Digitalization, Banking Performance, and Sharia Supervisory Board Efficiency: Evidence from Indonesian Islamic Commercial Banks

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Abstract : *The massive digital transformation in the Islamic banking industry has fundamentally changed the operational and supervisory landscape of Islamic banking. Furthermore, Islamic banking performance, measured through financial indicators and Islamic compliance, is a crucial factor in determining the complexity of supervision required by the SSB. The efficiency of SSB is crucial given its role as the guardian of the enforcement of Islamic principles in every bank product and operation. This study aims to examine and analyze the influence of digitalization and Islamic banking performance (bank size, leverage, bank age, and profitability) on the efficiency of SSB. Digitalization is operationalized using a text-mining approach applied to bank annual reports, while SSB efficiency is measured through a disclosure score derived from the content of SSB reports. Using a quantitative approach, this research investigates how digitalization and banking performance influence SSB efficiency. Panel data regression via EViews 25 was employed to analyze 40 sampled Islamic commercial banks registered with the OJK during 2019–2024. The results indicate that digitalization, bank size, leverage, and profitability do not significantly on the efficiency of the SSB. However, bank age significantly influences the efficiency of the SSB. Simultaneously, digitalization, bank size, leverage, bank age, and profitability significantly on the efficiency of SSB. Practically, these findings suggest that Islamic banks should prioritize the accumulation of institutional experience and the strengthening of SSB member competence over reliance on digital infrastructure alone when designing sharia supervision mechanisms.*

Keywords : *Sharia Supervisory Board Efficiency, Digitalization, Banking Performance*

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1. INTRODUCTION

Digitalization is modernization in the use of information technology through interconnected networks or the internet (Berutu et al., 2024). This is where "digital theory" comes from as an impact of technological advances (Aji, 2016). In development, advances in digital technology have had a great impact in transforming the Islamic banking industry. Data from the Financial Services Authority (OJK) shows that the penetration of digital banking in Islamic banks in Indonesia is still relatively low compared to conventional banks. In 2021, only 45% of Islamic banks have a comprehensive digital platform, while the other 55% still rely on traditional service

models (OJK, 2021). A survey by the Islamic Financial Services Board (IFSB) shows that 77% of Islamic Bankings Syariah indicates that only 3% are processing the transformation of their banking system and only 3% are planning to start digitalization. Islamic banking tends to carry out digital transformation due to a change in the system from manual to digital (Muslimin et al., 2024).

Rusydiana et al., (2021) stated that digitalization creates new challenges for SSB in ensuring sharia compliance with increasingly complex digital products and services. This condition shows a significant gap between the potential for digitalization and actual implementation. Rabbani et al., (2021) found that digitization can improve the effectiveness of SSB through better access to real-time transaction data and information. However, Hasan et al., (2020) identified that the speed of digital innovation often creates a gap between the technological competence of SSB members and the complexity of digital products that must be monitored. The results of these findings show that there is a gap that digitalization on the one hand increases the effectiveness of SSB, but in other research, digitalization often causes gaps in SSB in supervising product implementation in Sharia banks. Meanwhile, in Bukair & Rahman, (2015), it was found that SSB plays a crucial role in ensuring that Islamic bank operations run in accordance with Islamic principles.

The gap between the supervisory objectives of the SSB and the condition of Islamic banks is increasingly complex, caused not only by the development of digital-based systems, but also by internal factors, namely the increasing performance of Islamic banking. Many Islamic banking research has raised the link between the performance of Islamic banking and SSB with varied findings.

Mollah et al., (2015) found that Islamic banks with increasingly large assets have high operational complexity so that it can potentially affect the ability of SSB to conduct product supervision. Also, high levels of leverage can affect the independence and effectiveness of SSB supervision, especially in situations where banks face pressure to meet their financial obligations. Hasan et al., (2020) found that the optimal level of leverage can actually encourage Islamic banks to develop a more comprehensive supervisory system to protect the interests of stakeholders and ensure sharia compliance.

Meanwhile, the bank's performance research gap is in the form of profitability, which is indicated through Return on Assets (ROA) as one of the key factors that can affect the effectiveness of the Sharia Supervisory Board (SSB) supervision. Mollah et al., (2015) found that a high level of profitability allows Islamic banks to allocate more adequate resources to support the sharia supervision function, including the provision of infrastructure and technology required by SSB. This is reinforced by findings Nomran & Haron, (2022) which reveal a positive relationship between ROA and the quality of sharia supervision, where banks with higher profitability tend to have a more comprehensive supervisory system. However, in contrast to Farag et al., (2018) who found that a high level of profitability can actually create pressure for SSB to be more accommodating to product and service innovations that may be risky from a sharia compliance perspective. Also from Cherni & Ben Amar, (2024) who found that there is still a gap that needs to be followed up between the success of the performance of Islamic banks and the effectiveness of SSB supervision.

Some of the studies above show that there is a gap in findings between the digitization and SSB variables, as well as the performance variables of Islamic banks with SSB: digitalization is found to both strengthen SSB effectiveness through better data access (Rabbani et al., 2021) and widen the competence gap between SSB

