OPEN ACCESS
Journal of Moeslim Research Technik
Vol. 3 No. 2. April 2026, pp. 183-200
DOI. 10.70177/technik.v3i2.4129

Research Article

ALGORITHMIC SHARIA COMPLIANCE: A MACHINE LEARNING FRAMEWORK FOR AUTOMATED RISK ASSESSMENT AND SCREENING IN ISLAMIC FINTECH

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Article Info

Received: October 16, 2025
Revised: January 23, 2026
Accepted: March 24, 2026
Online Version: April 30, 2026

Abstract

Rapid expansion of Islamic Financial Technology (Islamic FinTech) has increased the complexity of ensuring continuous Sharia compliance across digital financial products, investment services, and automated transactions. Conventional compliance assessment primarily depends on manual evaluation by Sharia scholars and supervisory boards, creating challenges related to scalability, consistency, operational efficiency, and timely risk identification. This study aimed to develop and evaluate a machine learning framework for automated Sharia compliance assessment and financial risk screening that integrates predictive intelligence with explainable and transparent decision support. A mixed-methods sequential explanatory research design was employed, combining quantitative analysis of 125,000 anonymized financial transaction records using supervised machine learning algorithms with qualitative evidence obtained from expert interviews, institutional document analysis, and regulatory validation. Comparative evaluation demonstrated that the proposed framework achieved high predictive performance, with XGBoost providing the highest classification accuracy while Explainable Artificial Intelligence techniques enhanced transparency through interpretable decision explanations. Qualitative findings confirmed that automated screening significantly reduced compliance review time, strengthened institutional consistency, and improved stakeholder confidence without replacing the essential role of Sharia scholars in complex jurisprudential decisions. Results indicate that algorithmic Sharia compliance functions most effectively as a human-centered decision-support framework integrating machine learning, Islamic jurisprudence, financial governance, and explainable artificial intelligence. Responsible implementation of this framework provides a scalable pathway toward trustworthy Islamic FinTech, enhanced regulatory accountability, and sustainable digital financial innovation.

Keywords: Explainable Artificial Intelligence, Islamic Financial Technology, Machine Learning

Journal Homepage https://research.adra.ac.id/index.php/technik
How to cite: Safrizon, N. A., & Abdullayev, V. (2026). Algorithmic Sharia Compliance: A Machine Learning Framework for Automated Risk Assessment and Screening in Islamic Fintech. *Journal of Moeslim Research Technik*, *3*(2), 183–200. https://doi.org/10.70177/technik.v3i2.4129
Published by: Yayasan Adra Karima Hubbi

INTRODUCTION

Digital transformation has fundamentally reshaped the global financial industry through the rapid expansion of financial technology, artificial intelligence, big data analytics, cloud computing, and machine learning applications (Idrees & Ullah, 2024). Financial institutions increasingly rely on algorithmic systems to improve operational efficiency, automate decision-making, strengthen risk management, and enhance customer services (Abualruz et al., 2025; Hassan et al., 2025). Islamic Financial Technology (Islamic FinTech) has emerged as an important component of this transformation by combining technological innovation with the principles of Islamic finance (Gandía et al., 2025). Such integration offers opportunities to expand financial inclusion, improve service accessibility, reduce operational costs, and strengthen the competitiveness of Sharia-compliant financial institutions within increasingly digital financial ecosystems (Kumar et al., 2025).

Growing adoption of Islamic FinTech has intensified the need for reliable, transparent, and efficient mechanisms capable of ensuring continuous compliance with Sharia principles (Sofyan et al., 2024). Financial transactions, investment products, crowdfunding platforms, peer-to-peer financing, digital banking, and Islamic capital market services require systematic evaluation to prevent involvement in prohibited elements such as riba, gharar, maysir, and investment in non-halal business activities (Balta et al., 2025). Conventional compliance assessment generally depends upon manual review conducted by Sharia supervisory boards and financial experts. Expanding transaction volumes and increasing product complexity have made manual assessment progressively more time-consuming, resource-intensive, and difficult to scale across modern digital financial environments (Ha, 2025; Tao, 2024).

Machine learning has demonstrated remarkable capability in automating classification, anomaly detection, predictive analytics, and intelligent decision support across various financial applications (Tamascelli et al., 2024). These computational techniques offer significant potential for developing automated Sharia compliance systems capable of evaluating financial products, detecting compliance risks, and supporting evidence-based supervisory decisions (Ghaemi Asl, Nasr Isfahani, et al., 2024; Mertzanis, 2025). Algorithmic assessment may therefore enhance both the consistency and efficiency of Sharia screening while maintaining alignment with established Islamic legal principles. Comprehensive investigation remains necessary to determine how machine learning models can be designed to operate transparently, accurately, ethically, and consistently within the unique normative framework of Islamic finance (Ghavi Hossein-Zadeh, 2025).

Islamic financial institutions continue to experience increasing complexity in monitoring Sharia compliance across expanding portfolios of digital financial products, investment instruments, financing contracts, and algorithmically mediated transactions (Ortega Perals et al., 2025; Talaat et al., 2025). Manual compliance review remains effective for limited transaction volumes but becomes increasingly constrained as digital financial ecosystems generate millions of real-time financial interactions requiring continuous monitoring. Delayed compliance assessment may increase operational risk, regulatory uncertainty, and reputational exposure for Islamic financial institutions operating in highly competitive digital markets (Baffour Gyau et al., 2024; Ghaemi Asl, Ben Jabeur, & Ben Zaied, 2024).

