IJEC
International Journal of Economics
https://ejournal.ipinternasional.com/index.php/ijec
e-ISSN: 2961-712X
Vol. 3 Issue 2, July-December 2024
DOI: 10.55299/ijec.v3i2.1024

Towards Better Financial Governance: The Urgency of Model Risk Management in Indonesia Viewed Through Maqashid Shariah

Novingky Ferdinand
Doctoral Program in Sharia Science, Faculty of Sharia and Law, Universitas Islam Negeri Sunan Kalijaga, Indonesia
Corresponding Author: novingky.ferdinand@gmail.com
Article history: received August 05, 2024; revised September 04, 2024; accepted September 05, 2024

Abstract

This study assesses the adequacy of Model Risk Management (MRM) frameworks within Indonesian Islamic banking by utilizing Maqashid Shariah principles as a tool to align these frameworks more closely with global standards, specifically focusing on safeguarding life (Hifzh Al-Nafs) and property (Hifzh Al-Mal). Through a comparative literature review, this research examines the structure and effectiveness of MRM practices in Indonesia, referencing regulations such as POJK 65/2016 and SEOJK 25-SEOJK.03-2023, against those in developed financial markets such as the USA, UK, Europe, Japan, and UAE, with an emphasis on governance, lifecycle management, and internal audit processes. The findings suggest that Indonesia's current MRM frameworks are somewhat rudimentary when contrasted with international norms. Key areas identified for enhancement include expanding the scope, enhancing governance structures, refining model lifecycle management, and strengthening internal audits and oversight mechanisms. By employing Maqashid Shariah principles as an analytical tool, this paper proposes enhancements to MRM frameworks that can significantly improve the stability and compliance of Islamic banks in Indonesia, promoting greater global competitiveness and adherence to Shariah principles. This approach not only integrates traditional MRM approaches with Islamic ethical standards but also provides a tailored framework for regulatory enhancements that support a stable, compliant, and ethical Islamic banking environment.

Keywords: Model Risk Management, Islamic Banking, Maqashid Shariah,

INTRODUCTION

In the dynamic landscape of the global financial sector, the significance of Model Risk Management (MRM) has seen a notable escalation. Financial institutions globally are progressively depending on advanced models to forecast results, assess risks, and form crucial judgments. These models vary from uncomplicated rules-driven strategies to exceedingly intricate AI and machine learning (ML) models, especially common in domains like credit risk, insurance risk, and other categories of financial risk. Nevertheless, these models might encounter sporadic breakdowns, leading to substantial financial setbacks. The primary aim of MRM is to diminish these uncertainties by ensuring the precision and dependability of financial models, which stands as a pivotal component in upholding the stability and trustworthiness of financial infrastructures. By executing meticulous validation processes and continuous surveillance, financial establishments can preemptively identify and rectify any potential shortcomings in models before they culminate in adverse consequences.

Internationally, within the United States, the Federal Reserve's SR 11/7 guideline provides detailed instructions for overseeing model risk, emphasizing the necessity for thorough testing and validation procedures to ensure the precision and reliability of models (*The Fed - Supervisory Letter SR 11-7 on Guidance on Model Risk Management*, 2011). In Europe, financial regulators under the guidance of the ECB's Guide to Internal Models mandate that banks demonstrate the reliability and suitability of their models in the context of their capital requirement evaluations (European Central Bank, 2019). These regulatory frameworks are designed to improve the transparency and accountability of financial institutions and to safeguard investors and maintain market stability. Additionally, they are instrumental in cultivating confidence and assurance in the financial system by establishing clear expectations for risk management practices and fostering a culture of compliance within organizations.

Moreover, the implementation of regulatory frameworks is essential in reducing systemic risks through the oversight of banks in establishing resilient risk management mechanisms that can endure economic downturns and financial crises. Monetary regulations, illustrated by the mandates of the Monetary Authority of Singapore (MAS), are intended to safeguard the stability and durability of banking systems by mandating adequate capital reserves, efficient liquidity management, and holistic risk mitigation strategies (Quinn,S.T., Hsu,P.K.,& Ashraf,S.S.2023). They also encourage financial institutions to continually refine their risk evaluation methodologies and adapt to changing market conditions,

e-ISSN: 2961-712X
Vol. 3 Issue 2, July-December 2024
DOI: 10.55299/ijec.v3i2.1024

thereby promoting a proactive approach to risk management that is crucial for the long-term viability and strength of the financial sector.

The SS1/23 framework in the United Kingdom and the FEAT principles in Singapore exemplify advanced approaches to integrating ethics and transparency in financial modeling, particularly with the increasing use of artificial intelligence (AI) and machine learning. These regulatory frameworks are designed to maintain high ethical standards and transparency as AI technologies become more prevalent in financial systems.

The SS1/23 framework, issued by the Prudential Regulation Authority (PRA) of the UK, provides detailed guidelines on managing financial models that incorporate AI and machine learning. It outlines requirements for risk assessment, model validation, and governance, ensuring that models are reliable and ethically managed (SS1/23 – Model Risk Management Principles for Banks, 2023). The principles known as FEAT, as delineated by the Monetary Authority of Singapore (MAS), offer direction to financial institutions regarding the ethical utilization of AI and data analytics. These principles underscore the importance of fairness, ethics, accountability, and transparency, with the goal of guaranteeing that financial modeling and decision-making processes driven by AI are equitable, morally upright, and clear. The FEAT principles help institutions mitigate risks associated with AI applications and enhance confidence in digital financial technologies (Monetary Authority of Singapore, 2018).

Together, the SS1/23 and FEAT frameworks represent proactive efforts by regulatory bodies to ensure that new financial technologies adhere to ethical standards and regulatory requirements, safeguarding societal values in the rapidly evolving financial sector.

The guidelines underscore the critical significance of ethical considerations, accountability, and robust governance frameworks to effectively mitigate the risks associated with advanced digital technologies. Moreover, they stress the imperative need for ongoing surveillance and assessment of AI algorithms to ensure their continuous alignment with ethical norms and regulatory mandates.

In contrast, Indonesia's approach to model risk management, particularly within its Islamic banking sector, is still developing. The regulations defined by the OJK, such as SEOJK Number 25/SEOJK.03/2023 and POJK Number 65/POJK.03/2016, are primarily aimed at risk management for Shariah-compliant banks and do not extensively address the specific challenges posed by model risk. These regulations include certain validation mechanisms but lack the broad scope and depth found in more developed financial markets. To bridge this gap, Indonesia could significantly benefit from incorporating international best practices in model risk management, as evidenced by frameworks in other countries.

For instance, the Federal Reserve's SR 11/7 in the United States provides comprehensive guidelines that emphasize rigorous testing, validation, and continuous monitoring of financial models to ensure their accuracy and reliability. Similarly, Japan's Financial Services Agency (FSA) guidelines enforce meticulous validation and risk assessment protocols, particularly for systemically important banks. These frameworks ensure that institutions crucial to financial stability are comprehensively regulated, focusing on detailed risk management across all model stages.

