margin	0,416	0,021	0,413	#N/A	0,163	0,027	-0,057	0,450	0,735	0,123	0,858	24,14	58
2018-2020	Operating Profit Margin	0,520	0,088	0,416	#N/A	0,670	0,449	49,28	6,77	5,34	0,002	5,35	30,19	58
2015-2017	Percentage of Independence Director	0,260	0,031	0,2	0	0,239	0,057	-0,489	0,636	0,889	0	0,889	15,09	58
2018-2020	Percentage of Independence Director	0,306	0,031	0,236	0	0,238	0,057	-1,256	0,288	0,78	0	0,78	17,77	58
2015-2017	Educational Score	15,89	0,858	15	17	6,423	41,26	1,838	1,096	32	5	37	890	56
2018-2020	Educational Score	16,16	0,823	15	10	6,100	37,21	1,169	1,005	29	5	34	889	55
2015-2017	Tech degree	0,404	0,075	0	0	0,563	0,316	0,079	1,020	2	0	2	23	57
2018-2020	Tech degree	0,527	0,089	0	0	0,663	0,439	-0,290	0,887	2	0	2	29	55

In the second group, banks receive higher mean and maximum value for tech cost over revenue in the period of 2018 -2020. The mean rises from 6.5% to 8.9% and the maximum value after using AI is 8.2%, which is 5.2% higher than before using AI.

In terms of profitability, all three ratios increased remarkably. With ROA, the mean, median and maximum increase from 1.3% to 1.6 %, 1.11% to 1.36% and 3.1% to 7.6% respectively. With NPM, the mean increases by 13%; the median increases by 1.4% and the maximum increases drastically from 50% to 364%.

Group 2's board of directors' s characteristics have a small positive change in the mean value but the maximum stay nearly the same.

GROUP 3: 2019

Year	Variables	Mean	Standard Error	Median	Mode	Standard Deviation	Sample Variance	Kurtosis	Skewness	Range	Minimum	Maximum	Sum	Count
2015-2019	Tech Cost/Revenue	0,040	0,005	0,026	#N/A	0,038	0,001	1,320	1,423	0,150	0,001	0,151	2,26	56
2019-2020	Tech Cost/Revenue	0,052	0,009	0,031	#N/A	0,046	0,002	-0,506	0,986	0,149	0,001	0,150	1,30	25
2015-2019	ROA	0,010	0,001	0,011	#N/A	0,005	0,00003	0,064	0,148	0,024	0,0002	0,024	0,574	56
2019-2020	ROA	0,012	0,001	0,013	#N/A	0,005	0,00002	-1,183	-0,048	0,014	0,005	0,020	0,297	25
2015-2019	Net Profit Margin	0,200	0,016	0,183	#N/A	0,123	0,015	-1,003	0,309	0,431	0,004	0,436	11,23	56
2019-2020	Net Profit Margin	0,211	0,020	0,212	#N/A	0,102	0,010	-0,230	0,421	0,370	0,054	0,424	5,27	25
2015-2019	Operating Profit Margin	0,350	0,025	0,342	#N/A	0,191	0,036	14,09	2,79	1,322	0,049	1,37	19,59	56
2019-2020	Operating Profit Margin	0,372	0,032	0,375	#N/A	0,159	0,025	0,285	0,064	0,677	0,082	0,759	9,31	25
2015-2019	Percentage of Independence Director	0,219	0,025	0,146	0	0,186	0,034	-0,977	0,491	0,625	0	0,625	12,24	56
2019-2020	Percentage of Independence Director	0,254	0,041	0,25	0	0,207	0,043	-1,059	0,352	0,63	0	0,63	6,34	25
2015-2019	Educational Score	17,87	0,800	17	15	5,88	34,53	-0,585	-0,205	23	5	28	965	54
2019-2020	Educational Score	16,67	1,264	15,5	15	6,19	38,32	-1,015	0,088	19	7	26	400	24
2015-2019	Tech degree	0,196	0,054	0	0	0,401	0,161	0,483	1,57	1	0	1	11	56
2019-2020	Tech degree	0,458	0,134	0	0	0,658	0,433	0,349	1,16	2	0	2	11	24

