

# DO TECHNOLOGY-RELATED INVESTMENTS HAVE A REMARKABLE IMPACT ON THE SCALABILITY AND PRODUCTIVITY OF THE FINANCIAL INDUSTRY?

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## ABSTRACT

Digital transformation makes investing in information and communications technology essential for all industries including the financial industry. In the Indonesian banking sector as part of the financial industry, technology-driven banking services were found to increase both banking transactions and customer numbers. This study investigates whether technology-related investments significantly enhance the scalability and productivity of commercial banks in Indonesia. This is quantitative research. The research employs a panel data regression of 80 observed data during the period 2019-2023. This study found that spending amount on technology-related investment has an impact on scalability and productivity. Specifically, technology-related investment increase revenue growth and productivity (sales per employee). The research findings have both academic and practical impacts. The results could encourage the bankers and decision makers to determine appropriate technological investment strategies. Investors can also consider highly digitalized banks as valuable investment. This research extends the current literature on the relationship between digitalization and banking performance, with a focus on commercial banks in Indonesia. This study offers two other proxies to assess banking performance: scalability and productivity, as technological advances aim to enhance company growth and productivity.

**Keywords:** *Technology, Software, Banking, Productivity, Scalability, Indonesia*

## 1. INTRODUCTION

Technology and banking

The digital transformation makes investments in information and communications technology a necessity for all types industry including financial sectors [1]. Banking institutions as part of financial industry have dynamically pushed the integration of information technology in their banking services [2]. This investment does not only aim to strengthen banking competitive advantage but also to understand the customers' needs. Customers' demand has made modern banking systems evolve. Banking institutions have recognized the significance of new technologies to improve their performance and customer satisfaction [3]. Banking institutions have to transform their strategies, activities, and mechanism to offer innovative digital and technological-based services. The innovative services and technological changes can be attractive offers for customers because they

can access banking facilities anytime and anywhere [4].

Indonesia's banking sector has undergone a significant transformation, evolving from a simple system to a modern financial industry. The adoption of digital technologies in financial services has brought about major changes within the sector [5]. Banks consider digital transformation as one of the crucial strategies to compete and sustain in this technological era [6]. Digital transformation of banking industry has at least two positive impacts namely enhancing banking accessibility and increasing the competitiveness of Indonesian banks.

Referring to the report issued by Financial Service Authority, the number of banking offices tend to decline in these five years. Indonesia as an emerging market has some challenges and opportunities faced by banking industry. Furthermore, the policy implications: Research on Indonesia can inform policymakers in other countries. Learning from Indonesia's experiences in

regulating and managing the banking sector, particularly, in response to economic shocks and structural changes, can be highly beneficial. Despite its unique features, studying the Indonesian market can offer valuable insights applicable to other contexts, particularly, in understanding the impact of regulatory changes and economic development on banking performance [7].

Multiple previous studies have shown that innovations in banking technology, such as internet banking and electronic transactions, have the potential to improve banking performance [8], [9]. Research in digital transformation of banking sector also predominantly studied the growth and development of digital banking across different nations [9]. Most of prior studies focus on profitability when they talk about performance. Technology aims to enhance company growth and productivity. Therefore, examining different proxies for company growth and productivity will be beneficial. Although there have been numerous studies investigating the impact of digitalization on productivity, the studies come up with conflicting and mixed findings [6]. This research is crucial for understanding the particular factors that drive digital transformation in banking. By addressing these gaps, this current study is expected to offer a more comprehensive understanding of how related-technological investments influence banking performance and productivity.

Building on this line of research, this study examines the relationship between technological investment and banking scalability and productivity in Indonesia as an emerging market. The rest of this paper is organized as follows. In Section 2, a brief literature review of the relevant theories is presented and followed by hypothesis development. Section 3 discusses the research methods and the variables. In Section 4 discusses and analysis the empirical results. Section 5 summarizes the main findings and highlights the contribution of this study to the existing literature. This section also provides some policy recommendations for policymakers to optimize the potential of technological investment in banking industry.

