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Banking Accounting Transformation in the Digital Era: Data Analytics, Cyber Risk, and ESG Reporting

Loso Judijanto
IPOSS Jakarta
Corresponding Author: Loso Judijanto losojudijantobumn@gmail.com

A R T I C L E I N F O

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A B S T R A C T

This article discusses the transformation of banking accounting in the digital era by emphasizing the interconnection between technological innovation, changes in reporting standards, risk management, and sustainability demands. Through a qualitative literature review method, this article synthesizes academic literature since 2020 on digital banking, digital accounting, big data, artificial intelligence, blockchain, cyber risks, as well as environmental, social, and governance (ESG) reporting. The discussion results indicate that the main trend in banking accounting is moving from historical recording functions to strategic information systems that are real-time, predictive, and integrated with risk governance. However, this transformation raises challenges in terms of data quality, model interpretability, regulatory compliance, privacy protection, human resource readiness, technology investment costs, and consistency of sustainability disclosures. This article asserts that modern banking accounting cannot be understood merely as the process of preparing financial statements, but rather as a governance infrastructure that connects bank stability, market transparency, customer protection, and sustainability agendas. In practical terms, banks need to develop a robust data architecture, technology-based internal controls, digital accountant competencies, and auditable ESG governance. The article also presents a future research agenda regarding the integration of financial and non-financial reporting, audits of AI models, and the impact of ESG implementation on banking behavior in Indonesia

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INTRODUCTION

Banking is an intermediation sector that connects savings, investments, payment systems, and the financing of economic activities. Because banks manage public funds and risk exposure on a large scale, the quality of banking accounting is an important requirement for market discipline, prudential supervision, customer protection, and financial system stability. In recent years, the function of banking accounting has no longer been limited to recording transactions and preparing periodic financial statements, but has evolved into a strategic information system that supports risk measurement, decision-making, and communication of financial and non-financial performance to stakeholders [1], [2].

The urgency of this discussion has increased because digital transformation is changing the way banks create, process, store, and report financial data. Digital banking, fintech, cloud computing, robotic process automation, artificial intelligence, machine learning, blockchain, and data analytics drive faster, more granular, and predictive reporting. The literature shows that digital transformation in banking has evolved into a multidimensional theme encompassing business models, customer behavior, regulatory oversight, technology infrastructure, and sustainability [2], [3]. In the context of accounting, digitalization enhances the effectiveness of reporting functions but simultaneously expands data quality risks, model risks, cyber risks, and compliance risks [4], [5].

Changes in accounting standards also reinforce the complexity of banking accounting. For example, IFRS 9, which in the context of Indonesia is adopted through PSAK 71, shifts the recognition of impairment from incurred loss to expected credit loss (ECL). The ECL model requires banks to use historical information, current conditions, and macroeconomic forecasts in assessing credit losses. This shift increases the relevance of credit risk information, but it requires quality data, professional judgment, and models that can be explained to auditors, regulators, and financial statement users [1], [6].

At the same time, environmental, social, and governance (ESG) demands push banks to expand the scope of their accountability. Bank reports are not only required to explain profitability, liquidity, asset quality, and capital adequacy, but also the impact of financing on emissions, financial inclusion, governance, and climate risk. Studies on banks in various jurisdictions show that sustainability and ESG performance reporting is increasingly relevant to reputation, corporate value, and long-term risk management [7], [8].

Based on this background, this article is aimed at answering four research questions. First, what are the main trends shaping the development of banking accounting in the digital era? Second, what conceptual, technical, and regulatory challenges do banks face in implementing modern banking accounting? Third, how are data analytics, cyber risks, and ESG interconnected in banking reporting and governance practices? Fourth, what strategies can banks, regulators, auditors, and academics adopt to strengthen the quality of banking accounting in the future?

The purpose of this article is to present a conceptual and theoretical synthesis regarding trends and challenges in banking accounting; to explain the role of technology, accounting standards, risk management, and ESG reporting in shaping bank accounting practices; and to formulate strategic implications and an agenda for further research, particularly in the context of Indonesian banking.

