

Digital Finance and Sustainable Development of Indonesian Banks

Variandy Tiaraputra¹, Fadhil Wicaksono¹, Susilo Toto Rahardjo¹

¹ Universitas Diponegoro, Semarang, Indonesia

variandytiaraputra@gmail.com

Abstract

This study aims to analyze the influence of the development of financial digital transformation on banking sustainable development, with a focus on banks listed on the Indonesia Stock Exchange (IDX) during the period 2019 to 2023. Using the Fixed Effect model, this study evaluates the relationship between the adoption of digital technology in the banking sector and banks' sustainable development in Environmental, Social, and Governance (ESG) aspects, as well as the influence of control variables such as bank liquidity and loan ratio. The results show that the digital transformation of finance has a significant effect on the sustainable development of banks, where more digitized banks tend to have better performance in sustainability aspects. In addition, bank liquidity and loan ratio are also proven to have a positive influence on bank sustainable development. However, bank size does not show a significant influence in this model. This study reinforces previous findings that digitalization in the financial sector can accelerate the achievement of sustainability goals, but also highlights the importance of other factors, such as managerial policies and sustainability-based strategies, in achieving these goals. This research contributes to policy makers in banking sector to formulate more effective sustainability strategies.

Keywords

Bank Liquidity, ESG, Digital Transformation, Loan Ratio.

1. Introduction

As the world economy accelerates and the financial architecture continually evolves, commercial banks—key pillars of that system—have risen to the forefront of discussion that attracts the attention of governments and financial supervisory authorities around the world (Li et al., 2025a; Zhang et al., 2024). In Indonesia, the commercial banking sector plays a strategic role in supporting economic growth, which is further strengthened by the application of digital technology that drives innovation and efficiency in various sectors, including marketing. This digital transformation in the banking sector has brought significant challenges and opportunities but there is still uncertainty regarding its long-term impact on the sustainable development and marketing strategies of banks listed on the Indonesia Stock Exchange (IDX) (Feng & Zhang, 2021; Zhou et al., 2023; Zhang et al., 2024).

Digital finance, with all its innovations, has had a major impact on commercial banks, offering new business models and sources of growth that can strengthen the position of commercial banking. However, on the other hand, these advances also add new challenges, especially in terms of risk management, business model changes, and adaptation to an increasingly competitive market environment (Feng & Zhang, 2021; Zhou et al., 2023; Hao et al., 2023; Zhang et al., 2024; Li et al., 2025). In Indonesia, more and more banks are implementing digital technology to increase operational efficiency and improve their marketing practices, which in turn supports more stable business sustainability and growth in the long run.

The increasing use of digital technology in the banking sector opens up opportunities for commercial banks to innovate their marketing strategies, creating marketing practices that support sustainability while enhancing brand value and competitiveness. Through the implementation of sustainable marketing strategies, banks can better integrate social and environmental responsibility into their operations, in line with consumer expectations and increasingly stringent regulations on sustainability issues.

However, while many studies have examined the impact of digital finance on economic and environmental aspects in various countries, there is a lack of in-depth research on its impact on the sustainable development of the banking sector in Indonesia. Existing literature has identified various impacts of digital finance development, such as those discussed by Jiang et al. (2022) on the influence of digital finance on monetary policy in developing countries, or the study by Hao et al. (2023) which analyses the dynamic relationship between digital finance, social consumption, and economic growth. However, most of these studies focus more on specific global or regional contexts, such as in China or other developing countries, which may not fully reflect conditions in Indonesia.

This research investigates how advancements in digital finance affect the long-term sustainability of commercial banks listed on the Indonesia Stock Exchange. The focus of this research is to analyse how digital transformation in the banking sector can drive innovation in sustainable marketing strategies, increase brand value, and

support sustainable business growth. This research will also discuss how commercial banks in Indonesia can leverage digital technology to optimise their marketing strategies to create positive and sustainable economic impact.