Banks in group 3 have higher average tech cost over revenue, from 4% to 5.1%. The profitability ratios of group 3 all see an increase in mean and median but a the decrease in the maximum value. With ROA, the mean and median go from 1.02% to 1.11% and 1.1% to 1.27% respectively while the maximum value decreased by 4.6%. With NPM, the mean and the median grow by 0.1% both. In contrast, the maximum value after period is lower than the before time by 1.2%

OPM is the variable that has the biggest difference when comparing two periods of time. From 2015 to 2019, the mean, median and maximum are 34.9%, 34.2% and 137%. After 2019, the mean gains 2.3%, the median gains 0.6 % while the maximum decreases.

Group 3' board of directors has some changes but similar to the two groups above, these changes are not considered.

5.2 Regression

In the regression model, AI investment (Investment in AI) is both used as dependent and independent variables. In table 1 and 2, the results are presented with three figures: the R-square on top, on the second row, is significance F, on the third row is coefficients and the last row is the p-value

In the first analysis, investment in AI is used as an independent variable to examine its effects on the profitability and the human resources of banks.

Table 1 Profitability and Employees Variables

Dependent variables	Investment in AI
ROA	0,00013 0,858 1,31E-11 0,858
NPM	0,0019 0,490 1,9E-09 0,490
OPM	0,037 0,002 1,04E-08 0,002
Number of employees	0,0008 0,683 7,8E-05 0,683

To discover the relationship between AI and the profitability of banks, the linear regression of 3 dependent variables: ROA, NPM and OPM and the investment in technology was chosen by the

author. The four values the author picked to analyze in detail are R-square, significance F, coefficients and p-value. The R-square presents how much the independent variables affect the dependent variables.

The first row is presenting the effects of technology investment on ROA – the ratio shows how much the company can earn from its revenue. The R Square is 0,00012924 which means only 0,013% of banks' ROA was influenced by technology costs. The significant F is 0.85 and is considered as high. Therefore, the relationship between ROA and technology investment is highly likely inexistent. Looking at the p-value with the value of 0.85 while to define the relationship between two variables, its p-value needs to smaller than 0.5.

On the other hand, two profit margin variables' statistics explain the association with technology investment. For the NPM, the number of banks was affected is 0,192%. To say the NPM is affected by technology investment, the p-value needs to be smaller than 0.5 and the p-value of NPM is 0.48. The coefficient is positive which means two variables move in the same direction. If technology investment increases then NPM will increase and vice versa.

With OPM, the linear regression is stronger than NPM. The R-square is 0.037 which means that 3.7% of banks' operating profit margin is affected by technology cost. From the table above, the significance F is moderate with only 0,002 and the p-value is also small. The two values reveal that there is a relation between OPM and technology investment. The coefficient is positive showing that two variables move in the same direction.

With an aim to understand the effects of advanced technology on the human resources of banks, the author used simple linear regression to analyze the relation between the number of employees and the investment in AI and technology. From the result, there is no relationship between the technology investment and the number of employees. Two variables have the significance F and the p-value both are larger than 0.5.

Table 2 Board of Director Variables

Dependent variables	Percentage of Independent Directors	Educational Score	Technical Education of Directors
	0,25	0,25	0,25
	6,49E-15	6,49E-15	6,49E-15
	5410401,513	448065	-443413
Investment in AI	0,001	1,25E-13	0,528

In the second table, the author presented the result about the association between the board of directors and the investment in technology. The author wanted to find out whether the board of directors impacts the decision to invest in technology and AI. The investment in AI is considered a dependent variable. In this analysis, multiple linear regression was used to assess the impact of three variables representing the board of directors : percentage of independent directors, educational score and number of directors with technology degrees. Based on the result, 25% of the technology investment is affected by the board of directors. The percentage is considerably high explaining the importance of the board of directors in planning the budget for technological assets. Going into detail, the author saw the different levels of effects among variables. The percentage of independent directors and educational score both have a positive relationship with the investment in technology. The coefficients of both variables are positive with the p-value much smaller than 0.05. The p-value shows that the investment in technology is strongly affected by the independent directors and the level of education of the board. If the number of independent directors increases and their education degrees are at a higher level, banks will spend more on computers and software.