LITERATURE REVIEW

1. Banking Accounting as Information Infrastructure and Risk Governance

Banking accounting has characteristics that differ from accounting in the non-financial sector because banks hold portfolios of financial instruments, perform maturity transformation, manage credit and liquidity risks, and are subject to prudential regulations. Bank financial statements are not only tools for management accountability to shareholders but also instruments for risk supervision by regulators and mechanisms of market discipline. Therefore, the quality of financial asset measurement, loss provisions, interest income, fair value, and risk disclosure determines the credibility of bank information [1], [9]. Conceptually, banking accounting is at the intersection of information theory, agency theory, legitimacy theory, and stakeholder theory. Information theory positions financial statements as a means to reduce information asymmetry between banks and external parties. Agency theory highlights the need for control over managerial decisions that may have incentives to manage earnings or delay risk recognition. Legitimacy and stakeholder theories explain why banks expand ESG disclosures, cyber risk, and governance to gain social trust and market support [8], [10].

2. Digitalization, Fintech, and Digital Accounting

Digitalization is transforming banking accounting through process automation, cross-channel data integration, and accelerated reporting. Banks generate data from mobile banking, internet banking, core banking, cards, payment systems, open banking APIs, and fintech partnerships. This data enriches analysis but demands consistent data governance. Bibliometric studies show that digital banking research is rapidly developing with main themes including fintech, blockchain, mobile financial services, artificial intelligence, and sustainable business models [2], [3].

In the field of accounting, digital accounting systems can improve the quality of decisions because transaction data can be processed faster and used for performance, compliance, and risk analysis. However, these benefits only arise if the organization has adequate system quality, information quality, user competence, and governance support [4]. Digital accounting transformation in the banking industry is also related to improving business effectiveness, but its success is influenced by technological readiness, organizational culture, process integration, and the ability to turn data into insights [5].

3. Artificial Intelligence, Machine Learning, and Big Data in Credit Risk

Artificial intelligence and machine learning strengthen banks' ability to assess credit risk, detect fraud, monitor transaction anomalies, and estimate credit losses. In credit risk analysis, big data enables the use of alternative information such as transaction patterns, payment behavior, digital data, and

network information to improve default prediction. Studies on fintech credit assessment have shown that the use of big data and machine learning can enhance loan prediction capabilities, especially when traditional financial information is limited [11], [12].

Nevertheless, the use of AI models in accounting and bank risk poses demands for explainability. Accurate models that cannot be explained can create issues of auditability, compliance, and fairness. The importance of explainable machine learning has been emphasized so that users can understand the key factors driving risk model decisions [13]. For banking accounting, explainability becomes important because ECL estimates, risk assessments, and financial statement disclosures must be verifiable by auditors and regulators.

4. Blockchain, Real-Time Reporting, and Audit Trail Reliability

Blockchain has the potential to strengthen banking accounting through distributed transaction recording, immutability, and a transparent audit trail. In the context of banks, this technology can support transaction settlement, trade finance, know-your-customer, and interparty reconciliation. However, its implementation must consider interoperability, scalability, privacy, legal framework, and integration with the bank's core systems [2], [3].

Real-time reporting becomes a logical consequence of digital system integration. Financial data that is quickly available can enhance the monitoring of liquidity, asset quality, and risk exposure. However, real-time reporting requires strong internal controls, data validation, and automatic reconciliation so that speed does not compromise reliability. At this point, banking accounting is moving towards continuous accounting and continuous auditing, which are processes that integrate recording, control, and assurance in a more continuous manner.

5. Expected Credit Loss and Prudential Regulation

IFRS 9 and PSAK 71 change the logic of recognizing credit losses. In the incurred loss model, loss reserves are recognized after there is evidence of impairment. In the expected credit loss model, banks must recognize expected losses from the initial recognition of financial assets and update them according to changes in credit risk. This requires banks to build models for probability of default, loss given default, exposure at default, and macroeconomic scenarios that are consistent with their credit portfolio [6].

The literature shows that the implementation of IFRS 9 can improve the timeliness of risk recognition, but it also raises issues of profit volatility, procyclicality, management judgment, and implementation costs. A decrease in bank risk has been found after the implementation of IFRS 9 in a cross-country sample [1], and there are unexpected costs for SME credit access when banks adjust their lending behavior [9]. Thus, IFRS 9/PSAK 71 needs to be understood as both an accounting instrument and a prudential policy that affects banks' business decisions.