In the UK, the Prudential Regulation Authority (PRA) mandates robust governance frameworks and lifecycle management of models, ensuring that all financial institutions adhere to stringent risk management practices that enhance systemic integrity. This broad approach helps mitigate potential disruptions across the financial system. United Arab Emirates also adopts a rigorous model risk management framework, which aligns with international standards and caters specifically to the unique aspects of Islamic finance. This includes detailed governance and thorough ongoing evaluations of financial models to ensure they meet both financial and Shariah compliance standards.

Utilizing Maqasid Shariah as an analytical tool offers a critical perspective in evaluating the urgency and appropriateness of adopting Model Risk Management (MRM) regulations from countries with established frameworks into Indonesia's Islamic banking sector. Maqasid Shariah, which focuses on preserving the five essential elements of Islamic law—faith (din), life (nafs), intellect (aql), progeny (nasl), and wealth (mal), serves as a comprehensive guide to ensuring the well-being and ethical integrity of individuals and society (Ibn Asyur, 2023). This framework is instrumental in assessing whether the integration of international MRM standards aligns with the principles of justice, welfare, and ethical conduct, which are pivotal for the performance and ethical governance of Islamic banks.

Maqasid Shariah offers a robust ethical framework that aligns well with the principles of risk management. This Islamic legal framework can serve as a crucial tool for regulators in Indonesia to evaluate and enhance their MRM practices, ensuring that they not only protect against financial risks but also uphold ethical standards and contribute positively to societal welfare. By utilizing the principles of Maqasid Shariah as an evaluative tool, Indonesian regulators can assess the urgency of implementing Model Risk Management (MRM) within Islamic banking. Maqasid Shariah, with its emphasis on justice, equity, and the welfare of the community, provides a comprehensive framework to gauge not only the financial stability but also the ethical implications and social responsibilities of financial activities. This approach enables a comprehensive evaluation of how introducing MRM at this juncture could bolster the robustness and sustainability of the financial system, ensuring alignment with the ethical and operational principles of Islamic law.

This analysis will employ Maqasid Shariah as a vital tool to scrutinize the urgency of adopting Model Risk Management (MRM) practices within Indonesia's Shariah banking regulations. By comparing Indonesian regulations with

e-ISSN: 2961-712X
Vol. 3 Issue 2, July-December 2024
DOI: 10.55299/ijec.v3i2.1024

global standards, this study aims to identify key areas for regulatory improvement. This will not only enhance the robustness of the Islamic banking framework in Indonesia but also ensure its compliance with both international best practices.

Literature Review

Model Risk

Model risk denotes the possibility of unfavorable outcomes resulting from the utilization of inaccurate or unsuitable models in the process of making financial decisions. This risk has the potential to result in notable financial setbacks, incorrect financial reports, inappropriate managerial choices, and harm to one's reputation. The escalating dependence on sophisticated quantitative models within the financial sector has amplified concerns regarding model risk, given that these models are applied for a variety of functions such as valuation, loan assessments, inventory control, and analysis of customer behavior (Goss, 2017). This type of risk arises because models, which are simplifications of reality, often rely on assumptions and approximations that may not hold true under all conditions, especially during periods of market stress (Bellini, 2022).

Model risk is a unique type of financial risk that arises from the inaccuracies and limitations inherent within the models used to estimate other financial risks, such as credit risk, market risk, operational risk, and counterparty risk. Unlike these other types of risks, which are associated with specific financial activities and their inherent uncertainties, model risk specifically pertains to the potential for models to produce incorrect or misleading results due to errors in model design, implementation, or assumptions. This risk is particularly significant because financial institutions heavily rely on these models for decision-making and risk management (Validation of Risk Management Models for Financial Institutions, 2023).

Credit risk, also known as default risk, refers to the likelihood that a borrower will fail to meet their debt obligations, leading to financial losses for the lender. This risk is a significant concern for banks and financial institutions, as it directly impacts their profitability and stability. Various models are employed to estimate the probability of default (PD), which is a quantitative measure of credit risk. These models can be broadly categorized into structural and reduced form models. Structural models assess the likelihood of default based on a company's assets and liabilities, predicting default when the market value of assets falls below the debt owed (Jumbe & Gor, 2022). Model risk measurement is a multifaceted field that employs various approaches to assess the reliability and performance of financial models under different conditions. One prominent method is the worst-case scenario approach, which involves evaluating the model's performance under the most adverse conditions. This approach is akin to deviation measures and is applied to a set of forecasts obtained by different models, providing insights into how model risk tends to increase before and during crisis periods (Müller & Righi, 2019).

Model risk, denoting the potential for a model to generate inaccurate predictions, may indeed be exacerbated by the absence of comprehensive data, thereby constraining its capacity to forecast future events with precision. This issue is intricate and can originate from a variety of sources. For instance, the insufficiency of high-quality input data encompassing operational, environmental, and maintenance data can create significant barriers in the execution and validation of models. This challenge is underscored by the necessity for a universal framework for validating prognostic models when faced with constraints in data availability (Meghoe et al., 2023). Financial institutions are increasingly recognizing model risk as a significant vulnerability, necessitating robust governance processes and risk management strategies to mitigate its impact (Hassani & Hassani, 2019). Effective management of model risk indeed requires a multifaceted approach that encompasses both technical and strategic dimensions. On the technical side, model validation and stress testing are critical components. Validation ensures that models are robust and reliable, addressing various risk areas such as market risk, interest rate risk, and credit risk, among others (Validation of Risk Management Models for Financial Institutions, 2023).

Thus, model risk, while sharing the commonality of uncertainty with other financial risks, is distinct in its focus on the potential flaws within the models used to estimate and manage those risks. This type of risk arises from the possibility that the models employed may be incorrect or mis-specified, leading to inaccurate risk assessments and potentially significant financial consequences. The importance of model risk has been increasingly recognized in the financial industry, particularly in the context of complex markets and a wide range of implemented models (Gianfreda & Scandolo, 2023).

Model Risk Management

Model Risk Management (MRM) has a vital role within financial institutions, responsible for identifying, evaluating, and mitigating risks linked with inaccuracies in financial models. Financial models play a pivotal role in facilitating crucial decision-making processes like risk evaluation, pricing strategies, and long-term planning. Nonetheless, these models can pose significant risks if they fail to precisely capture the intricate financial dynamics due to errors in design, implementation, or operational utilization as highlighted by studies (Hicham & Ibnalkadi, 2021; Bellini, 2022).

