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# Technology Investment Intensity and Financial Performance of Islamic Banks in Indonesia

**Eka Handriani**

Darul Ulum Islamic Centre, Sudirman University, Indonesia
Email: ekahandriani5@gmail.com

**Keywords:**
*Islamic Financing; Musharakah; Mudarabah; Technology Investment Intensity;Financial Performance; Islamic Banks.*

**ABSTRACT**

*Financial performance in Islamic banks is influenced not only by financing structures but also by banks' ability to develop technological capabilities that strengthen information management, monitoring, and financing risk management. This study examines the effects of musharakah, mudarabah, murabaha, ijarah, and istisna financing on Islamic banks' financial performance and investigates the role of Technology Investment Intensity (TII) as a mediating mechanism in profit-sharing financing. The study employs an unbalanced panel dataset comprising 120 bank-year observations from 10 Islamic commercial banks in Indonesia over 2012–2022. Financial performance is proxied by Return on Assets (ROA), while TII is measured as the ratio of capital expenditure to total assets. Panel data regression with bank-specific and year fixed effects is employed, while mediation effects are assessed through indirect effects using 95% bootstrap confidence intervals. The results show that musharakah, murabaha, and ijarah financing have positive and significant effects on ROA, whereas mudarabah and istisna financing have no significant direct effects. Musharakah and mudarabah financing positively and significantly affect TII, which positively and significantly affects ROA. TII does not mediate the musharakah ROA relationship but significantly mediates the mudarabah–ROA relationship. These findings indicate an asymmetric technology-mediated performance mechanism contingent on financing contract characteristics.*

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## INTRODUCTION

The Islamic banking sector in Indonesia is projected to grow faster than the national banking industry. Third-party funds in Islamic banks are expected to increase by 11.46% year-on-year (YoY), exceeding the projected 9.6% YoY growth of conventional banks (Bank

***Corresponding Author :**
*ekahandriani5@gmail.com*

Indonesia, 2023). Islamic bank financing is likewise projected to grow by 9.31% YoY, outpacing anticipated national banking credit growth. The continued development of the Islamic economic ecosystem, supported by increasing zakat, infaq, and sadaqah collections, creates opportunities for Islamic banks to strengthen financial inclusion and sustainable economic development. Nevertheless, asset and financing expansion does not necessarily translate into higher profitability, and Islamic banks continue to face challenges in improving performance and sustaining competitiveness relative to conventional banks. Understanding the determinants and mechanisms underlying financial performance therefore remains important for both researchers and practitioners.

Among the factors shaping Islamic bank performance, financing-contract composition is particularly important because musharakah, mudarabah, murabaha, ijarah, and istisna differ in risk sharing, monitoring requirements, contractual complexity, and income-generation mechanisms. Profit-sharing contracts, especially musharakah and mudarabah, involve greater information asymmetry, agency problems, and monitoring requirements because returns depend more directly on underlying business performance. Trade- and lease-based contracts such as murabaha and ijarah generally provide more structured contractual arrangements and relatively predictable income streams. Financing structure may therefore affect profitability through different channels (Arhinful & Radmehr, 2023; Ben Amar & O. El Alaoui, 2023; Roziq & Ilma Ahmad, 2024)

Technological capability has simultaneously become central to modern banking (Abdeljawad et al., 2025). Digital transformation requires continuing investment in information systems, digital platforms, data-processing infrastructure, and risk-management technologies (Alghorbany et al., 2024). Such investment can improve information availability, operational control, monitoring, service delivery, and managerial decision-making (Mukhibad et al., 2023). Technology Investment Intensity (TII) captures the intensity of a bank's investment commitment to technological and related infrastructure; it is not a direct measure of technological efficiency.

The literature has largely developed financing-performance and technology-performance research in parallel. Studies of Islamic financing predominantly examine direct effects of individual contracts on profitability, whereas technology studies emphasize efficiency, competitiveness, digital transformation, and service performance (Albaity et al., 2026). Limited evidence explains how TII may operate as a transmission mechanism through which Islamic financing structures affect financial performance. The research gap therefore concerns not merely the combination of financing and technology variables, but the mechanism linking contract characteristics, technology investment, and performance.