members and increasingly complex digital products (Hasan et al., 2020), while bank performance indicators such as size, leverage, and profitability show inconsistent relationships with supervisory quality across studies (Mollah et al., 2015; Farag et al., 2018; Cherni & Ben Amar, 2024). This inconsistency indicates that digitalization and bank performance have not been examined together as a single, integrated set of predictors of SSB efficiency, which is the research gap this study addresses. Furthermore, most of the studies reviewed above were conducted on Islamic banking systems outside Indonesia or examined digitalization and bank performance separately, so their findings cannot be directly generalized to the Indonesian context, where Islamic banks operate under the dual banking system and OJK-specific sharia governance regulations that shape how SSB efficiency is achieved. This regulatory and institutional setting is distinct from the jurisdictions covered in prior research, which justifies re-examining these relationships specifically among Indonesian Islamic commercial banks. Moreover, this research model was carried out to analyze cases in several Islamic commercial banks in Indonesia. While the differences between this study and the previous research are; First, the digitization and performance variables of Islamic banks are integrated into a collection of independent variables as an emphasis on more comprehensive research objectives. Second, the performance of Islamic banks and the characteristics of banks which include the size of the bank developed in leverage, the life of the bank, and profitability. Third, the research object which includes several Islamic commercial banks in Indonesia totaling 10 institutions is expected to be stronger as the latest findings. Thus, the most important part of the purpose of this research is to offer a new contribution to the study of the efficiency of the Sharia Supervisory Board (SSB) by integrating the digitalization factor along with the performance of Islamic banks with research objects on several Islamic commercial banks in Indonesia.

2. THEORY AND METHODS

This study is grounded in Sharia Governance Theory, which positions the Sharia Supervisory Board as the organ responsible for ensuring that an Islamic bank's operations, products, and contracts comply with sharia principles, and views the efficiency of that supervision as a function of the resources, information, and institutional conditions available to the board (Grassa, 2013; Ginena, 2014). This grand theory is complemented by agency theory, which explains SSB oversight as a mechanism that reduces the information asymmetry between bank management and stakeholders regarding sharia compliance (Safieddine, 2009), and by contingency theory, which holds that the effectiveness of a governance mechanism such as the SSB depends on how well it is matched to the organization's internal characteristics and external environment rather than on any single universal design (Hamza, 2013). Within this framework, digitalization and bank performance characteristics are conceptualized as contingency factors: digitalization changes the volume and complexity of information the SSB must process, while bank size, leverage, age, and profitability shape the resources and organizational maturity available to support the supervisory function. Sharia Governance Theory therefore provides the conceptual bridge linking digitalization and banking performance, as antecedent conditions, to SSB efficiency as the governance outcome examined in this study.

2.1 Digitalization of Sharia Banking

Some research on digitalization in banking related to banking performance and efficiency of the Sharia Supervisory Board can be seen in the following studies; Muslimin et al., (2024) examined the impact of digitalization on the Islamic banking industry. The results of the study show that Islamic banking is currently undergoing a lot of digital transformation with a system change from manual to digital. This transformation is also supported by existing indicators in Islamic banking to always increase customer value and satisfaction, including by transforming towards digital. Theoretically, this research is very relevant as a reference, because Muslimin et al., (2024) provide many indicators that digitalization is not just a change of manual system to digital but also a transformation of values to increase customer satisfaction.

There is also digital research, but the research object is general to financial institutions, namely (Hasan et al., 2020). In this study, it was found that the impact of digital transformation on Islamic financial practices, reveals that technological innovations create new challenges for sharia supervision. From the aspect of research ideas, digitalization research can be used theoretically but cannot be used as a reference analytically, because this research only focuses on the technological aspect without integrating bank characteristic factors.

Several other studies show more discussion on the benefits of digitalization programs or transformations in Islamic banking in Indonesia, such as those carried out by Cherni & Ben Amar, (2024) and Laksono & Nisa, (2024). Cherni & Ben Amar, (2024) researched the influence of digitalization in several general sharia banks in increasing SSB efficiency. The results of the study show that digitalization has a positive influence on improving the efficiency of the Sharia Supervisory Board in. However, this study does not discuss control variables (bank size, leverage, bank age and profitability) as independent variables to strengthen the research results. Meanwhile, Laksono & Nisa, (2024) researched the use of technology in the development of Islamic banking operations in Indonesia, as well as the challenges and opportunities faced by this industry in adopting digital technology. This study provides valuable insights into the dynamics of the development of Islamic banking in Indonesia, especially in the context of the use of digital technology to improve the industry's operations and competitiveness. Technology can improve operational efficiency, expand service reach, improve customer experience, drive product innovation, and strengthen security and compliance. The types of technology used by Islamic banking include e-banking, cloud computing, blockchain, and artificial intelligence.

2.2 Sharia Banking Performance

There is a study that is thematically similar to this study in terms of the selection of Islamic bank performance variables, namely the research of Rahmadita & Amri, (2024). The focus of this research is to find out how the influence *of Financial Leverage* and Company Size on Financial Performance in Sharia Commercial Banks for the 2018-2022 period both partially and simultaneously. Research with the financial leverage variable is proxied through *the Debt to Equity Ratio*, the company size variable is proxied with Size, the dependent variable of financial performance is proxied with the Return on Assets proxy to calculate the value of the results of the independent variable

and the dependent variable. The research method uses quantitative research methods. The population of this study was all Sharia Commercial Banks registered with the OJK, sample withdrawal using the purposive sampling method obtained samples that met the criteria of 10 Sharia Commercial Banks for the 2018-2022 observation period. Data analysis techniques with multiple linear regression techniques. The results obtained in the study show that the variables of financial leverage and company size have a significant effect both partially and simultaneously on financial performance.

Pranata & Hasyim, (2024) conducted a study to investigate the impact of financial performance, as measured by OCR, CAR, FDR, and NPF proxies on profitability by considering the Financial Leverage variable as a moderation factor in Sharia Commercial Banks. The population in this study includes all Sharia Commercial Banks that publish financial statements to the Financial Services Authority (OJK) for the 2018-2022 period, a sample of 12 Islamic commercial banks that meet the criteria based on. Data analysis was conducted using the multiple linear regression method of *the Fixed Effect Model (FEM)* selection panel data. The results showed that OCR and NPF had a significant impact on *Return on Assets (ROA),* while CAR and FDR had no significant effect on ROA. In addition, through *the Moderated Regression Analysis (MRA)* test, it was found that DER acts as a moderation variable that affects the relationship between CAR, FDR, and NPF to ROA, but does not affect the relationship between OCR and ROA. This research proves that *Financial Leverage* by considering debt can be an indicator to measure financial performance on profitability.