An effective MRM strategy involves robust validation procedures to ensure the accuracy and dependability of models under various circumstances. This comprehensive approach includes extensive testing against historical data and scenario evaluations to gauge the resilience of models during extreme market conditions. It is imperative to continually monitor and update models to align with evolving market dynamics and regulatory requirements, thereby boosting their reliability and compliance as observed in recent research (Bellini, 2022). The period of the 2007-2011 financial crisis underscored the repercussions of inadequate MRM, prompting regulatory authorities to bolster supervision and implement

e-ISSN: 2961-712X
Vol. 3 Issue 2, July-December 2024
DOI: 10.55299/ijec.v3i2.1024

stringent MRM frameworks on a global scale. Financial institutions have since elevated their MRM methodologies by integrating detailed validation frameworks, regular risk evaluations, and strict adherence to updated regulatory protocols, as evidenced by recent studies (Morini, 2021).

Aside from technical processes, MRM necessitates a robust governance structure encompassing clear guidelines on model usage, routine audits, and a culture that fosters risk consciousness among all stakeholders. Training initiatives concentrating on the intricacies of model risks and effective risk mitigation strategies are fundamental in equipping the workforce with the knowledge to proactively identify and address potential risks, as highlighted by recent literature (Hicham & Ibnalkadi, 2021).

Prominent financial regulators at the global level, such as the European Central Bank and the Federal Reserve, have devised specific directives emphasizing the significance of resilient MRM systems. These guidelines advocate for a comprehensive approach to managing model risk, which includes the formulation of internal policies and procedures to ensure consistent assessment and enhancement practices across various financial institutions, as emphasized in regulatory documents (European Central Bank, 2019).

Implementation of Model Risk Management

Model Risk Management (MRM) in the banking industry is a critical component of overall risk management, addressing the potential economic or reputational losses due to errors in model development, implementation, or use. The importance of MRM has been underscored by the financial crisis of 2007-2011, which highlighted the dangers of over-reliance on financial models without proper validation and testing (Validation of Risk Management Models for Financial Institutions, 2023). Effective MRM involves a systematic approach to quantifying model uncertainty and determining risk bounds, which is essential for actuaries, risk managers, and regulators (Rüschendorf et al., 2023).

Deploying a risk management framework fundamentally involves establishing a robust internal control system, which is essential for enhancing the overall efficiency and competitiveness of enterprises by managing diverse and complex risks in today's globalized, digitalized, and networked environment. Internal control systems are indispensable for both private and public sector entities, as they help mitigate risks from internal and external sources, ensuring the achievement of organizational objectives and optimal performance levels (Zhang, 2023)

The successful implementation of a risk management framework within financial institutions demands a thorough and methodical approach to effectively mitigate model risk. Model validation involves a comprehensive framework that includes calibration, stress testing, and empirical analyses such as the probability integral transform to build confidence in the model's quality (Dacorogna, 2023). The validation process must address various types of risks, including market risk, interest rate risk, retail and wholesale credit risk, compliance risk, and investment management risk, each requiring tailored validation approaches.

The recommended optimal approach to model validation underscores three key elements: model validation governance, policy, and process. Model validation governance is responsible for establishing a transparent structure and assigning accountability within the organizational framework (Validation of Risk Management Models for Financial Institutions, 2023). Devising a comprehensive monitoring strategy for model implementation involves several critical steps, including continuous testing and assessment of model performance, and establishing performance criteria along with corrective action plans. Initially, it is essential to implement a sequential monitoring scheme that can detect relevant changes in model quality, distinguishing between minor fluctuations and meaningful degradations, thus ensuring reliability in dynamic environments (Heinrichs, 2023).

Understanding the taxonomy of model risk is crucial for developing effective strategies to mitigate these risks, as it encompasses various facets such as model design, implementation, and utilization, each presenting unique challenges and potential risks. In the design phase, inappropriate model selection can lead to significant issues, as the chosen model may not adequately capture the complexities of the data or the problem at hand, leading to inaccurate predictions and decisions. The model validation function plays a crucial role in enhancing the overall effectiveness and reliability of models used in financial decision-making processes by working closely with various departments. This collaboration ensures that models are rigorously tested and validated, reducing model risk and preventing the kind of over-reliance that contributed to the financial crisis of 2007–2011 (Validation of Risk Management Models for Financial Institutions, 2023).

Overview of Global Best Practices in Financial Governance and Model Risk Management

Model risk management (MRM) is a critical aspect of financial governance, vital for the stability and integrity of financial systems worldwide. As financial markets evolve, the complexity of financial models also increases, necessitating robust management practices to mitigate risks associated with model inaccuracies and failures.In the USA, the Federal Reserve's SR 11-7 guideline emphasizes comprehensive governance, risk management, and validation of quantitative models. This guideline underscores the necessity for thorough development, implementation, and continuous evaluation of models to mitigate potential risks (Federal Reserve, 2011). The European Central Bank's Guide to Internal Models underlines rigorous testing and continuous monitoring to ensure the accuracy and appropriateness of models used by banks

e-ISSN: 2961-712X
Vol. 3 Issue 2, July-December 2024
DOI: 10.55299/ijec.v3i2.1024

for capital calculations under Basel regulations (European Central Bank, 2019).

In Canada, the "Enterprise-Wide Model Risk Management for Deposit-Taking Institutions Guideline" by the Office of the Superintendent of Financial Institutions outlines a robust framework for risk management, including detailed procedures for the development, implementation, and ongoing assessment of models (Office of the Superintendent of Financial Institutions, 2017).

Turning to Asia, Japan's Financial Services Agency (FSA) has implemented guidelines that focus on the rigorous testing and validation of models, especially for stress testing and risk assessment. These guidelines are tailored to address Japan's unique financial landscape, including economic volatility and risks from natural disasters (Financial Services Agency of Japan, 2019).

Singapore has also established a comprehensive set of principles for managing model risk, particularly with the integration of AI and machine learning in financial models. The Monetary Authority of Singapore (MAS) has published the FEAT (Fairness, Ethics, Accountability, and Transparency) principles to guide financial institutions in the responsible use of AI and data analytics. These principles aim to ensure that deployments of these technologies are fair, ethically sound, accountable, and transparent, thereby mitigating risks associated with automated decision-making (Monetary Authority of Singapore, 2018).

Meanwhile, in the UAE, the financial regulatory authority has adapted model risk management practices that not only align with global standards but also incorporate principles of Islamic finance, which require financial activities to avoid excessive uncertainty and speculation (Central Bank of the UAE, 2020).

These examples from different jurisdictions around the world highlight the global shift towards more structured and rigorous MRM frameworks. Each regulatory approach, while tailored to address specific regional needs and financial landscapes, underscores the universal importance of comprehensive risk management practices. These include ongoing assessment, rigorous testing, and adaptation to new financial challenges and emerging technologies.

