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DIGITALIZATION AND DISCRETIONARY LOAN LOSS PROVISIONS: THE MEDIATING ROLE OF CORPORATE GOVERNANCE IN ISLAMIC BANKS

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ABSTRACT

This paper examines the mediating role of effective corporate governance mechanisms, specifically the Board of Directors (BD) and the Sharia Supervisory Board (SSB), in the relationship between digitalization and managers' disclosure of loan loss provisions in Islamic banks. The empirical analysis uses panel data from 2012 to 2021 for a sample of 79 Islamic banks operating across 20 countries. The study employs the Generalized Method of Moments (GMM) to estimate the regression models, uses the Sobel test to assess the mediation effect, and follows the framework proposed by Baron and Kenny (1986). The findings reveal that digitalization significantly reduces earnings management practices, while simultaneously enhancing the effectiveness of governance and control mechanisms. Moreover, the results confirm that both the Board of Directors and the Sharia Supervisory Board play a significant mediating role in the relationship between digitalization and discretionary loan loss provisions (DLLP). These findings offer important implications for regulators, policymakers, and shareholders by improving their ability to monitor managerial behavior and strengthen investment oversight. By fostering greater transparency, timely disclosures, and improved error detection, digitalization enhances the effectiveness of governance within Islamic banks. In the context of rapid digital transformation, this study contributes to the existing literature by offering novel insights into how emerging digital technologies are reshaping the Islamic banking sector and by highlighting the critical role of governance mechanisms in mitigating earnings management in a digitalized environment.

KEYWORDS: Digitalization; Corporate governance; Islamic banks; Discretionary loan loss provisions; Earnings management; Sharia Supervisory Board.

1. INTRODUCTION

The corporate governance of Islamic Banks (IBs) has become a critical area of research due to the rapid growth of Islamic finance globally and its distinct ethical framework (Mukhibad et al., 2024). The 2007–2008 financial crisis highlighted the resilience of IBs, which demonstrated superior performance in profitability, risk management, and liquidity compared to conventional banks (Harahap et al., 2023; Zaid et al., 2025). Numerous studies confirm that IBs provide a more stable and sustainable alternative to traditional finance (Mutamimah & Saputri, 2023; Ammar et al., 2023). Earnings management practices are widespread in the banking sector (Kolsi & Grassa, 2017; Mersni & Ben Othman, 2016), yet in IBs, such practices contradict the ethical and Sharia-compliant principles that should discourage discretionary behavior and prohibit unethical accounting manipulation (Shamsuddin & Ismail, 2013; Muthoifin et al., 2024). Nevertheless, empirical evidence on earnings management in IBs remains limited and conflicting (Shamsudin et al., 2024; Haribowo, 2024). Some studies suggest that Sharia principles limit manipulative practices, while others indicate that profit-maximization motives can still drive discretionary behavior. Loan loss provisions (LLPs) serve as a crucial mechanism for detecting such earnings management due to the opacity of reserve data (Boulila Taktak, 2011; Mersni & Ben Othman, 2016; Ashoor et al., 2023). Mismanagement in this area can have serious economic consequences, as evidenced during the global financial crisis (Tran et al., 2019).

Effective corporate governance mechanisms, including independent boards of directors and Sharia supervisory boards, are vital to controlling earnings management (Shamsudin et al., 2024). Additionally, digital transformation offers IBs opportunities to enhance competitiveness through big data, AI, and fintech innovations (Hamadou et al., 2024). However, the interaction between digitalization and the effectiveness of corporate governance in controlling discretionary loan loss provisions (DLLP) remains underexplored.

This study aims to fill several gaps in the literature. First, it examines the mediating role of corporate governance mechanisms, specifically the effectiveness of boards of directors and Sharia supervisory boards, in the relationship between digitalization and earnings management in IBs. This approach advances prior research by focusing not only on governance as a control mechanism but also on its interplay with digital innovation, which is largely absent in existing studies (Alam et al., 2022;

Shamsudheen et al., 2023). Second, this study employs a novel textual analysis methodology, using Python to quantify digitalization-related terms in annual reports, offering a precise and replicable measure of digital transformation. Third, our findings help identify which governance mechanisms are most effective in mediating earnings management in a digitalized IB context, providing actionable insights for regulators, standard-setters, and shareholders.

Overall, this paper makes several novel contributions to the literature on Islamic banking, corporate governance, and digital transformation. First, while prior research has examined earnings management and governance in Islamic banks (Shamsudheen et al., 2023), studies on board characteristics and Shariah Supervisory Boards, this study deepens the understanding of earnings management in IBs under Shariah principles by coupling the discretionary loan-loss provision (DLLP) mechanism with a digital transformation context. This addresses the gap identified in recent works (Fitria, 2025) that calls for more empirical analyses of how digitalization interacts with governance in the Islamic banking context. Second, the paper goes beyond the usual governance-control lens by highlighting the role of digitalization in shaping the effectiveness of corporate governance. Recent research (Mersni & Ben Othman, 2016; Ashoor et al., 2023) emphasizes the digital shift in IBs and the need for effective governance mechanisms alongside it. We empirically test how governance effectiveness (Boards and Sharia Supervisory Boards) mediates the relationship between digitalization and DLLP, thereby advancing the literature on the interplay between digital governance and DLLP in Islamic finance. Third, we provide robust empirical evidence on the mechanisms that mitigate discretionary accounting practices in a rapidly digitalizing Islamic banking environment. While earlier studies focused separately on governance or digitalization, our paper integrates both and examines the mediating pathways, which remain under explored in the extant literature (Awwad et al., 2024; Zaid et al., 2025).