## 2. LITERATURE REVIEW

### 2.1. The Development of Banking Technology in Indonesia

Referring to the report published by the central bank, Bank Indonesia escalated digitalization to strengthen the integration of the national digital

economy. This resulted in the achievement of the adult population's digital transactions which reached 25.98 billion, it was targeted at 17 billion. This significant growth reflects public acceptance and preference digital banking and digital payments.

From the following figure, we can see the inclining number of assets and sources of fund of banking industry in Indonesia. The banking assets has been increasing these past five years. The sources of fund also reveal growing number. The advancement of banking technology in the recent years has given positive impact on banks' assets.

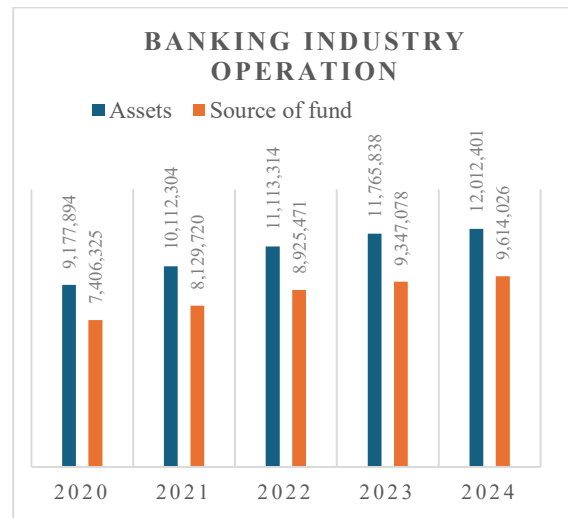


Figure 1: Banking assets and source of fund.

Referring to the banking statistics issued by Financial Service Authority, one interesting fact is depicted in the following table. Despite the increase of assets and source of fund, the number of banks' offices tended to decline these past five years. Once it increased in 2021 only, then it kept decreasing the years after. This trend suggests that technology-driven banking services are likely contributing to higher transaction volumes, while customers are increasingly moving away from traditional in-branch services.

Table 1: The Comparison of Assets, Source of Fund, and the Number of Offices

Year	Assets	Source of fund	Offices
2020	9.177.894	7.406.325	30.733
2021	10.112.304	8.129.720	32.366
2022	11.113.314	8.925.471	25.377
2023	11.765.838	9.347.078	24.276
2024	12.012.401	9.614.026	24.268

Source: Banking Statistics by Financial Services Authority.

In today's world, technology is an inseparable part of every business transaction [10]. In response to the recent technological advancement, financial institutions are shifting to online and digitalized services. The bank digitalization is the integration of digital technology into all banking areas that alters the way banks operate and communicate with customers [6], [11]. The technological advancement such as software, internet banking, digital banking, mobile banking apps, and so on and so forth can acquire the demand of customers about modern banking services [6]. The increasing contribution of the sector to the growth of the economy requires aggressive digital transformation adopted in the sector [9]. As the sector's contribution to economic growth continues to rise, banks need to adopt proactive technological investment strategies to stay competitive and address the changing needs of the market.

The development of banking technology in Indonesia has undergone a remarkable transformation over the past few decades. Banking industry started with traditional banking services and manual processes in the early years. The late 1990s marked a significant jump in this type of industry. Automated Teller Machines (ATMs) was firstly introduced in that year. It was followed by the rise of internet and mobile banking in the 2000s as mobile banking applications are the results of advances in information technology [12]. The fintech boom in the 2010s introduced a wave of innovative financial solutions, including e-wallets and peer-to-peer lending platforms, while regulatory frameworks were established to support this growth. Today, advancements in artificial intelligence and cyber security [13], big data, and open banking are shaping the future of the sector, promoting financial inclusion and improving customer experiences across the archipelago. These technological innovations are driving a more interconnected and

efficient banking environment, enabling greater accessibility, enhanced security, and personalized services that meet the diverse needs of customers.

## 2.2. Technology to Enhance Growth and Productivity

The development of industry revolution stimulated the development of financial technology industry [14] which is projected to shift financial industry's system. Technology is seen as a consumer of inputs to produce outputs [3]. In the banking sector, technology is expected to enhance growth and productivity by automating its operating processes, enabling data analytics, and improving customer experiences. Technology demands for significant amount of money. Investment in technology can improve banking activities [15]. The adoption of advanced technology can also enhance customer service, improve sophisticated products and services, and fasten banking transactions. However, this considerable should increase the productivity and profitability of the bank [16].

