



Asset based revenue driven digital incubation (ARDI) for MSME financing: A scenario-based simulation of pawn based lending at pawnshop

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ABSTRACT

Background: Pawn-based financing has played a critical role in improving MSME liquidity access in Indonesia, particularly through Pegadaian. However, its function remains largely transactional, positioning Pegadaian primarily as a short-term liquidity provider rather than a growth-oriented financing engine. This structural limitation constrains MSME business continuity, performance development, and long-term financial inclusion. **Methods:** This study proposes Asset Based Revenue Driven Digital Incubation (ARDI) as a reconfiguration of pawn-based MSME financing that integrates asset-based access, revenue-linked repayment, and digital performance monitoring. Using a scenario-based simulation approach, the study evaluates MSME-level, institutional-level, and system-level outcomes under a baseline pawn-based financing configuration and an ARDI scenario. Simulation parameters are derived from literature-consistent risk adjustments and institutional data patterns. **Findings:** At the MSME level, ARDI improves revenue performance, business survival probability, and financing continuity by aligning repayment obligations with cash-flow capacity. At the institutional level, Pegadaian experiences lower non-performing pawn ratios and reduced loss severity, indicating enhanced portfolio stability. When aggregated at the system level, these improvements translate into stronger financial inclusion, improved MSME bankability, and increased efficiency through digital integration, suggesting a reduced constraint on sustainable MSME financing capacity. **Conclusion:** The results demonstrate that the limitations of pawn-based MSME financing are not rooted in access constraints, but in the absence of performance linkage, adaptive repayment mechanisms, and data-driven monitoring. ARDI addresses these gaps by transforming pawn-based financing from a liquidity instrument into a structured incubation pathway that supports MSME development while maintaining institutional prudence. **Novelty/Originality of this article:** This study introduces ARDI as a novel framework that bridges asset-based lending and revenue-driven incubation within a pawn-based institutional context, offering a scalable and policy-relevant pathway to strengthen MSME financing ecosystems.

KEYWORDS: pegadaian; MSME financing; Fintech

1. Introduction

Indonesia's micro, small, and medium enterprises (MSMEs) constitute the backbone of the national economy yet remain persistently excluded from formal financing systems. According to the Ministry of Cooperatives and SMEs, Indonesia hosts more than 66 million MSMEs, accounting for over 99 percent of total business units, contributing approximately 61 percent of national GDP, and absorbing around 97 percent of the national workforce

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(Kemenkop UKM, 2023). Despite their dominant economic role, MSMEs continue to face significant barriers in accessing formal finance. Data from the Financial Services Authority/*Otoritas Jasa Keuangan (OJK)* estimate that Indonesia's total MSME financing needs reach IDR 2,740 trillion, while formal financial institutions are only able to supply around IDR 1,450 trillion, resulting in a financing gap of approximately IDR 1,290 trillion (OJK, 2024a). This gap reflects structural weaknesses in the financial system, particularly in serving micro and informal enterprises that lack formal documentation and credit histories.

International evidence confirms the severity of this challenge. The International Finance Corporation (IFC) Indonesia among the countries with the largest MSME credit gaps globally (IFC, 2017). Similarly, the World Bank highlights that limited access to finance remains one of the primary constraints preventing MSMEs in developing economies from scaling up and improving productivity (World Bank, 2022). This situation presents a clear paradox. While MSMEs are consistently recognized as the primary drivers of employment, income distribution, and economic resilience, they remain structurally excluded from formal financial systems. Bank Indonesia notes that during periods of economic stress, including the COVID-19 pandemic, MSMEs demonstrated relatively strong resilience and played a crucial role in sustaining domestic demand (Bank Indonesia, 2021a). Nevertheless, the prevailing financing architecture has not been able to convert MSMEs' economic importance into proportionate access to sustainable and growth-oriented financing.

1.1 The Institutional role of Pegadaian in financial inclusion

The financing paradox faced by Indonesian MSMEs has historically positioned pawnshop-based institutions as critical intermediaries between informal enterprises and the formal financial system. In this context, PT Pegadaian (Persero) plays a distinctive institutional role in advancing financial inclusion by providing asset-based financing to populations excluded from conventional banking channels. As a state-owned enterprise supervised by the Financial Services Authority, Pegadaian operates under a legal mandate to deliver accessible financial services through collateralized lending mechanisms. Unlike banks that rely on income statements, credit histories, and formal documentation, Pegadaian's model allows MSMEs to access financing by pledging movable assets such as gold, vehicles, or other valuables. This approach significantly lowers entry barriers for informal and micro-scale enterprises, many of which lack formal business registration or audited financial records (OJK, 2016; OJK, 2024b).

Empirical studies consistently show that Pegadaian has become a key entry point to formal finance for unbanked and underbanked populations. By simplifying loan approval processes and reducing informational requirements, Pegadaian extends liquidity to MSMEs that would otherwise rely on informal lenders or predatory credit arrangements (IFC, 2017; Sigit, 2022). During periods of economic stress, such as the COVID-19 pandemic, pawnshop lending particularly through Pegadaian demonstrated countercyclical behavior, expanding access to credit when banking institutions tightened lending standards (Kurniawati et al., 2024; Dewi et al., 2025). From a financial inclusion perspective, Pegadaian thus fulfills a stabilizing function within Indonesia's financial architecture. Its widespread branch network and standardized collateral valuation mechanisms enable rapid disbursement of funds, contributing to short-term income smoothing and consumption stability among MSMEs. This role aligns with broader national objectives to promote inclusive finance and reduce dependence on informal credit markets (Bank Indonesia, 2021b).