2.3 Performance and Efficiency of the Sharia Supervisory Board

Research related to the performance of Islamic banking and the Sharia Supervisory Board are; Research by Mollah et al., (2017) who conducted comparative research between Islamic and conventional banks. In this study, it was found that effective sharia supervision contributes positively to the performance of banks. Bank size and profitability also affect the effectiveness of sharia supervision, but it does not explore the role of digitalization.

Taken together, the literature above shows that digitalization in Islamic banking, the performance of Islamic banking, and the role of the Sharia Supervisory Board remain active and evolving research areas. Consistent with the contingency perspective outlined in the Grand Theory of this study, digitalization and the four bank performance indicators (size, leverage, age, and profitability) are treated as related contingency factors rather than isolated predictors, which is what distinguishes this study from the research reviewed above: prior studies generally examine digitalization or bank performance separately, whereas this study integrates both as independent variables explaining a single dependent variable, namely the efficiency of the Sharia Supervisory Board. This study further differs in its sample, which draws on 10 Islamic commercial banks in Indonesia, distinguishing it from the samples used in the previous studies discussed above.

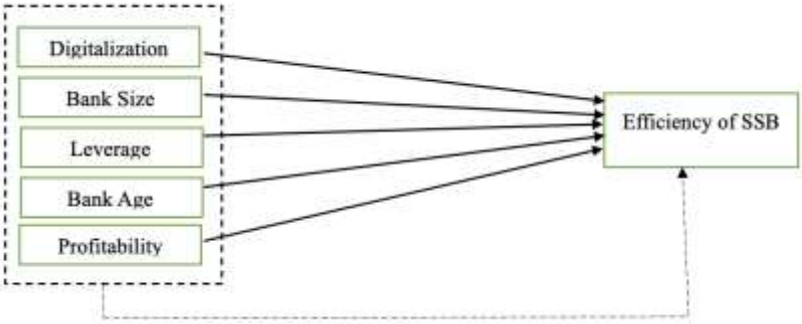

Figure 1: Research Model

2.4 Research Methods

This type of research is library research with a quantitative approach. Literature research is a type of research with data collection techniques, namely examining books, literature, records, and various reports related to the problem to be solved (Sari & Asmendri, 2020).

The data collected from the sample measures the digitalization and performance of Islamic banking on the efficiency of the Sharia Supervisory Board in Sharia Banks in Indonesia, taken from the annual reports published by Islamic commercial banks in Indonesia on the Financial Services Authority website (www.ojk.go.id) covering the time range 2021-2024.

The population of this study covers all Islamic commercial banks (Bank Umum Syariah) registered with the Financial Services Authority (OJK) in Indonesia. The sample was determined using a purposive sampling technique with the following criteria: (1) the bank is registered as an Islamic commercial bank with the OJK during the 2021-2024 observation period; (2) the bank consistently published complete annual reports, including the Sharia Supervisory Board report, throughout the observation period; and (3) the required data for all research variables are fully available in the annual report. Based on these criteria, the study sample consists of 10 Islamic commercial banks in Indonesia, namely Bank Aceh Syariah, BCA Syariah, BJB Syariah, BSI, BTPN Syariah, Bukopin Syariah, Bank Mega Syariah, Bank Muamalat, Bank Panin Dubai Syariah, and Bank Victoria Syariah, observed over 4 years, resulting in 40 bank-year observations (balanced panel data).

2.5 Variable Measurement

The independent variables in this study are digitalization and banking performance. Banking performance is further divided into four indicators, namely bank size, leverage, bank age, and profitability.

Digitalization is measured using a text-mining method adapted from Kriebel & Debener (2020) and Chhaidar et al. (2022). This method was developed to identify emerging technology trends and captures technology adoption not only in terms of hardware and software spending, but also its use in developing new services, allowing banks to benefit from digital financial services and maintain a competitive environment. The digitalization score is calculated as follows:

$$DIG\ (annual\ report_{i,t}) = Ln\left(\sum_{x=1}^{n}\frac{tf}{Nt}\right)$$

Where tf is the number of occurrences of keyword x, Nt is the total number of words in the annual report, and n is the total number of keywords tested (n = 77), covering terms such as "digital", "mobile", "internet", "fintech", "blockchain", "artificial intelligence", "online", "information technology", "mobile banking", "internet banking", "e-commerce", and related digital-technology terms.

Bank size is measured as the natural logarithm of total assets. Leverage (debt ratio) is measured by dividing total debt by total assets. Bank age is measured by the number of years since the bank's establishment. Profitability is measured using Return on Assets (ROA), calculated as net income divided by total assets.

The dependent variable in this study is the efficiency of the Sharia Supervisory Board, measured through a disclosure score derived from the content of SSB reports, following the approach proposed by Cherni & Ben Amar (2024). Table 1 presents the items used to assess the disclosure of the SSB report. The score is calculated using a binary coding scheme in which a disclosed item is scored "1" and a non-disclosed item is scored "0". The score is then computed as the ratio of the actual disclosure score (X) to the maximum possible disclosure score (TS), as follows: Score_disclosure = X / TS.