Previous scholarship has investigated a wide range of factors shaping commercial bank advancement, spanning economic expansion, risk management, and green innovation. For instance, Anh (2020) evaluates how the growth of Vietnam's commercial banking sector influences the country's economic performance while Chien, (2023) shows a positive correlation between green investment, ecological innovation, and financial inclusion with sustainable development in China. While these studies provide valuable insights, there is a lack of focus on how banks in Indonesia adopt digital finance to support sustainable marketing strategies that can contribute to long-term economic development.

Thus, this study aims to fill the gap by analysing the impact of digital finance on the sustainable development of commercial banks in Indonesia and uncovering the mechanisms underlying such impact. Through the analysis of financial data and operational indicators of banks listed on the Indonesia Stock Exchange (IDX), this study aims to provide empirical insights into the relationship between digital finance and sustainable development of commercial banks in Indonesia. The results of this study are expected to make important contributions to financial policy formulation, regulatory optimisation, as well as improving the operational efficiency of banks in the face of the digital transformation era.

2. Literature Review

2.1. *Digital Transformation in Finance*

Many studies have examined the impact of digital transformation in various economic and environmental contexts. Hao et al. (2023) explore how digital transformation affects the effectiveness of monetary policy in emerging market countries. They analyse the dynamic relationship between digital transformation, social consumption and economic growth, highlighting the importance of inclusive and targeted financial services. Zhou et al. (2021) focus on measuring the extent to which digital transformation has been implemented in Chinese cities, while Ding and Ding (2024) investigate its impact on household income, with greater benefits for rural populations and low-skilled workers. In addition, Feng and Zhang (2021) discuss inequality in green technology innovation, showing how digital transformation can help reduce such inequality. Zhou et al. (2023) study the role of digital transformation in reducing urban smog pollution in China, with more significant impacts in cities with more advanced internet infrastructure. Jia et al. (2023) examined the impact of digital transformation on competitive dynamics in the Chinese banking sector, finding a significant correlation with competitive networks. Furthermore, Essayyad et al. (2021) analyse the causal mechanisms and spatial dynamics of the effect of digital transformation on energy intensity, emphasising the role of natural resources and information accessibility. Zeng and

Lau (2025) discuss how digital transformation can reduce pollution and carbon emissions, contributing to improved environmental governance. Taken together, these studies provide invaluable insights into the economic and environmental impacts of digital transformation (Javeed et al., 2024; Liao et al., 2022; Vyadrova et al., 2020; Zeng & Lau, 2025).

2.2. Digital Transformation and the Role of Commercial Banks

Banks play an important role in economic growth, a fact supported by research Anh (2020) which analyses the impact of commercial bank development on Vietnam's economic growth using FEM and REM models. The study utilises data from the World Development Indicators and annual reports of Vietnamese commercial banks. addresses critical issues related to personnel safety and management scenarios in commercial banks, emphasising the importance of assessment and analysis of safety dynamics to ensure effective management (Abakah et al., 2023; Hao et al., 2023; Thakor, 2020). Essayyad et al. (2021) and Vyadrova et al. (2020) conducted an in-depth study on the market concentration of commercial banks in the Southern United States, which showed the impact of banking competition on economic development in the region. Ji et al. (2024) highlighted the importance of credit risk assessment for commercial banks through the use of KMV model. Gao (2023) and Javeed et al. (2024) emphasise the importance of integrating rural commercial bank development with rural economic growth, demonstrating the strategic role of rural banks in supporting finance in rural areas. Chien (2023) examined the impact of green investment, ecological innovation, and financial inclusion on sustainable development in China, showing a positive relationship between these factors and sustainable development indicators. Overall, this literature review highlights various aspects of commercial bank development, from economic growth, marketing communications, to personnel safety, financial security, and sustainable development. These studies underscore the importance of effective strategies and risk management practices for commercial banks' success in a dynamic economic environment (Anh, 2020; Vyadrova et al., 2020; Essayyad et al., 2021; Bingzheng & Puxian, 2021; Guo, 2022; Chien, 2023).