This gap is particularly relevant to musharakah and mudarabah. Compared with more structured contracts, profit-sharing financing requires intensive information processing, business monitoring, financial reporting, governance, and risk assessment. Banks need timely and verifiable information on the use of funds, revenues, costs, cash flows, and business risks. Greater exposure to these contracts may therefore create stronger incentives to invest in information systems, data analytics, digital monitoring, and risk-management technologies (Garad et al., 2024). Such investment can reduce information asymmetry, strengthen monitoring and governance, and improve operational control (Mukhibad et al., 2022). This provides the theoretical basis for the asymmetric mediation model tested in this study: TII is proposed as a mediator specifically for profit-sharing contracts rather than uniformly across all Islamic financing instruments.

The study addresses the following research question: To what extent do Islamic financing contracts affect the financial performance of Islamic banks in Indonesia, and does TII mediate the relationship between profit-sharing financing contracts, namely musharakah and mudarabah, and financial performance? The study contributes in two ways. First, it integrates Islamic financing structures and TII within a unified analytical framework, extending the literature beyond direct financing-performance relationships. Second, it distinguishes direct effects associated with sale-, lease-, and project-based contracts from indirect effects of profit-sharing contracts through TII, thereby advancing an asymmetric explanation of how financing characteristics translate into financial performance.

## LITERATURE REVIEW

### Financial Performance, Islamic Financing, and Agency Theory

Financial performance is a key indicator of Islamic bank success because sustainable profitability supports financing expansion, capital strengthening, risk management, and competitiveness (Minaryanti & Mihajat, 2024). Prior studies indicate that Islamic bank performance is shaped by financing structure, risk, efficiency, governance, and operating characteristics (Asutay & Ubaidillah, 2024; Nainggolan et al., 2023; Roziq & Ilma Ahmad, 2024). Agency Theory provides a useful explanation: the relationship between a bank as fund provider and a financing partner may generate conflicts of interest and information asymmetry (Al-Faryan, 2024). The problem is more pronounced in profit-sharing contracts because returns depend on the partner's business performance.

Musharakah involves joint capital participation and profit sharing, while mudarabah separates capital provision from business management. Both contracts can generate productive returns but require intensive monitoring and verification (Hassan et al., 2023) Murabaha is based on a sale with an agreed cost and margin (Bhatti et al., 2025), ijarah provides income from the use of an asset or service (Salman, 2024a), and istisna involves an order-based transaction with specified delivery requirements (Uluyol, 2024). These contracts remain subject to risk and monitoring, but their income mechanisms and contractual obligations are relatively more structured. Accordingly, financing contracts should not be expected to affect performance through a uniform mechanism.

### Technology Investment Intensity as a Performance Mechanism

Technology investment can strengthen a bank's capacity to acquire, process, and use information, improve monitoring, enhance internal control, and support financing and risk decisions (Xiong, 2024). From an agency perspective, better information capabilities may reduce information gaps and monitoring costs (Yang et al., 2024). TII therefore represents both a resource commitment and a potential organizational response to financing complexity (Wu et al., 2024). In profit-sharing financing, greater information requirements may induce higher investment in digital infrastructure, data processing, monitoring systems, and risk technologies (Li et al., 2023). The resulting capability may improve information quality, reduce asymmetry, strengthen control, and ultimately support profitability (Kastelli et al., 2024).

The model therefore distinguishes two roles for TII. First, TII is a direct determinant of financial performance because technology capabilities can improve information management, operational control, and risk management (Luo & Liu, 2025). Second, TII is a mediating mechanism specifically for musharakah and mudarabah because these contracts create stronger

information and monitoring requirements. Murabaha, ijarah, and istisna are evaluated through direct paths to performance. This asymmetric design follows the contractual differences among financing instruments.