Several studies in digital transformation examined the growth and development of digital banking [6], [9], [11]. Digital banking platforms offer easiness and accessibility from anywhere and anytime to enhance customers' convenience. Process automation in banking technology has saved time, improved security operation [15] and reduced operational costs [17]. Additionally, banking technology using artificial intelligence in the banking sector allows banks to analyse and evaluate risk more accurately. By leveraging these technologies, banks can increase efficiency and push innovation [2]. At the end, banks can maintain customers, attract new customers, and remain competitive in a rapidly growing financial industry

## 2.3. Hypotheses Development

Regarding the influence of technological and software developments on banking scalability and productivity, the hypotheses can be based on the evidence that an increase in investment in these areas leads to a firm's performance [1], [4], [10]. For instance, banks investing in advanced digital technology and automated systems are likely to experience growth and productivity. Therefore, banks have made significant steps towards using technology to secure and automate banking [18].

Technological investment in the banking sector has great potential to create more efficient business processes [15], [19]. Investment in banking

technology can take various forms such as digital banking platforms, cloud computing, software upgrade and development, e-payment systems, robotic process automation, cybersecurity solutions, and so on. Adoption of technology investment positively relates to digital technology outcomes in banks [9]. Banks that adopt sophisticated software solutions are expected to improve employee productivity [4]. The previous studies found that the advancement of technology in the financial industry can increase productivity [8]. Another study was also conducted to investigate the impact of technology advancements on banking performance [4] and found that technology investment had impact on profitability.

There is a lack of research focusing on exploring software expenditure and technology-related investments. Research into software expenditure and technological investment is critical for understanding how these factors influence the scalability and productivity of banks. By examining the relationship between technological spending and performance, such studies can help financial institutions optimize their investments to drive growth, enhance operational efficiency, and better serve customers. Based on the abovementioned explanations, this study derives the following hypotheses:

H1 : Technological investment has a significant impact on banking scalability and productivity.

H2 : Software expenditure has a significant impact on banking scalability and productivity.

### 3. RESEARCH METHODOLOGY

This study adopts a quantitative method by quantifying all the information into numeric data. Listed commercial banks were examined in this study. A total of 80 banks were selected due to the completeness of the data. The data sources were collected from the Refinitiv database and published reports from each bank’s official website. The observed data were tested and analysed using STATA. Sample data were derived from the following table:

Table 2: The Sample Selection

Sample	No
Listed banks in Refinitiv	18 banks
Incomplete data	2 banks
Number of observed data	16 banks for the latest 5 years

Source: Refinitiv database, 2024

This study examines the relationship between technological investments and banking scalability and productivity through the following model:

$$SCALA1_{i,t} = b_0 + b_1TECINVC_{i,t} + b_2SOFTWR_{i,t} + b_3BKSIZE_{i,t} + e_{i,t}$$

$$SCALA2_{i,t} = b_0 + b_1TECINVC_{i,t} + b_2SOFTWR_{i,t} + b_3BKSIZE_{i,t} + e_{i,t}$$

$$PRODC1_{i,t} = b_0 + b_1TECINVC_{i,t} + b_2SOFTWR_{i,t} + b_3BKSIZE_{i,t} + e_{i,t}$$

$$PRODC2_{i,t} = b_0 + b_1TECINVC_{i,t} + b_2SOFTWR_{i,t} + b_3BKSIZE_{i,t} + e_{i,t}$$

Scalability and productivity variables. Like previous studies, this study measures bank scalability as bank’s revenue growth (SCALA1it) and third-party fund growth (SCALA2it). The higher the revenue growth and third-party fund growth indicate the scalability of the banks is improving. Third-party deposits can be considered in line with the banking predominant strategy to enhance customers’ involvement in future transactions [3]. Referring to Refinitiv data sources, net income after tax (PRODC1it) and sales per person (PRODC2it) are categorized as the productivity indicators.