On the contrary, the number of directors with technology degrees has a negative association with the money spent on technology. The coefficient is negative, which means two variables move in different directions. If more directors have at least one degree related to technology, the money spent on technology will decrease

6 Conclusion

This section consists of three parts based on the findings. First, the author presents the results and their meaning based on the data analysis. Secondly, the author writes about the practical implications of the findings. The last part is the self-assessment of the author where she points out the limitations and recommendations for future researches about this topic.

6.1 Discussion of findings

The main ideas of the study are finding the relationship between the board of directors and the investment in artificial and the effects of artificial intelligence on the profitability of banks and their human resources

The first objective being assessed is the effects of artificial intelligence on banks' profitability. Because banks do not list down the exact spending for artificial intelligence, the research uses the technology cost to replace it.

H1: The AI investment influences the profitability of banks

H2: The AI investment influences the number of official employees.

In the first place, according to the descriptive statistics, the money spent on technology after using AI is higher than before using it in all three groups. It can be seen that banks are spending more on AI and there were some positive changes in the profitability of banks from group 2 and group 3.

In regression analysis, the author saw a positive and strong relationship between the investments in AI and the profit margin.

From the two models, it can be said that hypothesis 1 existed and there was a relationship between banks and profitability. The banks using AI from 2018 and 2019 had the most obvious increase in profits while the banks from group 1 had little change even though they pioneered in using the technology.

In the second place, based on the regression results, the employees were not affected by the investment in technology and AI. Large investment in technology did not affect the human resources of banks. Hypothesis 2 is proved to be wrong.

The second target of the study was to explore the relationship between the board of directors and the budget for AI. To measure the board of directors in this study, the author uses three features that can be calculated under numbers and are available officially.

H3: The board of directors' education level impacts the AI investment

H4: The number of directors with technology degree impacts the AI investment

H5: The number of independent directors affects the amount of investment in AI appliances.

The board of director's education was represented under two variables: tech degree and educational score. With the tech degree variables, it had almost no effect on the investment in AI. More directors with technology degrees did not increase the money spent on AI. Hypothesis 4 was considered as a wrong statement.

On the contrary, the educational score and the number of independent directors had impacts on the investment of AI according to the regression. The higher the education score was, the more money banks spent on AI and vice versa. With independent directors, if banks' board of directors included more independent directors, they had a tendency to invest more in technology. The author concluded that hypotheses 3 and 5 were accepted.

6.2 Implications

The topic of artificial intelligence is attracting numerous attentions from all over the world. With the capabilities of artificial intelligence, it will be a helpful assistant in improving the efficiency and quality of work. However, the race of using AI is just at the beginning and the results are unclear. From the study, although banks from group 1 using AI earliest, their profitability didn't have any changes. The reasons could be because the AI applications are not fully developed and when implementing them, bankers had little knowledge in utilizing them at the right place. Banks from

group 2 and 3 learned from group 1 and it seemed like they had a better strategy for the process of adopting AI in the workplace.

One of the main reasons the author started this study was to assess the impacts of the board of directors in the technology 4.0 revolution. The board of directors needs to have enough knowledge and experience to understand how AI works and put it under control. To be able to do that, academic degrees are proved to play an important role. Moreover, the role of independent directors contributes positively to the development of AI in banks.

From the findings of this study, three implications that bank managers could take into consideration before jumping into the AI race. Firstly, the impact of AI on profitability has existed but it depends on how banks use AI in their operations. When the technology was at the early stage of development, its effects were modest. Banks need to conduct a thorough study with experienced people to see the pros and cons of using AI.

Lack of understanding of AI can lead to many troubles for bank managers. They need to understand how AI applications analyze data and make conclusions so that they could use it wisely to make appropriate decisions. They also have to know the risks when operating AI applications. The technological risks can cause tremendous damages to banks if confidential information is leaked out or the system stops working.

These are reasons why the board of directors' academic background influences the investment of AI. When the board has not acquired enough information about AI, it is very risky and challenging to try new and complicated technology.