Table 1. Sharia Supervisory Board Report Disclosure Items

No	Report Item
1	Title
2	Informant
3	Opening communication
4	A clear statement that the management of the Islamic financial institution is responsible for proper compliance with sharia rules and principles
5	Confirmation that the SSB has performed the appropriate testing and general-review procedures
6	Transactions and contracts reviewed
7	The sharia opinion covers matters relating to contracts, transactions, and dealings
8	Reporting of sharia non-compliance incidents (if any)
9	The SSB report is signed by all Board members
10	Date of the report
11	Additional disclosure: SSB endorsement of the financial statements
12	Duties and responsibilities of the SSB
13	SSB meetings held
14	Sharia audit

Source: adapted from Cherni & Ben Amar (2024)

2.6 Data Analysis Techniques

The data analysis technique used is panel data regression analysis assisted by the Eviews analysis tool (Ghozali, 2018). Panel data combine time-series and cross-sectional data (Gujarati, 2004); this study uses a balanced panel, in which every cross-sectional unit (bank) has the same number of time-series observations. The quantitative analysis consists of: a) panel data regression model estimation, b) panel data regression model selection, c) classical assumption testing, and d) hypothesis testing. The panel data model is written as follows:

$$Yit = \alpha + \beta 1X1it + \beta 2X2it + \beta 3X3it + \beta 4X4it + \beta 5X5it + e_{it}$$

Where Yit is the efficiency of the Sharia Supervisory Board of bank i in year t; α is the constant; β is the regression coefficient; X1it is digitalization; X2it is bank size; X3it

is leverage; X4it is bank age; X5it is profitability of bank i in year t; and eit is the error term.

Following Alan et al. (2014), Eviews provides three techniques to estimate the panel data model: the Common Effect Model (CEM), which pools time-series and cross-section data using ordinary least squares without accounting for individual or time dimensions; the Fixed Effect Model (FEM), which assumes that differences between individuals can be accommodated through differences in the intercept, estimated using the dummy-variable technique; and the Random Effect Model (REM), which treats individual-specific effects as part of a random error component uncorrelated with the observed explanatory variables (also known as the error component model).

The most appropriate model among CEM, FEM, and REM was determined through a sequential model-selection procedure. The Chow test (F test) was used to choose between CEM and FEM: if the probability of the F-statistic and Chi-square is greater than α = 5%, the Common Effect Model is selected; if it is less than α = 5%, the Fixed Effect Model is selected. Where FEM is indicated by the Chow test, the Hausman test is subsequently used to choose between FEM and REM: if the probability of the Chi-square statistic is greater than α = 5%, the Random Effect Model is selected; if it is less than α = 5%, the Fixed Effect Model is selected. Where FEM is indicated by both the Chow and Hausman tests, the Lagrange Multiplier (LM) test, following Breusch and Pagan (1980), is additionally used to choose between CEM and REM: if the probability value is less than \u03b1 = 5%, the Random Effect Model is selected; if it is greater than \u03b1 = 5%, the Common Effect Model is selected. The results of the Chow, Hausman, and LM tests, together with the justification for the final model selected, are reported in Section 3.1.

Classical assumption testing was performed to ensure the regression model satisfies the BLUE (Best Linear Unbiased Estimator) criteria (Gujarati & Porter, 2009), covering normality, heteroscedasticity, multicollinearity, and autocorrelation tests using Eviews. The normality test used the Jarque-Bera test, where a probability greater than 0.05 indicates normally distributed residuals (Ghozali, 2018). The heteroscedasticity test used the Glejser test, which regresses the absolute value of the regression residuals on all independent variables (Glejser, 1969); a probability greater than 0.05 for each independent variable indicates the absence of heteroscedasticity. The multicollinearity test used the pairwise correlation coefficients among the independent variables; a correlation coefficient below the conventional threshold of 0.80 indicates the absence of multicollinearity (Gujarati & Porter, 2009). The autocorrelation test used the Durbin-Watson (DW) statistic available in the Eviews regression output, compared against the lower (dL) and upper (dU) critical values at a given significance level (Durbin & Watson, 1951); as a rule of thumb, a DW value close to 2 indicates the absence of autocorrelation, a value close to 0 indicates positive autocorrelation, and a value close to 4 indicates negative autocorrelation (Gujarati & Porter, 2009).

Hypothesis testing consists of the coefficient of determination test (R^2), which measures how much of the variation in the dependent variable is explained by the independent variables, with values closer to 1 indicating stronger explanatory power (Ghozali, 2011); the t-statistic test, which examines the partial effect of each independent variable on the dependent variable, where a p-value below 0.05 indicates

a significant partial effect (Ghozali, 2011); and the F-statistic test, which examines the simultaneous effect of all independent variables on the dependent variable, where a p-value below 0.05 indicates a significant simultaneous effect (Ghozali, 2011).

3. RESULTS AND DISCUSSION

3.1 Data Analysis Results

3.1.1 Panel Data Model Selection

Model selection was conducted sequentially using the Chow test, the Hausman test, and the Lagrange Multiplier (LM) test to determine the most appropriate estimation technique among the Common Effect Model (CEM), Fixed Effect Model (FEM), and Random Effect Model (REM).

Table 2. Chow Test

Effects Test	Statistic	d.f.	Prob.
Cross-section F	–	–	0.0003
Cross-section Chi-square	–	–	0.0003

Source: secondary data processed (2025)

The Chow test produced a probability value of 0.0003, which is smaller than 0.05, indicating that the Fixed Effect Model is preferred over the Common Effect Model.

Table 3. Hausman Test

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	–	–	0.4379

Source: secondary data processed (2025)

The Hausman test produced a probability value of 0.4379, which is greater than 0.05, indicating that the Random Effect Model is preferred over the Fixed Effect Model.

Table 4. Lagrange Multiplier Test

	Cross-section	Time	Both
Breusch-Pagan	–	–	0.0267

Source: secondary data processed (2025)

The Lagrange Multiplier test produced a probability value of 0.0267, which is smaller than 0.05, indicating that the Random Effect Model is preferred over the Common Effect Model.

Taken together, the Chow, Hausman, and LM tests consistently point to the Random Effect Model as the statistically indicated specification. Nevertheless, this study employs the Common Effect Model as the final estimation technique, based on two considerations: first, the CEM coefficients are more consistent with the theoretical relationships underlying this study; and second, the significance levels obtained under the CEM specification were more favorable than those produced by the FEM and REM specifications. This deviation from the statistically indicated model is acknowledged as a methodological limitation of this study and is revisited in the Conclusion.