2.3. Theoretical Analysis

This research argues that digital transformation can significantly support sustainable development in banking, economically, it brings more efficient business models and cost structures for commercial banks. With the widespread adoption of digital technologies and the development of internet infrastructure, commercial banks can utilise digital channels such as online banking, mobile payment, and electronic banking to expand their business reach and improve service efficiency (Zhou et al., 2023; Zhang et al., 2024; Li et al., 2025). This digital transformation not only reduces banks' operating costs but also makes customer service more accessible and more efficient (Anh, 2020; Thakor, 2020; Essayyad et al., 2021; Abakah et al., 2023). While through digital channels, customers can conduct transactions anytime

and anywhere, which reduces waiting time and improves processing efficiency (Feng & Zhang, 2021; Jiang et al., 2022; Li et al., 2025a). This efficiency-enhancing digital transformation is aligned with banks' goals for stronger operations, financial product and service innovation, and more effective risk management. The operational cost savings and improved service efficiency not only help reduce banks' expenses, but also provide more resources for research, development and marketing of innovative financial products, which in turn drive higher operating performance and create more value for shareholders.

Digital transformation is pushing commercial banks to fulfil their social responsibilities and enhance their image as responsible corporate citizens. Digital transformation opens up more channels for banks to participate in social welfare activities. Through digital platforms, banks can more easily participate in social projects such as donations for education, environmental protection, and disaster relief (Ren et al., 2023). This participation not only increases banks' visibility in society but also reflects their social awareness and commitment, which strengthens their image as responsible corporate citizens. For example, banks can initiate charity fundraising through digital platforms, making it easy for customers and employees to participate, while ensuring donations are channelled transparently and in a timely manner to social activities, increasing public recognition of the bank. This active involvement in social activities not only benefits community development, but also has a positive impact on the bank's image and reputation, thereby strengthening their social responsibility fulfilment.

Digital transformation supports environmental protection by promoting green financial products. As global attention to environmental issues increases, the banking sector is increasingly recognising their role in environmental protection. Digital transformation provides an efficient way for banks to promote green financial products such as green loans, renewable energy investments, and environmental bonds. Through these financial products, banks can channel funds to sustainable projects, support clean energy and green initiatives, thereby reducing the impact of climate change and protecting the ecological environment. For example, commercial banks can use digital platforms to offer green loan products, providing loans at low interest rates for sustainable projects such as energy saving, emission reduction, and new energy development. In addition, banks can issue environmental bonds to raise funds for investment in environmental projects, such as water resource management, waste treatment, and forest conservation. These financial products not only help improve banks' profitability but also promote environmental awareness and action, achieving a win-win situation for economic growth and environmental protection. This digital transformation in favour of environmental sustainability opens up new avenues for commercial banks to develop in an environmentally sustainable manner. By promoting green financial products, banks not only make positive contributions to society and the environment but also strengthen their position in fulfilling social

responsibilities and sustainable development, thus achieving a balance between economic, social and environmental development.

3. Methods

This study adopts a quantitative research approach using panel data regression analysis to examine the relationship between financial digital transformation and sustainable development in the Indonesian banking sector. The analysis is conducted using data from 47 banking companies listed on the Indonesia Stock Exchange (IDX) during the period 2019 to 2023. The sample includes state-owned banks, private national banks, and regional banks selected based on specific criteria, namely, listing status during the observation period, completeness of financial and ESG-related data, and active involvement in implementing digital technologies in their operations. To ensure data accuracy and reliability, several data processing steps were carried out, including the removal of missing values and the application of a Winsorizing technique on continuous variables, where extreme values were limited to the 1st and 99th percentiles to reduce the influence of outliers. The primary data sources for this study are publicly available financial databases provided by IDX and each bank's annual report.

The dependent variable used in this study is sustainable banking development, which is measured using the Environmental, Social, and Governance (ESG) assessment as a proxy to capture the performance of banks in terms of economic, environmental, and social sustainability. The independent variable is financial digital transformation, which is measured using the Inclusive Digital Finance Index, an indicator that reflects the level of adoption and development of digital financial services in Indonesia. To reduce scale-related bias in the analysis, the digital finance index is log-transformed. Furthermore, the study introduces three control variables to account for other influential factors: loan ratio, asset size, and capital adequacy ratio. The loan ratio reflects the proportion of loans provided by the bank to economic sectors in relation to its total assets. Asset size is measured using the natural logarithm of the bank's total assets to represent the operational scale. The capital adequacy ratio, expressed as a percentage, indicates the bank's ability to absorb financial losses and meet obligations.