The remainder of the paper is organized as follows: Section 2 presents the literature review and hypothesis development; Section 3 describes the methodology; Section 4 discusses the empirical results; and Section 5 concludes with theoretical, practical, and policy implications.

2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

The digital transformation of Islamic banks is essential to enhance their competitiveness and meet customer expectations. By integrating digital technologies, these institutions can optimize their operational processes and improve data management. However, they also face challenges related to transparency and accounting integrity, which underlines the importance of effective governance to minimize profit manipulation and respect Islamic ethical principles (Al-Malkawi *et al.*, 2014). Indeed, modernization theories are essential to understand contemporary development, especially in the context of digitalization. They highlight how integrating new technologies can foster economic and social advancement while posing specific challenges. In the context of Islamic banks, it is crucial to examine the control mechanisms specific to this sector to fully understand the accounting benefits of this digital transformation. This interdisciplinary approach underscores the interplay among technological developments, social values, and governance (Khelil *et al.*, 2023).

2.1. *The Effect of Digitalization on Earnings Management*

Digitalization has had a significant impact on the banking sector, including Islamic financial institutions, leading to changes in earnings management practices. The goal of this transformation is to improve profits and competitiveness. Research has shown that digital transformation improves the quality of accounting information, reducing the need to manipulate results (Zhai *et al.*, 2022). Digitalization and computerization can help address principal-agent problems and information asymmetry, ultimately enhancing the quality of accounting information. Senior managers may manipulate accounting information to meet higher financial performance expectations arising from digitalization (Han *et al.*, 2023).

Niu *et al.* (2023) discovered that the digitalization of Islamic Banks can decrease earnings management and enhance the reliability of financial information. Wang and Hou (2024) argue that digital tools improve transparency and accuracy in financial reporting. Babilla (2023) cautions that digital transformation may introduce private, unobservable factors, leading to missing variables and selection bias that can impact revenue management. Overall, digitalization reduces human involvement in reporting, ensuring consistency and transparency.

Qi and Xiao (2020) emphasized the influence of accounting information on bank management and investor decisions, highlighting its connection to digitalization in banks. Han *et al.* (2023) stressed the importance of digital transformation in banks for building digital economic systems, improving data analysis capabilities, and enhancing the efficiency of resource allocation. Qi and Xiao's (2020) study demonstrates that digital transformation reduces earnings manipulation. This indicates that digitalization significantly affects earnings management practices, playing a critical role in reducing manipulation. Therefore, we propose and test the following hypothesis (H1): Digitalization negatively affects earnings management.

2.2. *The Impact of Digitalization on the Effectiveness of Control Mechanisms*

2.2.1. *The Impact of Digitalization on Board Effectiveness*

Technological advancements in banking offer various advantages to both banks and their boards (Carl *et al.*, 2017). predicts significant changes in banking jobs, such as faster transactions and lower costs, potentially making some jobs obsolete. Empirical evidence supports these impacts.

Oliveira *et al.* (2022) conducted a study on the future of work in Switzerland, revealing that 50% of tasks could be automated by 2030 due to digital transformation, leading to significant changes in the job market. Verhoef *et al.* (2021) found that banks with digitally literate boards outperform competitors, underscoring the importance of digital transformation in the financial sector. Oliveira *et al.* (2022) further illustrate how technological advancements affect board directors across areas such as information management, strategy formulation, and strategic planning.

Verhoef *et al.* (2021) highlight the benefits of digitalization for board directors, allowing them to work more efficiently and meaningfully. The proper use of new technologies is crucial for effective corporate governance, enabling better decision-making, transparent communication with stakeholders, and real-time response to market challenges. This study underscores the importance of digitalization in enhancing the effectiveness of board directors. With these arguments in mind, we propose and test the following hypothesis (H2.a): Digitalization positively influences board effectiveness.

2.2.2. The Effect of Digitalization on the Effectiveness of the SSB

Given the importance attributed to full disclosure and transparency in IB governance, our hypotheses examine the extent of SSB disclosures in IBs' annual reports to assess the effectiveness of the SSB. This aligns with Amalina Wan Abdullah et al. (2013), who used the disclosure mechanism as a supervisory indicator to assess the SSB's effectiveness in performing its functions.

Recent studies by Leung and Snell (2021) emphasize the use of technological advancements by IBs and their SSBs for improved governance, transparency, and disclosure. Digitization has enabled faster, more interactive dissemination of reports, as highlighted by Naimi-Sadigh et al. (2021). This has led to increased efficiency, reduced routine tasks, and enhanced communication of benefits, emphasizing the importance of complying with regulations and ethical practices.

Research by Tahri et al. (2023) and Leung and Snell (2021) investigates the use of digital technologies in IB institutions and their effects on disclosure practices. The study also examines the impact of digitalization on SSBs' culture, thereby improving their effectiveness in technology adoption.

