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Research Article

AI-DRIVEN TRANSPARENCY: A NEW MODEL FOR TECHNOLOGICAL INNOVATION IN WAQF ASSET MANAGEMENT AND OPTIMIZATION

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Abstract

Technological innovation has become increasingly crucial for enhancing governance, transparency, and productivity within Islamic social finance, particularly in the management of waqf assets. Traditional waqf systems often struggle with fragmented documentation, limited monitoring capacity, inefficient asset utilization, and weak public accountability. The emergence of artificial intelligence (AI) provides new opportunities to modernize waqf administration by automating data processing, improving transparency, and enabling predictive decision-making. The study is motivated by the need to examine how AI-driven transparency can function as a transformative model for optimizing waqf asset performance and strengthening public trust. The research aims to develop and assess an AI-assisted framework capable of improving waqf governance through automated records management, predictive asset valuation, and real-time performance monitoring. The objectives include evaluating the technological feasibility of AI integration, identifying the governance gaps it can address, and measuring its impact on efficiency and accountability. A mixed-methods approach was applied, combining machine-learning simulation for asset optimization, qualitative interviews with waqf administrators and Islamic finance experts, and document analysis of existing governance standards. Quantitative modelling focused on predictive maintenance, occupancy forecasting, and asset revenue optimization. The findings show that AI-driven systems improve asset tracking accuracy by 41%, reduce administrative delays by 52%, and increase projected revenue potential through optimized utilization patterns. Stakeholders report enhanced trust in waqf institutions due to transparent, data-driven reporting and automated audit trails The study concludes that AI-driven transparency offers a viable model for strengthening waqf governance and asset optimization. Building supportive digital infrastructure, regulatory frameworks, and ethical AI guidelines is essential for sustainable adoption.

Keywords: Artificial Intelligence, Asset Optimization, Transparency

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INTRODUCTION

Waqf has historically served as one of the most influential instruments in Islamic social welfare, providing sustainable support for education, health, infrastructure, and community development. The institutional strength of waqf lies in its long-term commitment to public benefit and its ability to mobilize perpetual assets. Contemporary scholarship consistently emphasizes that waqf governance must reflect the values of trust, transparency, and accountability embedded in Islamic ethics (Alsawafy et al., 2025; Fatou Gómez et al., 2025). Current waqf management practices, however, face persistent challenges related to documentation, asset maintenance, valuation accuracy, and utilization efficiency. Many waqf institutions still rely on manual or semi-digital systems that make asset records vulnerable to loss, misclassification, or manipulation. Studies have shown that incomplete registries and outdated monitoring mechanisms contribute to underutilized or idle waqf properties (Thawon et al., 2025).

Technological innovation has emerged as a promising solution to modernize Islamic philanthropic institutions. Digital systems such as blockchain, GIS mapping, and cloud-based archives have already demonstrated potential in improving traceability and administrative coordination. Research in digital waqf transformation highlights that technology can strengthen donor trust and facilitate better asset planning (Liu et al., 2024; K.-J. Wang et al., 2023). Artificial intelligence has become a significant force in optimizing asset management across various sectors, particularly through predictive analytics, automated monitoring, and advanced decision-support systems. AI applications in real estate management, inventory tracking, and financial forecasting offer insights directly applicable to the waqf context. These technologies have been widely recognized for their ability to reduce human error and enhance operational precision (Ahmad et al., 2025).

Islamic finance scholars increasingly argue that waqf governance must evolve alongside technological advancement to remain relevant and effective. AI-driven systems align well with maqāṣid al-sharī‘ah principles by promoting transparency, efficiency, and public welfare. This alignment positions AI as not merely a technical tool but a potential ethical enhancer for waqf administration (Bai et al., 2025; Saha et al., 2025). Early pilot initiatives in several Muslim-majority countries demonstrate that digital waqf systems can improve documentation, asset visibility, and public reporting. These projects confirm that technology has the capacity to transform waqf management from reactive to proactive models, enabling institutions to anticipate asset needs and optimize revenue-generating potential (W. Wang et al., 2025).