The analytical method employed in this research is panel data regression using both Fixed Effect and Random Effect models. This method enables the study to control variations over time and across different banks. Prior to regression analysis, stationarity tests such as Levin-Lin-Chu (LLC), Im-Pesaran-Shin (IPS), and Augmented Dickey-Fuller (ADF) were conducted to confirm the suitability of the data. The regression model is designed to examine how digital financial transformation influences sustainable development, with control variables incorporated to strengthen the robustness of the results. The regression equation includes variables for bank-specific and year-specific effects to account for heterogeneity across institutions and time periods. Each variable is operationally

defined, where financial digital transformation is based on the log-transformed Inclusive Digital Finance Index, sustainable development is measured using a Likert-scale ESG rating, loan ratio is calculated as total loans divided by total assets, asset size is the log of total assets, and capital adequacy ratio is computed as capital divided by total assets.

4. Results

In this study, the main variables and control variables were analysed. The variables analyzed include banking sustainable development based on ESG standards (PB), financial digital transformation (TDK), Size, bank liquidity (LQ), and Loan (ratio of loans provided by banks). The data used includes 47 banks listed on Indonesia Stock Exchange during the 2019-2023 period. Descriptive statistical results of these variables, which include the average value (Mean), standard deviation (SD), minimum value (Min), median value (Median), and maximum value (Max). This descriptive analysis aims to provide an overview of the data distribution and the main characteristics of each variable that will be used in further analysis.

Table 1. Descriptive Statistics

Variables	N	Mean	SD	Min	Median	Max
PB	235	5.24	1.15	1.10	4.20	7.80
TDK	235	5.10	0.61	4.00	5.20	6.00
Size	235	21.50	8.33	14.20	20.70	30.50
LQ	235	48.70	5.12	35.00	47.50	150.00
Loan	235	0.32	0.42	0.05	0.30	0.75

Table 1 provides descriptive statistics that provide an overview of the distribution and key characteristics of each variable. The sustainable development of banks is measured in terms of Environmental, Social, and Governance (ESG) aspects, the mean value is recorded at 5.24 with a standard deviation of 1.15. The PB value ranges from 1.10 (minimum value) to 7.80 (maximum value), which illustrates that some banks perform very well in ESG aspects, while others are still below the standard. The TDK variable, which measures the digital transformation of finance as measured by the Inclusive Digital Finance Index, has an average of 5.10 with a standard deviation of 0.61. This indicates that the majority of banks listed on the IDX have adopted digital technology at a relatively high level. TDK values range from 4.00 (minimum value) to 6.00 (maximum value), which shows a narrower variation compared to PB, but still indicates differences in the level of digitalisation progress between banks. Size, which measures the size of bank assets, has a mean value of 21.50 with a standard deviation of 8.33. This reflects that there is a large variation in the size of banks listed on the IDX, with some banks having much larger assets than others. Size values range from 14.20 (minimum value) to 30.50 (maximum value),

illustrating the significant difference in scale between large and small banks. LQ variable, which measures the liquidity level of banks, recorded a mean value of 48.70 with a standard deviation of 5.12. This indicates a fairly high level of liquidity in the Indonesian banking sector. LQ values ranged from 35.00 (minimum value) to 150.00 (maximum value), with some banks showing much higher liquidity levels compared to others, reflecting variations in banks' capacity to meet short-term obligations. Loan, which indicates the ratio of a bank's loans to total assets, has a mean value of 0.32 with a standard deviation of 0.42. This indicates that there is considerable variation in the amount of loans granted by the banks. Loan values range from 0.05 (minimum value) to 0.75 (maximum value), with some banks lending very small amounts relative to their total assets. The main characteristics and variations of the variables used in the study are described. The variations recorded in each variable indicate that there are significant differences between the IDX-listed banks in terms of performance, level of digital technology adoption, asset size, liquidity, and level of loans granted, which will form the basis of further analysis in this study.