In addition, when the favour to use AI at the workplace is increasing, people are worried about losing their jobs. It is reasonable when AI already could do repetitive and simple tasks While after the study, the change in the number of employees is not caused because of the investment in AI, the banks' employees must gain more skills and knowledge about technology in general and AI in specific. It will help bankers use AI as an assistant instead of letting it replace your position at works.

6.3 Limitations and recommendation

In this section, the author explains the limitations that might restrict the results of this study and give recommendations for future researches.

First, there are three limitations to this topic. First, there are only 43 banks in ASEAN in this study due to the lack of information. With more banks, the study can make more detailed and broader results representing the whole ASEAN's banking industry.

Secondly, because of the differences in the format of annual reports, the author couldn't collect all information of all variables of 43 banks. Some banks lack information about the educational background of the board of directors. And a few banks haven't published their 2020 annual reports.

Thirdly, because the applications of AI in the banking industry are at the beginning, the time period in this study is not too long to see the changes made by AI. If banks from 3 three groups can have information of three years before and after using AI, the author can have deeper insights into the effects of AI in banks' profitability and how the board of directors reacts to the AI adaptation.

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Appendices

Appendix 1. Descriptive statistics of tech cost on revenue and ROA group 1

2015-2016	
Tech Cost/Revenue	
Mean	0,081494508
Standard Error	0,015728166
Median	0,062853494
Mode	#N/A
Standard Deviation	0,066728958
Sample Variance	0,004452754
Kurtosis	0,277418051
Skewness	0,924779752
Range	0,231884369
Minimum	1,59171E-05
Maximum	0,231900286
Sum	1,466901152
Count	18

2017-2020	
Tech Cost/Revenue	
Mean	0,1078496
Standard Error	0,0136308
Median	0,0894524
Mode	#N/A
Standard Deviation	0,0817847
Sample Variance	0,0066887
Kurtosis	-0,6084144
Skewness	0,6640303
Range	0,2993981
Minimum	0,0001753
Maximum	0,2995734
Sum	3,8825859
Count	36

2015-2016	
ROA	
Mean	0,0121424
Standard Error	0,000845
Median	0,0109729
Mode	#N/A
Standard Deviation	0,0035849
Sample Variance	1,285E-05
Kurtosis	4,7150804
Skewness	2,0754617
Range	0,0143464
Minimum	0,0088964
Maximum	0,0232428
Sum	0,2185629
Count	18

2017-2020	
ROA	
Mean	0,010848
Standard Error	0,0006548
Median	0,0103575
Mode	#N/A
Standard Deviation	0,0039287
Sample Variance	1,544E-05
Kurtosis	1,9916098
Skewness	1,0351463
Range	0,0176991
Minimum	0,0038868
Maximum	0,0215859
Sum	0,3905292
Count	36

Appendix 2. Descriptive statistics of NPM and OPM of group

2015-2016	
Net Profit Margin	
Mean	0,2996274
Standard Error	0,0226589
Median	0,2775576
Mode	#N/A
Standard Deviation	0,0961337
Sample Variance	0,0092417
Kurtosis	-0,934511
Skewness	0,3234828
Range	0,3281035
Minimum	0,1559386
Maximum	0,4840421
Sum	5,3932923
Count	18

2017-2020	
Net Profit Margin	
Mean	0,2763732
Standard Error	0,0147059
Median	0,2839089
Mode	#N/A
Standard Deviation	0,0882354
Sample Variance	0,0077855
Kurtosis	-0,5316767
Skewness	0,2431841
Range	0,3522945
Minimum	0,1316667
Maximum	0,4839612
Sum	9,9494357
Count	36

2015-2016	
Operating Profit Margin	
Mean	0,5283852
Standard Error	0,0262594
Median	0,5452796
Mode	#N/A
Standard Deviation	0,1114093
Sample Variance	0,012412
Kurtosis	2,5561655
Skewness	-1,2456673
Range	0,4606723
Minimum	0,2616779
Maximum	0,7223503
Sum	9,5109336
Count	18