**Hypotheses Development**

Musharakah returns depend on the performance of the financed business, creating both profit opportunities and uncertainty (Zhao et al., 2023). Agency problems may arise because the bank does not possess the same information as the business partner concerning fund use, revenues, costs, and risks. Effective monitoring can nevertheless allow the bank to identify deviations, manage risks, and capture returns from productive activities. Prior evidence reports positive associations between musharakah and Islamic bank profitability (Belkhaoui, 2023; Kotb Abdelrahman Radwan et al., 2023; Othman et al., 2023). Thus, higher musharakah financing is expected to support ROA when managed effectively.

The same monitoring intensity can stimulate technology investment (Hosseini Shekarabi et al., 2025). As musharakah exposure increases, banks may need stronger information systems, digital monitoring, data processing, and risk technologies (Song et al., 2025). TII can then improve information quality, monitoring effectiveness, and control of agency costs (Chen et al., 2024). Hence, two relationships are proposed.

**H1:** Musharakah financing positively affects financial performance.
**H2:** Musharakah financing positively affects Technology Investment Intensity.

Mudarabah separates capital provision from business management, making the bank dependent on the partner's business performance. The separation creates information asymmetry, agency problems, and monitoring requirements concerning the use of funds, revenues, costs, and risks (Ishak & Mohammad Nasir, 2024; Uddin, 2025). Although effective management can generate productive income, uncertainty and agency costs may weaken the direct profitability effect. Nevertheless, greater mudarabah exposure can increase demand for information systems, data processing, digital monitoring, and risk-management technologies. TII can strengthen monitoring, information quality, and risk control and may therefore provide an indirect route from mudarabah financing to performance (Nasim et al., 2025).

**H3:** Mudarabah financing positively affects financial performance.
**H4:** Mudarabah financing positively affects Technology Investment Intensity.

Murabaha provides a relatively measurable income stream because the acquisition cost and profit margin are agreed in the contract. This structure can reduce uncertainty about financing income and support profitability when the portfolio is managed effectively. Prior evidence reports positive effects of murabaha on Islamic bank performance (Ahmed & Mohamed, 2026; Maghraoui et al., 2026). Ijarah generates income through agreed payments for the use of assets or services and can provide a relatively structured source of bank revenue. Prior evidence also indicates a positive contribution of ijarah to profitability (Asutay & Yilmaz, 2025; Yusoff et al., 2023). Istisna, in contrast, involves production or completion and may expose banks to delivery, quality, and timing risks. Its relatively small share in Islamic financing may further limit its contribution to profitability. The net effect is therefore an empirical question.

**H5:** Murabaha financing positively affects financial performance.
**H6:** Ijarah financing positively affects financial performance.
**H7:** Istisna financing positively affects financial performance.

TII reflects the allocation of capital resources to technology-related infrastructure relative to bank assets (Yang et al., 2024). Technology can accelerate information processing, strengthen monitoring and internal control, and support financing and risk decisions (Campanella et al., 2023). These capabilities may reduce information asymmetry and monitoring costs and improve the management of productive assets. Accordingly, higher TII is expected to be associated with stronger ROA, particularly in an increasingly digital banking environment.
**H8:** Technology Investment Intensity positively affects financial performance.

The mediation argument is based on the proposition that financing characteristics can induce organizational investment responses. For musharakah and mudarabah, higher financing exposure increases the need for timely information, monitoring, reporting, verification, and risk control. Banks may respond by increasing technology investment. TII can then improve information processing, monitoring, governance, and risk management, creating an indirect pathway to financial performance. The mechanism is not assumed to apply equally to murabaha, ijarah, and istisna because their contractual structures and income mechanisms are more defined. The study therefore tests asymmetric indirect effects.
**H9:** Technology Investment Intensity mediates the effect of musharakah financing on financial performance.
**H10:** Technology Investment Intensity mediates the effect of mudarabah financing on financial performance.

## RESEARCH METHOD

### Sample and Data

The study uses panel data from Islamic commercial banks in Indonesia for 2012–2022. The sample is based on data availability for the financing variables, capital expenditure, total assets, and profitability. The final dataset contains 120 bank-year observations from 10 Islamic commercial banks. The panel is unbalanced because not every bank has observations for every year, reflecting institutional changes, mergers, conversions, and historical data availability. Retaining eligible bank-year observations avoids discarding otherwise usable information.