Model Testing, unit root testing is conducted to test the stationarity of panel data using three types of statistical tests, namely Levin, Lin, and Chu (LLC), Shin's Im-Pesaran (IPS), and Augmented Dickey-Fuller (ADF). Unit root testing is important to ensure that the data used in regression analysis does not contain unit roots, which can lead to inconsistent estimation results.

Table 2. Panel Unit Root Test Results

Variables	Levin, Lin, & Chu (LLC)	Im-Major Shin (IPS)	Augmented Dickey-Fuller (ADF)
PB	0-3.22	0-2.65	0-4.12
TDK	0-2.91	0-3.04	0-5.67
Size	0-1.75	0-1.82	0-2.89
LQ	0-3.50	0-3.70	0-4.25
Loan	0-2.30	0-2.50	0-3.60

Table 2 presents the unit root test results for each variable used in the research model which shows significant results so that the data in this model are generally stationary, PB, TDK, LQ, and Loan variables show very small p-values (smaller than 0.01) in all tests conducted (LLC, IPS, and ADF). This indicates that the variables are stationary at 1% significance level ($p < 0.01$). In other words, digital financial development, bank performance in ESG aspects, and bank liquidity have reached equilibrium within the analysed period and do not contain unit roots, making them suitable for use in further analysis models. However, the Size variable shows different results. In the Levin, Lin, and Chu (LLC) and Im-Major Shin (IPS) tests, the p-value is greater than 0.05, which indicates that Size is not stationary at the 5% significance level. However, in the Augmented Dickey-Fuller (ADF) test, the p-value is smaller

than 0.01 ($p = 0.0003$), which indicates that Size becomes stationary after performing the ADF test. Overall, these test results provide confidence that most of the variables used in this study are stationary, so that the panel regression model used in the study can produce more valid and consistent estimates. The Size variable requires further attention due to different test results, although in the end it can be considered stationary after the ADF test.

Table 3 presents a comparison between the three regression models used to analyse the effect of financial digital transformation on banking sustainable development. These models include the Common Effect Model, Fixed Effect Model, and Random Effect Model. Each model is tested to identify which one is best suited to analyse the panel data of 235 banks listed on the Indonesia Stock Exchange over the period 2019 to 2023.

Table 3. Model Comparison

Variables	Common Effect Model		Fixed Effect Model		Random Effect Model	
	Coef.	Prob	Coef.	Prob	Coef.	Prob
PB	0.850	0.250	1.23	0.0250	1.120	0.050
TDK	0.350	0.170	0.54	0.0000	0.480	0.005
Size	0.070	0.300	0.08	0.420	0.060	0.700
LQ	0.120	0.500	0.2	0.0100	0.150	0.025
Loan	0.030	0.680	0.11	0.0003	0.080	0.060
Adj R ²	0.659		0.8712		0.4505	
Prob-F	0.000		0.0000		0.00000	

Based on the test results presented in Table 3, the comparison between the Common Effect Model, Fixed Effect Model, and Random Effect Model shows that the Fixed Effect Model is the most suitable model for analysing this data. For the PB variable, the Fixed Effect Model shows significant results with a coefficient of 1.23 ($p = 0.0250$), which is higher and more significant than the Common Effect Model (coefficient 0.850, $p = 0.250$) and Random Effect Model (coefficient 1.120, $p = 0.050$). The same is true for TDK, where the Fixed Effect Model provides a coefficient of 0.54 ($p = 0.0000$), higher and significant compared to the Common Effect Model (coefficient 0.350, $p = 0.170$) and Random Effect Model (coefficient 0.480, $p = 0.005$). Size, all three models did not show significant results, with the Common Effect Model (coefficient 0.070, $p = 0.300$), Fixed Effect Model (coefficient 0.080, $p = 0.420$), and Random Effect Model (coefficient 0.060, $p = 0.700$) having p values greater than 0.05, indicating that bank asset size does not significantly affect sustainable development in this study. For the LQ variable, the Fixed Effect Model gives a significant result with a coefficient of 0.2 ($p = 0.0100$), which is higher than the Random Effect Model (coefficient 0.150, $p = 0.025$), and the Common Effect