2017-2020	
Operating Profit Margin	
Mean	0,5380854
Standard Error	0,0214188
Median	0,5410598
Mode	#N/A
Standard Deviation	0,1285127
Sample Variance	0,0165155
Kurtosis	1,5361569
Skewness	-0,5167257
Range	0,620779
Minimum	0,2493888
Maximum	0,8701678
Sum	19,371076
Count	36

Appendix 3. Descriptive statistics of the board of directors' characteristics of group 1

2015-2016	
Percentage of Independence Director	
Mean	0,432642
Standard Erro	0,0499001
Median	0,4276018
Mode	0,3333333
Standard Dev	0,2117083
Sample Varia	0,0448204
Kurtosis	0,2585568
Skewness	-0,589383
Range	0,75
Minimum	0
Maximum	0,75
Sum	7,7875566
Count	18

2017-2020	
Percentage of Independence Director	
Mean	0,465894
Standard Erro	0,0372584
Median	0,485
Mode	0
Standard Dev	0,2235503
Sample Varia	0,0499747
Kurtosis	-0,087357
Skewness	-0,687309
Range	0,75
Minimum	0
Maximum	0,75
Sum	16,772185
Count	36

2015-2016	
Educational Score	
Mean	22,882353
Standard Erro	1,8428765
Median	21
Mode	19
Standard Dev	7,5983744
Sample Varia	57,735294
Kurtosis	-0,174689
Skewness	0,6520015
Range	27
Minimum	12
Maximum	39
Sum	389
Count	17

2017-2020	
Educational Score	
Mean	22,972222
Standard Erro	1,0804806
Median	22
Mode	22
Standard Dev	6,4828834
Sample Varia	42,027778
Kurtosis	-0,835197
Skewness	0,5211411
Range	22
Minimum	13
Maximum	35
Sum	827
Count	36

2015-2016	
Tech degree	
Mean	0,2777778
Standard Erro	0,1086325
Median	0
Mode	0
Standard Dev	0,4608886
Sample Varia	0,2124183
Kurtosis	-0,941538
Skewness	1,0848609
Range	1
Minimum	0
Maximum	1
Sum	5
Count	18

2017-2020	
Tech degree	
Mean	0,4444444
Standard Erro	0,0839921
Median	0
Mode	0
Standard Dev	0,5039526
Sample Varia	0,2539683
Kurtosis	-2,063503
Skewness	0,2334486
Range	1
Minimum	0
Maximum	1
Sum	16
Count	36

Appendix 4. Descriptive statistics of tech cost on revenue and ROA group 2

2015-2018	
Tech Cost/Revenue	
Mean	0,06526025
Standard Error	0,00930694
Median	0,04951514
Mode	#N/A
Standard Deviation	0,07087956
Sample Variance	0,00502391
Kurtosis	4,76396866
Skewness	2,126414
Range	0,30329412
Minimum	0,00273089
Maximum	0,30602501
Sum	3,78509441
Count	58

2018-2020	
Tech Cost/Revenue	
Mean	0,0897775
Standard Error	0,0170974
Median	0,042427
Mode	#N/A
Standard Deviation	0,13021
Sample Variance	0,0169547
Kurtosis	16,980311
Skewness	3,5511512
Range	0,8190338
Minimum	0,0014219
Maximum	0,8204557
Sum	5,2070937
Count	58

2015-2018	
ROA	
Mean	0,0136534
Standard Error	0,0009836
Median	0,0111571
Mode	#N/A
Standard Deviation	0,0074911
Sample Variance	5,612E-05
Kurtosis	0,0994343
Skewness	1,0615698
Range	0,0260915
Minimum	0,0053746
Maximum	0,0314661
Sum	0,7918963
Count	58

2018-2020	
ROA	
Mean	0,0161357
Standard Error	0,0015035
Median	0,0136742
Mode	#N/A
Standard Deviation	0,0114504
Sample Variance	0,0001311
Kurtosis	13,052996
Skewness	2,8621308
Range	0,0748748
Minimum	0,0019035
Maximum	0,0767783
Sum	0,9358708
Count	58