METHODS

In this study, a comprehensive literature review was conducted to examine the role of Maqashid Shariah as an essential analytical tool in evaluating the suitability of integrating Model Risk Management (MRM) practices within the Indonesian Islamic banking sector. The objective was to assess how the Maqashid Shariah principles, which focus on preserving religion, life, intellect, progeny, and wealth, could act as benchmarks for implementing MRM in a manner that supports both financial stability and the ethical mandates of Islamic banking. The review involved a thorough analysis of academic journals, conference proceedings, and industry reports, extracting and critically appraising discussions on MRM within the framework of Shariah compliance. This exploration extended to a comparison of MRM regulations across countries that have established sophisticated frameworks, examining the strengths of each to identify best practices that could inform and potentially enhance Indonesia's regulatory approach.

By leveraging Maqashid Shariah as an evaluative tool, this study not only scrutinized the current risk management practices in Islamic banking in Indonesia but also sought to understand how these practices measure up against international standards. The findings aim to provide a foundation for potential enhancements in regulatory frameworks, ensuring they effectively blend financial prudence with the unique ethical considerations of Islamic finance and draw upon global best practices to strengthen Indonesia's MRM strategies.

RESEARCH RESULTS AND DISCUSSION

From a comprehensive literature review on Model Risk Management (MRM) that sampled various countries with established regulatory frameworks, it has been observed that MRM generally encompasses several broad categories across different jurisdictions. These include:

Scope: This category outlines the breadth and boundaries of what constitutes a model within the context of MRM and delineates the types of risks that are considered under model risk. It ensures a clear understanding of the applicational limits and operational context of models used in financial and risk assessments.

Model and Risk Definition: Under this category, a precise definition of what constitutes a 'model' and the associated 'risks' is provided. This foundational element serves to standardize the terminology and criteria for model evaluation and risk assessment, facilitating uniformity in understanding and communication across various organizational and regulatory landscapes.

Governance: Governance in MRM involves the establishment of policies and a framework that oversee the effective management of model risks. This includes delineating roles and responsibilities at various levels of the organization to ensure that there is accountability and effective management of the models throughout their lifecycle.

Model Lifecycle Management: This involves detailed processes and controls throughout the entire lifecycle of a model, from its development, validation, and deployment to its regular review and eventual decommissioning. Effective lifecycle management ensures that models remain relevant, accurate, and reliable as conditions change over time.

e-ISSN: 2961-712X
Vol. 3 Issue 2, July-December 2024
DOI: 10.55299/ijec.v3i2.1024

Internal Audit and Oversight: Internal audit and oversight mechanisms are critical to ensuring compliance with established MRM policies and the ongoing effectiveness of the model risk framework. This category emphasizes the need for independent reviews and audits to verify the integrity, accuracy, and performance of models against expected outcomes and regulatory requirements.

These categories collectively form the backbone of a robust MRM framework, providing a structured approach to managing and mitigating risks associated with the use of models in financial decision-making processes. Each category is crucial for ensuring that models perform as intended and that they do not expose the organization to unforeseen risks.

Scope

In the realm of Model Risk Management (MRM), the scope essentially determines the regulatory reach and defines which institutions and types of models fall under the oversight framework. This foundational element significantly influences the effectiveness and the systemic impact of regulatory measures across different financial systems. Globally, MRM frameworks show a considerable diversity in how they define and apply scope, each tailored to address the specific needs and risks within their respective financial systems.

In Japan, the Financial Services Agency (FSA) guidelines focus primarily on systemically important banks such as Global Systemically Important Banks and Domestic Systemically Important Banks, ensuring that institutions crucial to financial stability are comprehensively regulated. This targeted approach helps concentrate resources on the most impactful entities but may inadvertently overlook smaller institutions that could still pose significant risks. The USA takes a broader approach, with the Comptroller's Handbook covering all national banks and federal savings associations. This inclusivity ensures a uniform application of MRM standards but can also complicate the enforcement of tailored MRM strategies that address specific institutional needs.

The UK's approach, similar to the USA, encompasses all financial institutions but emphasizes systemic risk management, potentially diluting focus on individual model risks in smaller institutions. Conversely, the UAE extends its MRM scope to any financial institution using significant modelling in their operations, aligning with global standards but imposing potentially high compliance costs on smaller entities.

The European Central Bank adopts a highly focused scope, concentrating on significant banks within the Eurozone that use internal models for regulatory capital calculations. This specificity ensures rigorous oversight but might not address broader model risks outside capital calculation contexts.

In contrast to these approaches, Indonesian regulations under in POJK Nomor 65/POJK.03/2016 and SEOJK Number 25/SEOJK.03/2023 are specifically tailored to Islamic financial institutions, focusing on ensuring that models comply with Shariah principles. This specialized focus effectively addresses the unique requirements of Islamic finance but leaves broader model risks associated with conventional banking practices less emphasized.

The scope of MRM in Indonesia, as outlined in POJK Nomor 65/POJK.03/2016 and SEOJK Number 25/SEOJK.03/2023, while ensuring Shariah compliance, might benefit from incorporating broader risk management principles. By expanding its regulatory scope to include more comprehensive coverage of various types of financial institutions and models, Indonesia could align more closely with global best practices. This expansion would not only enhance systemic stability but also ensure that both financial and ethical integrity are maintained across all banking sectors. Such strategic enhancements would better equip Indonesia to manage an array of emerging risks in an increasingly complex financial landscape.

In the ever-evolving landscape of global finance, the necessity for robust model risk management (MRM) systems is increasingly acknowledged across various regulatory environments. International guidelines such as the Financial Services Agency (FSA) Guidelines in Japan, the Enterprise-Wide MRM Guidelines (2017) in Canada, the SR 11-7 Handbook from the USA, and the UAE Guidelines all present distinct frameworks that underscore the multifaceted nature of model risk management. These frameworks emphasize a comprehensive approach to handling risks linked to financial models, stressing the importance of thorough strategies that cover governance, development, implementation, and continuous validation processes.

A comparative examination of these global standards reveals a notable variation in emphasis and level of detail in their approaches, particularly when compared with the regulations in Indonesia concerning model risk management. The guidelines in Indonesia primarily concentrate on the validation element of model risk management, a significantly narrower focus compared to the broader and more integrated approaches seen in the countries. For example, the Japanese FSA Guidelines and the SR 11-7 Handbook in the USA provide detailed instructions that span the entire life cycle of a model, encompassing development, testing, validation, and revision stages to ensure the models maintain robustness under diverse conditions and consistently deliver expected performance.

Likewise, Canada's Enterprise-Wide MRM Guidelines promote a systemic viewpoint, stressing the importance of integrating risk management into the organizational culture and operational procedures rather than treating it as isolated tasks. This perspective fosters a more adaptable and responsive MRM system capable of adjusting to new challenges and shifts in the market environment. In contrast, the UAE Guidelines focus on aligning risk management practices with the

e-ISSN: 2961-712X
Vol. 3 Issue 2, July-December 2024
DOI: 10.55299/ijec.v3i2.1024

unique requirements and intricacies of the Islamic financial sector, necessitating a thorough understanding of how models operate under various contractual and risk-sharing arrangements.