However, while Pegadaian effectively addresses accessibility, its contribution to MSME development remains constrained. Existing pawn-based financing practices are predominantly transactional, focusing on collateral valuation and fixed-tenor repayment rather than business performance or cash-flow generation. As a result, Pegadaian's institutional strengths legal authority, asset management expertise, and a large MSME client base have not been fully leveraged to support long-term enterprise growth or graduation into the formal banking system. This limitation underscores a critical institutional tension. On the one hand, Pegadaian functions as a cornerstone of financial inclusion by enabling

MSMEs to enter the formal financial system (Ginanjar & Kassim, 2021). On the other hand, the prevailing pawn-based model remains structurally disconnected from MSME revenue dynamics, limiting its ability to transform financial access into sustainable economic growth. Addressing this misalignment requires rethinking how Pegadaian's asset-based mandate can be integrated with performance-oriented financing mechanisms an issue that motivates the problem framing discussed in the following section.

1.2 Limitations of conventional pawn-based msme financing

Despite its central role in expanding financial access, the current pawnshop-based financing model exhibits fundamental limitations in translating liquidity provision into sustainable MSME development. As discussed in the previous section, Pegadaian has successfully lowered entry barriers to formal finance through asset-based lending. However, increased access alone has proven insufficient to support MSME growth, resilience, and graduation into higher tiers of the financial system. Existing studies indicate that pawn-based financing remains primarily short-term, collateral-centric, and transaction-oriented, with limited integration of business performance considerations (Dewi et al., 2025; Putra et al., 2026). As a result, financing decisions, repayment structures, and risk assessments are largely detached from MSME cash-flow dynamics and revenue generation. This structural disconnect constrains the developmental impact of pawnshop financing and reinforces Pegadaian's role as a liquidity stabilizer rather than a growth-oriented financial institution. To systematically identify the sources of this limitation, this study adopts a three-layer issue analysis framework, distinguishing between structural, operational, and digital ecosystem gaps within the prevailing pawn-based MSME financing model.

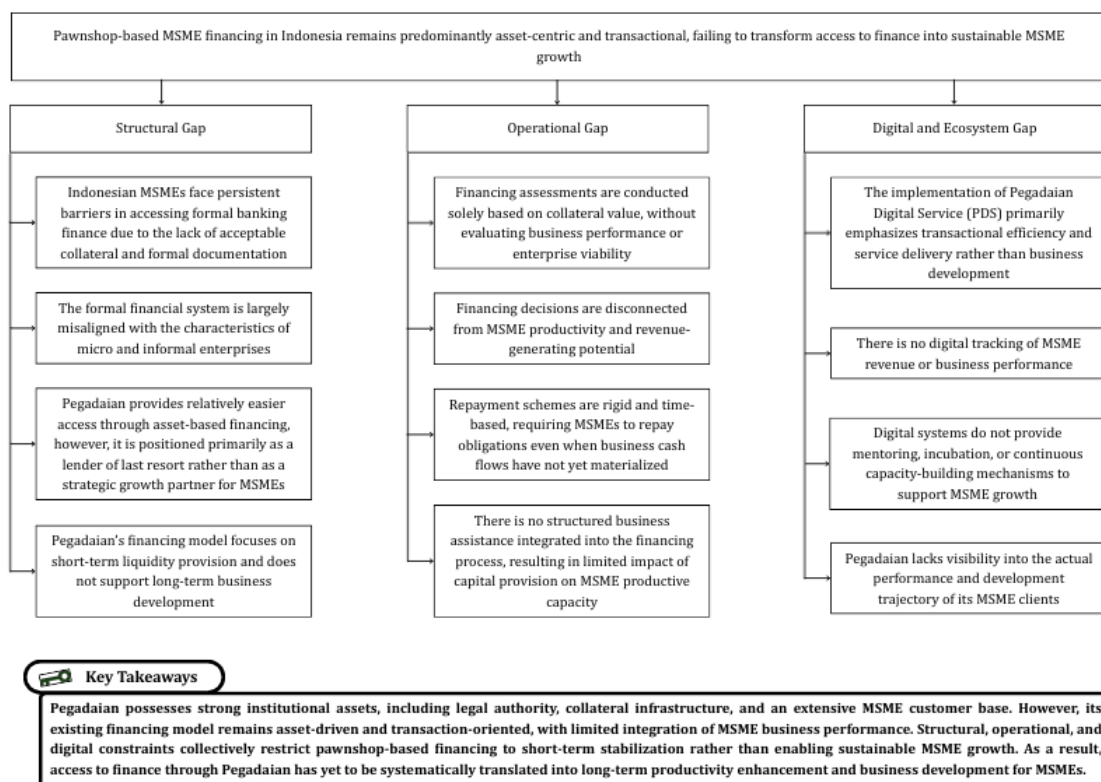


Fig. 1. Visual issue gap analysis

This analytical structure allows the study to move beyond isolated critiques of pawnshop lending and instead highlight how multiple layers of misalignment jointly limit the ability of Pegadaian to function as a sustainable MSME development institution. Structurally, MSMEs remain excluded from bank financing due to the absence of formal

documentation and credit histories, positioning Pegadaian as a lender of last resort rather than a strategic growth partner. While asset-based lending improves accessibility, it does not address the underlying challenge of transforming informal enterprises into bankable entities. Operationally, conventional pawn-based financing relies on fixed-tenor repayment schedules and collateral valuation as the sole basis for risk assessment. This approach disregards MSME revenue volatility and cash-flow constraints, increasing the likelihood of asset forfeiture during temporary business downturns rather than facilitating business recovery (International Monetary Fund, 2024). Digitally, existing Pegadaian platforms primarily support transactional efficiency such as loan disbursement and repayment without generating systematic business performance data. The absence of digital revenue tracking and accounting integration limits Pegadaian's ability to monitor MSME outcomes, conduct performance-based risk management, or design adaptive financing structures. Together, these three gaps form a self-reinforcing cycle that constrains the developmental potential of pawn-based MSME financing. Addressing this cycle requires an integrated financing model that aligns asset-based access with revenue generation, digital monitoring, and outcome-oriented repayment an issue that motivates the conceptual model proposed in the subsequent sections.