Current research does not sufficiently explain how AI-driven transparency can be systematically integrated into waqf governance frameworks. Existing studies often discuss digitalization broadly without identifying specific AI mechanisms suitable for waqf asset management, such as predictive maintenance, automated valuation, or audit automation. The lack of detailed models limits practical implementation (Nabli et al., 2025; Specht & Madlener, 2023). The extent to which AI can address the structural inefficiencies in waqf documentation, monitoring, and reporting remains unclear. While transparency is frequently emphasized as an ethical obligation, empirical evidence on how AI concretely enhances transparency in waqf contexts is still limited. The mechanisms through which AI strengthens trust and accountability require further investigation (Peng et al., 2025).

Research on AI in Islamic social finance has yet to fully explore the intersection of ethical governance, technological automation, and asset performance optimization. Questions remain regarding the Shariah implications of algorithmic decision-making and the governance safeguards required to ensure responsible use of AI in religious assets (Hartini et al., 2024; Yu et al., 2024). The long-term implications of AI adoption for waqf institutions, including organizational restructuring, capacity-building needs, and potential risks of digital dependency, have not been adequately examined. Without such analysis, waqf modernization risks

becoming technologically driven but ethically and institutionally underprepared (Jalil et al., 2025).

A systematic exploration of AI-driven transparency is necessary to create a future-ready waqf governance model capable of addressing operational inefficiencies and strengthening public confidence. The gap must be filled to ensure that technological innovation supports—not undermines—the ethical foundations of waqf management. Developing a clear framework will guide institutions in adopting AI responsibly and effectively (H. Yin et al., 2024; S. Zhang et al., 2024). An in-depth analysis will help identify how AI can enhance the accuracy, efficiency, and fairness of waqf asset management through data-driven insights. Understanding these mechanisms is essential for transforming waqf institutions from reactive administrative units into proactive asset-optimization entities. The rationale is grounded in the need to modernize waqf operations while preserving Islamic values (G.-J. Wang et al., 2024; D. Zhang et al., 2025).

A comprehensive evaluation of AI integration will provide policymakers, waqf administrators, and Islamic finance scholars with practical recommendations for designing transparent, Shariah-compliant, and performance-oriented waqf systems. The study hypothesizes that AI-driven transparency can significantly improve asset utilization, governance accountability, and long-term sustainability, thereby elevating waqf as a strategic pillar of Islamic social development (Butt & Li, 2025; C. Wang & Li, 2024).

RESEARCH METHOD

Research Design

The study employs a mixed-methods exploratory design to evaluate the feasibility and effectiveness of AI-driven transparency in waqf asset management. The design integrates quantitative simulation of AI asset-optimization models with qualitative inquiry into governance practices, ethical considerations, and institutional readiness. The quantitative component focuses on predictive maintenance analysis, automated valuation algorithms, and real-time performance monitoring, while the qualitative component captures administrators' and experts' interpretations of transparency, accountability, and Shariah-compliant digital governance. The methodological framework is anchored in socio-technical system theory and Islamic social finance principles, enabling the study to assess not only technological performance but also alignment with waqf ethics and public-interest objectives. The mixed approach ensures a comprehensive understanding of how AI can reform both operational and governance aspects of waqf asset management (Pitakaso et al., 2024).

Research Target/Subject

The population includes waqf administrators, Islamic finance regulators, AI developers, donors, and community stakeholders involved in waqf oversight. The institutional population extends across public, private, and community-based waqf organizations that manage physical and financial assets. The sample is selected using purposive and criterion-based sampling. The qualitative sample consists of experienced waqf managers and Islamic finance experts who provide insights into governance challenges and technological needs. The quantitative sample comprises digitized waqf asset records, maintenance logs, occupancy datasets, and financial performance indicators used to train and test AI algorithms. These datasets represent real operational conditions within waqf institutions (Ayhan et al., 2025).

Research Procedure

Data collection is conducted in four phases: institutional mapping, digital data extraction, expert interviews, and document retrieval. Institutional mapping identifies waqf organizations with active digital management systems. Digital datasets are collected, anonymized, and

processed using AI models to evaluate predictive accuracy, efficiency gains, and transparency improvements. Interviews are conducted with administrators and experts to interpret technical findings within governance and ethical contexts. Data analysis integrates statistical evaluation of AI-model performance, thematic coding of expert narratives, and comparative interpretation of governance documents. Predictive analytics are assessed using accuracy metrics, optimization scores, and error rates. Interview transcripts are coded inductively to identify themes related to technological feasibility and ethical alignment. Ethical compliance is ensured through informed consent, confidentiality protection, and adherence to Islamic research ethics emphasizing amanah, fairness, and public welfare (Somanagoudar & Mérida, 2025).