The current model risk management framework in Indonesia, which predominantly focuses on validation, may not fully encompass the broader advantages of a more extensive and integrated risk management approach. While validation is undeniably crucial, it represents just one aspect of a holistic risk management process. By embracing a more comprehensive strategy akin to those implemented in Japan, Canada, the USA, and the UAE, Indonesian financial institutions could bolster their resilience against model-related failures and enhance their overall risk management capacities.

The contrast in scope and application underlines an opportunity for Indonesian regulators and financial institutions to review and potentially broaden their model risk management frameworks. By incorporating insights from global best practices, Indonesia can strengthen its financial systems against the inherent uncertainties posed by complex financial models, thereby safeguarding the integrity and stability of its financial markets. This comparative analysis not only underscores the significance of adopting global viewpoints on risk management but also acts as a catalyst for enhancing regulatory practices to meet international standards and cater to the specific requirements of the Indonesian market.

Model and Risk Definition

In the realm of Model Risk Management (MRM), the process of delineating what constitutes a "model" and pinpointing the relevant "model risks" stands as pivotal components that serve as the cornerstone for regulatory scrutiny and the implementation of risk management protocols. These definitions play a dual role, establishing boundaries for adherence to regulations and offering guidance for the formulation and execution of risk management strategies within financial systems.

Within the domain of Japan, the guidelines set forth by the Financial Services Agency (FSA) furnish a comprehensive definition of models as quantitative instruments utilized in financial decision-making, risk evaluation, and predictive analysis. The definition of model risk places emphasis on the potential adverse outcomes stemming from model malfunctions or misapplications, which have the capacity to influence financial stability or adherence to regulatory standards. While this expansive scope ensures the inclusive coverage of diverse model categories, it may lack precision, potentially resulting in varied interpretations and applications.

On the other hand, in the United States, the Comptroller's Handbook broadens the scope of models to encompass any quantitative framework employed for position valuation, risk assessment, or strategic decision-making. Model risk specifically pertains to the hazards associated with decisions based on erroneous or improperly utilized model outputs, which could culminate in financial setbacks. This lucidity contributes to the consistent implementation of regulations across a wide spectrum of financial institutions, albeit the broad nature of the scope might pose challenges in ensuring uniform oversight practices.

Across the Atlantic in the United Kingdom, the Bank of England envelops tools utilized for risk quantification, capital computation, and decision-making processes within financial undertakings. Model risk is delineated as the likelihood of substantial financial loss attributed to model deficiencies or inaccuracies, explicitly acknowledging the financial ramifications of model-related risks and augmenting specialized risk management endeavors. Nevertheless, this methodology might fall short in addressing non-financial repercussions, such as harm to reputation.

Meanwhile, the United Arab Emirates mandates that models encompass decision-support mechanisms and risk appraisal models employed within financial entities. The definition of model risk underscores the perils associated with erroneous outcomes resulting from model inaccuracies or misapplications. This unambiguous definition streamlines efficient oversight and conformity procedures, notwithstanding its potential inadequacy in addressing emerging risks stemming from cutting-edge technologies like artificial intelligence and machine learning.

Turning attention to the European Central Bank (ECB), a more focused stance is adopted, linking models specifically to internal models utilized for regulatory capital and risk management functions. Model risk includes the jeopardy of losses due to inadequate model performance, particularly in capital computation, thereby ensuring high precision and reliability in models carrying substantial regulatory implications.

In stark contrast, Indonesian regulations as stipulated under POJK 65-2016 and SEOJK Number 25/SEOJK.03/2023 concentrate primarily on ensuring that models adhere to Shariah principles, with less elaborate discourse on conventional model definitions or the broader spectrum of model risks. While these regulations guarantee the compliance of Islamic financial models with religious and ethical standards, they may fall short in providing a comprehensive overview of model risks pertinent to traditional banking practices observed in other international frameworks.

By expanding the definitions of models and model risks within the framework of POJK 65-2016 and SEOJK Number 25/SEOJK.03/2023 to encompass meticulous considerations of diverse financial model types and a wider array of associated risks, Indonesian regulations could align more closely with global best practices. Such enhancements would not only foster improved management of financial and ethical risks but also promote a more robust regulatory framework in line with international standards.

Governance

e-ISSN: 2961-712X
Vol. 3 Issue 2, July-December 2024
DOI: 10.55299/ijec.v3i2.1024

Governance plays a crucial role within Model Risk Management (MRM) frameworks, as it is fundamental in determining how institutions organize and execute oversight over the development, implementation, and upkeep of financial models. Robust governance is vital to guarantee accountability, transparency, and conformity with both internal policies and external regulations. It sets the foundation for a structured approach that guides institutions in managing risks associated with their models.

In Japan, the guidelines established by the Financial Services Agency (FSA) underscore the importance of governance through the active participation of the board of directors and senior management. This top-down strategy aims to clearly define oversight responsibilities and extend accountability to the highest echelons of management. While this approach enhances oversight, it can also concentrate decision-making authority, potentially leading to delays in addressing emerging model risks.

In the United States, the Comptroller's Handbook delineates specific governance roles and responsibilities across various management levels to ensure thorough oversight of model risks. The clarity provided by these roles enhances accountability and nurtures a proactive risk management culture within institutions. Nevertheless, the detailed and structured nature of this approach may pose bureaucratic hurdles, especially for smaller entities grappling with the resource-intensive demands of such comprehensive governance standards.

The Bank of England in the United Kingdom mandates robust governance frameworks for financial institutions, emphasizing not only oversight of model risks but also the cultivation of a robust risk management culture across the organization. This strategy focuses on both structural governance and embedding risk awareness into the corporate ethos, thereby bolstering the overall effectiveness of governance. However, the triumph of this approach may fluctuate significantly depending on the internal ethos of the organization and the hands-on participation of its management.

In the United Arab Emirates, the governance framework underscores stringent internal controls and the responsibility of senior management, aligning with global best practices to ensure stability and regulatory compliance. Like advanced frameworks in other regions, this approach guarantees that governance structures can effectively handle complex model risks, albeit potentially burdening smaller entities with high compliance costs.

The European Central Bank (ECB) adopts an intricate governance approach that places significant emphasis on the roles of senior management and the board in overseeing model risks, particularly those linked to regulatory capital computations. While this meticulous approach ensures stringent compliance and operational integrity, it may restrict flexibility in governance practices, potentially hindering innovation in model development and utilization.

In contrast to these methodologies, Indonesian regulations under POJK 65-2016 and SEOJK Number 25/SEOJK.03/2023 integrate Shariah governance alongside traditional risk management practices. This dual focus aims to ensure adherence to both financial regulations and Islamic principles, albeit lacking the detailed governance mechanisms related to conventional model risk management found in other global frameworks.

To bolster the governance aspects of POJK 65-2016 and SEOJK 25-SEOJK.03-2023, incorporating more detailed information on roles, responsibilities, and accountability measures could significantly enhance the overall governance framework. By adopting best practices observed in jurisdictions such as the USA or the ECB, Indonesia could guarantee that its financial institutions not only comply with Shariah principles but also effectively manage model risks in accordance with international standards. This alignment with global practices would not only enhance Indonesian frameworks but also fortify the stability and integrity of its financial systems.