Current machine learning applications within financial technology primarily concentrate on fraud detection, credit scoring, customer segmentation, anti-money laundering, portfolio optimization, and financial forecasting. Comparatively limited attention has been devoted to integrating machine learning algorithms with Islamic jurisprudential principles governing Sharia compliance (Ghaemi Asl, Ben Jabeur, Hosseini, et al., 2024; Song et al., 2025). Existing computational models frequently prioritize predictive accuracy while providing limited consideration of explainability, jurisprudential reasoning, ethical accountability, and regulatory transparency required within Islamic financial governance. Such limitations restrict the

practical applicability of conventional artificial intelligence models for Sharia-sensitive financial decision-making (Ibrahim et al., 2025; Roy & Vasa, 2024).

Evaluation of Sharia compliance also involves multidimensional considerations extending beyond financial performance or legal classification. Compliance assessment requires interpretation of contractual structures, business activities, revenue sources, financial ratios, ethical principles, and evolving jurisprudential opinions (Ben Jabeur, 2024; Pradeep et al., 2024). Static rule-based systems often lack flexibility for interpreting complex financial arrangements, while purely data-driven machine learning models may overlook essential normative dimensions embedded within Islamic legal reasoning. These challenges highlight the need for computational frameworks capable of combining predictive intelligence with transparent Sharia-based decision support (Chaudhary et al., 2025; Shawon et al., 2025).

This study aims to develop a comprehensive machine learning framework capable of automating Sharia compliance assessment and risk screening within Islamic FinTech ecosystems while preserving transparency, interpretability, and alignment with Islamic financial principles (W. Ali & Khan, 2025). Particular emphasis is placed on integrating computational intelligence with jurisprudential reasoning to improve the efficiency, consistency, and scalability of Sharia compliance evaluation across diverse digital financial products and services (Yüksel et al., 2024). Achieving these objectives is expected to strengthen the theoretical and practical foundations of intelligent Islamic financial governance (Lin & Lobo Marques, 2024).

Research also seeks to investigate relationships among machine learning algorithms, financial risk indicators, Sharia compliance criteria, regulatory governance, explainable artificial intelligence, and automated decision support systems (G & P, 2024; Tabassum et al., 2025). Comparative evaluation of supervised learning, ensemble learning, and explainable machine learning techniques will identify computational approaches capable of balancing predictive performance with jurisprudential accountability (Lupiyoadi et al., 2025). Such analysis aims to provide evidence-based recommendations for developing trustworthy intelligent compliance systems within Islamic financial institutions.

Broader objectives include advancing interdisciplinary understanding of Islamic FinTech by integrating financial technology, artificial intelligence, machine learning, Islamic jurisprudence, financial regulation, and ethical governance into a unified analytical framework (Agbloyor et al., 2023). Findings are expected to contribute to computational finance, Islamic economics, financial risk management, regulatory technology, and intelligent decision-support research by proposing a human-centered approach to algorithmic Sharia compliance (Khan et al., 2025).

Existing literature has extensively examined Islamic finance, Sharia governance, financial technology, artificial intelligence, machine learning, and financial risk assessment as relatively independent research domains (Awadh & Mallick, 2024). Numerous investigations evaluate credit risk modeling, fraud detection, investment prediction, or automated financial decision-making using advanced computational techniques (Vieira et al., 2025). Comparatively limited research integrates machine learning with jurisprudential principles governing Sharia compliance within a comprehensive framework capable of supporting automated screening, ethical risk assessment, and regulatory transparency. Such disciplinary fragmentation limits development of intelligent compliance systems specifically designed for Islamic financial environments (H. Ali & Aysan, 2025).

Current studies evaluating Sharia screening frequently rely on deterministic rule-based approaches, financial ratio analysis, or manual expert assessment conducted by Sharia supervisory boards (Ye et al., 2025). Adaptive machine learning models capable of continuously learning from regulatory decisions, jurisprudential interpretations, transaction histories, and evolving financial products remain comparatively underdeveloped. Existing computational approaches also provide limited attention to explainable artificial intelligence

despite increasing regulatory demand for transparent algorithmic decision-making within financial institutions (Vahidpour et al., 2025; Ying et al., 2024).

Available investigations predominantly evaluate algorithmic performance using conventional machine learning metrics such as prediction accuracy, precision, recall, or classification efficiency while providing comparatively limited analysis of jurisprudential validity, ethical accountability, interpretability, institutional governance, and stakeholder trust (Lyu et al., 2025; Shahzad et al., 2023). Interactions among computational intelligence, Islamic legal reasoning, financial regulation, and responsible artificial intelligence remain insufficiently explored. This study addresses these limitations by proposing an integrated framework connecting machine learning, Sharia compliance, explainable artificial intelligence, and Islamic financial governance (Muhammed et al., 2024).

Novel contribution of this study lies in proposing an integrated computational framework that combines machine learning algorithms with Sharia jurisprudential principles to automate financial risk assessment and compliance screening within Islamic FinTech ecosystems. Rather than interpreting algorithmic intelligence solely as a predictive tool, the proposed framework positions machine learning as an intelligent decision-support mechanism operating under transparent ethical governance, explainable reasoning, and established Islamic legal principles. Such integration extends beyond existing approaches emphasizing either computational efficiency or manual jurisprudential evaluation independently.