Recent studies by Ninglasari and Muhammad (2021) emphasize the potential of blockchain technology and digital wallets for IBs' SSB activities. These technologies help overcome errors and improve data processing speed for Zakat management. Digital wallets, or cryptocurrency wallets, also facilitate financial transactions and store information. Implementing these digital solutions enhances Zakat disclosure and improves the efficiency of IBs, ensuring competitiveness and sustainable growth. However, the effectiveness of SSB still relies on the driving role of new technologies (Tahri et al., 2023). We propose the following hypothesis (H2.b): Digitalization positively influences SSB efficiency.

2.3. The Mediating Effect of Control Mechanisms on the Relationship between Digitization and Earning Management

The use of new digital technologies has made stakeholder engagement easier, especially in terms of preparing for, participating in, and voting at general meetings. This has improved the safety and effectiveness of shareholder-company relationships (Fathima, 2020).

Khanchel (2007) analyzed factors that enhance

banking governance, including directors' expertise in their reports, board meetings, and audit committees, as well as detailed disclosure by SSBs. Lv and Xiong (2022) explored the impact of control mechanisms and digital transformation on banking governance. Chen et al. (2022) found that effective control mechanisms, combined with digitization, reduce actual earnings management in banks, highlighting the importance of financial technologies in detecting and reducing information filtering. Adams et al. (2018) highlighted the importance of directorial skills in bank governance. Poorly designed control mechanisms can result in monitoring gaps and financial inaccuracies. Digital systems can automate controls, but must be appropriately configured to detect anomalies and mitigate risks effectively.

Chen et al. (2022) emphasized the importance of IT and technology competence in IBs' control mechanisms to prevent negative earnings management. Wen et al. (2023) highlighted the role of digital skills and practical control tasks in improving financial reporting quality through financial technologies. Control mechanisms act as mediators, enhancing the benefits of digitization for accounting outcomes. Adams et al. (2018) emphasize the importance of practical control tasks in evaluating the impact of new technologies on accounting quality. They stress the need for competent control mechanisms to conduct audits, evaluate banking operations, identify technology-related risks, and implement security protocols. Control mechanisms must be trained to work with digital technologies, understand risks, and utilize digitized data to enhance accounting benefits. Competent control mechanisms are essential to prevent digitization from negatively affecting earnings management. Therefore, the following hypothesis is formulated (H3): The effectiveness of control mechanisms mediates the relationship between digitization and earnings management.

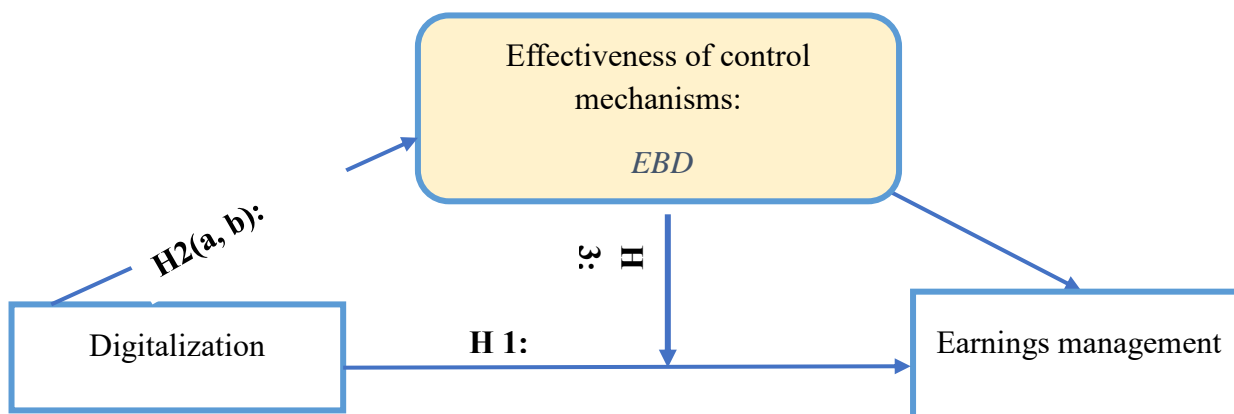


Figure 1: The Research Proposed Theoretical Model (Own Design)

3. RESEARCH METHODOLOGY

3.1 Research Sample and Data

The sample included data from annual reports of 79 Islamic Banks (IBs) located in 20 countries. This data was obtained by downloading reports from official bank websites. The study period ranges from 2012 to 2021. Data were manually collected from both English and Arabic annual reports, yielding 790 observations per bank-year from 2012 to 2021.

3.2. Definitions and Measurement of Variables

3.2.1. Dependent Variable

We will apply a multivariate regression model

with DLLP as the dependent variable to examine the influence of BI control mechanisms on the relationship between earnings management practices and digitization. This measure is frequently used by researchers such as Boulila Taktak et al. (2010) and Ben Othman and Mersni (2014) in the study of Islamic Banks (IBs) due to their adherence to Sharia law. These banks employ both discretionary and non-discretionary methods, with the basic model of the measure defined by these components:

$$LLP = \beta_0 + \beta_1 \text{Non-discretionary LLP} + \beta_2 \text{Discretionary LLP} + \epsilon_{it} \tag{1}$$

Then, using the estimated coefficients ($\beta_1, \beta_2, \beta_3$) from equation (1), we evaluate the non-discretionary component of LLP, the non-discretionary loan loss provision set by NDLLP.