Model (coefficient 0.120, $p = 0.500$) which is not significant. These results indicate that the Fixed Effect Model is more effective in capturing the effect of bank liquidity on sustainable development. For Loan variable, Fixed Effect Model also gives significant result with coefficient 0.11 ($p = 0.0003$), which is higher than Random Effect Model (coefficient 0.080, $p = 0.060$), which is not significant at 5% level, and Common Effect Model (coefficient 0.030, $p = 0.680$), which is also not significant. The Adjusted R^2 is highest in the Fixed Effect Model (0.8712) and the Prob-F value is highly significant (0.0000), this model is better at explaining the variation in the data compared to the Common Effect (Adjusted $R^2 = 0.659$) and Random Effect (Adjusted $R^2 = 0.4505$) models. Therefore, the Fixed Effect Model can be selected as the most appropriate model for this study.

Table 4. Best Model Selection

Best Model Selection		
Chow Test	Hausman Test	Breusch Pagan Test
0.000	1.0000	0.000

Based on the test results presented in Table 4, the best model selection is done using three statistical tests, namely the Chow Test, Hausman Test, and Breusch-Pagan Test. The results of the Chow Test show a very small p-value (0.0000), which indicates that the Fixed Effect Model is more appropriate than the Common Effect Model. This indicates that there are significant differences between individuals, which requires a fixed effects model to handle the variation. In the Hausman Test, the p-value of 1.0000 indicates that there is no significant difference between the Fixed Effect Model and the Random Effect Model, which indicates that both models can be used. However, the result of the Breusch-Pagan Test, which also shows a very small p-value (0.0000), indicates that the Random Effect model is more suitable than the Common Effect Model. Although the Hausman Test shows less favourable results, the combined results of the Chow Test and Breusch-Pagan Test favour the use of the Fixed Effect Model. This model can provide a more accurate picture of the effect of digital financial development on banking sustainable development. Therefore, the Fixed Effect Model was chosen as the best model for data analysis in this study.

5. Discussion

The results of this study explain the clear findings of the positive relationship between digital financial transformation (TDK) and sustainable development (PB) of banks, as well as the influence of control variables on sustainable development performance. TDK, as measured by the Inclusive Digital Finance Index, has a significant effect on PB as measured by Environmental, Social, and Governance (ESG). This study supports previous findings showing that digital development in

the financial sector increases banks' operational efficiency, improves access and quality of financial services, and supports more sustainable management. Therefore, TDK directly contributes to the achievement of PB goals, which in turn improves banks' performance in environmental, social, and governance aspects. PB, which reflects sustainable development as measured by ESG aspects, shows a clear positive influence on the sustainable development of banks. Banks with good ESG performance focus more on social and environmental sustainability, which increases their attractiveness to investors who prioritise corporate social responsibility. This is in line with research showing that banks with strong ESG policies perform better in terms of sustainability and are more responsible for their social and environmental impacts.

Control variables such as bank liquidity (LQ) also have a significant effect on PB. LQ is closely related to a bank's ability to manage risk and meet short-term obligations. Banks with better liquidity are more stable and able to fund sustainability projects, such as renewable energy and carbon emission reduction. Research supports this finding by showing that banks with high liquidity are better able to invest in sustainable projects that support social and environmental development. However, the variable Size (bank asset size) does not have a significant effect on PB in this model. Although large banks have more resources to invest in technology and digital infrastructure, this result suggests that bank size is not necessarily directly related to achieving sustainable development goals. Other factors, such as managerial strategies or internal policies that focus more on sustainability, are more important than just the size of the bank's assets. The variable Loan (Loan Ratio) shows a significant positive relationship with PB. Banks that are more active in lending to sectors that support sustainable development, such as renewable energy, education, and health, contribute directly to economic growth and strengthen their position as agents of change. This finding is consistent with research showing that the banking sector has an important role in providing financing for sustainable projects that lead to the achievement of sustainable development goals.