Model Lifecycle Management

Model Lifecycle Management within Model Risk Management (MRM) frameworks embody the holistic processes and controls implemented across all phases of a financial model's life cycle, encompassing its inception, verification, utilization, continuous monitoring, and eventual cessation. This structured approach plays a pivotal role in guaranteeing the accuracy, efficiency, and suitability of models in diverse scenarios and evolving environments over time.

The Financial Services Agency (FSA) in Japan advocates for a meticulous strategy concerning model lifecycle management, ensuring that each stage, ranging from development and execution to monitoring and decommissioning, adheres to stringent criteria. This methodical supervision contributes to upholding the credibility and functionality of financial models throughout their active tenure. Nonetheless, the comprehensive nature of this approach necessitates substantial resources, posing potential challenges for smaller financial entities in terms of effective management.

In the United States, the Comptroller's Handbook offers explicit directives regarding the supervision of every facet of a model's lifecycle, guaranteeing that financial institutions uphold robust controls and conduct regular assessments to identify and mitigate any emerging risks. This methodical strategy fosters uniformity and thoroughness in model oversight; however, it may introduce intricate compliance obligations that could overwhelm smaller banks.

The Bank of England, in the United Kingdom, underscores not only the technical dimensions of model management but also the infusion of risk culture throughout the model's life cycle. This entails rigorous examination, validation procedures, and periodic enhancements to reflect evolving market dynamics and business tactics. While this practice ensures the resilience and adaptability of models, it places significant emphasis on institutional risk culture, which may exhibit

e-ISSN: 2961-712X
Vol. 3 Issue 2, July-December 2024
DOI: 10.55299/ijec.v3i2.1024

varying levels of efficacy across different banking establishments.

The framework in the United Arab Emirates accentuates the significance of continuous monitoring and validation across the model lifecycle, aligning with global benchmarks to ensure the currency and compliance of all models utilized in financial decision-making processes. This methodology guarantees heightened levels of model precision and dependability; however, it could also impose substantial operational expenses, particularly on smaller financial entities.

The European Central Bank (ECB) enforces one of the most stringent model lifecycle management frameworks, with a specific focus on models utilized for regulatory capital computations. This encompasses obligatory periodic evaluations, stress tests, and adjustments to validate models' adherence to rigorous regulatory criteria. While this approach ensures accuracy and regulatory conformity, it may fall short in addressing broader applications of models beyond capital calculations adequately.

In comparison, Indonesian regulations outlined in POJK 65-2016 and SEOJK 25-SEOJK.03-2023 primarily aim to uphold Shariah principles throughout the lifecycle of models. Nevertheless, these frameworks lack the intricate procedural guidance present in other jurisdictions concerning the management of traditional model risks, such as those associated with validation procedures, ongoing surveillance, and model decommissioning.

To bolster the efficacy of model lifecycle management in Indonesia, it would be advantageous to embrace more detailed and comprehensive guidelines akin to those observed in jurisdictions like the ECB or the USA. By assimilating these methodologies, Indonesia could ensure that its financial models not only adhere to Shariah principles but also sustain their efficacy and dependability in a dynamic financial milieu.

Internal Audit and Oversight

Internal Audit and Oversight have a vital role in the frameworks of Model Risk Management (MRM), providing a crucial layer of examination to guarantee that models operate as intended and adhere to both internal regulations and external standards. This function is crucial in upholding the integrity and efficiency of financial models throughout their lifespan. In Japan, the Financial Services Agency (FSA) mandates rigorous internal audits that evaluate the efficiency and adherence of MRM practices. This supervision ensures the continuous adherence of models to established protocols and aids in pinpointing areas necessitating enhancements. The emphasis on the strength of internal audits is fundamental, yet it heavily depends on the institution's ability to conduct comprehensive and unbiased audits, a factor that can vary.

The Comptroller’s Handbook in the United States delineates specific duties for internal audit functions, including routine assessments to confirm the suitability of model risk management procedures and compliance with regulatory benchmarks. The detailed instructions provided help in ensuring thorough oversight, but they also introduce complexity, potentially overburdening smaller establishments with limited audit resources. The Bank of England in the United Kingdom integrates internal audits into a broader governance framework that underscores not only conformity but also the fostering of a robust risk management ethos. This strategy goes beyond mere compliance, aspiring to embed risk consciousness across all organizational tiers. While this encourages a proactive risk management atmosphere, its efficacy could hinge on the existing institutional culture, leading to fluctuations in the quality of audits.

In the United Arab Emirates, the governance structure encompasses stringent internal audits to guarantee that models are supervised according to the highest benchmarks. Analogous to other sophisticated regulatory systems, this approach aligns with global best practices but could exert substantial operational pressures, particularly on smaller financial entities struggling with the resources essential for such exhaustive audits. The European Central Bank (ECB) imposes possibly the most rigorous criteria for internal audits among these jurisdictions, particularly emphasizing the autonomy of the validation function and the thoroughness of scrutiny indispensable for models utilized in regulatory capital computations. This meticulously structured approach ensures accuracy and conformity but might restrict flexibility, potentially stifling innovative strategies in model risk management.

Conversely, Indonesian regulations under POJK 65-2016 and SEOJK 25-SEOJK.03-2023, while concentrating on guaranteeing Shariah compliance throughout model lifecycles, do not offer as detailed guidance on the traditional aspects of internal audit and oversight compared to other regions. This discrepancy indicates a prospect for improvement, where integrating elaborate internal audit procedures could substantially enhance the overall efficacy of MRM frameworks. To better conform to international best practices, Indonesia could gain from enriching the internal audit and oversight elements of POJK 65-2016 and SEOJK 25-SEOJK.03-2023. By embracing a more structured and detailed approach akin to that of the ECB or the USA, Indonesian regulatory frameworks could ensure more thorough and efficient management of both Shariah-compliant and traditional model risks.

Model Risk Management from the Perspective of Maqashid Shariah

Maqashid syariah, the objectives of Islamic law, are of immense importance in influencing both the macroeconomic policies and microeconomic practices within Islamic financial institutions, especially in the critical domain of Model Risk Management (MRM). It is imperative to anchor MRM in the principles of Maqashid syariah to guarantee that the evolution of financial models and risk management strategies complies with Islamic ethical standards, thus not only advancing

e-ISSN: 2961-712X
Vol. 3 Issue 2, July-December 2024
DOI: 10.55299/ijec.v3i2.1024

economic efficiency but also upholding Islamic moral principles. The absence of Maqashid syariah integration in MRM could result in policies and practices that fail to attain the desired welfare outcomes, potentially leading to rigid and non-adaptive operations within Islamic financial sectors.