Table 1: GMM estimation LLP model.

Variables	LLP
NPL	2.54*** (0.021)
Δ NPL	-4.18*** (0.061)
Observations	788
Number of Panel	79
AR(2) test (p-value)	-1.04 (0.298)
Hansen test	18.63 (0.135)
Sargan test statistics	5643 (0.000)
Mean VIF	1.17

Notes: $LLP_{it} = \hat{\beta}_0 + \beta_1 NPL_{it-1} + \beta_2 \Delta NLP_{it} + \beta_3 \Delta TL_{it}$
 LLP_{it} = Total provisions for loans, Musharaka, Mudharaba and Murabaha investment for bank i at the year t, deflated by beginning loans. NPL_{it-1} = the beginning balance of non-performing loans for bank i at the year t deflated by beginning loans. ΔNLP_{it} = Change in the value of non-performing loan for bank i at the year t, deflated by beginning loans. ΔNLP_{it} = Change in the value of total loan, for bank i at the year t, deflated by beginning loans.

Note: *** significance level at 1%; ** significance level at 5%; * significance level at 10%.

$$NDLLP_{it} = \beta_0 + \beta_1 NPL_{it-1} + \beta_2 \Delta NLP_{it} + \beta_3 \Delta TL_{it} \tag{2}$$

The Discretionary Loan Loss Provision (DLLP) is calculated by subtracting the non-discretionary LLP (NDLLP) from the total LLP. The DLLP is estimated via the residual obtained from equation

(1). Our basic estimating equation is as follows (Eq. 3):

$$DLLP_{it} = LLP_{it} - NDLLP_{it} \tag{3}$$

3.2.2. Mediating Variables

One of the mediating variables utilized in our study is Board of Directors (BoD) effectiveness. This effectiveness is conceptualized along three dimensions: the individual potential of the directors, the Council's past practices, and the collective potential, as illustrated in the table below. To obtain a unique index measuring the overall BoD effectiveness, we will employ Principal Component Analysis (PCA). This method will be utilized to synthesize the different dimensions and create a composite variable.

The mediating variables used in our study include the effectiveness of the Board of Directors (BD), which is based on individual potential, past practices, and group potential. A principal component analysis (PCA) will be performed to obtain a single index measuring board effectiveness.

Furthermore, the effectiveness of the Shariah Supervisory Board (SSB) is assessed using a disclosure-based approach. The SSB effectiveness index is calculated by dividing the actual disclosure score (X) attributed to the bank by the total maximum expected disclosure score (TS), according to the following formula:

$$Score_disco = \frac{X}{TS} \tag{4}$$

Table 2: Measuring Board Effectiveness

Dimensions	Proxy	Authors
The individual potential	Independence Expertise	
The past practice	Number of recommendations: -CEO succession practices and disclosure. -	(Conheady et al., 2015); (Ben-Amar and Mcilkenny, 2014); (Al-Malkawi et al., 2014)
	Recommendations concerning the disclosure of information. -	
	Recommendations on the adoption of certain corporate rules. -	(Darmadi, 2013); (Gerald's Alves, 2011).
	Recommendations concerning shareholder voting and representation.	
The group's potential	The number of director meetings attended.	

Table 3: Items related to the Disclosures of the effectiveness SSB.

Items	Authors
The items related to the disclosure in the SSB report (Diclo_report) are:	
1) Title	Amalina Wan Abdullah et al. (2013) Darmadi (2013) Al-Malkawi et al. (2014)
2) Addressee	
3) Opening/introductory paragraph (clear purpose of engagement)	
4) A clear statement that the management of Islamic financial institutions is responsible for properly complying with Shari'ah rules and principles	
5) Confirmation that the SSB has performed appropriate test procedures and review - general	
7) Transactions and dealings	
8) Shari'ah opinion will include matters about contract transactions and dealings	
10) Report on the violations of Shari'ah compliance (if any)	
11) The SSB's report should be signed by all members of the Board	
12) Date of the report	
13) Additional disclosure: SSB attestation on the financial report	
14) SSB duties and responsibilities	
15) SSB meeting	
16) Shari'ah audit	
17) Statement of sources and uses of zakat	
18) Disclosure of Policy on Zakat	
19) Disclosure of the amount subject to zakatable	
20) Disclosure of Zakat beneficiaries	

3.2.3. Independent Variable

The digitization score (DIG) is an explanatory variable we measured using Python. Calculation methods by Chhaidar et al. (2022), Barnewold and Lottermoser (2020), and Cherni and Ben Amar (2024):

$$IG (rapport\ annuel_i) Ln \sum_{x=1}^n = \frac{tf}{NT} \tag{5}$$

3.2.4. Control Variables

In this study, we utilized the following control variables:

SIZE_BANK: calculated by taking the natural logarithm of total assets (Al-Homaidi et al., 2020).

LEVERAGE: determined as the ratio of total debt to total assets (Salem et al., 2021).

AGE_BANK: calculated by determining the number of years since the bank was founded (Milad & Bicer, 2020).