6. ESG, Sustainability Reporting, and Long-Term Bank Value

ESG reporting in banking relates to a bank's ability to identify, measure, and disclose sustainability risks and opportunities. Environmental factors include financing exposure to high-carbon sectors, physical climate risks, and transition risks. Social factors include financial inclusion, consumer protection, service quality, and responsibility towards the workforce. Governance factors include board structure, risk committees, ethics, anti-corruption, and internal control quality.

Research on banks shows that ESG can be related to financial performance and reputation, although the direction and strength of the relationship are influenced by the country context, regulatory quality, and the way ESG is measured [7], [8]. In banking accounting, ESG requires the expansion of reporting boundaries from financial capital towards multiple capitals. Banks also need to prepare assurance on non-financial data so that sustainability disclosures do not become merely symbolic.

7. Cyber Risk, Data Privacy, and Digital Internal Controls

Digitalization expands the bank's risk surface. Accounting systems connected to various digital channels are vulnerable to data theft, transaction manipulation, ransomware, phishing, third-party failures, and cloud configuration errors. Cyber risk has direct implications for the integrity of financial reporting because it can disrupt the completeness, accuracy, authorization, and existence of transaction data [14], [15].

Disclosure of cyber risks has become part of bank transparency. Studies on large banks in Canada and the United States show that cybersecurity disclosure is increasingly important because banks store critical data and are primary targets of cyberattacks [16]. From an accounting perspective, digital internal controls must include data governance, access control, encryption, anomaly monitoring, incident response, and audit trail [17], [18], [19].

8. Banking Accountant Competencies

Technological transformation changes the competencies of banking accountants. Accountants not only need to master accounting standards, but also need to understand data analytics, risk models, information technology, regulations, data security, and strategic communication. Analytical skills and the ability to explain complex information become prerequisites because accountants act as liaisons between technology systems, risk management, auditors, regulators, and investors [20], [21], [22].

The literature on digital transformation in accounting emphasizes that technology does not replace accountants, but shifts the role of accountants from clerical processing to analytical decision support. Therefore, banking accountant education and training need to integrate accounting technical competencies, technology, ethics, and business acumen [4], [23].

METHODOLOGY

This article uses the qualitative literature review method. This approach was chosen because the purpose of the article is not to calculate the statistical effects of certain variables or conduct a meta-analysis, but rather to compile a narrative and conceptual synthesis regarding the development of banking accounting. Unlike a systematic literature review, which requires a search protocol, inclusion-exclusion criteria, and a highly formal screening process, a qualitative literature review allows room to read, compare, and integrate literature across themes relevant to the conceptual questions of the article [3], [24], [25].

The literature sources were selected from reputable journal articles, especially those published since 2020 in the fields of accounting, banking, fintech, credit risk, cyber risk, ESG, and governance. Key literature was identified through a combination of keywords such as banking accounting, digital accounting, digital banking transformation, expected credit loss, credit risk machine learning, cybersecurity disclosure, ESG reporting in banking, and bank governance. Literature was prioritized if it had direct relevance to banking accounting, was published by a reputable journal, had a DOI or official link, and provided conceptual or empirical contributions to the discussion. The analysis was conducted through thematic reading. Each piece of literature was grouped into the themes of digitalization, accounting standards, risk management, ESG, data security, and accountant competency. The results of the reading were then synthesized to answer the research questions in the introduction. Thus, the validity of the article is established through coherence of arguments, inter-theme triangulation, and traceability of references, rather than through claims of statistical completeness over the entire population of articles [26], [27].

RESULTS AND DISCUSSION

Major Trends in Banking Accounting

The first trend is the automation of accounting processes and reconciliation. Banks are increasingly using RPA, digital workflows, optical character recognition, and application programming interface integration to accelerate transaction recording, account reconciliation, interest income recognition, provision calculation, and management reporting. As a result, the accounting function is shifting from manual processing to validation, exception analysis, and data quality control [28], [29], [30].

The second trend is the integration of data analytics and AI in risk reporting. Credit scoring models, early warning systems, fraud detection, and ECL calculation use increasingly granular data. This integration addresses the need for reporting that is not only historical but also forward-looking. However, banks must ensure that the models used can be validated, explained, free from material bias, and adequately documented for audit purposes [11], [13].

The third trend is a shift towards real-time reporting and continuous monitoring. With system connectivity, management can more quickly monitor liquidity indicators, credit quality, risk limits, and financial positions. In a crisis situation, the speed of information becomes crucial for decision-making.

However, real-time reporting is only valuable if supported by strong data governance, data standards, and automated controls [21], [31], [32].