Appendix 5 Descriptive statistics of NPM and OPM of group 2

2015-2018	
Net Profit Margin	
Mean	0,2355717
Standard Error	0,0153407
Median	0,231798
Mode	#N/A
Standard Deviation	0,1168317
Sample Variance	0,0136496
Kurtosis	-0,8775816
Skewness	0,4025564
Range	0,4245064
Minimum	0,0760725
Maximum	0,500579
Sum	13,663159
Count	58

2018-2020	
Net Profit Margin	
Mean	0,3637369
Standard Error	0,0741989
Median	0,2456983
Mode	#N/A
Standard Deviation	0,5650818
Sample Variance	0,3193175
Kurtosis	23,287454
Skewness	4,6702289
Range	3,5869384
Minimum	0,0559198
Maximum	3,6428582
Sum	21,096741
Count	58

2015-2018	
Operating Profit Margin	
Mean	0,416265
Standard Error	0,0214617
Median	0,4133602
Mode	#N/A
Standard Deviation	0,1634471
Sample Variance	0,026715
Kurtosis	-0,057087
Skewness	0,4496431
Range	0,7353608
Minimum	0,1225016
Maximum	0,8578624
Sum	24,143368
Count	58

2018-2020	
Operating Profit Margin	
Mean	0,5204561
Standard Error	0,0879895
Median	0,415693
Mode	#N/A
Standard Deviation	0,6701082
Sample Variance	0,449045
Kurtosis	49,279101
Skewness	6,7702482
Range	5,3437047
Minimum	0,0020911
Maximum	5,3457958
Sum	30,186454
Count	58

Appendix 6 Descriptive statistics of the board of directors' characteristics of group 2

2015-2018	
Percentage of Independence Director	
Mean	0,2601386
Standard Errc	0,031338
Median	0,2
Mode	0
Standard Dev	0,2386629
Sample Varia	0,05696
Kurtosis	-0,4887093
Skewness	0,6356907
Range	0,8888889
Minimum	0
Maximum	0,8888889
Sum	15,088037
Count	58

2018-2020	
Percentage of Independence Director	
Mean	0,3064322
Standard Errc	0,0312775
Median	0,2361111
Mode	0
Standard Dev	0,2382022
Sample Varia	0,0567403
Kurtosis	-1,2561065
Skewness	0,2884028
Range	0,78
Minimum	0
Maximum	0,78
Sum	17,77307
Count	58

2015-2018	
Educational Score	
Mean	15,892857
Standard Errc	0,858373
Median	15
Mode	17
Standard Dev	6,4234756
Sample Varia	41,261039
Kurtosis	1,8376921
Skewness	1,0959665
Range	32
Minimum	5
Maximum	37
Sum	890
Count	56

2018-2020	
Educational Score	
Mean	16,163636
Standard Errc	0,8225622
Median	15
Mode	10
Standard Dev	6,1002843
Sample Varia	37,213468
Kurtosis	1,1687246
Skewness	1,0051932
Range	29
Minimum	5
Maximum	34
Sum	889
Count	55

2015-2018	
Tech degree	
Mean	0,4035088
Standard Errc	0,0745061
Median	0
Mode	0
Standard Dev	0,5625087
Sample Varia	0,316416
Kurtosis	0,0788534
Skewness	1,0195422
Range	2
Minimum	0
Maximum	2
Sum	23
Count	57

2018-2020	
Tech degree	
Mean	0,5272727
Standard Errc	0,0893468
Median	0
Mode	0
Standard Dev	0,6626139
Sample Varia	0,4390572
Kurtosis	-0,2898648
Skewness	0,8873977
Range	2
Minimum	0
Maximum	2
Sum	29
Count	55

Appendix 7 Descriptive statistics of tech cost on revenue and ROA group 3

2015-2019	
Tech Cost/Revenue	
Mean	0,040416725
Standard Error	0,005041888
Median	0,026439053
Mode	#N/A
Standard Deviation	0,037730033
Sample Variance	0,001423555
Kurtosis	1,320001724
Skewness	1,422661126
Range	0,150209586
Minimum	0,001017704
Maximum	0,15122729
Sum	2,263336606
Count	56