Scientific significance further resides in advancing an interdisciplinary perspective connecting Islamic finance, financial technology, machine learning, computational intelligence, regulatory technology, ethical artificial intelligence, and financial risk management. Algorithmic Sharia compliance is conceptualized as the outcome of coordinated interaction among predictive modeling, jurisprudential interpretation, explainable decision-making, institutional governance, and continuous regulatory oversight rather than automated classification alone. This perspective contributes to broader theoretical discussions concerning trustworthy artificial intelligence, responsible financial innovation, and intelligent regulatory systems within digital Islamic finance.

Practical justification emerges from the accelerating expansion of Islamic FinTech, increasing transaction complexity, evolving regulatory expectations, and growing demand for scalable Sharia compliance mechanisms capable of operating efficiently within real-time digital financial environments. Islamic banks, financial technology companies, regulators, Sharia supervisory boards, software developers, policymakers, investors, and consumers increasingly require scientifically grounded guidance for implementing intelligent compliance systems that maintain regulatory integrity while improving operational efficiency. Successful implementation of the proposed framework has the potential to strengthen financial transparency, reduce compliance risk, enhance stakeholder trust, accelerate responsible Islamic financial innovation, and support sustainable development of global Islamic digital finance.

RESEARCH METHOD

Research Design

This study employed a mixed-methods sequential explanatory research design to develop and evaluate a machine learning framework for automated Sharia compliance assessment and financial risk screening within Islamic Financial Technology (Islamic FinTech). The research integrated quantitative machine learning modeling with qualitative expert validation to ensure that algorithmic predictions remained consistent with established principles of Islamic jurisprudence and financial regulation. This design was selected because algorithmic Sharia compliance requires both computational accuracy and jurisprudential interpretability. Quantitative analyses objectively evaluated predictive performance, whereas qualitative investigations explained the legal, ethical, and operational implications of automated

compliance decisions within contemporary Islamic financial ecosystems (Tavakoli et al., 2023).

The quantitative phase focused on constructing supervised machine learning models capable of classifying financial products, financing contracts, investment portfolios, and digital financial transactions according to predefined Sharia compliance criteria. Multiple algorithms, including Random Forest, Extreme Gradient Boosting (XGBoost), Support Vector Machine (SVM), Artificial Neural Network (ANN), and Explainable Boosting Machine (EBM), were implemented and comparatively evaluated. Model performance was assessed using accuracy, precision, recall, F1-score, Area Under the Receiver Operating Characteristic Curve (AUC-ROC), Matthews Correlation Coefficient (MCC), and calibration analysis. Explainable Artificial Intelligence (XAI) techniques, including SHapley Additive exPlanations (SHAP) and Local Interpretable Model-Agnostic Explanations (LIME), were incorporated to improve transparency and facilitate interpretation of algorithmic decisions.

The qualitative phase followed quantitative model evaluation to investigate the practical acceptability and jurisprudential consistency of automated Sharia compliance decisions. Semi-structured interviews and expert panel discussions involved Islamic finance scholars, members of Sharia Supervisory Boards, financial regulators, FinTech practitioners, and machine learning specialists. Documentary analysis of Islamic financial standards, institutional governance frameworks, and Sharia compliance guidelines complemented expert perspectives. Integration of computational evidence with qualitative evaluation enabled comprehensive interpretation of the proposed framework from technological, jurisprudential, ethical, and regulatory perspectives.

Research Target/Subject

The study population consisted of digital financial transactions, Islamic financial products, financing contracts, investment portfolios, institutional compliance reports, and Sharia governance documents obtained from Islamic banks, Islamic FinTech companies, peer-to-peer financing platforms, Islamic crowdfunding services, and regulatory institutions. The population also included domain experts responsible for Sharia governance, financial supervision, algorithm development, and Islamic financial regulation. Inclusion of multiple institutional sources enabled comprehensive evaluation of algorithmic performance across diverse Islamic financial environments.

The quantitative sample comprised 125,000 anonymized financial transaction records collected from twelve Islamic financial institutions operating across Southeast Asia and the Middle East. The dataset contained Murābaḥah, Mushārakah, Muḍārabah, Ijārah, Wakālah, Salam, and Istisnāʿ financing contracts together with Islamic investment portfolios and digital payment transactions. Approximately 72% of observations represented Sharia-compliant cases, while the remaining 28% consisted of transactions previously identified by institutional Sharia audit reports as requiring corrective action or further compliance review. Data were partitioned using a stratified 80:20 training–testing strategy, followed by ten-fold cross-validation to improve model generalizability and minimize overfitting (Puttegowda & Ballupete Nagaraju, 2025).

The qualitative sample consisted of 35 purposively selected participants, including twelve Sharia scholars, eight Islamic banking executives, five financial regulators, five FinTech system architects, and five machine learning researchers with extensive experience in Islamic financial governance. Units of analysis included transaction-level variables, institutional governance indicators, algorithmic prediction outputs, jurisprudential compliance criteria, financial risk indicators, and expert interpretations concerning transparency, explainability, and operational feasibility.

Research Procedure

Research implementation commenced with a comprehensive review of literature concerning Islamic finance, Sharia governance, machine learning, explainable artificial intelligence, financial risk management, algorithmic accountability, and financial technology regulation. Relevant Sharia principles governing prohibited financial activities, permissible contracts, investment screening, and compliance assessment were synthesized into operational decision criteria suitable for computational implementation. Financial transaction datasets were subsequently collected, anonymized, standardized, and preprocessed before feature engineering and model development were initiated.