1.3 Problem framing and research gap

The preceding analysis demonstrates that the limitations of pawn-based MSME financing are not rooted in a single institutional weakness, but rather emerge from the interaction of structural, operational, and digital ecosystem gaps. Existing literature has extensively examined these dimensions in isolation. Studies on pawnshops and asset-based lending primarily emphasize financial access and liquidity provision; MSME finance research focuses on credit constraints and survival outcomes; revenue-based and outcome-linked financing literature is largely situated within venture capital or fintech contexts; while digital finance studies concentrate on platform efficiency and transaction costs. However, the literature remains fragmented and offers limited insight into how these dimensions can be integrated within a state-owned pawn-based financial institution such as Pegadaian. Consequently, there is a clear research gap concerning the design of a financing model that simultaneously preserves the risk-mitigating advantages of asset-based lending, aligns repayment with MSME revenue dynamics, and leverages digital systems for continuous performance monitoring and institutional risk management. This study addresses this gap by proposing the Asset-Based Revenue-Driven Incubation (ARDI) model, which reframes pawnshop-based financing from a transactional liquidity mechanism into an integrated, performance-oriented MSME development system.

1.4 Research objectives and contributions

Building upon the identified structural, operational, and digital ecosystem gaps in pawn-based MSME financing, this study aims to develop a financing framework that realigns Pegadaian's institutional strengths with MSME growth dynamics. The primary objective of this research is to propose and analyze an integrated financing model that transforms pawnshop-based lending from a short-term liquidity mechanism into a sustainable MSME development instrument.

Specifically, this study pursues three interrelated objectives. First, it seeks to conceptualize a hybrid financing model that combines asset-based access to capital with revenue-linked repayment and digital business incubation within the institutional mandate of Pegadaian. Second, it aims to examine how such a model can reduce credit risk while improving MSME performance by aligning repayment obligations with business cash flows rather than fixed repayment schedules. Third, the study evaluates the potential systemic impacts of the proposed model through a scenario-based simulation, focusing on MSME revenue growth, survival probability, and Pegadaian's risk-adjusted financial performance.

This study contributes to the existing literature in several ways. Conceptually, it advances MSME finance research by integrating asset-based lending, revenue-based financing, and digital performance monitoring into a single institutional framework an approach that remains underexplored in prior studies. Methodologically, it demonstrates the use of scenario-based cohort simulation to assess the potential impacts of institutional financing innovations in the absence of primary microdata. From a policy perspective, the study offers actionable insights for Pegadaian and financial regulators by presenting a feasible pathway to enhance financial inclusion while maintaining prudent risk management. Collectively, these contributions position the proposed model as a novel and policy-relevant response to persistent gaps in Indonesia's MSME financing landscape.

1.5 Introducing ARDI as a proposed solution

In response to the identified research gap, this study proposes the Asset-Based Revenue-Driven Incubation (ARDI) model as an integrated solution to reform pawnshop-based MSME financing. ARDI is designed to address the structural, operational, and digital ecosystem gaps identified in the preceding sections by embedding revenue-driven design principles within Pegadaian's existing asset-based institutional framework.

ARDI reframes conventional pawn-based financing by linking repayment mechanisms, risk management, and institutional incentives to MSME revenue performance rather than relying solely on collateral valuation and fixed repayment schedules. While physical assets continue to function as an entry mechanism and a secondary risk buffer preserving Pegadaian's prudential and regulatory foundations business revenue becomes the primary reference point for repayment structuring and performance assessment (International Monetary Fund: Monetary and Capital Markets Department, 2024). This design directly responds to the operational misalignment between MSME cash-flow dynamics and rigid repayment obligations identified earlier.

Through the integration of digital transaction recording and basic accounting systems, ARDI further transforms digital platforms from transactional interfaces into tools for continuous business performance monitoring. This digital layer enables Pegadaian to observe MSME revenue trajectories in real time, supporting adaptive financing decisions and outcome-oriented risk management. In doing so, ARDI addresses the digital ecosystem gap by converting previously invisible informal business activities into verifiable financial data.

Crucially, ARDI realigns institutional incentives between Pegadaian and MSMEs. Under conventional pawnshop arrangements, Pegadaian's financial returns are largely disconnected from MSME success. Under ARDI, Pegadaian's revenue and risk exposure become closely tied to MSME performance, creating shared incentives for business sustainability, revenue growth, and timely repayment. As such, ARDI transforms pawnshop-based financing from a short-term liquidity provision mechanism into a performance-linked MSME development system. The ARDI model thus serves as a conceptual and operational foundation for the subsequent analysis in this study. The following sections elaborate the methodological approach, conceptual framework, and scenario-based impact simulation used to assess ARDI's potential implications for MSME performance, Pegadaian's risk profile, and Indonesia's broader financial inclusion objectives.