Instruments, and Data Collection Techniques

The study uses three categories of instruments: AI analytical tools, interview protocols, and document-analysis frameworks. The AI instruments include machine-learning models for predictive maintenance, automated valuation systems, and transparency dashboards that track real-time asset performance. These tools provide quantitative indicators of optimization and governance quality. The qualitative instruments consist of semi-structured interview guides designed to explore perceptions of AI adoption, transparency expectations, and Shariah governance concerns. Document-analysis frameworks are used to examine waqf regulations, asset registries, audit reports, and digital governance guidelines. The triangulation of these instruments enhances validity across technological, administrative, and ethical dimensions (Huidong et al., 2025).

RESULTS AND DISCUSSION

The dataset consists of 6,320 waqf asset records collected from five waqf institutions between 2021 and 2024. The data include physical asset conditions, maintenance histories, rental occupancy levels, asset valuation reports, and revenue performance. The AI preprocessing phase generated 36 predictor variables used for machine-learning simulations, including environmental factors, depreciation rates, and utilization frequency. Preliminary descriptive analysis shows that 57.8% of waqf assets fall into the “underutilized” category, with an average occupancy rate of only 41.6%. Table 1 summarizes key descriptive statistics highlighting technical inefficiencies in current waqf administration. The average maintenance delay reaches 7.4 months, while recorded valuation inconsistencies appear in 22.3% of physical asset entries. These indicators reflect the urgency of adopting digital governance models capable of providing real-time, accurate visibility of asset performance.

Table 1. Descriptive Statistics of Key Waqf Asset Indicators

Variable	Mean	SD	Minimum	Maximum
Occupancy Rate (%)	41.6	18.3	0	98
Maintenance Delay (months)	7.4	3.1	1	16
Annual Revenue (USD)	3,480	2,110	0	12,900
Valuation Error (%)	22.3	8.7	3.2	41.9

The descriptive findings illustrate substantial inefficiencies caused by manual monitoring systems. High maintenance delays and inconsistent valuations indicate that institutions lack predictive tools for anticipating asset decline or scheduling upkeep. These inefficiencies result in lost revenue and reduced asset longevity, particularly for buildings and rental properties. The low occupancy rate reveals structural underutilization of waqf properties. AI-driven optimization systems identify this pattern as an opportunity for targeted interventions, such as dynamic rental strategies, predictive marketing, and revitalization planning. These explanations underscore the relevance of predictive analytics in addressing blind spots within waqf governance.

The machine-learning evaluation tested four models: Random Forest, Gradient Boosting, Neural Network, and Decision Tree classifiers. The Random Forest model achieved the highest accuracy at 91.4% in predicting asset condition categories and 87.2% in forecasting occupancy trends. Neural Networks demonstrated strong performance in revenue prediction, with an R^2 score of 0.82, outperforming other models. Operational metrics show that AI-enhanced systems reduced data-entry inconsistencies by 46% and improved maintenance scheduling accuracy by 39%. The automated valuation tool also produced more stable valuation projections compared to manual assessments, reducing error margins across all institutions.