PROFITABILITY: assessed by the profitability of assets, calculated as the ratio of net income to total assets (Al-Homaidi et al., 2020).

3.3. Research Models

The paper uses the generalized method of

moments (GMM) to address endogeneity in the explanatory variables, particularly the cross-sectional dimension (Chowdhury & Rasid, 2016). The study examines the mediating role of control mechanisms, such as BD and SSB, in the relationship between digitalization and DLLP. It employs Baron and Kenny's hierarchical regression procedure to examine mediation and presents three conceptual models to guide the empirical investigation:

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$$DLLP_{it} = \alpha_0 + \alpha_1 DLLP_{i,t-1} + \alpha_2 DIG_{i,t} + \alpha_3 SIZE_{i,t} + \alpha_4 LEV_{i,t} + \alpha_5 PROFIT_{i,t} + \alpha_6 AGE_{i,t} + \varepsilon_{i,t} \tag{6}$$

$$EBD_{i,t} = \alpha_0 + \alpha_1 EBD_{i,t-1} + \alpha_2 DIG_{i,t} + \alpha_3 SIZE_{i,t} + \alpha_4 LEV_{i,t} + \alpha_5 PROFIT_{i,t} + \alpha_6 AGE_{i,t} + \varepsilon_{i,t} \tag{7}$$

$$ESSB_{i,t} = \alpha_0 + \alpha_1 ESSB_{i,t-1} + \alpha_2 DIG_{i,t} + \alpha_3 SIZE_{i,t} + \alpha_4 LEV_{i,t} + \alpha_5 PROFIT_{i,t} + \alpha_6 AGE_{i,t} + \varepsilon_{i,t} \tag{8}$$

$$DLLP_{it} = \alpha_0 + \alpha_1 DLLP_{i,t-1} + \alpha_2 DIG_{i,t} + \alpha_3 EBD_{i,t} + \alpha_4 ESSB_{i,t} + \alpha_5 SIZE_{i,t} + \alpha_6 LEV_{i,t} + \alpha_7 PROFIT_{i,t} + \alpha_8 AGE_{i,t} + \varepsilon_{i,t} \tag{9}$$

We summarize all the variables in Table 4 as follows:

Table 4. Description of the Variables.

Symbol	Detailed Description	Variable Type
DLLP _{i,t}	Discretionary loan loss provisions of bank i at time t	Dependent
EBD _{i,t}	Efficiency of the Board of Directors of bank i at time t	Independent
ESSB _{i,t}	Effectiveness of the Sharia Supervisory Board of bank i at time t	Independent
DIG _{i,t}	Digitalization of bank i at time t	Moderator
SIZE _{i,t}	Bank size	Control
LEV _{i,t}	Debt ratio	Control
PROFI _{i,t}	Bank profitability	Control
AGE _{i,t}	Bank age	Control
ε _{i,t}	The error term	Control

4. ESTIMATION AND DISCUSSION OF RESULTS

4.1. Descriptive Analysis of the Sample

Table 5 displays descriptive statistics for both dependent and independent variables, including mean, median, standard deviation, minimum, maximum, skewness, kurtosis, and specific statistical tests. Data spans from 2012 to 2021 with 79 observations.

The study found that the variable DLLP has a low mean of 0.033 and a high standard deviation of 10.965, with all observations ranging from -49.750 to 56.708. The distribution is right-skewed and exhibits marked leptokurtosis, prompting a non-linear transformation to improve asymmetry.

The mediator's EBD and ESSB have low overall means of -7.89e-10 and 0.565, respectively, with EBD having a significant standard deviation of 1.230, indicating panel heterogeneity. ESSB shows an almost homogeneous distribution with a standard deviation of 0.297. Observations for EBD range between -3.022 and 4.041, while ESSB observations range from 0 to 1. Both variables show leftward skewness and mark leptokurtosis, rejecting the normality hypothesis and exhibiting significant serial correlation.

The independent variable DIG has a low mean and high standard deviation, indicating a non-

homogeneous distribution and strong dispersion. Observations range from 0 to 0.098, with leftward skewness and leptokurtic distribution. The distribution fails the normality test and shows significant serial correlation.

Table 5: Descriptive Statistics.

	DLLP	EBD	ESSB	DIG	Size	Profit	Lev	Age
No of obs	789	790	790	790	790	790	790	790
Mean	0.033	7.89e-10	0.565	0.008	22.830	0.339	0.711	24.674
Median	-0.228	0.001	0.666	0.001	22.899	0.197	0.841	32
St. Dev	10.965	1.230	0.297	0.017	2.560	1.807	0.596	25.194
Min	-49.750	-3.022	0	0	15.253	0	0.004	0
Max	-49.750	4.041	1	0.098	24.171	36.548	9.114	158
Skewness	2.022	-0.055	-0.968	3.060	0.398	18.768	10.428	1.826
Kurtosis	2.022	3.510	2.642	12.822	4.510	364.614	147.387	8.730
JB test	-	8.979	127.7	3913	96.09	4.4e+06	7.0e+05	1520
JB Probability	-	0.011	0.000	0.000	0.000	0.000	0.000	0.000
BB test	-	21.75	25.698	98.651	10.31	4.81	6.54	3.8e+06
BB Probability	-	0.000	0.000	0.000	0.006	0.090	0.038	0.000

4.2. Used Test

The study of stationarity reveals that all series are non-stationary and integrated of order 1. Kao and Pedroni cointegration tests confirm the presence of significant long-term relationships among the variables. Additionally, heteroscedasticity tests yield p-values of 0.000, rejecting the homoscedasticity

hypothesis in the analyzed models.