3.1.2 Classical Assumption Test

Classical assumption testing was carried out to ensure that the regression model satisfies the BLUE (Best Linear Unbiased Estimator) criteria, covering normality, multicollinearity, heteroscedasticity, and autocorrelation.

The normality test produced a Jarque-Bera statistic of 3.075498 with a probability value of 0.0999, which is greater than 0.05, indicating that the residuals of the regression model are normally distributed.

Table 5. Multicollinearity Test (Pairwise Correlation Matrix)

	X1	X2	X3	X4	X5
X1 (Digitalization)	1.000	0.2287	0.2898	0.1808	0.0453
X2 (Bank Size)	0.2287	1.000	0.0090	-0.1554	0.1488
X3 (Leverage)	0.2898	0.0090	1.000	0.1767	-0.0413
X4 (Bank Age)	0.1808	-0.1554	0.1767	1.000	-0.2232
X5 (Profitability)	0.0453	0.1488	-0.0413	-0.2232	1.000

Source: secondary data processed (2025)

All pairwise correlation coefficients among the independent variables are below the conventional threshold of 0.80, indicating that the regression model is free from multicollinearity.

Table 6. Heteroscedasticity Test (Glejser Test)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.059529	3.393529	0.606899	0.5479
X1	0.0000556	0.0000985	0.564803	0.5759
X2	-0.000617	0.001127	-0.547104	0.5879
X3	0.383174	0.737846	0.519315	0.6069
X4	-0.000652	0.017633	-0.036969	0.9707
X5	-0.018835	0.020426	-0.922136	0.3630

Source: secondary data processed (2025)

The Glejser test regresses the absolute value of the residuals on all independent variables. As shown in Table 6, the probability value of every independent variable is greater than 0.05, indicating that none of the independent variables significantly explains the absolute residuals, and the regression model is therefore free from heteroscedasticity.

Table 7. Autocorrelation Test (Durbin-Watson)

Durbin-Watson stat	0.922597

Source: secondary data processed (2025)

The Durbin-Watson statistic of the main regression model is 0.922597. Using the conventional rule of thumb, a DW value close to 2 indicates the absence of autocorrelation, while a value closer to 0 indicates positive autocorrelation. As the obtained DW value of 0.92 is well below 2 and close to the lower end of the 0-4 range, this indicates the likely presence of positive autocorrelation in the residuals of the model. This is acknowledged as a limitation of the Common Effect Model specification used in this study and is discussed further in the Conclusion.

3.1.3 Hypothesis Testing

This study tested the hypothesis with panel data regression analysis. The tests carried out include the t test, the F test and the determination coefficient. The results of the test were carried out as follows:

Table 8. Coefficient Determination Test

R-squared	0.371156	Mean dependent var	-3.635000
Adjusted R-squared	0.278679	S.D. dependent var	0.983056
S.E. of regression	0.834916	Akaike info criterion	2.614510
Sum squared resid	23.70087	Schwarz criterion	2.867841
Log likelihood	-46.29019	Hannan-Quinn criter.	2.706106
F-statistic	4.013495	Durbin-Watson stat	0.922597
Prob(F-statistic)	0.005720		

Source: secondary data processed (2025)

The coefficient of determination, presented in Table 4, is 0.278679, meaning that digitalization, bank size, leverage, bank age, and profitability jointly explain 27.86% of the variation in SSB efficiency, while the remaining 72.14% is explained by variables outside the study. This moderate explanatory power suggests that qualitative governance factors not captured in this model, such as SSB member competence and independence, likely account for a substantial share of the variation in supervisory efficiency.

Table 9. Test F

R-squared	0.371156	Mean dependent var	-3.635000
Adjusted R-squared	0.278679	S.D. dependent var	0.983056
S.E. of regression	0.834916	Akaike info criterion	2.614510
Sum squared resid	23.70087	Schwarz criterion	2.867841
Log likelihood	-46.29019	Hannan-Quinn criter.	2.706106
F-statistic	4.013495	Durbin-Watson stat	0.922597
Prob(F-statistic)	0.005720		

Source: secondary data processed (2025)

Based on the results of the F test presented in Table 3, the probability value of F is 0.005, which is less than 0.05. This indicates that digitalization, bank size, leverage, bank age, and profitability simultaneously affect the efficiency of the Sharia Supervisory Board.

Table 10. T test

Dependent Variable: Y
Method: Panel Least Squares
Date: 10/06/25 Time: 00:57
Sample: 2021 2024
Periods included: 4
Cross-sections included: 10
Total panel (balanced) observations: 40

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.114320	3.373344	0.626773	0.5350
X1	-0.000337	0.000174	-1.934088	0.0615
X2	-0.000820	0.001124	-0.729159	0.4709
X3	0.287013	2.060233	0.139311	0.8900
X4	-0.061277	0.018289	-3.350416	0.0020
X5	-0.010534	0.064370	-0.163643	0.8710

Source: secondary data processed (2025)

Based on the results of the panel data regression estimation using the Panel Least Squares method with the Common Effect Model, the analysis of 40 observations consisting of 10 cross-section units (Islamic banks) over a 4-year period (2021-2024) produced the following regression equation:

$Y = 2.114320 - 0.000337X1 - 0.000820X2 + 0.287013X3 - 0.061277X4 - 0.010534X5.$

The partial (t-statistic) test results, presented in Table 2, show that only bank age (X4) has a statistically significant effect on SSB efficiency ($p = 0.0020$, $p < 0.05$), with a negative coefficient indicating that SSB efficiency changes as banks accumulate more years of operation. Digitalization (X1), bank size (X2), leverage (X3), and profitability (X5) are not statistically significant ($p > 0.05$ for all four), meaning their partial effects on SSB efficiency cannot be confirmed at the 95% confidence level in this sample. Rather than treating this as an absence of relationship, this pattern is interpreted in the Discussion below as evidence that SSB efficiency is shaped more by accumulated institutional experience than by digital infrastructure or balance-sheet characteristics alone.