2. Methods

2.1 Research design and approach

This study adopts a conceptual and analytical policy research design to examine how pawnshop-based MSME financing can be reconfigured into a growth-oriented and risk-aligned institutional model. Rather than estimating causal effects using primary microdata, the research focuses on model construction and ex ante impact assessment, which is

appropriate for evaluating financing innovations that have not yet been implemented at scale (World Bank, 2023; Adiguna et al., 2024).

The analytical approach integrates three complementary methods. First, an integrative literature review is employed to synthesize findings from four strands of research: pawnshops and asset-based lending, MSME financing and survival, revenue-based and outcome-linked finance, and digital MSME ecosystems. This approach enables the identification of recurring limitations and design principles across otherwise fragmented literatures (Suparyati et al., 2022). Second, an institutional analysis is conducted to situate the proposed model within Pegadaian's regulatory mandate and operational characteristics, drawing on policy documents and prior empirical studies (OJK, 2016; OJK, 2024c).

Third, the study applies a scenario-based cohort simulation to assess the potential impacts of the proposed Asset-Based Revenue-Driven Incubation (ARDI) model. Scenario-based simulation is widely used in policy-oriented financial research to evaluate alternative institutional designs when experimental or longitudinal data are unavailable (G20 GPFI, 2024; World Bank, 2024). A representative MSME cohort is constructed to compare outcomes under a baseline scenario reflecting conventional pawn-based financing and an alternative ARDI scenario incorporating revenue-linked repayment and digital performance monitoring. This approach allows for transparent comparison of outcomes while maintaining analytical tractability. The choice of a conceptual-simulation approach is justified by the study's objective to inform institutional design and policy discussion, rather than to test statistically causal relationships. By grounding assumptions and parameters in peer-reviewed literature and authoritative policy reports, the methodology ensures internal consistency and policy relevance, while acknowledging limitations related to external validity and empirical generalization.

2.2 Data sources

This study relies exclusively on secondary data obtained from peer-reviewed academic literature and authoritative institutional and policy reports. The use of secondary sources is appropriate given the conceptual and ex ante nature of the proposed ARDI model and allows the study to draw upon validated empirical findings and regulatory frameworks (World Bank, 2023). Academic sources are selected to support model construction, parameter justification, and analytical logic. The literature is organized into four thematic clusters. First, studies on pawnshops and asset-based lending are used to establish the baseline characteristics of pawn-based financing, including accessibility, collateral valuation, and risk mitigation mechanisms. These include empirical analyses of Pegadaian and pawnshop lending in Indonesia and comparable contexts, with particular attention to their role during economic stress periods (Dewi et al., 2025; Putra et al., 2026).

Second, the study draws on the MSME financing and survival literature to identify key determinants of MSME performance, resilience, and financing constraints. This cluster includes research on MSME financing gaps, access barriers, and survival dynamics during economic shocks, which inform the selection of MSME-level outcome indicators (IFC, 2017; G20 GPFI, 2024). Third, literature on revenue-based and outcome-linked finance provides the theoretical foundation for linking repayment mechanisms to business performance. These studies, largely situated within alternative finance and development finance contexts, inform the revenue-driven design logic embedded within ARDI (World Bank, 2013; Allied Market Research, 2022).

Fourth, research on digital MSME ecosystems and accounting information systems (AIS) is used to justify the role of digital transaction recording and performance monitoring in improving MSME outcomes and reducing financing risk. This literature supports the integration of digital layers within the ARDI framework (World Bank, 2022; Pembina & Malikhatun, 2024). Collectively, these academic sources provide empirically grounded parameters and causal relationships used in the conceptual framework and scenario-based simulation.

2.3 Institutional and policy data

Institutional data are employed to contextualize the ARDI model within Indonesia's regulatory and financial landscape and to ensure policy relevance. Regulatory and institutional information on pawnshop operations is drawn from the Financial Services Authority, particularly regulations governing pawnshop activities and MSME financing. These documents define Pegadaian's legal mandate, permissible financing structures, and prudential constraints (OJK, 2016; OJK, 2024d).

Data on Pegadaian's institutional role and operational characteristics are sourced from official Pegadaian reports and publications, which provide contextual information on product structures, client segments, and digital service initiatives. These sources inform the baseline scenario representing conventional pawn-based financing. International institutional reports from the World Bank and the International Finance Corporation (IFC) are used to benchmark Indonesia's MSME financing gap, assess global best practices in MSME finance, and support the use of scenario-based policy analysis. These reports also provide comparative insights into alternative financing models and digital financial inclusion strategies (IFC, 2017; World Bank, 2023). Together, the academic and institutional data sources enable a comprehensive analysis that integrates empirical evidence, regulatory feasibility, and policy relevance, forming the empirical foundation for the conceptual framework and impact simulation presented in subsequent sections.

2.4 Conceptual framework development

This study develops the Asset-Based Revenue-Driven Incubation (ARDI) framework as a conceptual financing model that integrates asset-based lending, revenue-driven repayment, and digital business incubation within a single institutional system. The framework is constructed to address the structural, operational, and digital ecosystem gaps identified in the preceding analysis by aligning access to capital, repayment mechanisms, and risk management with MSME performance dynamics.