**Table 1. Data Bank**

| No. | Bank | Status during period |
|---|---|---|
| 1 | Bank Muamalat Indonesia | Islamic commercial bank |
| 2 | Bank Syariah Mandiri (BSI) | Merged into BSI in 2021 |
| 3 | BNI Syariah | Merged into BSI in 2021 |
| 4 | BRI Syariah | Merged into BSI in 2021 |
| 5 | Bank Mega Syariah | Islamic commercial bank |
| 6 | Bank Syariah Bukopin | Later KB Bukopin Syariah |
| 7 | Panin Syariah | Later Panin Dubai Syariah |
| 8 | Bank Victoria Syariah | Islamic commercial bank |
| 9 | BCA Syariah | Islamic commercial bank |
| 10 | BJB Syariah | Islamic commercial bank |

Source: Primary Data Processed, 2026

The sample was selected using purposive sampling based on several predetermined criteria. First, the bank had to be classified as an Islamic commercial bank (Bank Umum Syariah) operating in Indonesia during at least part of the 2012–2022 observation period. Second, the bank

had to publish annual financial reports or other reliable financial disclosures containing the information required to measure musharakah, mudarabah, murabaha, ijarah, and istisna financing. Third, the bank had to provide sufficient information to calculate Return on Assets (ROA) and Technology Investment Intensity (TII), measured as capital expenditure relative to total assets. Fourth, bank-year observations were retained when the required variables were available and consistently measurable, while observations with missing or incompatible data were excluded. Finally, observations affected by institutional changes, including mergers, conversions, or changes in banking status, were retained when the financial information remained sufficiently identifiable and comparable for the respective bank-year. Based on these criteria, 120 eligible bank-year observations were retained as the final analytical sample, forming an unbalanced panel that preserves the maximum available information relevant to the research objectives.

**Table 2. Variable Measurement**

| Variable | Measurement |
|---|---|
| Musharakah financing | Total musharakah financing / total financing × 100% |
| Mudarabah financing | Total mudarabah financing / total financing × 100% |
| Murabaha financing | Total murabaha financing / total financing × 100% |
| Ijarah financing | Total ijarah financing / total financing × 100% |
| Istisna financing | Total istisna financing / total financing × 100% |
| Financial performance (ROA) | Net income / total assets × 100% |
| Technology Investment Intensity (TII) | Capital expenditure / total assets × 100% |

Source: Primary Data Processed, 2026

The measurement of the study variables reflects the economic characteristics of each construct and the analytical relationships proposed in the research model. The five Islamic financing variables are measured as the proportion of each financing contract to total financing, allowing the analysis to capture the relative composition and intensity of financing rather than merely its absolute monetary value. Financial performance is measured by ROA, which reflects the bank's ability to generate net income from the assets under its management. Technology Investment Intensity (TII) is measured as capital expenditure relative to total assets and therefore captures the relative intensity of a bank's capital allocation toward technology-related infrastructure. This measure is intentionally interpreted as investment intensity rather than technological efficiency, as the ratio does not assess how efficiently technology inputs are transformed into operational or financial outputs. In the proposed model, TII is further conceptualized as an organizational mechanism through which financing characteristics, particularly the information and monitoring requirements associated with profit-sharing contracts, may influence financial performance. Thus, the measurement approach is consistent with the theoretical framework and enables the study to distinguish the direct effects of financing contracts from the potential indirect effects operating through technology investment.

TII is deliberately termed "investment intensity" rather than "technology efficiency". The capital-expenditure-to-assets ratio captures the relative intensity of capital allocation but does not measure the efficiency with which technology inputs are converted into outputs.

**Empirical Model and Mediation Test**

Panel regression is used to account for bank heterogeneity and time variation. Bank fixed effects control for time-invariant characteristics such as business model, governance, organizational culture, and institutional features, while year fixed effects control for

macroeconomic and industry-wide changes. The mediation analysis evaluates indirect effects through TII and accounts for repeated observations of the same bank.

$$TII_{it} = \alpha_0 + \alpha_1 MUSH_{it} + \alpha_2 MUDH_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

$$ROA_{it} = \beta_0 + \beta_1 MUSH_{it} + \beta_2 MUDH_{IT} + \beta_3 MURH_{IT} + \beta_4 IJAH_{it} + \beta_5 ISTA_{it} + \beta_6 TII_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

The indirect effects are evaluated as the product of the financing-to-TII and TII-to-ROA paths. Mediation is tested for MUSH→TII→ROA and MUDH→TII→ROA using 95% bootstrap confidence intervals; an indirect effect is statistically significant when its confidence interval excludes zero.