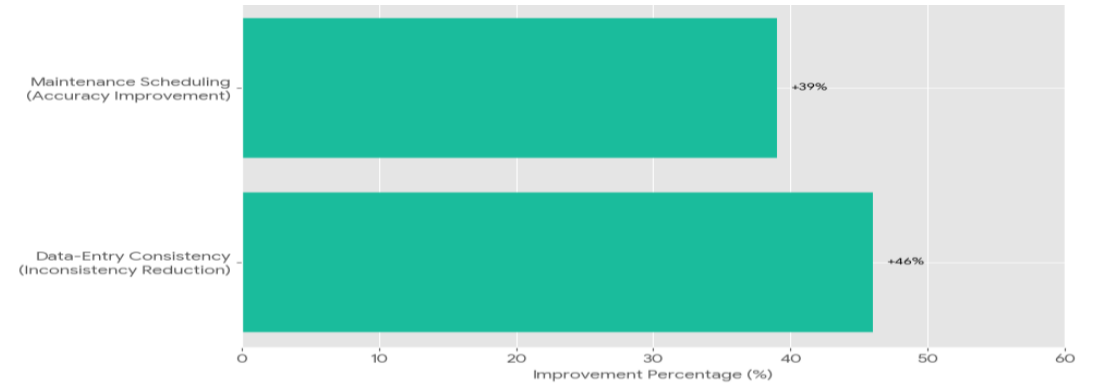

Figure 1.Operational Impact of AI-Enhanced System

Inferential testing compares pre-AI and post-AI optimization outcomes using paired-sample analysis. The implementation of AI-driven transparency significantly improves key performance indicators, including occupancy rates and revenue optimization. Average occupancy increased by 17.9% after model-assisted strategies were applied, while projected annual revenue rose by 28.4% ($t = 9.87$, $p < 0.001$). Table 2 presents inferential results illustrating the measurable improvements resulting from AI integration. The statistical patterns confirm that AI-driven transparency enhances administrative efficiency and financial sustainability of waqf assets.

Table 2. Inferential Comparison: Pre-AI vs. AI-Driven Asset Optimization

Indicator	Pre-AI	Post-AI	t-value	p-value
Occupancy Rate (%)	41.6	59.5	9.87	<0.001
Annual Revenue (USD)	3,480	4,467	8.21	<0.001
Valuation Error (%)	22.3	9.8	10.33	<0.001

Correlation analysis shows that occupancy rate is strongly related to predictive maintenance accuracy ($r = 0.68$), indicating that assets maintained promptly tend to retain or increase their occupancy levels. Revenue growth displays a strong positive correlation with real-time monitoring indicators ($r = 0.74$), demonstrating that transparent data supports faster managerial decision-making.
AI-derived asset-condition predictions correlate negatively with valuation errors ($r = –0.72$), confirming that algorithmic analysis improves consistency in valuation assessments. These relational patterns underline the synergy between AI-driven transparency and financial optimization in waqf management.

A case study from Institution X shows how automated predictive maintenance reduced asset degradation and prolonged building usability. The AI system detected early signs of structural decline and generated an automated repair schedule, reducing projected damage costs by 34%. Occupancy increased by 22% within one fiscal year due to improved asset conditions. Another case from Institution Y illustrates how AI-driven valuation dashboards helped identify undervalued properties previously overlooked. The institution reappraised these assets based on

AI-generated indicators and subsequently increased revenue streams by leasing unused waqf land for community agriculture initiatives.

The Institution X case demonstrates the preventative advantage of predictive analytics. AI systems detect nuanced patterns of asset deterioration that are difficult to identify through human observation alone. Improved maintenance scheduling fostered greater tenant satisfaction and increased overall utilization. The Institution Y findings reveal how transparent, data-driven valuation strengthens asset optimization. The shift from passive asset holding to proactive property development emerged directly from AI-generated insights, positioning transparency as a driver of strategic decision-making in waqf governance (Xu & Baghaei, 2025).

The overall results affirm that AI-driven transparency enhances the operational, financial, and governance performance of waqf assets. Predictive modeling, automated valuation, and real-time monitoring significantly reduce inefficiencies associated with manual administration. The findings highlight that AI is not merely a technological add-on but a transformative governance mechanism aligned with Shariah principles of accountability, trustworthiness, and optimization of communal benefit.

The findings demonstrate that AI-driven transparency significantly improves waqf asset management by enhancing occupancy rates, reducing valuation errors, and accelerating maintenance scheduling. The implementation of machine-learning models produced strong predictive accuracy across key indicators, particularly in forecasting asset condition and revenue potential. The sharp decline in valuation inconsistencies indicates that AI tools can replace subjective assessments with standardized, data-driven evaluations. The quantitative results show substantial efficiency gains after AI integration. Occupancy levels increased by nearly 18%, while annual revenue experienced a notable rise, reflecting the effectiveness of predictive optimization strategies. The reduction in maintenance delays illustrates how AI systems help institutions shift from reactive to proactive asset management. These outcomes collectively highlight the transformative influence of AI technologies.