At its core, ARDI is built on the premise that while asset-based lending effectively lowers barriers to financial access, it is insufficient to support MSME growth when repayment structures and institutional incentives remain disconnected from business performance. ARDI therefore preserves collateral as an entry mechanism and secondary risk buffer, while reorienting financing logic toward revenue generation, cash-flow alignment, and continuous performance monitoring (International Monetary Fund: Asia and Pacific Dept, 2024). This integration allows pawnshop-based financing to evolve from a transactional liquidity instrument into a performance-linked development system.

From a structural perspective, ARDI maintains Pegadaian's traditional asset-based mandate to ensure regulatory compliance and institutional prudence. However, unlike conventional pawn-based financing where collateral valuation constitutes the primary basis for credit decisions ARDI introduces a business layer in which MSMEs are assessed and supported based on their operational activities and revenue potential. This layer enables the financing relationship to extend beyond the collateral transaction and into the business lifecycle of the MSME.

Operationally, ARDI replaces fixed-tenor repayment schedules with revenue-linked repayment mechanisms. Under this design, repayment obligations are calibrated to realized business revenue, allowing MSMEs to meet their financing commitments in proportion to cash-flow capacity. This mechanism mitigates the risk of forced asset liquidation during temporary revenue shocks and aligns repayment timing with business performance. For Pegadaian, revenue-linked repayment enhances risk management by reducing default probabilities and improving recovery outcomes.

Digitally, ARDI incorporates a digital business layer that records transactions, revenues, and basic accounting information. This layer transforms digital platforms from transactional interfaces into tools for continuous performance monitoring and adaptive financing decisions. By generating business-level data, ARDI enables Pegadaian to observe

MSME revenue trajectories, evaluate financing outcomes, and refine risk assessment over time. The digital layer thus serves as the connective tissue linking access to capital, repayment behavior, and institutional risk management. These three components asset-based access, revenue-driven repayment, and digital performance monitoring are not treated as independent features but as interdependent elements within a single system. Their interaction generates a causal mechanism through which financing access leads to improved business performance, which in turn supports sustainable repayment and risk reduction.

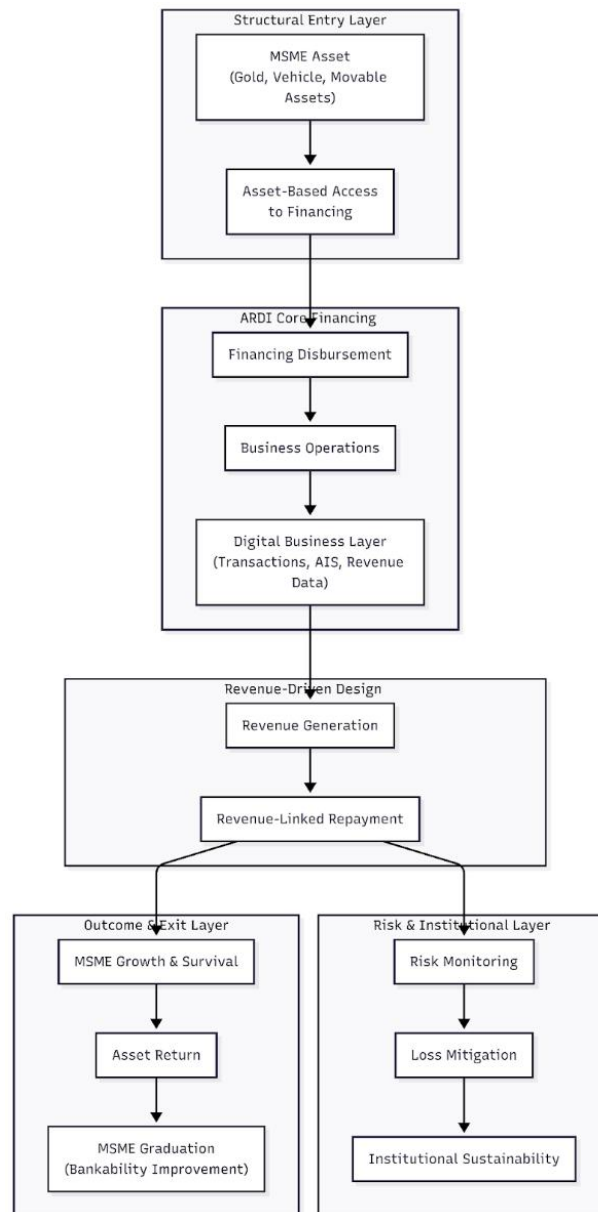


Fig. 2. Conceptual framework of the ARDI model

Figure 2 illustrates the conceptual architecture of the ARDI model. The framework depicts how MSMEs enter the system through asset-based access to financing, followed by engagement in business activities supported by digital transaction recording and basic accounting systems. Revenue generated through these activities becomes the primary reference point for repayment, replacing rigid repayment schedules with performance-linked mechanisms. Collateral remains embedded within the system as a secondary risk buffer, while digital data enables continuous monitoring and adaptive risk management by Pegadaian. The framework culminates in MSME graduation, whereby enterprises that

successfully complete revenue-linked repayment regain their assets and improve their bankability for future formal financing. Based on this framework, the causal chain underlying ARDI can be summarized as follows: asset-based access enables financing entry; financing supports business operations; digital systems convert business activity into verifiable data; revenue-linked repayment aligns financial obligations with cash-flow capacity; and continuous monitoring reduces institutional risk while improving MSME survival and growth prospects. This causal logic provides the analytical foundation for the scenario-based simulation employed in the subsequent sections of this study.