2019-2020	
Tech Cost/Revenue	
Mean	0,05180436
Standard Error	0,00914001
Median	0,03105718
Mode	#N/A
Standard Deviation	0,04570004
Sample Variance	0,00208849
Kurtosis	-0,50596772
Skewness	0,98554518
Range	0,14926324
Minimum	0,00084416
Maximum	0,1501074
Sum	1,29510904
Count	25

2015-2019	
ROA	
Mean	0,01025457
Standard Error	0,000693
Median	0,01104465
Mode	#N/A
Standard Deviation	0,00518594
Sample Variance	2,6894E-05
Kurtosis	0,06357247
Skewness	0,14796831
Range	0,02376819
Minimum	0,00023387
Maximum	0,02400206
Sum	0,57425601
Count	56

2019-2020	
ROA	
Mean	0,01189683
Standard Error	0,00091051
Median	0,012739
Mode	#N/A
Standard Deviation	0,00455254
Sample Variance	2,0726E-05
Kurtosis	-1,1828799
Skewness	-0,0480087
Range	0,01443862
Minimum	0,00516975
Maximum	0,01960838
Sum	0,29742087
Count	25

Appendix 8 Descriptive statistics of NPM and OPM of group 3

2015-2019	
Net Profit Margin	
Mean	0,20047201
Standard Error	0,01640855
Median	0,18341553
Mode	#N/A
Standard Deviation	0,12279036
Sample Variance	0,01507747
Kurtosis	-1,0026078
Skewness	0,30878594
Range	0,43146834
Minimum	0,00441267
Maximum	0,43588101
Sum	11,2264324
Count	56

2019-2020	
Net Profit Margin	
Mean	0,21074339
Standard Error	0,02034331
Median	0,21223386
Mode	#N/A
Standard Deviation	0,10171654
Sample Variance	0,01034625
Kurtosis	-0,2298485
Skewness	0,42134428
Range	0,36974661
Minimum	0,05420978
Maximum	0,42395639
Sum	5,26858463
Count	25

2015-2019	
Operating Profit Margin	
Mean	0,34978597
Standard Error	0,02548329
Median	0,34152642
Mode	#N/A
Standard Deviation	0,19069949
Sample Variance	0,03636629
Kurtosis	14,0915933
Skewness	2,79408798
Range	1,32175311
Minimum	0,04882531
Maximum	1,37057842
Sum	19,5880142
Count	56

2019-2020	
Operating Profit Margin	
Mean	0,3723765
Standard Error	0,03179779
Median	0,37530392
Mode	#N/A
Standard Deviation	0,15898897
Sample Variance	0,02527749
Kurtosis	0,28473797
Skewness	0,06358489
Range	0,67693846
Minimum	0,08227159
Maximum	0,75921006
Sum	9,30941259
Count	25

Appendix 9 Descriptive statistics of the board of directors' characteristics of group 3

2015-2019	
Percentage of Independence Director	
Mean	0,2185056
Standard Err	0,0248117
Median	0,1458333
Mode	0
Standard Dev	0,1856736
Sample Varia	0,0344747
Kurtosis	-0,977211
Skewness	0,4914818
Range	0,625
Minimum	0
Maximum	0,625
Sum	12,236311
Count	56

2019-2020	
Percentage of Independence Director	
Mean	0,2537665
Standard Err	0,0413431
Median	0,25
Mode	0
Standard Dev	0,2067155
Sample Varia	0,0427313
Kurtosis	-1,058937
Skewness	0,3515086
Range	0,63
Minimum	0
Maximum	0,63
Sum	6,3441631
Count	25

2015-2019	
Educational Score	
Mean	17,87037
Standard Err	0,7996533
Median	17
Mode	15
Standard Dev	5,8762274
Sample Varia	34,530049
Kurtosis	-0,584954
Skewness	-0,205411
Range	23
Minimum	5
Maximum	28
Sum	965
Count	54

2019-2020	
Educational Score	
Mean	16,666667
Standard Err	1,2635736
Median	15,5
Mode	15
Standard Dev	6,1902214
Sample Varia	38,318841
Kurtosis	-1,015232
Skewness	0,0884266
Range	19
Minimum	7
Maximum	26
Sum	400
Count	24