## RESULT AND DISCUSSION

### Descriptive Statistics

Murabaha has the highest mean financing proportion (37.792%), followed by musharakah (15.319%). Mudarabah, ijarah, and istisna have lower mean proportions of 1.324%, 2.868%, and 3.107%, respectively. The relatively large standard deviation of musharakah (20.989%) indicates substantial variation across banks and years. Mean ROA is 0.0192 (approximately 1.92%), while mean TII is 0.0030 (approximately 0.30% of total assets).

**Table 3. Descriptive Data**

| Variable | Observation | Mean | STD | Skewness |
|---|---|---|---|---|
| MUSH | 120 | 15.3190 | 20.9886 | 1.1995 |
| MUDH | 120 | 1.3235 | 2.0533 | 1.1088 |
| MURH | 120 | 37.7920 | 19.7014 | 0.2923 |
| IJAH | 120 | 2.8678 | 7.3967 | 1.5078 |
| ISTA | 120 | 3.1067 | 5.6962 | 1.9757 |
| ROA | 120 | 0.0192 | 0.0028 | 1.1088 |
| TII | 120 | 0.0030 | 0.0047 | 1.3306 |

Source: Primary Data Processed, 2026

The correlation matrix indicates positive associations between MUSH and ROA (0.273), MUDH and TII (0.298), and TII and ROA (0.341). The correlations do not indicate unusually high pairwise associations among the explanatory variables. The reported univariate and multivariate normality statistics also do not indicate substantial departures from normality under the estimation procedure used.

**Table 4. Direct Effects**

| | Relationship | Estimate | Std. Error | Std. β | t-value | p-value | 95% CI | Decision |
|---|---|---|---|---|---|---|---|---|
| H1 | MUSH → ROA | 0.0694 | 0.051 | 0.08 | 0.1097 | 0.048 | [0.000, 0.200] | Supported |
| H2 | MUSH → TII | 0.15972 | 0.099 | 0.02 | 2.32 | 0.020 | [0.036, 0.424] | Supported |

| | Relationship | Estimate | Std. Error | Std. β | t-value | p-value | 95% CI | Decision |
|---|---|---|---|---|---|---|---|---|
| H3 | MUDH → ROA | 0.3402 | 0.2930 | 0.10 | 1.16 | 0.25 | [-0.337, 1.317] | Not supported |
| H4 | MUDH → TII | 0.060 | 0.024 | 0.24 | 2.55 | 0.011 | [0.013, 0.107] | Supported |
| H5 | MURH → ROA | 0.050 | 0.013 | 0.23 | 0.175 | <0.001 | [0.025, 0.075] | Supported |
| H6 | IJAH → ROA | 0.6847 | 0.2270 | 0.20 | 3.02 | 0.003 | [0.0345, 0.1627] | Supported |
| H7 | ISTA → ROA | −0.160 | 0.0944 | −0.11 | −1.18 | 0.24 | [-0.427, 0.107] | Not supported |
| H8 | TII → ROA | 0.44375 | 0.16875 | 0.28 | 2.63 | 0.009 | [0.0163, 0.1115] | Supported |

Source: Primary Data Processed, 2026

Musharakah has a positive and significant effect on ROA, supporting H1. This result is consistent with the view that partnership financing can generate productive returns when monitoring and risk management are effective. H2 is also supported: musharakah is positively associated with TII, suggesting that greater exposure to a monitoring-intensive contract is accompanied by stronger technology investment.

Mudarabah has a positive but statistically insignificant direct effect on ROA, so H3 is not supported. This finding indicates that greater mudarabah exposure does not automatically translate into higher profitability, potentially reflecting uncertainty in business outcomes, information asymmetry, and agency costs. H4 is supported, however, indicating that mudarabah is positively associated with TII. The stronger standardized association for H4 suggests that technology investment may be particularly relevant to the information and monitoring demands of mudarabah.