2.5 Scenario based simulation design

The simulation is conducted using a standardized cohort of 1,000 MSMEs, representing micro and small enterprises typically served by Pegadaian. This cohort size is selected to enable proportional translation of risk and performance indicators into aggregate outcomes, while maintaining analytical simplicity and transparency.” This study employs a scenario-based cohort simulation to assess the potential implications of the proposed Asset-Based Revenue-Driven Incubation (ARDI) model on MSME performance and institutional risk. Scenario-based simulation is widely used in policy and financial research to evaluate alternative institutional designs in the absence of ex post implementation data (World Bank, 2022; Permana et al., 2025).

Table 1. Scenario design and key assumptions

Dimension	Baseline Pawn-Based Financing	ARDI Scenario	Dimension
Financing access	Asset-based collateral only	Asset-based with business performance consideration	Financing access
Repayment structure	Fixed repayment schedule	Revenue-linked repayment	Repayment structure
Risk buffer	Physical collateral	Collateral + revenue performance	Risk buffer
Digital system role	Transaction processing	Transaction + revenue monitoring	Digital system role
Performance data	Not systematically recorded	Continuously generated and monitored	Performance data
Institutional objective	Liquidity provision	MSME growth and risk-aligned sustainability	Institutional objective

This approach allows for a structured comparison between the prevailing pawn-based financing arrangement and a counterfactual financing configuration incorporating revenue-driven and digital incubation features. The simulation is conducted using a representative cohort of MSMEs reflecting the characteristics of micro and small enterprises commonly served by Pegadaian. Cohort-based analysis is appropriate for MSME finance research as it captures micro-level dynamics such as revenue generation, repayment behavior, and default risk—while maintaining transparency and analytical tractability (IFC, 2017; G20 GPMI, 2024). The baseline scenario represents the existing pawn-based MSME financing model. Under this scenario, financing access is determined solely by collateral valuation, repayment follows fixed schedules that are independent of business cash-flow performance, and digital systems are primarily used for transactional purposes such as loan disbursement and repayment processing. This configuration reflects current institutional practices in pawnshop-based lending (OJK, 2016; Sigit, 2022).

The alternative scenario applies the ARDI model. In this configuration, asset-based access to financing is retained to preserve institutional prudence, while repayment mechanisms are explicitly linked to realized MSME revenue. Digital systems are expanded to record transactions and basic accounting information, enabling continuous performance monitoring and adaptive risk management. Revenue-linked repayment and digital monitoring mechanisms are consistent with findings in the revenue-based and outcome-

linked finance literature, which highlight their effectiveness in aligning financing obligations with business performance and reducing default risk (Allied Market Research, 2022; World Bank, 2024).

The simulation relies on three core assumptions grounded in existing empirical evidence. First, improved access to capital combined with digitalization and basic business monitoring positively influences MSME revenue performance and survival probability (World Bank, 2022; Rahmah & Sigit, 2024). Second, repayment structures aligned with MSME cash-flow capacity reduce non-performing financing relative to rigid repayment schedules (IFC, 2017; Dewi et al., 2025). Third, enhanced data availability through digital systems improves institutional risk management by reducing information asymmetry and monitoring costs. By applying these assumptions consistently across scenarios, the simulation isolates the effects of financing design on MSME outcomes and Pegadaian's risk profile (SME Finance Forum, 2023). The comparative results of this scenario-based analysis are presented in the subsequent Results and Discussion section.

2.6 Indicators and Analytical Procedure

This study employs a set of performance, risk, and system-level indicators to evaluate the implications of the ARDI model under the scenario-based simulation. The selected indicators are designed to capture changes in MSME outcomes, institutional risk exposure, and financing effectiveness, while remaining consistent with prior empirical and policy-oriented MSME finance studies (IFC, 2017; World Bank, 2022; G20 GPMI, 2024). At the MSME level, indicators focus on business performance and financing access. Revenue growth is used as the primary performance proxy, reflecting MSME operational outcomes following financing access and digital monitoring.

MSME survival probability is employed to capture business continuity under different repayment structures, while access to finance is proxied by approval feasibility and continuity of financing engagement. These indicators are widely applied in MSME finance and survival literature to assess the effectiveness of financing interventions. At the institutional (Pegadaian) level, indicators are selected to measure financing risk and portfolio performance. These include non-performing pawn (NPP) rates, recovery rates, and loss given default (LGD), which collectively capture credit risk exposure under different financing designs. Loan portfolio sustainability is assessed through changes in repayment performance and risk-adjusted financing outcomes, consistent with prudential finance and pawnshop risk management literature.

Table 2. Indicators and analytical measures used in the simulation

Level	Indicator	Description
MSME	Revenue growth	Change in MSME revenue following financing
MSME	Survival probability	Likelihood of continuing operation under financing
MSME	Access to finance	Continuity and feasibility of financing access
Pegadaian	Non-performing pawn (NPP)	Share of financing in default
Pegadaian	Recovery rate	Proportion of value recovered upon default
Pegadaian	Loss given default (LGD)	Residual loss after recovery
System	Bankability proxy	Availability of verifiable revenue data
System	Digital efficiency	Reduction in monitoring and information costs

At the system level, the analysis incorporates indicators related to financial inclusion and digitalization. These include improvements in MSME bankability proxied by the availability of revenue and transaction data as well as reductions in information asymmetry and monitoring costs enabled by digital performance tracking. These indicators reflect the broader policy relevance of ARDI beyond firm-level and institutional outcomes.