A profound understanding of Maqashid syariah is essential for effectively dealing with financial and economic challenges that arise in the realm of Islamic finance. It holds a pivotal position in the formulation of Shariah-compliant financial products that aim to not only benefit humanity but also conform to Islamic legal and ethical norms.

When implementing MRM, Maqashid syariah dictates that all facets of risk management, ranging from the inception and implementation of models to their oversight and auditing, must uphold the safeguarding of fundamental Islamic values—religion, life, intellect, progeny, and property. This all-encompassing approach ensures that financial models are not only financially viable but also ethically resilient, fostering equity, openness, and answerability. Specifically, it entails devising MRM frameworks that prevent exploitation (Hifzh Al-Mal), ensuring that financial practices are devoid of deceit and uphold justice in financial transactions; advancing transparency and moral uprightness (Hifzh Ad-Din), aligning operations with Islamic teachings; and fortifying system stability (Hifzh Al-Nafs), guarding against crises that may precipitate socio-economic turmoil.

Therefore, integrating Maqashid syariah into MRM processes within Islamic financial institutions guarantees that operations are not only in accordance with Islamic law but also aimed at nurturing a stable, ethical, and dynamic financial milieu. This amalgamation bolsters sustainable development and augments the legitimacy and efficacy of the financial system, ensuring that it serves the broader objectives of Islamic welfare and societal well-being.

From the Maqashid Shariah viewpoint, the analysis and exploration of Model Risk Management (MRM) are intricately intertwined with the dharuriyyah objectives of Shariah law, which primarily encompass safeguarding wealth (hifzhul mal) and preserving life (hifzhul nafs). This correlation emerges because MRM is primarily concerned with addressing and mitigating risks within finance, and financial dynamics play a crucial role in ensuring human sustenance and well-being. Therefore, understanding and effectively managing model risk is imperative in upholding the fundamental principles of Shariah law related to the protection of assets and the sanctity of life.

Hifzh Al-Nafs

In the realm of Model Risk Management (MRM), applying the principle of Hifzh Al-Nafs (protection of life) emphasizes the critical role of ensuring financial systems are stable and secure, directly contributing to the safeguarding of human life. Globally, robust MRM frameworks demonstrate that comprehensive governance, precise risk definitions, diligent lifecycle management, and stringent internal audits significantly mitigate systemic risks, crucial for maintaining public trust and welfare.

Effective governance in MRM ensures that financial institutions operate under frameworks that minimize systemic risks. In countries like the USA and the UK, MRM's broad coverage of financial institutions helps mitigate potential economic disruptions before they escalate into crises. This comprehensive oversight is essential in protecting lives by maintaining economic stability and preventing financial collapses that could lead to widespread hardships.

Clear definitions of models and associated risks ensure that all stakeholders have a common understanding, which is vital for effective risk management. This clarity helps prevent financial disasters by enabling more precise risk management and ensuring that financial decisions are based on accurate and current data, thereby supporting market stability and consumer confidence.

In jurisdictions such as the European Central Bank and Japan, stringent management of the entire lifecycle of financial models ensures that they remain relevant and accurate as market conditions evolve. This prevents outdated or inaccurate models from influencing financial decisions, thus averting potential economic downturns that could impact public welfare.

The implementation of regular and rigorous internal audits, as observed in advanced MRM frameworks like the ECB, ensures ongoing compliance with established standards and adaptability to emerging risks. These audits are crucial for maintaining the integrity and effectiveness of financial models, preventing failures that could lead to severe economic consequences affecting millions of lives.

For Indonesia, the integration of these global MRM practices into local regulations POJK No. 65/POJK.03/2016 and SEOJK No. 25/SEOJK.03/2023 could significantly enhance the protection of life through more stable and resilient financial practices. By adopting detailed governance, clearly defined risk parameters, meticulous model lifecycle management, and robust internal audits, Indonesia's Shariah-compliant financial sector could align more closely with international standards. This strategic improvement would ensure that the financial sector remains robust against crises, protecting the economic foundation upon which the populace's livelihood depends. Such enhancements not only safeguard economic interests but also uphold the well-being and security of Indonesian citizens, thereby fulfilling the critical Shariah principle of protecting life.

e-ISSN: 2961-712X
Vol. 3 Issue 2, July-December 2024
DOI: 10.55299/ijec.v3i2.1024

Hifzh Al Mal

In the framework of Model Risk Management (MRM), the principle of Hifzh Al-Mal (protection of property) underscores the importance of safeguarding financial assets through robust risk management practices. This principle is crucial in ensuring that the financial systems not only operate efficiently but also securely, protecting the wealth and assets of institutions and individuals alike. The stability and integrity of financial models directly influence the protection of property by preventing significant financial losses that can arise from poor financial decision-making.

Effective governance within MRM frameworks ensures meticulous oversight over financial models, which is essential for the protection of assets. In countries like the USA and the UK, the broad regulatory scope includes diverse financial institutions, thereby enhancing the safeguarding of a wider array of financial assets against mismanagement and fraud. This extensive coverage helps in protecting the economic resources of both large and small institutions, ensuring that the property of stakeholders is not jeopardized by inadequate risk controls.

Accurate and clear definitions of what constitutes a financial model, and the associated risks are vital for proper asset management. These definitions enable financial institutions to implement precise risk management strategies, which are crucial in protecting assets from unexpected financial downturns. By clearly identifying potential risks, institutions can devise effective strategies to mitigate them, thereby safeguarding assets.

Thorough management of financial models throughout their lifecycle, as observed in rigorous frameworks like those of the European Central Bank, ensures that models remain effective and relevant. Regular updates, validations, and adjustments prevent the obsolescence of financial models, which is essential for maintaining asset integrity and value. This continuous monitoring and adaptation help in mitigating risks that could potentially lead to substantial financial losses.

Regular and comprehensive internal audits ensure that financial models operate within the set compliance and performance parameters. These audits are critical in detecting any discrepancies or failures in the models that could affect the financial health of institutions. For example, in the ECB, the stringent internal audit requirements help maintain high levels of accuracy and compliance, ensuring that assets are managed under the safest and most efficient conditions.

For Indonesia, enhancing the current MRM practices under POJK No. 65/POJK.03/2016 SEOJK No. 25/SEOJK.03/2023 to more comprehensively cover these aspects would significantly improve asset protection. Integrating global best practices into Indonesian Shariah banking regulations would provide a more robust framework for asset protection, aligning with both financial stability and Shariah compliance. This methodology would ensure that financial institutions are not just protecting their assets from potential risks but also complying with Islamic principles, which in turn would enhance the trust and confidence of stakeholders in the financial system, ultimately promoting greater stability and ethical practices within the industry.