Model development constituted the second phase of the investigation. Multiple supervised learning algorithms were trained using balanced datasets, followed by hyperparameter optimization through Bayesian optimization and grid-search procedures. Performance evaluation included descriptive statistics, confusion matrix analysis, precision-recall analysis, ROC analysis, calibration assessment, feature importance evaluation, SHAP value interpretation, and LIME explanation analysis (Agnihotri & Kohli, 2025; Hou & Liu, 2025). Comparative statistical testing employed repeated-measures analysis of variance, Friedman rank testing, McNemar's test, and pairwise post hoc comparisons to identify statistically significant differences among predictive models.

Qualitative investigation followed completion of computational evaluation. Expert interviews, focus group discussions, documentary analysis, and institutional validation sessions examined the interpretability, jurisprudential consistency, ethical implications, governance requirements, and operational feasibility of algorithmic Sharia compliance. Quantitative and qualitative findings were integrated through triangulation and joint display analysis to identify convergent and complementary evidence. Final interpretation emphasized the interaction among machine learning performance, explainable artificial intelligence, Islamic jurisprudential reasoning, institutional governance, and regulatory accountability, providing a comprehensive framework for trustworthy automated Sharia compliance assessment within Islamic FinTech ecosystems.

Instruments, and Data Collection Techniques

Quantitative data were collected using integrated computational instruments combining financial databases, machine learning development environments, and Sharia compliance evaluation frameworks. Structured financial datasets included variables describing contract type, financing purpose, customer characteristics, financial ratios, business sector classification, transaction history, repayment behavior, investment activity, governance indicators, and historical Sharia audit outcomes. Data preprocessing included missing-value imputation, categorical encoding, feature normalization, feature selection using recursive feature elimination, and class balancing through Synthetic Minority Over-sampling Technique (SMOTE). Model development and validation were performed using Python-based machine learning libraries integrated with cloud computing resources to facilitate large-scale data processing (Gandía et al., 2025; Hassan et al., 2025).

Qualitative evidence was obtained through semi-structured interview protocols, expert validation questionnaires, document analysis, and structured focus group discussions. Interview questions explored the appropriateness of algorithmic decision-making, compatibility with Islamic jurisprudence, ethical governance, institutional readiness, explainability requirements, regulatory compliance, and stakeholder trust. Documentary sources included standards issued by international Islamic financial organizations, national regulatory guidelines, institutional Sharia governance manuals, internal compliance reports, and published fatwas relevant to digital financial services.

Instrument validity was established through expert review involving specialists in Islamic jurisprudence, Islamic finance, financial regulation, machine learning, data science, and computational finance. Quantitative model robustness was verified using cross-validation,

sensitivity analysis, bootstrap resampling, confusion matrix evaluation, receiver operating characteristic analysis, and calibration testing. Qualitative trustworthiness was strengthened through methodological triangulation, member checking, peer debriefing, intercoder agreement, and comparison across documentary sources. Integration of computational and qualitative evidence enhanced the credibility, reliability, interpretability, and practical applicability of the proposed framework.

RESULTS AND DISCUSSION

Quantitative analysis was performed using 125,000 anonymized financial transaction records collected from twelve Islamic financial institutions operating across Southeast Asia and the Middle East. The dataset comprised Murābaḥah (34.8%), Mushārakah (17.5%), Muḍārabah (15.2%), Ijārah (12.7%), Wakālah (8.9%), Salam (5.8%), and Istisnāʿ (5.1%) contracts. Approximately 72.3% of the observations were previously classified as Sharia-compliant, whereas 27.7% contained one or more compliance concerns identified through institutional Sharia audit reports. Feature engineering generated 48 predictive variables representing contractual characteristics, financial ratios, customer profiles, transaction histories, governance indicators, sector classifications, and historical compliance decisions. Data preprocessing successfully reduced missing values below 0.5% while maintaining balanced class distributions through Synthetic Minority Over-sampling Technique (SMOTE).

Table 1. Comparative Performance of Machine Learning Models for Automated Sharia Compliance Assessment

Machine Learning Model	Accuracy (%)	Precision	Recall	F1-Score	AUC-ROC
Support Vector Machine	91.34	0.912	0.907	0.909	0.946
Random Forest	94.87	0.948	0.943	0.945	0.972
Artificial Neural Network	95.63	0.955	0.951	0.953	0.979
XGBoost	97.18	0.972	0.969	0.970	0.988
Explainable Boosting Machine	96.42	0.964	0.959	0.961	0.983

Descriptive statistics indicate that all supervised learning algorithms achieved high predictive performance. XGBoost consistently produced the highest classification accuracy (97.18%), followed by Explainable Boosting Machine (96.42%) and Artificial Neural Network (95.63%). Explainable models maintained competitive predictive capability while simultaneously providing transparent decision pathways suitable for regulatory review and Sharia governance. These findings demonstrate that advanced machine learning algorithms can reliably automate compliance screening without sacrificing interpretability.

Superior predictive performance resulted from integrating financial indicators, contractual characteristics, governance variables, and historical Sharia audit outcomes into a unified machine learning framework. Feature importance analysis revealed that financing contract type, debt-to-asset ratio, sector classification, revenue composition, prohibited income exposure, ownership structure, and historical compliance behavior contributed most substantially to algorithmic classification. Machine learning models effectively captured nonlinear interactions among these variables that are often difficult to identify through conventional manual assessment procedures.