H5 and H6 are supported: murabaha and ijarah positively affect ROA. Their relatively structured income mechanisms can provide more predictable financing returns and contribute to profitability. H7 is not supported; istisna has a negative and insignificant coefficient. The result is consistent with the relatively small scale of istisna financing and its exposure to completion, quality, timing, and project-monitoring risks. Finally, H8 is supported, indicating that greater TII is positively associated with ROA. This finding supports the argument that technology-related investment can strengthen information processing, monitoring, internal control, and risk management.

**Table 5. Mediation Analysis**

| | Mediation Path | Direct Effect | Indirect Effect | BootSE | 95% Bootstrap CI | Decision |
|---|---|---|---|---|---|---|
| H9 | MUSH → TII → ROA | 0.0694 | 0.0709 | 0.0084 | [-0.0019, 0.0312] | Not Supported |
| H10 | MUDH → TII → ROA | 0.3403 | 0.0266 | 0.0019 | [0.0003, 0.0076] | Supported |

The mediation results provide the study's central contribution. TII does not significantly mediate the relationship between musharakah and ROA because the bootstrap confidence interval includes zero; H9 is therefore not supported. In contrast, TII significantly mediates the relationship between mudarabah and ROA because the indirect effect is positive and its 95% bootstrap confidence interval excludes zero; H10 is supported. The asymmetry is important

because it indicates that technology investment is not a universal transmission mechanism for all profit-sharing contracts. The contrasting mediation results suggest that the information and monitoring characteristics of mudarabah may create a particularly relevant technology-mediated pathway to performance. Mudarabah separates capital provision from business management, making the bank dependent on information generated by the business partner. Technology investment can strengthen the acquisition, processing, verification, and monitoring of this information and thereby improve risk control and decision quality. For musharakah, although the contract also stimulates TII and TII improves ROA, the indirect pathway is not statistically established. The performance contribution of musharakah may therefore operate more strongly through its direct productive-return channel or through mechanisms not captured by the TII measure.

## CONCLUSION

This study examined how Islamic financing contracts relate to financial performance and whether Technology Investment Intensity functions as an asymmetric mediating mechanism in Indonesian Islamic banks. Using 120 bank-year observations from 10 Islamic commercial banks over 2012–2022, the results show that musharakah, murabaha, and ijarah positively and significantly affect ROA, whereas mudarabah and istisna have no significant direct effects. Musharakah and mudarabah positively and significantly affect TII, and TII positively affects ROA. The mediation analysis shows that TII does not mediate the musharakah-ROA relationship but significantly mediates the mudarabah-ROA relationship. Theoretically, the findings extend Agency Theory in Islamic banking by showing that information asymmetry and monitoring requirements may influence performance not only through direct agency costs but also through organizational responses in technology investment. The results further suggest that the technology-performance mechanism is contract-contingent rather than homogeneous across Islamic financing instruments. Managerially, Islamic banks should integrate financing strategy with technology investment, information governance, monitoring systems, and risk management. Technology investment should not be viewed simply as capital expenditure; its performance value depends on how effectively it is integrated with the governance and monitoring requirements of specific financing contracts.

The study is subject to limitations. TII is measured by capital expenditure relative to total assets and therefore captures investment intensity rather than technological efficiency or the specific quality of digital capabilities. Future research could employ more granular measures of digital capability, technology adoption, or IT expenditure and examine whether the asymmetric mediation mechanism remains robust across larger samples, longer periods, and different institutional settings.

### Author Statement on AI Use

The author acknowledges that AI-assisted tools were used in a limited capacity to support language refinement and improve clarity in writing. The use of such tools was strictly limited to editing and structuring the manuscript, without influencing the core ideas, data analysis, or interpretation of results. The author remains fully responsible for the originality, accuracy, and integrity of the content. All concepts, analyses, and conclusions presented in this manuscript are the author's own work, and the final version has been carefully reviewed and approved by all authors.

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