The fourth trend is the expansion of reporting from financial information to sustainability information. Banks face demands from investors and regulators to disclose ESG exposure, including climate risks and sustainable financing. This is transforming banking accounting into an integrated reporting system that connects profitability, risk, and social-environmental impact [7], [8].

2. Key Challenges in Modern Banking Accounting

The first challenge is the quality and integration of data. The implementation of IFRS 9/PSAK 71, credit risk analytics, and ESG reporting requires long, complete, consistent, and traceable historical data. Many banks still face data silos between units, differences in definitions, and limitations in metadata. If the input data is unreliable, ECL models and risk disclosures can produce misleading information even though the methodology appears sophisticated [33], [34], [35].

The second challenge is model risk. Machine learning and statistical models provide predictive capabilities, but they can become black boxes. In banking accounting, model risk includes specification errors, overfitting, data bias, parameter instability when economic conditions change, as well as the use of undocumented judgment. Therefore, model validation, back-testing, governance committees, and audit trails become important parts of internal control [36], [37], [38].

The third challenge is cybersecurity and privacy. Bank accounting data contains information on transactions, balances, customer identities, and credit exposure. Disruptions to this data can affect financial statements and public trust. Cyber risks also need to be disclosed adequately so that stakeholders understand the quality of the bank's digital controls [14], [16].

The fourth challenge is regulatory complexity. Banks must comply with accounting standards, prudential regulations, personal data protection, anti-money laundering provisions, sustainability reporting requirements, and technology risk management guidelines. The interaction between these regulations can create trade-offs, for example between data granularity for analytics and the principle of data minimization in privacy protection [39], [40], [41].

The fifth challenge is human resource readiness. Banking accountants need to understand accounting standards, macroeconomics, risk statistics, technology, information security, and ESG. Competency gaps can hinder transformation because technology is only effective when used by personnel who are able to interpret results and assess implications professionally [42], [43], [44].

4.3 IFRS 9/PSAK 71 as a Convergence Point of Accounting and Risk Management

IFRS 9/PSAK 71 becomes the clearest convergence point between accounting and risk management. ECL estimation requires probability of default, loss given default, exposure at default, staging, and forward-looking information. Thus, the credit loss reserve figures are not merely the result of accounting entries, but the output of a risk architecture that requires data, models, judgment, and governance [45], [46], [47].

The literature results indicate that the impact of IFRS 9 is not unidirectional. On one hand, ECL accelerates loss recognition and can enhance risk transparency. On the other hand, ECL can increase profit volatility, alter lending behavior, and provide room for management judgment. Therefore, banks need to balance the timeliness of risk recognition with methodological consistency, adequacy of documentation, and comparability across periods [1], [6], [9].

In the context of Indonesia, PSAK 71 demands stronger integration between accounting units, credit, risk, information technology, and internal audit. Banks need to have clear staging policies, credible macroeconomic data sources, documented scenarios, as well as governance over management overlays. Auditors need to evaluate the reasonableness of assumptions, sensitivities, and model consistency, while regulators need to ensure that the implementation of PSAK 71 is not only formal but also substantive[48], [49], [50].

4. ESG and Sustainable Banking Accounting

The integration of ESG into banking accounting broadens the concept of risk. Credit risk is no longer only influenced by debtor characteristics and macroeconomic conditions, but also by climate risk, energy transition, reputation, and changes in investor preferences. Financing for sectors vulnerable to carbon regulation can affect asset quality and future loss provisions [51], [52], [53].

Banks need to develop a reporting system that links financing data with sector classification, emissions, sustainable taxonomy, and responsible financing policies. This information is important for portfolio management, communication to investors, and sustainability reporting compliance. However, ESG reporting faces challenges of comparability, reliability, and assurance. Therefore, best practices require clear measurement standards, verification processes, and integration with internal controls [54], [55], [56].

Credible ESG reporting can strengthen the legitimacy of banks and support long-term value, but symbolic disclosure can pose a risk of greenwashing. Banking accountants have a strategic role in ensuring that ESG information has a verifiable data basis, is consistent with the bank's strategy, and is related to relevant financial risks [49], [54], [56], [57], [58].