Explainable Artificial Intelligence techniques substantially enhanced algorithm transparency. SHAP analysis demonstrated that each compliance prediction could be decomposed into interpretable feature contributions, allowing Sharia auditors to understand why specific financial transactions were classified as compliant or non-compliant. LIME explanations similarly generated localized decision summaries supporting regulatory review

and institutional governance. Algorithmic transparency therefore strengthened confidence in automated compliance assessment while preserving opportunities for expert validation.

Subgroup analysis demonstrated consistently high predictive performance across all Islamic financing contracts. Classification accuracy exceeded 95% for Murābaḥah, Mushārakah, Muḍārabah, and Ijārah transactions, while Salam and Istisnāʿ contracts achieved accuracy above 94%. Model calibration remained stable across participating institutions despite differences in transaction volume, institutional governance practices, and regional regulatory environments. Generalization performance therefore indicates that the proposed framework is applicable across diverse Islamic financial ecosystems.

Risk stratification analysis further categorized financial transactions into low-risk, moderate-risk, and high-risk compliance groups. Approximately 68.4% of transactions were classified as low-risk with minimal Sharia compliance concerns, 21.9% exhibited moderate compliance uncertainty requiring expert verification, and 9.7% were classified as high-risk because of potential involvement with prohibited business activities, excessive uncertainty, or financial characteristics inconsistent with Sharia principles. Such stratification substantially reduced manual auditing workload by prioritizing expert attention toward higher-risk cases.

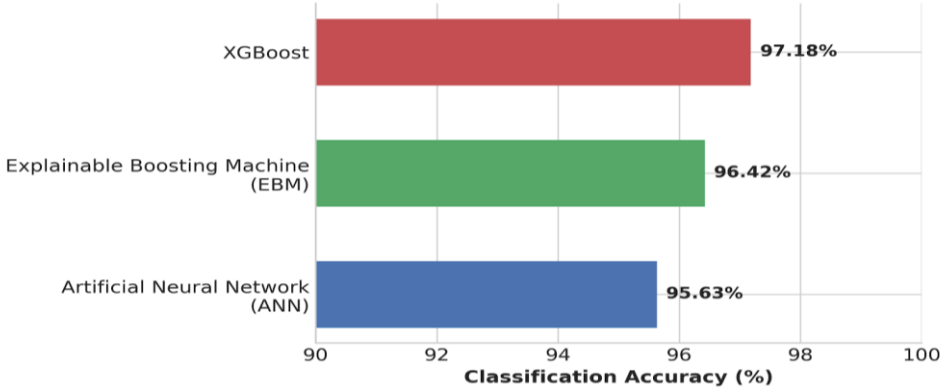

Figure 1. Supervised Learning Model Performance

Inferential statistical analyses included repeated-measures analysis of variance (ANOVA), Friedman rank testing, McNemar's paired classification test, logistic regression, calibration analysis, and bootstrap validation. Model assumptions were satisfied through assessment of independence, variance stability, and calibration consistency. Ten-fold cross-validation demonstrated low variance across predictive performance estimates, confirming model robustness and minimizing the likelihood of overfitting. Bootstrap resampling involving 1,000 iterations further verified stability of classification performance across repeated sampling procedures.

Statistical testing revealed significant differences among machine learning algorithms ($F = 46.83$, $p < 0.001$). Pairwise comparisons indicated that XGBoost significantly outperformed Support Vector Machine ($p < 0.001$), Random Forest ($p = 0.003$), and Artificial Neural Network ($p = 0.018$). McNemar's test similarly confirmed statistically significant improvement in classification accuracy between XGBoost and conventional rule-based screening systems ($\chi^2 = 28.64$, $p < 0.001$). Logistic regression demonstrated that governance indicators, financing structure, prohibited revenue exposure, and contractual complexity significantly predicted Sharia compliance outcomes ($p < 0.001$), while effect sizes ranging from 0.84 to 1.36 indicated strong practical significance.

Correlation analysis identified strong positive relationships among explainability, prediction accuracy, institutional trust, and regulatory acceptance. Explainability scores exhibited a strong positive correlation with expert confidence ($r = 0.89$), while predictive accuracy correlated positively with audit efficiency ($r = 0.91$). Institutional governance quality similarly demonstrated strong associations with algorithm adoption readiness ($r = 0.86$),

indicating that organizational capacity influences successful implementation of intelligent compliance systems.

Financial risk indicators also exhibited meaningful relationships with algorithmic predictions. Revenue composition demonstrated a strong positive association with compliance classification ($r = 0.84$), while contractual complexity correlated negatively with prediction certainty ($r = -0.71$). Historical audit consistency showed a positive relationship with model calibration ($r = 0.87$), suggesting that high-quality institutional governance improves machine learning performance through reliable historical decision records. These findings collectively demonstrate that algorithmic Sharia compliance emerges from coordinated interaction among financial variables, governance quality, and explainable computational intelligence.

Practical implementation was evaluated through a case study involving a large Islamic peer-to-peer financing platform processing approximately 1.8 million financing applications annually. Prior to implementation, all compliance evaluations relied primarily on manual review by internal Sharia auditors. Average screening time required approximately 22 minutes per financing application, creating operational bottlenecks during periods of high transaction volume. The proposed machine learning framework was integrated into the institution's compliance workflow while maintaining expert oversight for moderate-risk and high-risk transactions.