2015-2019	
Tech degree	
Mean	0,1964286
Standard Err	0,0535714
Median	0
Mode	0
Standard Dev	0,4008919
Sample Varia	0,1607143
Kurtosis	0,4826462
Skewness	1,5705722
Range	1
Minimum	0
Maximum	1
Sum	11
Count	56

2019-2020	
Tech degree	
Mean	0,4583333
Standard Err	0,1343148
Median	0
Mode	0
Standard Dev	0,6580053
Sample Varia	0,432971
Kurtosis	0,3487716
Skewness	1,1648099
Range	2
Minimum	0
Maximum	2
Sum	11
Count	24

Appendix 10 Regression Result of ROA and investment in technology

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,01136855
R Square	0,000129244
Adjusted R Square	-0,003886301
Standard Error	0,007662857
Observations	251

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1,89E-06	1,89E-06	0,0321859	0,857766161
Residual	249	0,0146211	5,872E-05		
Total	250	0,014623			

	Coefficients	*tandard Erro*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	0,012745896	0,0005261	24,228752	1,948E-67	0,011709792	0,013782	0,011709792	0,013782
Investment in Tech	1,3103275E-11	7,304E-11	0,1794043	0,8577662	-1,3075E-10	1,57E-10	-1,3075E-10	1,57E-10

Appendix 11 Regression Result of NPM and investment in technology

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,043795837
R Square	0,001918075
Adjusted R Square	-0,002090286
Standard Error	0,293119467
Observations	251

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0,0411138	0,0411138	0,4785186	0,489738598
Residual	249	21,393836	0,085919		
Total	250	21,43495			

	Coefficients	*tandard Erro*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	0,259854842	0,020123	12,91331	1,517E-29	0,220221804	0,2994879	0,220221804	0,2994879
Investment In Tech	1,93264E-09	2,794E-09	0,6917504	0,4897386	-3,5699E-09	7,435E-09	-3,5699E-09	7,435E-09

Appendix 12 Regression result of OPM and investment in technology

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,192423171
R Square	0,037026677
Adjusted R Square	0,033159314
Standard Error	0,351614505
Observations	251

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1,1836775	1,1836775	9,5741411	0,002198596
Residual	249	30,784557	0,1236328		
Total	250	31,968235			

	Coefficients	*tandard Erro*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	0,417276602	0,0241388	17,286563	1,583E-44	0,369734379	0,4648188	0,369734379	0,4648188
Investment in Tech	1,03699E-08	3,351E-09	3,0942109	0,0021986	3,7692E-09	1,697E-08	3,7692E-09	1,697E-08

Appendix 13 Regression result of the board of directors and investment in technology

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,5007898
R Square	0,2507904
Adjusted R Square	0,2413861
Standard Error	5865839,7
Observations	243

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regression	3	2,753E+15	9,176E+14	26,667621	6,494E-15
Residual	239	8,224E+15	3,441E+13		
Total	242	1,098E+16			

	Coefficients	*tandard Erro*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	-6682070	1158027,1	-5,770219	2,442E-08	-8963313	-4400826	-8963313	-4400826
Percentage of independence director	5410401,5	1634379,5	3,3103703	0,0010757	2190772,9	8630030,2	2190772,9	8630030,2
Educational Score	448065,19	56949,075	7,8678222	1,246E-13	335878,97	560251,42	335878,97	560251,42
Number of directors with tech degree	-443413,1	701775,28	-0,631845	0,5280922	-1825868	939041,69	-1825868	939041,69

Appendix 14 Regression result of investment in technology and the number of employees

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,028139
R Square	0,0007918
Adjusted R Square	-0,003944
Standard Error	18411,981
Observations	213

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regression	1	56681919	56681919	0,1672028	0,6830246
Residual	211	7,153E+10	339001062		
Total	212	7,159E+10			

	Coefficients	*tandard Erro*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	19891,821	1348,2232	14,7541	2,546E-34	17234,108	22549,534	17234,108	22549,534
Investment in Tech	7,755E-05	0,0001897	0,4089044	0,6830246	-0,000296	0,0004514	-0,000296	0,0004514