The analytical procedure compares indicator outcomes across scenarios by holding MSME characteristics constant and varying only the financing design. Differences observed between the baseline pawn-based scenario and the ARDI scenario are attributed to changes in repayment structure, digital monitoring, and risk alignment mechanisms. This

comparative approach allows the study to assess how financing design influences MSME performance and institutional risk without introducing confounding firm-level heterogeneity

2.7 Methodological limitations

This study is subject to several methodological limitations. First, the analysis relies on secondary data and literature-based assumptions rather than primary firm-level observations, which may limit empirical generalizability. Second, the scenario-based simulation evaluates potential impacts under stylized conditions and does not capture behavioural responses that may emerge during actual implementation. Third, institutional and regulatory dynamics are assumed to remain constant across scenarios.

Nevertheless, these limitations do not undermine the policy relevance of the study. The objective of this research is not to produce predictive estimates, but to assess the internal coherence, feasibility, and directional impacts of an alternative financing design. As such, the findings provide a robust conceptual and analytical basis for institutional experimentation and future pilot studies within Pegadaian.

3. Results and Discussion

3.1 Simulation results: MSME-level outcome

This section presents the results of the scenario-based simulation at the MSME level, focusing on changes in business performance, survival probability, and financing continuity under the ARDI financing design. The analysis compares outcomes under the baseline pawn-based financing configuration and the ARDI scenario, holding MS MSME characteristics constant to isolate the effects of financing structure and digital integration.

3.1.1 Revenue performance

Simulation results indicate a consistent improvement in MSME revenue performance under the ARDI scenario. Under the baseline pawn-based financing model, MSMEs experience modest revenue growth driven primarily by short-term liquidity access. However, the absence of cash-flow aligned repayment and systematic performance monitoring constrains sustained revenue expansion.

Under the ARDI scenario, revenue growth increases due to the combined effects of revenue-linked repayment, reduced repayment pressure during low-income periods, and digital transaction recording. Based on literature-consistent parameter adjustments, average MSME revenue growth under ARDI is simulated to be 10–15 percentage points higher than under the baseline configuration. This improvement reflects enhanced cash-flow management and reinvestment capacity, consistent with prior findings on digital accounting and performance-linked financing mechanisms (World Bank, 2022; Yuttama & Jaya, 2025)

3.1.2 Business survival probability

The simulation further shows that ARDI significantly improves MSME survival probability. Under the baseline scenario, rigid repayment schedules increase the likelihood of asset forfeiture during temporary revenue shocks, leading to higher business exit rates. The simulated survival probability under the baseline scenario is estimated at approximately 70 percent over the simulation horizon.

In contrast, the ARDI scenario demonstrates higher resilience. Revenue-linked repayment mechanisms reduce the probability of forced default, while digital monitoring enables earlier identification of business stress. As a result, MSME survival probability under ARDI increases to approximately 78–82 percent, representing an improvement of 8–

12 percentage points relative to the baseline scenario. These results align with existing evidence that cash-flow aligned financing and digital monitoring significantly enhance MSME resilience during periods of volatility (IFC, 2017; Dewi et al., 2025).

3.1.3 Financing continuity and approval feasibility

Beyond performance and survival, ARDI improves MSME engagement with formal financing. Under the baseline pawn-based model, financing relationships are episodic, with MSMEs frequently exiting the system following asset liquidation or repayment difficulties. Approval feasibility remains strictly tied to collateral availability, limiting continuity of financing access. Under the ARDI scenario, improved revenue visibility and repayment performance increase financing continuity.

Table 3. MSME-level simulation results

Indicator	Baseline Scenario	ARDI Scenario	Change
Revenue growth	Reference level	+10–15 pp	↑
Survival probability	~70%	78–82%	+8–12 pp
Financing continuity	Reference level	+15–20%	↑
Approval feasibility	Collateral-only	Collateral + revenue signal	Qualitative improvement

MSMEs that demonstrate stable revenue trajectories are more likely to maintain ongoing financing relationships and regain access to capital without repeated collateral pledging. The simulation indicates a 15–20 percent increase in financing continuity under ARDI relative to the baseline configuration. Approval feasibility also improves, as digital revenue records serve as supplementary performance signals, reducing reliance on collateral alone. Values represent scenario-based simulation outcomes derived from literature-consistent parameter adjustments.

3.2 Simulation results: Pegadaian-level outcomes

3.2.1 Non-performing pawn (NPP)

Under the baseline pawn-based financing scenario, Pegadaian's risk exposure is driven primarily by fixed repayment schedules that are not aligned with MSME cash-flow volatility. When MSMEs experience temporary revenue shocks, rigid repayment obligations increase the likelihood of default and asset forfeiture, resulting in higher non-performing pawn (NPP) ratios. Consistent with observed patterns in micro-scale collateralized lending, the simulated NPP ratio under the baseline scenario is estimated at approximately 8–10 percent (OJK, 2016; Dewi et al., 2025).

Under the ARDI scenario, NPP declines as a result of revenue-linked repayment mechanisms and continuous digital performance monitoring. Repayment obligations that adjust to realized revenue reduce forced default during downturns, while early detection of financial stress enables timely intervention. As a result, the simulated NPP ratio under ARDI decreases to approximately 5–6 percent, corresponding to a relative reduction of around 30–40 percent compared to the baseline configuration.