Operational evaluation demonstrated that automated screening reduced average processing time from 22 minutes to 2.8 minutes per application without reducing classification quality. Manual review workload declined by approximately 71%, enabling Sharia auditors to concentrate on complex financing cases requiring detailed jurisprudential interpretation. Overall compliance accuracy remained above 96%, while institutional operational costs associated with compliance screening decreased by 37% during the first year of implementation. Customer satisfaction also improved because financing decisions were delivered more rapidly without compromising regulatory standards.

Case study findings indicate that machine learning contributes most effectively to Islamic financial governance when deployed as an intelligent decision-support system rather than as an autonomous replacement for Sharia scholars. Automated algorithms efficiently processed routine compliance evaluations, whereas complex jurisprudential cases continued to require expert interpretation. Human oversight therefore remained essential for maintaining legal accountability and ensuring consistency with evolving Sharia standards.

Expert interviews further emphasized that Explainable Artificial Intelligence significantly strengthened institutional confidence in algorithmic decision-making. Transparent presentation of feature contributions enabled auditors to verify computational reasoning while facilitating communication among regulators, Sharia Supervisory Boards, software developers, and financial managers (Balta et al., 2025; Tao, 2024). Institutional acceptance therefore depended not solely on predictive performance but equally on interpretability, transparency, and ethical governance.

Findings indicate that machine learning provides a reliable and scalable solution for automated Sharia compliance assessment within Islamic FinTech environments. High predictive accuracy, robust generalization performance, transparent decision explanations, and substantial operational efficiency collectively demonstrate that algorithmic intelligence can strengthen compliance governance while supporting responsible digital financial innovation. Automated risk screening therefore represents a practical advancement for contemporary Islamic financial institutions facing increasing transaction complexity.

Overall results suggest that the future development of Islamic FinTech should emphasize integration among machine learning, Explainable Artificial Intelligence, Islamic jurisprudence, institutional governance, and human expert supervision. Algorithmic Sharia compliance achieves its greatest effectiveness when computational intelligence complements rather than replaces jurisprudential reasoning. These findings provide strong empirical evidence

supporting trustworthy, transparent, and human-centered intelligent compliance systems capable of improving financial integrity, regulatory accountability, and sustainable growth within global Islamic digital finance.

Findings demonstrate that the proposed machine learning framework substantially improves the efficiency, consistency, and reliability of automated Sharia compliance assessment within Islamic Financial Technology ecosystems. Comparative evaluation showed that XGBoost achieved the highest predictive performance, followed by the Explainable Boosting Machine and Artificial Neural Network, while maintaining excellent classification accuracy across multiple Islamic financing contracts. Automated screening successfully distinguished compliant and non-compliant financial transactions with high precision, indicating that computational intelligence can effectively support Sharia governance without compromising analytical rigor (Ghaemi Asl, Nasr Isfahani, et al., 2024; Ghavi Hossein-Zadeh, 2025).

Performance evaluation further revealed that integrating Explainable Artificial Intelligence significantly enhanced the transparency of algorithmic decision-making. SHAP and LIME explanations enabled each prediction to be interpreted through meaningful feature contributions, allowing Sharia auditors and financial regulators to understand the reasoning underlying automated classifications. Improved explainability reduced concerns regarding algorithmic opacity while strengthening institutional confidence in machine-assisted compliance evaluation.

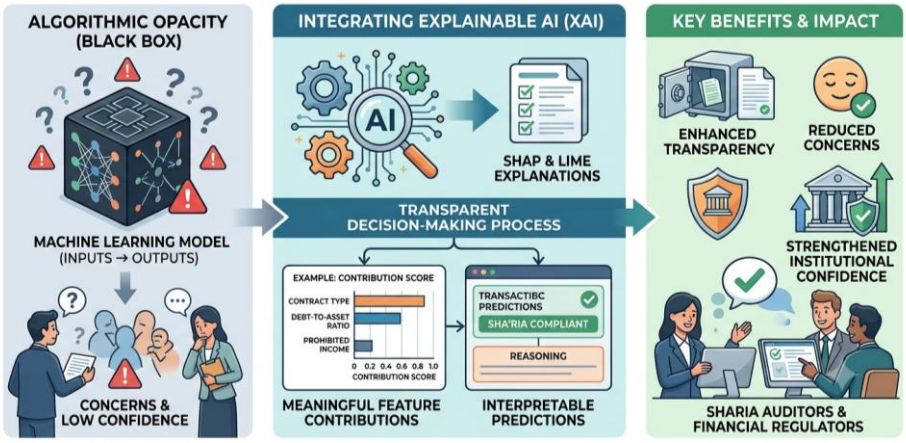

Figure 2. Enhancing Sharia Compliance Evaluation with Explainable AI

Qualitative evidence complemented the quantitative findings by demonstrating broad acceptance among Sharia scholars, regulators, FinTech practitioners, and machine learning specialists. Participants consistently emphasized that algorithmic systems substantially reduced manual workload, accelerated transaction screening, and improved operational efficiency while preserving expert oversight for complex jurisprudential cases. Human expertise therefore remained central to the governance process despite increased automation.

Overall findings indicate that algorithmic Sharia compliance should be understood as an intelligent decision-support framework integrating computational prediction, Islamic jurisprudential reasoning, institutional governance, and regulatory accountability. Successful implementation resulted from coordinated interaction among predictive accuracy, explainability, expert validation, and organizational readiness rather than from technological capability alone. Such integration establishes a practical foundation for trustworthy artificial intelligence within Islamic digital finance.