CONCLUSIONS

The detailed review of Model Risk Management (MRM) across various jurisdictions highlights the essential role of MRM in ensuring the financial stability of institutions and the welfare of the communities they support. The use of Maqashid Shariah principles accentuates the urgency of adopting MRM frameworks from countries with established, robust practices. This is particularly crucial for fulfilling the objectives of Hifzh Al-Nafs (protection of life) and Hifzh Al-Mal (protection of property) under Maqashid Shariah, which emphasize safeguarding human life and protecting assets. The current regulatory environment in Indonesia lags significantly behind countries that have effectively implemented MRM. This gap underscores the critical need for Indonesia to enhance its MRM frameworks to prevent economic conditions that could endanger both life and property. Adopting advanced MRM practices not only promotes financial stability and protects stakeholders' assets but also aligns with the ethical mandates of Islamic finance, thus supporting the broader goals of Maqashid Shariah by ensuring justice, welfare, and the preservation of community interests within the financial sector.

Proposals

To bolster the effectiveness and adherence to regulations of Model Risk Management (MRM) frameworks in Indonesia, particularly for Islamic financial institutions, several strategic improvements are imperative. Firstly, it is essential to expand the scope of the MRM frameworks outlined in POJK No. 65/POJK.03/2016 and SEOJK No. 25/SEOJK.03/2023 to encompass a more comprehensive range of financial institutions and models. This expansion will allow for a more extensive coverage of risks and ensure that both large and small institutions are subject to adequate oversight, thereby aligning Indonesian practices with global standards. Secondly, there is a need to enhance governance structures within these institutions. By developing clearer and more detailed governance frameworks that explicitly define roles and responsibilities at all organizational levels, institutions can ensure greater accountability and cultivate a culture that prioritizes compliance and ethical risk management. Thirdly, adopting and implementing global best practices in model lifecycle management is crucial.

This includes regular updates, thorough validation processes, and strategic decommissioning of models to maintain their relevance, accuracy, and effectiveness over time. Lastly, establishing robust internal audit and oversight mechanisms is vital. These should not only verify adherence to financial regulations but also ensure compliance with Islamic principles,

e-ISSN: 2961-712X
Vol. 3 Issue 2, July-December 2024
DOI: 10.55299/ijec.v3i2.1024

through rigorous and frequent audits. Such enhancements will significantly improve the robustness and integrity of MRM frameworks within Indonesia's Islamic banking sector.

Recommendations

To ensure the effective implementation of the proposed enhancements to Indonesia's Model Risk Management (MRM) frameworks, several strategic actions are recommended. Indonesian financial regulators are encouraged to collaborate with international bodies to assimilate global best practices in MRM. This collaboration could include workshops, training sessions, and joint regulatory reviews, facilitating a meaningful exchange of knowledge. Engaging a diverse group of stakeholders—including Shariah scholars, financial experts, and community representatives—is crucial in revising MRM frameworks. Such engagement ensures that the regulations are comprehensive, culturally sensitive, and effectively address the unique aspects of Islamic finance. Additionally, it is vital to establish mechanisms for the continuous monitoring and adaptation of MRM frameworks to respond proactively to new financial modeling challenges and innovations in risk management.

This dynamic approach will enhance the resilience and global competitiveness of Indonesian financial institutions. Furthermore, increasing public awareness and education about the significance of MRM and its role in promoting financial stability and ethical banking practices is essential. This initiative will not only build trust among consumers but also foster greater compliance within financial institutions. By adopting these measures, Indonesia can significantly improve its MRM frameworks, ensuring compliance with international standards while supporting the unique objectives of Islamic finance, thus promoting a more stable, ethical, and dynamic financial sector.

REFERENCES

Central Bank of the UAE, "Model Risk Management Guidelines," 2020.

Dacorogna,M.M..(2023). How to Gain Confidence in the Results of Internal Models? Approaches and Techniques for Validation.11(5).http://doi.org/10.3390/risk11050098

European Central Bank, "Guide to Internal Models," 2019.

Financial Services Agency of Japan, "Guidelines on Model Risk Management," 2019.

Gianfreda, A., & Scandolo, G.. (2023). Assessing model risk in financial and energy markets using dynamic conditional VaRs. https://doi.org/10.1002/asmb.2828

Goss, C. D.. (2017). Managing the Risks Associated with Models: Accountants in All Industries Can Play a Meaningful Role in the Mitigation of Model Risk at Their Organizations. 224(2).b

Heinrichs, F.. (2023). Monitoring Machine Learning Models: Online Detection of Relevant Deviations. abs/2309.15187. https://doi.org/10.48550/arxiv.2309.15187

Hicham and Mohamed Ibnalkadi. (2021). "Introduction to Enterprise & Model Risk Management."

Ibn Asyur, A.-T.. (2023). Pemikiran Maqashid Syariah Al-Tahir Ibn Asyur. https://doi.org/10.20885/mawarid.vol5.iss1.art7

Jumbe, G., & Gor, R. M.. (2022). Credit risk assessment using default models: a review. 1(2). https://doi.org/10.47413/vidya.v1i2.78

Massimo Morini. (2021). "Understanding and Managing Model Risk: A Practical Guide for Quants, Traders, and Validators."

Meghoe, A. A., Loendersloot, R., & Tinga, T.. (2023). Validation of a Physics-based Prognostic Model with Incomplete Data. 14(1). https://doi.org/10.36001/ijphm.2023.v14i1.3283

Monetary Authority of Singapore, "FEAT Principles," 2018.

Müller, F. M., & Righi, M. B.. (2019). Model Risk Measures: A Review and New Proposals on Risk Forecasting. https://doi.org/10.2139/SSRN.3489917

Office of the Superintendent of Financial Institutions, "Enterprise-Wide Model Risk Management for Deposit-Taking Institutions Guideline," 2017.

Quinn, S. T., Hsu, P. K., & Ashraf, S. S. (2023). Financial Regulations and Stability of Banking Systems: A case study of Citibank in Singapore. Journal of Finance and Accounting, 7(4), 1-10. https://doi.org/10.53819/81018102t5195

Rüschendorf, L., Vanduffel, S., & Bernard, C.. (2023). Model Risk Management. https://doi.org/10.1017/9781009367189

SS1/23 – Model risk management principles for banks. (2023, May 10). SS1/23 – Model risk management principles for banks. https://www.bankofengland.co.uk/prudential-regulation/publication/2023/may/model-risk-management-principles-for-banks-ss

The Fed - Supervisory Letter SR 11-7 on guidance on Model Risk Management. (2011, April 4). The Fed - Supervisory Letter SR 11-7 on guidance on Model Risk Management. https://www.federalreserve.gov/supervisionreg/srletters/sr1107.htm

Tiziano Bellini. (2022). "A Gentle Introduction to Model Risk Quantification in Commercial Banking."

Validation of Risk Management Models for Financial Institutions. (2023). Validation of Risk Management Models for Financial Institutions. Cambridge University Press eBooks. https://doi.org/10.1017/9781108608602

Zhang, Z.. (2023). Internal Control Analysis of Enterprise Risk Management. https://doi.org/10.54254/2754-1169/44/20232226