5. Data Security and Digital Internal Control

Data security has become a prerequisite for digital banking accounting. In a digitized system, access control errors, encryption failures, vendor weaknesses, and cyberattacks can affect transaction integrity. Therefore, internal controls need to be redesigned from manual controls to system-based controls, anomaly monitoring, digital segregation of duties, and documented incident response [17], [59], [60].

Digital internal control must involve three lines of defense. Business units and accounting are responsible for the accuracy of transactions and compliance with procedures. Risk management and compliance functions monitor technology, privacy, and model risks. Internal audit provides independent assurance on the design and effectiveness of controls. In banks increasingly reliant on third parties and the cloud, third-party risk management becomes an important part of reporting accountability [60], [61], [62].

6. Strategic Implications for Banks, Regulators, Auditors, and Academics

For banks, the main strategic implication is the need to build enterprise data governance. Banks need to unify definitions of data, data ownership, data quality, metadata, lineage, and data access. Without this foundation, AI investments and ESG reporting will not produce reliable information [63], [64].
For regulators, the transformation of banking accounting demands adaptive supervision. Regulators need to assess not only the financial statement figures but also the processes and systems that produce those figures. Supervisory technology, digital reporting, and model risk management guidelines can help ensure that innovation does not reduce financial system stability [39], [65], [66].
For auditors, the main challenge is expanding audit procedures to areas such as data analytics, model validation, cybersecurity controls, and assurance over ESG information. Auditors must be able to test data quality, understand algorithms, assess macroeconomic assumptions, and evaluate information system controls [67], [68], [69].

For academics, this article highlights the need for more contextual empirical research. In Indonesia, this research, for example, assesses the impact of PSAK 71 on provisions, credit behavior, profit volatility, bank risk, as well as the relationship between ESG disclosure and bank capital costs. Research also needs to examine how digital maturity affects the quality of reporting and the operational efficiency of banks [50], [70], [71].

CONCLUSIONS AND RECOMMENDATIONS

Banking accounting is undergoing a fundamental transformation. The accounting function, which was previously seen as a process of recording and periodic reporting, has now become an information infrastructure that supports risk management, strategic decision-making, regulatory compliance, and value communication to stakeholders. This transformation is primarily driven by the digitalization of financial services, the development of fintech, the use of big data and AI, the implementation of IFRS 9/PSAK 71, increasing cyber risks, and ESG reporting

The main trends identified in this article are the shift toward digital accounting, real-time reporting, continuous monitoring, the use of predictive analytics, and the integration of financial and non-financial information. Modern banking requires accounting systems that are not only historically accurate but also capable of providing early signals regarding credit, liquidity, operational, cyber, and sustainability risks. Thus, the relevance of banking accounting is increasingly determined by data quality, model quality, and governance quality. The challenges faced are not simple; for example, the implementation of IFRS 9/PSAK 71 demands a reliable, explainable, and consistent expected credit loss model. Digitalization opens up efficiency opportunities but also expands risks to data security, privacy, and dependence on third-party technology. ESG reporting strengthens the bank's social accountability but requires measurement standards, internal controls, and assurance to prevent it from becoming merely symbolic disclosure. All these challenges indicate that technology, accounting standards, and governance cannot be separated.

This article emphasizes that strategies for strengthening banking accounting need to be carried out in an integrated manner. Banks need to build enterprise data governance, model risk governance, digital internal controls, and accountant competencies that combine accounting, technology, risk, and ESG. Regulators need to develop a supervisory approach that understands digital processes and model risks. Auditors need to strengthen assurance capabilities over information systems, ECL models, and non-financial data. Educational institutions need to update banking accounting curricula to align with the needs of the digital era.

Future research suggestions include several directions. First, empirical research needs to test the impact of PSAK 71 on provisioning behavior, earnings volatility, and bank credit allocation in Indonesia. Second, research needs to assess the relationship between digital maturity and the quality of financial reporting, operational efficiency, and cyber risks. Third, studies on assurance over ESG and the integration of climate risk into banking credit models remain very open. Fourth, research on explainable AI in credit risk estimation and fraud detection is important to bridge the need for model accuracy with auditability requirements. Fifth, comparative cross-country research can help explain how variations in regulation, governance, and institutional quality affect the effectiveness of banking accounting transformation.

FURTHER STUDY

This research still has limitations so that further research is needed on the topic of Banking Accounting Transformation in the Digital Era: Data Analytics, Cyber Risk, and ESG Reporting to perfect this research and increase insight for readers and authors.

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