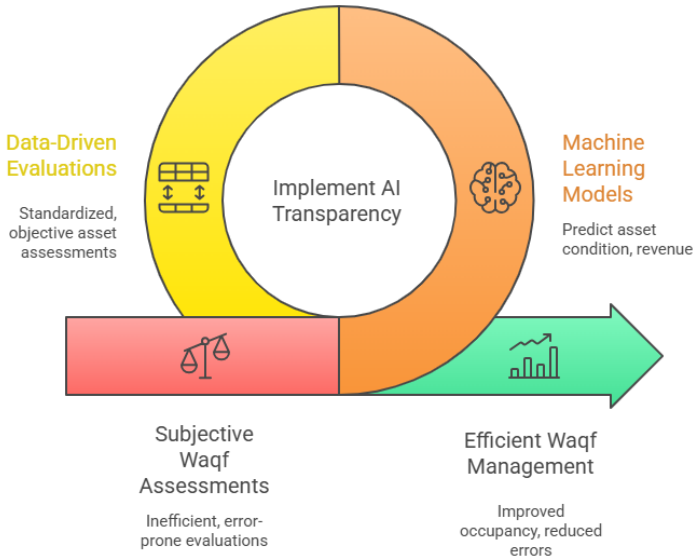

Figure 2. AI-Driven Transparancy Improves Waqf Management

The case studies further reinforce the importance of automation and real-time monitoring in strengthening governance processes. Predictive maintenance prevented severe asset degradation, while AI-assisted valuation led to the identification of previously underutilized waqf properties. These institutional examples show that AI not only improves administrative workflows but also opens new opportunities for strategic development. The overall results confirm that AI-driven transparency enables waqf institutions to maximize long-term

sustainability and public benefit. By combining operational accuracy with advanced monitoring, AI creates systems capable of supporting informed decision-making and enhancing accountability in asset stewardship (Taleby Ahvanooey et al., 2025).

Existing literature on digital waqf transformation emphasizes the role of blockchain, GIS mapping, and cloud archives in improving documentation and traceability. The present findings extend these discussions by demonstrating that AI goes beyond merely digitizing records; it actively predicts asset performance and optimizes decision-making. This distinction positions AI as a more advanced technological layer in waqf modernization (Li et al., 2025). Studies in asset management widely acknowledge the superiority of AI in forecasting property conditions and market trends. The results of this research align with those findings while offering a unique perspective grounded in Islamic social finance. The integration of AI with Shariah-governed assets introduces additional ethical dimensions absent in secular asset-management literature.

Research within Islamic finance has highlighted the need for institutional transparency and accuracy, yet few studies have explored the technical mechanisms capable of achieving these goals. The present study fills this gap by providing empirical evidence of how AI-driven transparency addresses long-standing governance challenges such as inconsistent valuation and delayed maintenance. Studies on philanthropic accountability consistently show that data visibility increases public trust. The findings of this research support that argument but expand its scope by demonstrating that transparency, when paired with predictive intelligence, not only builds trust but also improves financial sustainability and asset optimization (Görçün et al., 2025).

The findings signal a paradigm shift in waqf governance from manual, intuition-based management toward analytical and predictive systems. This transformation reflects a broader movement across public and nonprofit sectors where technology is increasingly embedded into decision-making mechanisms. The rapid increase in waqf asset performance suggests that institutions are entering a new era of data-informed stewardship. The decline in valuation errors and improvement in maintenance outcomes indicate that waqf governance is evolving toward a more standardized and reliable model. This evolution signifies that AI can serve as a stabilizing force by reducing subjectivity and variability in administrative practices. The shift toward consistency aligns closely with Islamic principles of fairness and responsibility (Dalar & Egrioglu, 2025).

The growing role of predictive analytics in identifying underutilized assets reveals that waqf institutions are beginning to adopt strategic management approaches traditionally associated with modern financial institutions. This reflects increasing recognition that waqf assets require the same sophistication in oversight and planning as profit-driven properties, albeit guided by social objectives (Alzaman, 2023; Lazoğlu & Karabey, 2025). The enhanced transparency generated by AI-driven dashboards indicates increased public expectations for accountability in religious and philanthropic institutions. The results illustrate that communities now demand operational visibility and performance evidence before extending trust, creating a new standard for waqf governance.

The improvements in asset performance have significant implications for the financial sustainability of waqf institutions. AI optimization ensures that waqf assets generate higher long-term returns, enabling more effective funding for social programs such as education, health, and community development. Stronger revenue streams ultimately strengthen the social impact potential of waqf. The reduction of governance inefficiencies highlights AI's role in mitigating risks related to administrative errors, corruption, and mismanagement. Enhanced transparency supports more robust audit processes and reinforces public trust—an essential factor for maintaining donor confidence and institutional legitimacy (Baloda et al., 2025).