3.2 Discussion

3.2.1 The Effect of Digitalization on the Efficiency of the Sharia Supervisory Board

The results of the analysis showed that the digitalization variable (X1) had a regression coefficient of -0.000337 with a standard error of 0.000174, a t-statistical value of -1.934088, and a probability of 0.0615 ($p > 0.05$) which means that digitalization has a negative but not significant effect on the efficiency of the Sharia Supervisory Board. This result sits between the two conflicting strands of prior findings noted earlier: it does not support Rabbani et al. (2021), who found that digitalization improves SSB effectiveness through better access to real-time data, but it also does not fully confirm Hasan et al. (2020), since the coefficient, while negative, is not statistically significant. This indicates that the implementation of digital technology in the sharia supervision system has not yet been able to fundamentally increase the efficiency of SSB performance in the Indonesian Islamic commercial banks sampled in this study.

The complexity of the task of sharia supervision requires an aspect of deep understanding that cannot be completely replaced by a digital system. The role of SSB in ensuring sharia compliance involves the interpretation of muamalah fiqh which is contextual and requires collective ijtihad (Nomran et al., 2018a). This deliberative process relies on direct interaction between board members to reach consensus on complex sharia issues. The current digitalization system tends to focus on administrative and documentation aspects, but has not been able to facilitate the sharia decision-making process that requires complex considerations.

The adoption of technology in terms of sharia supervision faces specific challenges related to infrastructure readiness and user competence. Although digital technologies offer the potential to improve information accessibility and speed up workflows, their implementation requires significant investment in training and development of adaptive systems (Safieddine, 2009). The limitations of digital literacy in SSB members, most of whom have traditional sharia education backgrounds, will hinder the optimal use of existing technology. This condition can create a space between the theoretical potential of digitalization and the realization of its practice in the field.

The efficiency of SSB is not necessarily determined by the speed of the process or the volume of transactions that can be monitored, but rather by the quality of supervision and the depth of the sharia analysis carried out. Efficiency metrics in the context of sharia supervision have unique characteristics that are different from operational efficiency in general (Garas & Pierce, 2010). Digitization may improve administrative efficiencies such as documentation and reporting, but it does not necessarily contribute to the substantial improvement of the quality of sharia compliance supervision that is at the core of the SSB's function.

These findings are in line with the argument that the efficiency of sharia governance is more dependent on human capital factors such as competence, independence, and commitment of SSB members than on technological infrastructure (Grassa & Matoussi, 2014). To achieve dominant supervisory efficiency, SSB members need strong academic qualifications, practical experience, and personal integrity. Therefore, the solution to maximize its benefits, investment in digital technology needs to be balanced with the development of human resource capacity.

3.2.2 The Effect of Bank Size on the Efficiency of the Sharia Supervisory Board

The results of statistical testing showed that the bank size variable (X2) had a regression coefficient of -0.000820, a standard error of 0.001124, a t-statistical value of -0.729159, and a probability of 0.4709 ($p > 0.05$), indicating a negative but not statistically significant effect on the efficiency of SSB. This result contrasts with studies that link larger bank size to greater operational complexity requiring more intensive SSB oversight (Farag et al., 2018); in this sample, asset size alone does not appear to translate into measurable differences in SSB efficiency.

The size of the bank does not have a significant influence on the efficiency of the Sharia Supervisory Board. This shows that larger banking institutions with more substantial assets should have more resources, should have the capability to carry out the function of Sharia supervision efficiently. However, the results of this study suggest that the size of institutional assets is not an automatic determinant of the correlation between the improvement of SSB work efficiency (Mollah & Zaman, 2015). This fact is worth noting given the common assumption that larger banking institutions with more substantial assets should have more adequate resources to support an efficient sharia supervision function. However, the results of this study indicate that the volume of institutional assets is not automatically directly proportional to the increase in SSB work efficiency.

The results of these findings can be explained by the relationship between the perspective of organizational complexity that increases along with the growth in the size of the bank. Islamic financial institutions that have larger total assets tend to face more complex operational structures, broader product diversification, and higher volume transactions (Almutairi & Quttainah, 2017). This complexity can actually expand additional challenges for SSB in carrying out its supervisory functions, as the scope of the area to be supervised becomes increasingly extensive. As a result, while large banks may have more resources, a proportionately higher supervisory workload can negate the benefits of the availability of those resources.

The efficiency of SSB is mainly driven by the quality of the internal governance structure and coordination mechanism, not by the breadth of the institution's operational scope. Research shows that the efficiency of sharia supervision is highly dependent on mandatory clarity, structural independence, and quality of communication between SSB and executive management (Mollah & Zaman, 2015). This

supervisory efficiency has no linear correlation with the size of the bank's assets. Banks with smaller sizes with optimal governance are able to achieve the efficiency of sharia supervision that is equal to or even higher than larger institutions with less than optimal governance. Limitations in the composition and number of SSB members regulated by regulation hamper the ability of large banks to leverage their scale in improving supervisory efficiency. Regulations limit the maximum number of SSB members and require specific qualifications to be met (Garas & Pierce, 2010). Because of these limitations, large banks reach the upper limit of their supervisory capacity, creating a ceiling effect where large banks no longer significantly increase their supervisory capacity simply by recruiting more SSB members. As a result, the advantages they have from large financial resources cannot be completely transformed into increased supervisory efficiency.