Table 6: Panel Data Unit Root Test.

	in Level			Decision	In First Difference			Decision
	LLC	IPS	Hadri		LLC	IPS	Hadri	
EBD	-13.237***		21.224	NS	-29.526***		-3.982**	S
ESSB	-20.934***		20.033	NS	-11.226***		-3.989**	S
DIG	53.612	-6.333**	5.056	NS	-2.8e+02**	-7.836**	5.897**	S

(***), (**), and (*) indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 7: Cointegration Tests.

Tests	M (1)	M (2a)	M (2b)	M (3)
Kao (1999)	-15.010 (0.000)	-1.069 (0.142)	0.811 (0.208)	-15.196 (0.000)
Pedroni (2004)	-17.556 (0.000)	-9.921 (0.000)	-14.444 (0.000)	-18.682 (0.000)
Decision	Cointegration	Cointegration	Cointegration	Cointegration

Table 8: Heteroscedasticity Test Results.

Model	M1	M2a	M2b	M3
Chi2 statistics	1.9e+07	31892.53	2.6e+07	5.9e+06
Prob > F	0.000	0.000	0.000	0.000
Heteroscedasticity	Presence	Presence	Presence	Presence

4.3. Correlation Matrix

The correlation matrix indicates significant but weak correlations between endogenous DLLP and most variables, except PROFIT and LEV, which are not significant. Although there are correlations among exogenous variables, the variance inflation factor (VIF) test yields a value of 1.16, indicating no significant multicollinearity. Alternative models could be considered to accommodate less correlated data.

Table 9: Correlation Matrix.

	DLLP	EBD	ESSB	DIG	SIZE	LEV	PROFIT	Age
DLLP	1.0000							
EBD	-0.2480 0.0000	1.0000						
ESSB	-0.0668 0.0607	0.1615 0.0000	1.0000					
DIG	-0.1635 0.0000	-0.0663 0.0624	0.0005 0.9898	1.0000				
SIZE	0.2316 0.0000	-0.0152 0.6701	-0.1767 0.0000	0.1100 0.0020	1.0000			
LEV	0.0098 0.7826	-0.0843 0.0178	-0.1004 0.0047	0.0233 0.5134	0.0102 0.7751	1.0000		
PROFIT	-0.0031 0.9297	0.0600 0.0920	0.0474 0.1832	-0.0170 0.6336	-0.0302 0.3960	-0.0056 0.8758	1.0000	
Age	-0.1237 0.0005	0.1879 0.0000	-0.1590 0.0000	0.1530 0.0000	0.2196 0.0000	0.1752 0.0000	-0.0105 0.7684	1.0000

Notes: (***), (**) and (*) correspond to statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 10: Model multicollinearity Test

Variable	VIF
EBD	1.15
ESSB	1.34
DIG	1.07
Age	1.22
PROFIT	1.01
SIZE	1.17
LEV	1.06
Mean VIF	1.16

4.4. Results and Discussion

The results from model 1 (Equation 6) indicate that the digitization variable has a negative and significant effect on the management of the result (DLLP) at the 5% threshold. The empirical model presented in Table 11 shows that the coefficient for the delayed (DLLP) variable is positive and statistically significant at the 1% level. We conclude that DLLP in the previous year influences DLLP in the current year, supporting hypothesis (H1). Digitalization plays a crucial role in transparency, speed of information disclosure, and error detection within banks. This enables banks to control the information disclosed in financial statements, thereby ensuring managers and executives provide relevant and reliable information (AlMulhim, 2023). Control mechanisms enabled by digitalization help in minimizing manipulation of results, as suggested by Wen *et al.* (2023) and AlMulhim (2023). Digital technologies drive bank innovations in behavioral analysis, risk forecasting, and minimizing earnings management. Teece (2018) demonstrated that the bank-wide application of digital technology can inhibit earnings management activities by improving resource utilization efficiency and information transparency. Agency theory, as proposed by Fama and Jensen (1983), emphasizes the relationship between "principal" and "agent", focusing on incentive and governance mechanisms to reduce conflicts of interest and optimize efficiency in these relationships. Dynamic capabilities theory also contributes to understanding how organizations cope with the impact of digitalization (Teece, 2018).

Digitization also reduces profit manipulation, and its impact on DLLP can be attributed to various mechanisms within IBs (Wang & Hou, 2024). Larger banks are more likely to engage in earnings management, as Abbadı (2021) supports. According to the table below, the results indicate that bank size is positively and significantly associated with earnings management at the 1% level. Bank size influences earnings management to improve financial performance. Older banks are easier to manipulate earnings, as they have a reputation to maintain and experience to minimize costs and

improve service quality (Kalbuana *et al.*, 2022). Debt ratio and profitability have a non-significant effect on earnings management, consistent with prior research (Astuti, 2017). Bank age has a significant positive effect on earnings management at the 5% threshold, as shown by Han *et al.* (2023).