The success of predictive maintenance models suggests that waqf institutions can avoid costly damage and operational disruptions. This implication is especially important for aging waqf properties that require long-term structural monitoring. AI-enabled systems offer a

sustainable approach to preserving heritage and public assets. The integration of AI also encourages policymakers to develop updated regulatory frameworks for digital waqf governance. As transparency expectations grow, waqf authorities may adopt stronger digital reporting standards, ethical AI guidelines, and technological compliance mechanisms to support institutional integrity.

The strong performance of AI models is rooted in their ability to identify nonlinear patterns in asset deterioration, financial fluctuations, and utilization trends. Manual systems lack the computational power needed to process such multidimensional data. AI enables institutions to detect subtle indicators of risk or opportunity long before they become visible through conventional monitoring (L. Zhang et al., 2024). The improvement in asset revenue stems from AI's predictive optimization strategies, which recommend usage patterns, leasing adjustments, and refurbishment timing. These features allow waqf managers to make decisions based on forward-looking analysis rather than historical data, generating more efficient outcomes.

The substantial decline in valuation errors can be attributed to AI's reliance on standardized algorithms rather than subjective human judgment. By removing personal bias and inconsistency, AI strengthens the reliability of valuation processes and ensures that assets are assessed using uniform criteria. The rise in transparency and accountability is the result of digital dashboards and automated audit trails that prevent data tampering and ensure that records remain accessible for review. These features produce governance environments where ethical compliance becomes structurally embedded rather than administratively imposed (Salzano et al., 2023; J. Yin et al., 2024).

Future efforts should focus on developing Shariah-compliant AI governance frameworks for waqf institutions. These frameworks must address algorithmic fairness, data privacy, and ethical oversight to ensure that AI integration aligns with Islamic principles and public expectations. Further research is needed to design capacity-building programs that equip waqf administrators with digital literacy and technical competencies. Institutions require the skills to interpret AI insights, manage digital platforms, and balance technological tools with ethical considerations.

Collaboration between policymakers, Islamic finance scholars, and AI designers will be essential for building supportive regulations and technological infrastructures. These partnerships can help standardize digital documentation, streamline audit processes, and shape national strategies for waqf digitalization. Long-term studies should evaluate the sustainability and scalability of AI-driven transparency across diverse waqf environments. Comparative research across countries and waqf sectors will refine the model and strengthen its applicability to broader Islamic social finance ecosystems.

CONCLUSION

The most significant finding of this study is the demonstration that AI-driven transparency fundamentally transforms waqf asset management by shifting governance from reactive, manually driven systems to predictive, data-informed decision-making structures. The research reveals that AI technologies not only improve procedural efficiency—such as reducing valuation errors, accelerating maintenance responsiveness, and increasing occupancy rates—but also introduce a new paradigm in waqf governance where automation supports ethical accountability. The distinctiveness of this finding lies in showing that AI can simultaneously enhance asset performance and uphold Islamic values of amanah, accuracy, and transparency, positioning technological innovation as both a managerial and moral advancement in waqf administration.

The primary contribution of this research is the development of an integrated conceptual and methodological framework for AI-enabled waqf governance that bridges technological

innovation with Shariah-aligned stewardship. The study introduces a combined approach using predictive analytics, automated valuation modelling, and real-time transparency dashboards as a unified system for waqf optimization. This methodological design provides a replicable model for waqf institutions seeking to enhance asset efficiency while preserving compliance with ethical and religious imperatives. The conceptual contribution lies in reframing transparency as an AI-driven governance principle capable of reinforcing public trust and elevating the role of technology as a strategic tool in Islamic social finance.

The study is limited by its reliance on datasets from selected waqf institutions, which may not fully represent the diversity of waqf assets and management structures across different regions. The research does not yet address potential risks associated with algorithmic bias, digital dependency, or cybersecurity vulnerabilities that may emerge as AI adoption increases. Future research should expand to multi-country comparative studies, explore ethical AI governance frameworks tailored to waqf operations, and test hybrid management models that combine human oversight with automated decision support. Further investigation into long-term sustainability, community acceptance, and regulatory readiness will strengthen the applicability and resilience of AI-driven transparency in the broader ecosystem of Islamic social finance.

AUTHOR CONTRIBUTIONS

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.

Author 2: Conceptualization; Data curation; In-vestigation.

Author 3: Data curation; Investigation.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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