These findings support the argument that the nature of sharia supervision is qualitative and judgment-based, not quantitative (Ginena, 2014). To ensure sharia compliance, SSB is required to conduct an in-depth analysis of the substance of transactions and products, where the intensity should not be reduced based on the size of the institution. A financing product requires the same level of scrutiny of its sharia compliance, whether the product is offered by a small or large bank. Therefore, the efficiency of supervision is determined more by the expertise and working of the SSB than by the scale of the bank's operations.

3.2.3 The Effect of Leverage on the Efficiency of the Sharia Supervisory Board

The results of statistical testing using E-views showed that the leverage variable (X3) had a regression coefficient of 0.287013 with a standard error of 2.060233, a t-statistical value of 0.139311, and a probability of 0.8900 ($p > 0.05$) which showed a positive but insignificant effect on SSB efficiency. These findings confirm that the amount of debt or external financing structures used by Islamic banks does not have a substantive impact on the performance of Islamic supervision. The findings are contrary to the predictions of conventional agency theory that high leverage will trigger stricter monitoring mechanisms, including oversight by SSB.

The fundamental difference between the concept of debt in conventional banking and the financing structure in Islamic banking explains why leverage has no effect on the efficiency of SSB. In the context of Islamic banking, leverage comes more from third-party funds in the form of mudharabah and wadiah which have different characteristics from conventional debt financing (Abedifar et al., 2013). These instruments do not create the same monitoring pressure as creditors in the conventional system because Islamic depositors have a more collaborative profit-loss-loss sharing relationship. As a result, increasing leverage does not automatically intensify the need for sharia compliance supervision by SSB The primary function of SSB is to ensure compliance with sharia principles in all aspects of bank operations, not to monitor financial risk or leverage management (Grassa, 2013). The SSB mandate focuses on qualitative aspects such as product halalness, contract validity, and conformity of business practices with sharia maqashid. The level of leverage, which is an indicator of capital structure and financial risk, is outside the primary responsibility of the SSB and is more of the domain of the board of directors and the audit committee. This separation of functions results in the level of leverage not affecting the intensity or efficiency of the SSB's work in carrying out its main tasks.

The corporate governance mechanism in Indonesian Islamic banking has integrated several layers of supervision that do not depend on a single indicator such

as leverage (Hamza, 2013). In addition to the SSB, there are other supervisory structures such as the board of commissioners, audit committees, and internal audits that are collectively responsible for monitoring risks including risks related to leverage. This distribution of responsibility means that SSB does not need to respond directly to changes in leverage, as this aspect has been addressed by other, more approaching governance structures.

This study confirms that the efficiency of SSB is more influenced by intrinsic factors such as member competence, institutional independence, and availability of resources for the sharia supervision function (Nomran et al., 2018). These variables have a direct impact on the ability of SSB to carry out its duties effectively and efficiently. Leverage, as an exogenous variable that reflects financial management decisions, has limited relevance to the internal dynamics that determine the performance of the SSB.

3.2.4 The Influence of Bank Age on the Efficiency of the Sharia Supervisory Board

The results of statistical testing showed that the bank age variable (X4) showed a regression coefficient of -0.061277 with a standard error of 0.018289, a t-statistical value of -3.350416, and a probability of 0.0020 ($p < 0.05$) which indicates that the age of the bank has a negative and significant effect on the efficiency of the Sharia Supervisory Board at a confidence level of 95%. These findings confirm that the operational duration of Islamic banks since their establishment has had a substantive impact on the performance of Islamic supervision. The longer the bank operates, the more efficient the SSB will be in carrying out its supervisory functions. The results of this study are in line with organizational learning theory and institutional maturity perspective which emphasizes the importance of experience in increasing the effectiveness of organizational processes.

Islamic banks that have been operating for longer have an advantage in terms of institutional memory and accumulated knowledge regarding sharia supervision practices (Mollah & Zaman, 2015). Over time, SSB faces various cases, problems, and various sharia issues in bank operations. This experience forms best practices that can be used as a reference in dealing with similar issues in the future. This accumulation of knowledge allows SSB to assess sharia compliance more quickly and accurately, because it is familiar with the patterns and characteristics of transactions that are common in the institution.

The stability of the composition and continuity of SSB membership in established banks contribute positively to the improvement of supervisory efficiency (Nomran et al., 2018). Banks that have been in operation for a long time generally have SSB members with longer tenures, so they have a deep understanding of the business model, risk profile, and operational complexity of the institution they supervise. This level of familiarity reduces the learning curve and allows SSB to quickly identify potential sharia issues without requiring a lengthy onboarding process each time conducting a review. In contrast, banks that are still new tend to experience higher turnover of SSB members or are still in the stage of adjusting the optimal board composition.

These findings confirm that organizational legitimacy and stakeholder trust formed over time create a positive feedback loop that strengthens the efficiency of SSB performance (Belal et al., 2015). Banks that have a good track record of sharia compliance over the years have gained the trust of regulators, customers, and the public. This trust gives SSB greater credibility and authority in the implementation of

supervisory recommendations. Management has also become more respectful and open to SSB's input, because the reputation of sharia is seen as a valuable asset that has been built in the long term and must be maintained with full responsibility. The theoretical implications of these findings strengthen the relevance of organizational learning theory and institutional theory in the context of Islamic banking governance.

3.2.5 The Effect of Profitability on the Efficiency of the Sharia Supervisory Board

The profitability variable has a regression coefficient of -0.010534 with a standard error of 0.064370, a t-statistical value of -0.163643, and a probability of 0.8710 ($p > 0.05$) which means that profitability has a negative but not significant effect on the efficiency of SSB. The value of the constant (C) of 2.114320 with a standard error of 3.373344, t-statistically 0.626773, and a probability of 0.5350 ($p > 0.05$) indicates that the constant is not statistically significant. These findings indicate that the profitability of Islamic banks does not have a direct correlation with the level of efficiency of Islamic supervision conducted by SSB. This result is interesting to study more deeply considering the assumption that institutions with superior financial performance should have better capacity to support various governance functions including sharia supervision.