Independent variables. This study focuses on the impacts of technological investments on banking scalability and productivity. Technological investments adopt two proxies which are technological-related investment (TECINVit) and software expenses (SOFTWRit). This study also takes bank size (BKSIZEit) as a control variable using. The proxy of assets size is used to access whether this variable also determines scalability and productivity.

#### 4. FINDINGS AND DISCUSSION

This session presents the statistical results of the study. It is started with the descriptive statistics of the data.

Table 3: Descriptive Statistics (in thousands)

Tech. Investment		Software Exp	
Mean	1,894,920	Mean	1,744,805
Standard Error	431,640	Standard Error	763,622
Median	503,179	Median	110,755
Standard Deviation	3,860,712	Standard Deviation	6,830,049
Minimum	0	Minimum	0
Maximum	21,377,781	Maximum	55,086,736

Source: Refinitiv database, 2024

The above table describes technology-related investment and software expenditure disbursed by the banks. The highest technology-related investment is Rp. 21.377 billions and the highest software expenditure is Rp. 55.086 billions. There is one bank that did not spend for technology-related investment and software expenditure in 2019, so that the lowest amount for the two expenditures were zero. The mean of technology-related investment is Rp1.894 billion and the mean of software expenditure is Rp. 1.744 billion, indicating a relatively modest investment across the sector.

Table 4: Multicollinearity

Variable	VIF	1/VIF
TECINV	1.22	0.817516
SOFTWR	1.23	0.819232
BKSIZE	1.01	0.937687
Mean VIF	1.15	

The highest VIF is SOFTWR with the value of 1.23 followed by TECINV and BKSIZE. The value of VIF (Variance Inflation Factor) values for all variables is below ten. When the value does not exceed the threshold of ten, it confirms that multicollinearity does not exist [20]. A series of tests were conducted before running multiple regressions. The result of Wald test confirms that heteroscedasticity exists. However, in the panel data set, heteroscedasticity commonly appears because

panel data comprises several cross-sectional observations. The robust option (Stata command, vce (robust)) is applied in the regressions to solve the heteroscedasticity.

Table 5: The Results of Chow Test, Breusch-Pagan LM Test, and Hausman Test (Scalability)

Test	Significance	Decision	Significance	Decision
	SCALA1 (Revenue growth)		SCALA2 (Third party fund growth)	
Chow (F test)	0.0000	FEM	0.0000	FEM
Breusch-Pagan LM test	0.0000	REM	0.0000	REM
Hausman test	0.0002	FEM	7.47	REM
Heteroscedasticity	0.0000			

Table 5 depicts the results of a series of tests performed. A set of statistical tests consisting of Chow Test (F Test), the Breusch-Pagan LM test, and Hausman test were conducted to choose the best model. Chow test is carried out to select either Pooled OLS or Fixed Effect will be selected. Fixed Effect model is selected if the Prob>F is less than alpha 0.05. The Breusch-Pagan LM test is applied to select between Pooled OLS and Random Effect. Random Effect model is chosen if the probability is less than alpha 0.05. The Hausman test is conducted to select between Random Effect and Fixed Effect model. Fixed Effect model is selected if the probability is less than alpha 0.05. Referring to the the above table, both fixed effect model and random affect model are selected for different scalability proxies.

The following table presents the results of the impacts of technology-related investment and software expenditure on revenue growth. The adjusted R-square is 0.9118 and F = 0.0000. This indicates that the projected variables have simultaneously significant impact on revenue growth.

Investing in software and technology can significantly enhance a bank's ability to streamline operations, improve customer experiences, and offer

innovative services. All of these are expected to contribute to revenue growth. Increased spending on technology often leads to higher operational efficiency, enabling banks to handle more transactions and boosts profitability. Additionally, strategic investments in technology allow banks to stay competitive, attract new customers, and expand their market share, driving sustainable long-term revenue growth.