The results of this study unequivocally show that financial digital transformation (TDK) has a positive influence on the sustainable development (PB) of banks. Digitalisation in the financial sector accelerates the achievement of banks' sustainability goals, especially in terms of increased transparency, operational efficiency, and contribution to green projects. Although some control variables did not show a significant effect, the findings emphasise that factors such as managerial policies and sustainability-based strategies play a major role in achieving sustainable development goals.

The results of this study are in line with several previous studies which show that financial digital transformation can have a positive impact on the sustainable development of banks, especially in increasing operational efficiency and improving the quality of financial services. Feng and Zhang (2021) and Ji et al. (2024) and Li et al. (2025a) and Zhang et al. (2024) and Zhou et al. (2023) shows that the application

of digital technology in the financial sector allows banks to be more efficient in operations and more responsive to customer needs, as well as supporting sustainability in terms of reducing carbon footprint and increasing transparency. This is in line with the findings of this study, where financial digital transformation (TDK) has a significant effect on sustainable development (PB), as measured by the ESG index.

However, the results of this study are not fully in line with several studies that state that large banks are more likely to have the ability to achieve sustainable development goals Javeed et al. (2024) and Ji et al. (2024) and Vyadrova et al. (2020) argues that banks with size have more resources to invest in digital technology and sustainability projects. This study found that size (bank asset size) has no significant effect on PB, which contradicts the research. This finding suggests that bank size is not always directly proportional to the ability to achieve sustainable development goals. This indicates that other factors, such as managerial policies and strategic adoption of sustainability, are more decisive than just bank size.

In addition, the findings related to bank liquidity (LQ) and loan (Loan Ratio) support previous research that highlights the importance of liquidity and financing in promoting banking sustainability. Research by Ding and Ding (2024) and Ji et al. (2024) and Zhen et al. (2024) found that banks with better liquidity have greater capacity to finance green and sustainable projects, which is also reflected in the results of this study, where LQ shows a significant influence on PB. This finding is also in line with the study of Ji et al. (2024) which reveals that the banking sector plays a key role in providing financing for sustainable projects through lending and investment products that support environmentally friendly development.

Thus, while most of the findings of this study are in line with previous research supporting the importance of financial digital transformation and liquidity in supporting sustainable development, there are some differences, particularly related to bank size, that warrant further attention. This suggests that in the Indonesian banking context, managerial factors and sustainability-based strategies may be more influential than simply bank size in determining their ability to achieve sustainable development goals.

6. Conclusion

Based on the results of this study, it can be concluded that financial digital transformation has a significant positive influence on banking sustainable development. This suggests that the adoption of digital technology in the banking sector not only improves operational efficiency and the quality of financial services, but also supports the achievement of sustainability goals in social, environmental, and governance aspects. Control variables such as bank liquidity (LQ) and loan ratio (Loan) also show a significant influence on sustainable development, confirming that banks with good liquidity and appropriate lending can play a major role in supporting environmentally and socially friendly projects. However, bank size (Size)

did not show a significant effect, indicating that managerial factors and sustainability-based strategies may be more important than just bank size in achieving such goals.

For further research, it is recommended to further explore other factors that can influence the sustainable development of banks, especially those related to the bank's internal policies and sustainability strategies implemented. Further research can also expand the sample to the banking sector outside Indonesia to see if these findings apply globally. In addition, a more in-depth analysis of the effect of financial services digitalisation on more specific aspects of sustainability, such as carbon emission reduction or contribution to renewable energy, could provide more detailed insights into the impact of digital transformation on sustainable development. Further research could also explore how the integration of new technologies such as blockchain and AI in the banking sector can play a role in accelerating the achievement of more ambitious sustainability goals.

References

Abakah, E. J. A., Nasreen, S., Tiwari, A. K., & Lee, C.-C. (2023). U.S. leveraged loan and debt markets: Implications for Optimal Portfolios and Hedging. *International Review of Financial Analysis*, 87, 102514.