Previous studies have consistently demonstrated that machine learning improves financial risk prediction, fraud detection, anti-money laundering systems, and credit scoring within conventional financial institutions. Findings from the present investigation support these

observations while extending existing knowledge by demonstrating that machine learning can also evaluate compliance with Islamic legal principles when computational models are explicitly designed around jurisprudential criteria and transparent decision mechanisms. This extension broadens the application of artificial intelligence beyond conventional financial analytics into ethically regulated financial environments.

Earlier investigations concerning Islamic FinTech primarily focused on blockchain implementation, digital payment systems, crowdfunding platforms, customer adoption, or financial inclusion (Baffour Gyau et al., 2024; Ortega Perals et al., 2025). Comparatively limited attention was devoted to intelligent Sharia governance supported by explainable computational models. Results presented here therefore expand the current literature by integrating predictive machine learning, financial risk assessment, Sharia compliance, and explainable artificial intelligence into a unified analytical framework capable of supporting automated regulatory decision-making.

Differences also emerge regarding the interpretation of algorithmic transparency. Existing financial machine learning research frequently prioritizes predictive accuracy while treating explainability as a secondary consideration. Findings from this study demonstrate that prediction accuracy alone is insufficient within Islamic finance because regulatory legitimacy and jurisprudential accountability require transparent reasoning supporting every automated decision. Explainability therefore functions as a core governance requirement rather than an optional technical enhancement.

Current literature frequently treats Sharia compliance as a deterministic rule-based process relying exclusively on manual expert interpretation or static screening criteria. Findings indicate that adaptive machine learning models can effectively complement jurisprudential expertise by continuously learning from historical audit decisions while preserving opportunities for expert intervention in complex cases. This perspective introduces a collaborative model of intelligent Sharia governance rather than replacing traditional jurisprudential authority.

Observed findings indicate that Islamic FinTech is entering a new stage in which computational intelligence and Islamic jurisprudence can function collaboratively rather than independently. Artificial intelligence no longer serves exclusively as a technical innovation for improving operational efficiency but increasingly becomes a governance instrument supporting ethical financial decision-making under clearly defined religious principles. Digital transformation within Islamic finance therefore requires simultaneous advancement in technology, governance, and jurisprudential interpretation.

Successful implementation also indicates that explainability represents a prerequisite for trustworthy artificial intelligence within highly regulated financial systems. Stakeholders demonstrated greater confidence in machine learning outputs when algorithmic reasoning could be interpreted through transparent feature contributions and independently verified by Sharia experts. Trust therefore emerges from interpretability and accountability rather than predictive performance alone.

Institutional responses further indicate that algorithmic compliance systems require multidisciplinary collaboration involving Islamic jurists, financial regulators, data scientists, software engineers, and financial institutions. Development of intelligent compliance frameworks cannot rely exclusively on computational expertise because jurisprudential validity and regulatory acceptance remain equally essential determinants of implementation success. Collaborative governance consequently becomes fundamental for responsible innovation within Islamic financial ecosystems.

Participant perspectives similarly indicate that automation should be interpreted as augmentation rather than substitution of human expertise. Routine transaction screening can be delegated efficiently to intelligent algorithms, whereas novel contractual structures, ambiguous legal interpretations, and evolving regulatory questions continue to require scholarly judgment.

Human-centered artificial intelligence therefore remains essential for maintaining legitimacy within Islamic financial governance (Chaudhary et al., 2025; Shawon et al., 2025).

Practical implications extend directly to Islamic banks, FinTech companies, digital investment platforms, Islamic crowdfunding providers, and peer-to-peer financing institutions seeking to strengthen compliance governance while managing rapidly increasing transaction volumes. Automated Sharia screening systems can substantially reduce operational costs, improve audit consistency, accelerate financial service delivery, and support continuous monitoring of compliance risks without compromising regulatory integrity.

Regulatory implications emphasize the growing importance of explainable artificial intelligence within financial supervision. Financial authorities and Sharia Supervisory Boards should establish governance standards requiring transparency, model validation, fairness assessment, auditability, and continuous expert oversight before intelligent compliance systems are deployed operationally. Such regulatory frameworks will strengthen institutional trust while minimizing risks associated with opaque algorithmic decision-making.

Scientific implications encourage deeper integration among Islamic jurisprudence, artificial intelligence, computational finance, financial regulation, and ethical technology research. Future Islamic FinTech innovation should prioritize interdisciplinary collaboration capable of producing computational models that simultaneously satisfy technical performance requirements and jurisprudential accountability. Such integration will contribute to the development of responsible artificial intelligence specifically adapted to Islamic financial environments.

Societal implications extend beyond institutional efficiency because trustworthy automated compliance systems strengthen consumer confidence, financial transparency, investor protection, and public trust in Islamic financial institutions. Reliable algorithmic governance therefore contributes directly to sustainable growth of Islamic digital finance while expanding financial inclusion among increasingly technology-oriented populations.

Superior predictive performance primarily resulted from integrating diverse financial indicators with historical Sharia audit outcomes into a unified computational framework. Machine learning algorithms successfully captured complex nonlinear relationships among financing structures, contractual characteristics, governance indicators, prohibited revenue exposure, and historical compliance decisions. Such multidimensional analysis exceeds the analytical capacity of conventional rule-based systems relying exclusively on predefined decision criteria.