The Sargan over-identification test validates the lagged variables as instruments (p-value 0.000), ensuring their validity. Similarly, Arellano and Bond's second-order autocorrelation test confirms the absence of second-order autocorrelation (p-value = 0.188), reinforcing the reliability of the results.

Model 2 (Equations 7 and 8) estimations, EBD, and ESSB, were conducted to verify the relationship between digitization and the effectiveness of control mechanisms. The results show positive, statistically significant coefficients for the delayed EBD and ESSB variables at the 1% threshold. In fact, digitization has a positive, statistically significant influence on BD efficiency at the 5% threshold and on SSB efficiency at the 1% threshold. Digitization positively influences BD and SSB efficiency, confirming hypotheses 2(a) and 2(b). IBs could benefit from systematically adopting technological trends to enhance board effectiveness and operational efficiency (Cherni & Ben Amar, 2024). Digital transformation enables boards to process large amounts of data, enhance fraud controls, improve reporting processes, and facilitate information sharing (Eberle, 2019). Similarly, authors such as Chen and Hao (2022) and (2023) have found the same positive relationship, meaning that the digitization of board functions will increase working efficiency and improve the flow of communication, information gathering, and sharing among board members.

Digitization also promotes the effectiveness of SSBs, emphasizing the importance of managing Shariah compliance issues and risks in the digital era. The impact of digitization on SSB effectiveness is increasingly becoming an obligation for IBs (Alam *et al.*, 2021). Institutional theory provides an analytical framework to understand the impact of digitization on SSB effectiveness (Khelil *et al.*, 2023). As a result, digitalization, in the context of effective sharia supervisory boards, is increasingly becoming an obligation rather than an option (Fitroni & Samsudin, 2023). We then conclude that digitization has a significant impact on improving bank performance and implementing an effective transparency strategy in banking activities.

The Sargan over-identification test supports the validity of the lagged variables as instruments in the first model (p-value = 0.218) and in the second model (p-value = 0.000). Arellano and Bond's second-order

autocorrelation test does not reject the hypothesis of no second-order autocorrelation (p -value = 0.327) and (p -value = 0.834 for the second model). The absence of second-order autocorrelation in the errors of the difference equation (AR2) reinforces the reliability of the results.

Model 3 (Equation 9) tests the mediating role of control mechanism effectiveness in the relationship between digitization and (DLLP). The empirical model results presented in Table 10 indicate that the DLLP variable is positive and significant. In fact, the coefficient on the lagged (DLLP) variable is positive and statistically significant at the 1% level. We conclude that DLLP in the previous year influences DLLP in the current year.

To understand the mediating role of effective control mechanisms between digitization and DLLP, transaction cost theory shows that effective management of these transaction costs can help ensure transparency and quality of financial information in the context of Islamic banking (Relano, 2023), so dynamic capability theory supports the framework of the current study on dynamic capability and innovation adoption. By promoting adaptability and responsiveness, this model strengthens boards' ability to effectively guide the organization into the future and achieve its long-term goals (Lasi et al., 2014; Warner & Wäger, 2019).

The results in Table 11 below verify the final stage of Baron and Kenny's approach, which is a commonly used method for examining the mediating role of an intermediate variable (control mechanisms) between an independent variable (digitization) and a dependent variable (DLLP). Indeed, the results show that the negative and insignificant effect of digitization disappeared when control mechanisms were introduced as a mediating variable, thereby verifying their mediating role between digitization and DLLP, particularly in the context of Islamic banks. Based on these results, we can confirm Fang et al.'s (2023) hypothesis (H3). In fact, all the conditions of Baron and Kenny's (1986) approach are met, and mediation by control mechanisms is therefore complete between digitization and earnings management. In fact, the results show that digitization alone is insufficient to curb the manipulation of results. This underscores the essential role of control mechanisms, which are considered an important foundation for

implementing innovation strategies (Wibowo et al., 2024). Indeed, we can say that digitalization in a weakly controlled context can improve earnings management only when governance mechanisms are in place. However, internal and external corporate governance mechanisms are the most effective devices for limiting managers' discretionary behavior. Although the effectiveness of these mechanisms depends on specific conditions that are not present in banks, our results show their importance as preeminent elements in establishing innovation systems and limiting manipulation within Islamic banks (HARAHAP et al., 2024).

The study indicates that firm size positively affects earnings management, consistent with agency theory. Larger firms, subject to intense pressure from financial analysts, are more likely to manage their earnings. These results are consistent with those of Barton and Simko (2002) and Liao et al. (2023).

The results indicate that profitability positively and significantly influences DLLP. The higher the profits, the more managers and shareholders engage in earnings management. According to Kalbuana et al. (2022), business activities aimed at maximizing profit allow investors and managers to manipulate earnings.

In addition, the results indicate that the debt ratio has a negative, insignificant impact on DLLP. Our results are consistent with prior work (Soesetio et al., 2023; Ruslim & Muspyta, 2021), which suggests that managers of highly leveraged firms may be subject to increased creditor control, making it more difficult for them to engage in earnings manipulation.

Bank age has a positive impact on DLLP, as shown by Mangala and Singla (2023). Older banks benefit from their experience, generating higher profits and enjoying a better reputation, thereby reducing agency costs. However, they feel pressure to expand into emerging markets (Debnath, 2017).