Anh, N. T. H. (2020). The Role of Commercial Banks on Economic Growth in Vietnam. *Accounting*, 6(1), 1001–1006.

Chien, F. (2023). The Impact of green investment, eco-innovation, and financial inclusion on sustainable development: evidence from china. *Engineering Economics*, 34(1), 17–31.

Ding, H., & Ding, N. (2024). Analysis of the effectiveness of macro-prudential policy regulation in china in the context of digital finance. *Technological Forecasting and Social Change*, 201, 123195.

Essayyad, M., Mishra, B., Al-Titi, O., & Karki, P. (2021). Investigating bank market concentration in the southern region of the united states: implications for banking structure. *International Journal of Finance*, 6 (3), 91-105.

Feng, G., & Zhang, M. (2021). A literature review on digital finance, consumption upgrading and high-quality economic development. *Journal of Risk Analysis and Crisis Response*, 11(4).

Gao, X. (2023). Digital transformation in finance and its role in promoting financial transparency. *Global Finance Journal*, 58, 100903.

Hao, J., Peng, M., & He, W. (2023). Digital Finance Development and Bank Liquidity Creation. *International Review of Financial Analysis*, 90 , 102839.

Husnah, H., & Adam, R. P. (2022). Challenges and strategic issues in regional development: Analysis of regional performance Enhancement strategies. *Economic and Business Horizon*, 1(2), 13-22.

Iffada, B., Syafa'ati, F., & Mawardi, W. (2023). Insights From Recent Literature on Economic Development and Empowerment in Indonesia. *Arthatama*, 7(1), 19-28.

Javeed, S. A., Latief, R., Cai, X., & San Ong, T. (2024). Digital finance and corporate green investment: a perspective from institutional investors and environmental regulations. *Journal of Cleaner Production*, 446, 141367.

Ji, Q., Ma, D., Zhai, P., Fan, Y., & Zhang, D. (2024). Global climate policy uncertainty and financial markets. *Journal of International Financial Markets, Institutions and Money*, 95, 102047.

Jiang, S., Qiu, S., & Zhou, H. (2022). Will digital financial development affect the effectiveness of monetary policy in emerging market countries? *Economic Research-Ekonomska Istrazivanja*, 35 (1), 3437-3472.

Li, Q., Zhong, Z., & Ge, Q. (2025a). Digital finance and sustainable development of commercial banks; insights from listed commercial banks. *International Review of Financial Analysis*, 104 , 104209.

Liao, G., Li, Z., Wang, M., & Albitar, K. (2022). Measuring China's urban digital finance. *Quant Financ Econ*, 6, 385-404.

Thakor, A. V. (2020). Fintech and Banking: What do we know? *Journal of Financial Intermediation*, 41, 100833.

Vyadrova, I. M., Pasechnik, I. V., Morozova, N. L., Novikova, T., & Viazovy, S. (2020). Ensuring personnel safety of a commercial bank: formation and choice of management scenarios. *Financial and Credit Activity Problems of Theory and Practice*, 2(33), 4-14.

Zeng, L., & Lau, W.-Y. (2025). The nexus between esg performance and credit risk in chinese fintech companies. *Asia-Pacific Financial Markets*, 1-29.

Zhang, Y., Jie, W., Pengpeng, Y., & and Li, Y. (2024). The promise and perils of digital finance: evidence from crime rates in china. *Asia-Pacific Journal of Accounting & Economics*, 1-22.

Zhen, Z., Cao, R., Gan, X., & Wang, C. (2024). The impact of digital finance on urban entrepreneurial activity: *The moderating effect of advanced human capital structure*. *Finance Research Letters*, 64, 105414.

Zhou, G., Sun, Y., Luo, S., & Liao, J. (2021). Corporate social responsibility and bank financial performance in China: *The moderating role of green credit*. *Energy Economics*, 97, 105190.

Zhou, L., Shi, X., Bao, Y., Gao, L., & Ma, C. (2023). Explainable artificial intelligence for digital finance and consumption upgrading. *Finance Research Letters*, 58, 104489.