*Table 6: The Impact of Technological Investment and Software Expenditure on Scalability (Revenue Growth)*

Variables	Coefficient	Std. Error	Significance
TECINV	0.162309	0.17433	0.046*
SOFTWR	-0.025483	0.08949	0.777
BKSIZE	0.0666123	0.00377	0.000*

\*Significant at 0.05

The current study employs panel data of five-year observations because it attempts to examine the latest practices of investment in banking technology and software expenditure. The above table displays the impacts of technological investment, software expenditure and bank size on revenue growth. These variables were predicted to have positive influences on the banks' revenue growth. However, not all predicted variables have significant influences on revenue growth. Software expenditure does not seem to have significant impact on revenue growth. The result of this study is in line with a prior study investigating the impact of technology advancements on banking performance. Its results provide mixed results in terms of performance proxies [4], [16]. Technology adoption in financial industry can generate more earnings [21]. To provide banking products and services the customers, banks tend to adopt the most advanced technology to increase their revenue [19].

*Table 7: The Impact of Technological Investment And Software Expenditure on Scalability (Third Party Fund Growth)*

Variables	Coefficient	Std. Error	Significance
TECINV	-0.527474	0.55829	0.345
SOFTWR	-0.168326	0.28657	0.557

BKSIZE	0.751834	0.00840	0.000*
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\*Significant at 0.05

Table 7 explains the results of the impacts of technology-related investment and software expenditure on third party fund growth. The adjusted R-square is 0.9362 and F = 0.0000. This indicates that the predictable variables have simultaneously significant impact on revenue growth. This result is in line with [3] which states that customers' deposits reflect bank's efficiency. Banking sector is becoming more competitive. This affects third party fund growth. This indicates that customers and depositors tend to put their fund on big banks. Investment on technology and software do not really attract depositors when they still enjoy and prefer utilizing traditional banking [12]. Banks still have main goal is to attract and retain depositors [3]. This study found only bank size affects third party fund growth. This indicates that banking customers in Indonesia are more interested in banks with big assets.

*Table 8: The Results of Chow Test, Breusch-Pagan LM Test, And Hausman Test (Productivity)*

Test	Significance	Decision	Significance	Decision
	Productivity 1 (IAT)		Productivity 2 (SPE)	
Chow (F test)	0.0000	FEM	0.0000	FEM
Hausman test	0.4220	REM	0.3921	REM
Breusch-Pagan LM test	0.1000	OLS	0.1000	OLS
Heteroscedasticity	0.0000			

Table 8 shows that both fixed effect model and random affect model are selected for different scalability proxies. The following table presents the results of the impacts of technology-related investment and software expenditure on sales per employee. The adjusted R-square is 0.7302 and F=0.0000. This indicates that the projected variables have simultaneously significant impact on productivity (sales per employee). Table 9 explains the regression results relating to the variable of sales per employee.

*Table 9: The impact of technological investment and software expenditure on productivity (Sales per employee)*

Variables	Coefficient	Std. Error	Significance
TECINV	42.15413	14.1521	0.004*
SOFTWR	-4.903777	7.25558	0.501
BKSIZE	1.306695	0.09154	0.000*

Table 9 summarizes the impact of technology related investment and software expenditure on productivity (sales per employee). Productivity could be defined as the positive changes of efficiency between the observed periods, while the profitability is the results of the efficiency demonstrating the ability of the bank to generate profit [23]. Therefore, banks need to be productive to earn more profit. Banking productivity can be measured using sales per employee and income after tax per employee.

Banks must leverage technology and software investments that enhance operational efficiency and enable employees to focus on high-value tasks. By optimizing their digital infrastructure through software expenditures and technology investment, banks can reduce costs, improve service delivery, and ultimately increase profitability per employee. This study also found that larger banks often experience higher productivity due to economies of scale, allowing them to leverage advanced technologies, streamline operations, and reduce per-unit costs, which smaller banks may struggle to achieve.

Sales per employee indicates the contribution of each employee toward banking sales/revenue. The results show that technology related investment and bank size affect sales per employee. Investment in technology is proven to increase employee's efficiency and productivity. Businesses tend to embrace the latest technology if they want to work more efficiently [24]. The characteristics of the banks including bank asset influence bank performance [25]. The bigger the banks in term of assets, the more efficient their banking operation.