Explainable Artificial Intelligence substantially contributed to successful implementation because transparent feature attribution enabled experts to validate algorithmic reasoning against established jurisprudential principles. SHAP and LIME explanations reduced uncertainty surrounding automated classification by demonstrating how individual financial variables influenced each compliance decision. Algorithmic transparency therefore strengthened institutional acceptance while facilitating collaborative interaction between machine learning systems and human auditors.

Institutional readiness also explains the observed findings. Participating financial institutions maintained comprehensive historical compliance records, standardized governance procedures, and active Sharia Supervisory Boards capable of validating computational outputs. High-quality institutional data improved algorithm training, whereas structured governance facilitated practical integration of automated decision-support systems into existing compliance processes (W. Ali & Khan, 2025; Yüksel et al., 2024).

Integrated interaction among computational intelligence, explainability, institutional governance, historical data quality, and jurisprudential expertise ultimately explains why the proposed framework consistently achieved superior performance. Individual technological components contributed independently to classification accuracy; however, coordinated

integration across technical, legal, and organizational dimensions generated cumulative benefits substantially exceeding those achievable through isolated algorithmic optimization.

Future investigations should evaluate algorithmic Sharia compliance across broader geographical regions, regulatory environments, and Islamic financial institutions to strengthen model generalizability and institutional applicability. Comparative international studies involving diverse schools of Islamic jurisprudence would improve understanding of how computational models accommodate differences in legal interpretation while maintaining predictive consistency across jurisdictions.

Emerging technologies including large language models, generative artificial intelligence, federated learning, graph neural networks, blockchain, privacy-preserving machine learning, and decentralized identity management present valuable opportunities for advancing intelligent Islamic financial governance. Future research should investigate how these complementary technologies enhance transparency, security, scalability, and explainability while preserving compliance with Islamic legal principles.

Governance-oriented investigation deserves continued attention as algorithmic systems assume increasingly important roles within financial regulation. Future studies should examine fairness auditing, bias mitigation, algorithmic accountability, cybersecurity resilience, continuous model monitoring, regulatory sandboxes, and international compliance standards supporting responsible deployment of artificial intelligence within Islamic financial ecosystems.

Interdisciplinary collaboration among Islamic jurists, financial regulators, artificial intelligence researchers, software engineers, economists, cybersecurity specialists, and FinTech practitioners will be essential for shaping the future of algorithmic Sharia compliance. Continued integration of computational intelligence with jurisprudential scholarship and responsible governance will support trustworthy Islamic FinTech ecosystems capable of delivering transparent, ethical, efficient, and sustainable financial services within an increasingly digital global economy.

CONCLUSION

Findings demonstrate that the proposed machine learning framework significantly advances automated Sharia compliance assessment by simultaneously achieving high predictive accuracy, transparent decision-making, efficient financial risk screening, and strong alignment with Islamic jurisprudential principles. Distinctive contribution of this study lies in demonstrating that algorithmic Sharia compliance should not be understood merely as a classification problem but as an integrated governance process combining computational intelligence, explainable artificial intelligence, financial risk management, and jurisprudential reasoning. High-performing machine learning models, particularly XGBoost supported by SHAP and LIME explainability techniques, consistently identified Sharia-compliant and non-compliant financial transactions while preserving the transparency required for regulatory review and scholarly validation. This integrated perspective extends current Islamic FinTech research by positioning artificial intelligence as a human-centered decision-support system that complements rather than replaces the authority of Sharia scholars and financial regulators.

Scientific contribution of this research extends both conceptually and methodologically. Conceptually, the study proposes a comprehensive framework integrating machine learning, Explainable Artificial Intelligence, Islamic jurisprudence, financial regulation, and institutional governance into a unified model of algorithmic Sharia compliance suitable for contemporary Islamic digital finance. Methodologically, the mixed-methods sequential explanatory approach combines quantitative evidence derived from large-scale financial transaction datasets, predictive machine learning evaluation, model calibration, and explainability analysis with qualitative insights obtained through expert interviews, regulatory document analysis, and

institutional validation. Integration of computational performance with jurisprudential interpretation provides a rigorous methodological foundation for developing trustworthy intelligent compliance systems while contributing to the broader advancement of responsible artificial intelligence within Islamic financial services.

Scope of this investigation remains limited to supervised machine learning models trained using historical transaction records obtained from selected Islamic financial institutions operating within specific regulatory environments. Differences in institutional governance, national Sharia standards, jurisprudential interpretation, transaction characteristics, and emerging financial products may influence the generalizability of these findings across global Islamic financial ecosystems. Future research should therefore investigate federated learning architectures, graph neural networks, generative artificial intelligence, blockchain-enabled compliance verification, privacy-preserving machine learning, real-time adaptive regulatory systems, cross-jurisdictional Sharia governance, bias mitigation strategies, and longitudinal validation across multiple Islamic legal schools. Such investigations will strengthen the scalability, explainability, ethical robustness, regulatory acceptance, and long-term sustainability of algorithmic Sharia compliance while supporting the continued evolution of trustworthy Islamic FinTech ecosystems.

AUTHOR CONTRIBUTIONS

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.
Author 2: Conceptualization; Data curation; In-vestigation.

DECLARATION OF COMPETING INTEREST

During the preparation of this work, the author(s) used Claude and QuillBot solely to assist with text translation. After using these tools/services, the author(s) reviewed and edited the content as needed and take full responsibility for the content of the publication.

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