The structural independence of the SSB from the financial aspects of the institution explains why profitability does not affect supervisory efficiency. The SSB is designed as an independent governance organ with a specific mandate to ensure sharia compliance, regardless of the bank's financial condition (Mollah & Zaman, 2015). The regulation stipulates that the remuneration and work facilities of SSB must be guaranteed by the institution without being associated with the achievement of financial targets. This independence structure ensures that SSB can carry out its supervisory function objectively without being affected by fluctuations in the bank's profitability. Consequently, both banks with high and low ROA have the same obligation to provide a support system for SSB.

The task of sharia supervision that is preventive and compliance-oriented has not changed based on the level of profitability of the institution (Garas & Pierce, 2010). The Sharia Supervisory Board (SSB) has the responsibility to review each product, contract, and transaction to ensure its conformity with sharia principles. The level of intensity and precision in the review process has not decreased even though banks have experienced a decrease in profitability, because compliance with sharia principles is an absolute fundamental prerequisite in Islamic banking operations. Even when the Return on Assets (ROA) decreases, SSB is still obliged to carry out all its supervisory functions with the same standards in order to maintain the institution's sharia legitimacy.

3.2.6 The Influence of Bank Size, Leverage, Bank Age and Profitability on the Efficiency of Sharia Supervisory Boards

The results of the F-statistical test showed a value of 4.013495 with a probability of 0.005720 ($p < 0.01$), which indicates that simultaneously or together, the five independent variables (digitalization, bank size, leverage, bank age, and profitability) have a significant effect on the efficiency of the Sharia Supervisory Board. These findings confirm that the combination of these five independent variables forms a comprehensive configuration that collectively affects the performance of sharia supervision. Although partial testing showed that not all variables had a significant

individual influence, the combined interactions and effects of the overall factors were shown to have a substantive impact on SSB efficiency.

Significant simultaneous influences show that the efficiency of the Sharia Supervisory Board is influenced by various dimensions of institutional characteristics and operational performance of Islamic banks. Based on the perspective of systems thinking, organizational outcomes such as the efficiency of governance mechanisms are not determined by a single factor, but by complex interactions between various interrelated elements (Mollah & Zaman, 2015). In this context, technological infrastructure (digitalization), organizational scale (bank size), capital structure (leverage), institutional maturity level (bank life), and profitability (ROA) each contribute to different aspects of the ecosystem that can strengthen or weaken SSB performance.

Based on contingency theory, the results of this study show that the efficiency of sharia supervision depends on the configuration of organizational attributes and environmental conditions (Hamza, 2013). There is no one universally applicable best practice, but rather an optimal configuration of factors tailored to the context of each institution. Banks that have different characteristics in terms of size, age, technology adoption, capital structure, and profitability require a tailored approach in designing and implementing sharia supervision mechanisms to achieve optimal efficiency.

These findings also provide a deeper understanding of the results of partial testing that show that some variables are not significant individually. Such insignificance does not necessarily mean that the variable is irrelevant, but rather indicates that the influence is indirect or condition-dependent, which is only apparent when interacting with other variables in the model (Pathan & Faff, 2013). For example, digitalization may require a certain organizational scale to be effectively implemented, or a high return on assets (ROA) rate can only make a real contribution to SSB efficiency when supported by adequate institutional maturity.

4. CONCLUSION

The results of this study show that simultaneously digitalization, bank size, *leverage,* bank age and profitability have a significant effect on the efficiency of the Sharia Supervisory Board. However, in part, digitalization, bank size, *leverage,* and profitability did not have a significant impact. Such insignificance does not necessarily mean that the variable is irrelevant, but rather indicates that its influence is indirect or dependent on certain conditions, which only become apparent when interacting with other variables in the model. Banks that have different characteristics in terms of size, technology adoption, capital structure, and profitability require a tailored approach in designing and implementing sharia supervision mechanisms to achieve optimal efficiency.

These findings carry several practical implications. For Islamic bank management and boards of commissioners, the results suggest that strengthening SSB efficiency should not rely solely on investment in digital infrastructure, but should prioritize building institutional experience, retaining SSB members over longer tenures, and codifying accumulated supervisory knowledge into standard operating procedures. For regulators such as the OJK, the results indicate that supervisory capacity-building programs may benefit newly established Islamic banks in particular, given the significant role of bank age in this study. For SSB members themselves, the findings underscore the continued centrality of sharia expertise and judgment relative to technological tools in fulfilling the supervisory mandate.

This study has several limitations. First, the sample is limited to 10 Islamic commercial banks in Indonesia observed over a 4-year period (2021-2024), which constrains the statistical power of the panel regression and the generalizability of the findings to other Islamic banking jurisdictions. Second, SSB efficiency is measured through a disclosure-based score, which captures the transparency of SSB reporting but may not fully reflect the substantive quality of sharia supervision. Third, the digitalization measure relies on a text-mining approach applied to annual reports, which captures the disclosure of digital-related terms rather than the actual depth or maturity of digital adoption. Fourth, although the Chow, Hausman, and LM tests consistently indicated the Random Effect Model as the statistically preferred specification, this study employed the Common Effect Model based on the theoretical consistency of its coefficients and the strength of its significance levels; this choice, together with the Durbin-Watson statistic indicating possible positive autocorrelation, means the reported coefficients should be interpreted with appropriate caution. Future research is encouraged to extend the observation period and sample size, report and compare estimates from the statistically indicated model alongside theory-consistent alternatives, incorporate qualitative measures of SSB competence and independence, and consider alternative or complementary proxies for both digitalization and SSB efficiency to validate and extend the findings of this study.

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