The results indicate that Sargan's over-identification test confirmed the validity of lagged variables as instruments (p -value = 0.019). Additionally, Arellano and Bond's second-order autocorrelation test did not reject the hypothesis of no second-order autocorrelation (p -value = 0.175), confirming the absence of second-order autocorrelation in the errors of the difference equation (AR2).

Table 11: Results of the Estimations by the GMM Method in the System.

Direct effect			
	DLLP	EBD	ESSB
L.DLLP	0.513 *** (0.040)		
L.EBD		0.527*** (0.072)	
L.ESSB			0.526*** (0.103)
DIG	-0.319** (0.156)	0.389 ** (0.174)	0.142*** (0.042)
SIZE	0.782*** (0.121)	-0.048** (0.019)	-0.017*** (0.004)
LEV	-0.039 (0.166)	-0.091** (0.035)	-0.039** (0.017)
PROFITABILITY	0.0349 (0.040)	0.0224*** (0.004)	-0.008*** (0.001)
AGE	0.050** (0.024)	0.018*** (0.006)	0.003*** (0.001)
Observations	710	711	711
Number of Panel	79	79	79
AR (2) test (p-value)	-1.32 (0.188)	-0.98 (0.327)	0.21 (0.834)
Sargan test statistics	59.30 (0.000)	22.32 (0.218)	53.80 (0.000)
Indirect effect			
L.DLLP	0.530*** (0.087)		
EBD	-0.880*** (0.265)		
ESSB	-0.130*** (0.148)		
DIG	-0.251 (0.363)		
SIZE	0.696*** (0.167)		
LEV	-0.015 (0.222)		
PROFITABILITY	0.247*** (0.048)		
AGE	0.184*** (0.031)		
Observations	710		
Number of Panel	79		
AR (2) test (p-value)	-1.36 (0.175)		
Sargan test statistics	35.16 (0.019)		

Notes: (***), (**) and (*) correspond to statistical significance at the 1%, 5%, and 10% levels, respectively.

4.7. Sobel Test

Kenny et al. (1998) recommend using the Sobel test (1982) to assess the significance and standardized error of the indirect effect. The findings indicate that board effectiveness, serving as a mediator between digitization and results management, is the most significant mediating variable (p-value = 0.064). Additionally, the SSB report disclosure variable serves as a mediator between digitization and results management, with a significant Z statistic (p-value = 0.001).

Table 12: Results of Sobel's test for the mediating effect of control mechanism efficiency.

M= EBD	X= DIG	Y=DLLP	Z_Sobel	Sig
M= ESSB	X= DIG	Y=DLLP	-1.850	0.065
			-3.209	0.001

5. CONCLUSION

This paper examines the impact of control mechanisms on the relationship between digitalization and accounting earnings quality in the Islamic banking (IB) sector. Using dynamic panel data and the generalized method of moments (GMM), the study analyzes 79 IBs globally from 2012

to 2021. The results show that effective control mechanisms can mitigate digital ledger positioning (DLLP) and act as a mediator in this relationship. The research remains at an exploratory stage.

The study is conducted in three stages. The first stage analyzes the impact of digitalization on earnings management, accounting quality, and governance of Islamic banks (IBs). It shows that digitalization reduces earnings management, improves accounting quality, and strengthens governance, making accounting information more relevant for decision-making. The second stage reveals that digitalization significantly improves the effectiveness of control mechanisms, such as the Board of Directors (BD) and the Shariah Supervisory Board (SSB), highlighting the importance of digital skills. Finally, the last stage demonstrates that control mechanisms play a crucial role in mediating between digitalization and accounting earnings quality, confirming their importance in ensuring the accuracy of financial reporting in a digital context.

Our study contributes to the existing literature in several ways. First, we contribute to the literature by demonstrating the effective governance of IBs' digitization on revenue management. Second, this study deepens the understanding of the mediating role of IBs' control mechanism effectiveness in the

relationship between digitization and DLLP. We find that digitizing IBs can directly improve information transparency, thereby reducing managers' earnings management. We also confirm that bank digitization can indirectly constrain earnings management by providing a better information environment for major shareholders, independent directors, and auditors.

Our findings offer several important practical and managerial implications. Better monitoring of managers' actions and the adoption of new business models strengthened by digitization can increase their control, stimulating banks' growth and competitiveness. Improving banking services, making them faster and more efficient, can also help managers make the best decisions at the right time by disclosing clear, relevant, and timely information, thus resolving the problem of information asymmetry. Digitization and emerging technologies in the context of accounting earnings quality are a hot topic at the moment, attracting significant interest from academics, regulators, and users of financial statements. In the age of digitization, this study adds to existing literature, complementing prior studies and providing further insight into how digitization and the technologies currently in vogue are transforming the banking profession.

Author Contributions: The study was conceptualized by S.C. and A.B. The methodology, software, and resources were provided by S.B., while both S.B. and A.B. were involved in validation, formal analysis, and investigation. Data curation and the original draft preparation were also completed by both authors. Additionally, S.C. and N.B. contributed to the review and editing of the manuscript. Visualization was handled by N.B., and supervision was jointly ensured by A.B and N.B. All authors have read and agreed to the published version of the manuscript.

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