*Table 10: The Impact of Technological Investment and Software Expenditure on Productivity (Net Income After Tax)*

Variables	Coefficient	Std. Error	Significance
TECINV	-16.66764	14.7462	0.262
SOFTWR	2.243628	7.56013	0.767
BKSIZE	0.5997194	0.09538	0.000

Table 10 explains the results of the impacts of technology-related investment and software expenditure on banking productivity using the proxy of net income after tax per employee. The adjusted R-square is 0.3325 and F = 0.0000. However, both technology-related investment and software expenditure do not have significant impact on employee's productivity using the proxy of net income after tax per employee.

Both technology-related investment and software expenditure may not have a significant impact on employee productivity, as measured by net income after tax per employee. Additionally, productivity (net income after tax per employee) can be influenced by various other factors, such as organizational structure, employee skills, and overall market conditions, which are not measured in this study.

Net income after tax per employee indicates how productive each employee to contribute net income to the bank. Employees might play significant role in expanding banking sales. However, the banks operating expenses cannot be neglected. At the end, net income is derived from sales deducted by all expenses.

The following table concludes the hypotheses of this study. There are two main variables tested in this study namely technology-related investment (TECHINV) and software expenditure (SOFTWR). The following table presents which variable has significant impact on the dependent variables. There are also two dependent variables which are scalability and productivity. Scalability consists of two proxies: Revenue growth (SCALA1) and Third party fund growth (SCALA2). Productivity consists of two proxies as well: Sales per employee (PRODC1) and net income after tax per employee (PRODC2).

Table 11: Summary of Hypotheses and Results

Hypotheses	Dependent Variables	Results
H1	Scalability 1 (Revenue Growth)	TECHINV
	Scalability 2 (Third party fund growth)	-
H2	Productivity 1 (Sales per employee)	TECHINV
	Productivity 2 (Net income after tax per employee)	-

This study found that technology related investment has significant impact on both scalability and productivity. Technology related investment affects revenue growth and sales per employee. This result prove that technology can boost banking revenue and push employees' productivity through their contribution to banking sales. Software expenditure seems not to have significant impact because software does not directly increase the customers experience. Another possible reason is that the benefits of such expenditures often take time to materialize and may not immediately generate impact to the banks.

## 5. CONCLUSION

The investment in banking industry has a purpose of strengthening banking competitive advantage and satisfy customers' need. Customers demand for efficient and easy banking transactions and modern banking systems. Banking institutions have recognized the significance of new technologies to improve their performance and customer satisfaction. Therefore, banks have to transform their activities and offer innovative digital and technological-based services. This paper examines the significant changes of Indonesian commercial banks due to the technology-related investment and software expenditure.

Technology-related investment in the banking sector is likely to create more efficient banking activities. Investment in banking technology can be in the forms of digital banking platforms, cloud computing, software upgrade and development, e-payment systems and others. Several past studies found that the adoption of technology investment affects banks' performance.

Past studies focus on profitability as performance indicator. Very minimum number of studies concern about how technology increase productivity and scalability. Technology aims to boost firm efficiency and productivity. At the end, it is expected to enhance the growth in many aspects. Therefore, this study looks at the scalability and productivity aspects.

Based on the statistical results, this study partially achieves its objective and accepts the hypotheses. Technological-related investments play a significant role while software expenditure does not. The findings of this study technology related investment have significant impact on both scalability and productivity. Technology-related investment affects scalability in term of revenue growth and productivity with the proxy of sales per employee. The findings argue that technology plays a significant role in enhancing the firm's growth. Furthermore, technology is also a driving factor of employees' productivity. Software spending appears to have a minimal effect since customers do not directly relate to it.

This study has numerous important implications for banking stakeholders including bankers, policymakers and investors. This current study identifies the influence of technology on bank scalability and productivity. This may help bankers and policymakers enhance their decision making in productivity. It also helps investors support their decision on technology investment in banking sector.

This study is not without limitations. This study includes a limited number of samples and two proxies of technological expenditures. The following are suggestions for the better future studies. The subsequent studies are expected to involve more samples to derive the influencing factors. Other than that, future studies may compare the technological factors in different countries as well. Using different periods will be another advantage to see the role of technology during this digital era. The future studies can also expand more advanced technology variables such as technology acceptance, technology level, the use of artificial intelligence and blockchain technology in financial industry.



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