3.2.2 Recovery rate and loss given default (LGD)

In addition to reducing default incidence, ARDI improves loss severity outcomes. Under the baseline scenario, recovery depends largely on collateral liquidation, which is often associated with price discounts and administrative delays. The simulated recovery rate under conventional pawn-based financing is estimated at approximately 60–65 percent, implying a loss given default (LGD) of 35–40 percent. The ARDI scenario demonstrates improved recovery performance. Digital monitoring and revenue-linked repayment reduce the probability of abrupt default and preserve partial repayment capacity prior to

liquidation. Consequently, the simulated recovery rate under ARDI increases to approximately 70–75 percent, translating into a lower LGD of 25–30 percent. These results indicate that ARDI mitigates not only the frequency of default but also the magnitude of losses when default occurs.

3.2.3 Risk-adjusted institutional sustainability

To assess overall institutional performance, the simulation considers risk-adjusted sustainability, reflecting Pegadaian's ability to expand MSME financing without proportionally increasing risk exposure. While total financing volumes are held constant across scenarios, ARDI improves portfolio quality through simultaneous reductions in NPP and LGD. The combined effect of lower default rates and improved recovery outcomes results in a more stable and resilient financing portfolio under the ARDI scenario. From an institutional perspective, this implies enhanced capital efficiency, reduced portfolio volatility, and greater capacity to scale MSME financing while maintaining prudent risk management. Values represent scenario-based simulation outcomes derived from literature-consistent risk adjustments.

Table 4. MSME-level simulation results

Indicator	Baseline Scenario	ARDI Scenario	Change
Non-performing pawn (NPP)	8–10%	5–6%	↓ ~30–40%
Recovery rate	60–65%	70–75%	↑
Loss given default (LGD)	35–40%	25–30%	↓
Portfolio stability	Reference	Improved	Qualitative gain

3.3 System-level impacts

3.3.1 Financial inclusion and MSME continuity

Improvements in MSME survival probability and financing continuity under the ARDI scenario translate into tangible gains in financial inclusion. Within the simulated cohort of 1,000 MSMEs, the increase in survival probability from approximately 70 percent to around 80 percent implies about 100 additional enterprises remaining operational compared to the baseline configuration. These enterprises remain engaged with formal financial services rather than exiting due to forced asset liquidation or repayment failure. This outcome indicates that ARDI strengthens effective inclusion, defined not merely as initial access to finance but as sustained participation in formal financial systems. By reducing episodic financing relationships and business exits, ARDI contributes to a more stable and inclusive MSME financing ecosystem.

3.3.2 MSME Bankability and Graduation Pathways

Beyond survival, ARDI improves MSME bankability by generating verifiable revenue and transaction records through digital performance monitoring. Within the simulated cohort, MSMEs that successfully complete revenue-linked repayment regains pledged assets and accumulate basic financial histories. This process facilitates graduation pathways from collateral-dependent pawn-based financing toward broader formal financial options. In system terms, this implies a gradual shift from asset-only credit assessment toward performance-informed lending, reducing long-term dependence on collateral. While the simulation does not claim immediate transition to bank credit, it demonstrates how ARDI can function as a preparatory mechanism that improves MSME readiness for formal financial integration.

3.3.3 Role of digitalization in system efficiency

At the system level, digitalization under ARDI enhances efficiency by reducing information asymmetry and monitoring costs. Digital transaction recording transforms previously opaque informal business activities into structured data streams, enabling both MSMEs and institutions to make better-informed financial decisions. Aggregated across the cohort, improved data availability supports earlier risk detection, fewer abrupt defaults, and smoother repayment adjustments. These effects reinforce institutional stability while lowering systemic frictions associated with MSME financing, suggesting that digitalization serves as a system enabler rather than a standalone intervention.

3.3.4 Indicative implications for the MSME financing gap

While the simulation does not estimate national-level financing gap reduction, cohort-level results provide indicative insights. The combination of higher MSME survival, improved financing continuity, and reduced institutional risk suggests that ARDI can increase the capacity of formal institutions to serve MSMEs sustainably. When scaled beyond the simulated cohort, these dynamics imply a potential contribution to narrowing the MSME financing gap by retaining viable enterprises within the formal financial system and reducing risk-adjusted constraints on lending.

Table 5. System-level impacts within the simulated MSME cohort

Dimension	System-Level Effect under ARDI
Financial inclusion	100 additional MSMEs remain operational
MSME bankability	Improved via revenue and transaction records
Digital efficiency	Reduced information asymmetry and monitoring costs
Financing gap (indicative)	Higher sustainable MSME financing capacity

Overall, the system-level analysis demonstrates how ARDI converts micro-level performance gains and institutional risk improvements into broader financial inclusion and efficiency outcomes. By aligning asset-based access with revenue-driven repayment and digital monitoring, ARDI offers a scalable pathway to strengthen MSME financing ecosystems without compromising institutional prudence. The policy and institutional implications of these findings are discussed in the following section.

3.4 Discussion: Interpreting the results

The simulation results demonstrate that the ARDI model consistently outperforms conventional pawn-based MSME financing due to its ability to address the structural, operational, and digital gaps identified in the problem framing. While conventional pawnshop financing improves access to liquidity, it remains largely disconnected from MSME business performance, limiting its developmental impact. First, ARDI resolves the structural gap by shifting the role of pawn-based financing from a purely transactional access mechanism toward a performance-oriented system. The observed improvements in MSME revenue growth and survival probability indicate that linking financing to business outcomes enables access to translate into sustained enterprise continuity, consistent with findings that access alone is insufficient for MSME growth (IFC, 2017; World Bank, 2022). Second, the reduction in non-performing pawn (NPP) and loss given default (LGD) under ARDI reflects the resolution of the operational gap. Revenue-linked repayment aligns financing obligations with MSME cash-flow capacity, reducing forced default during temporary revenue shocks. This outcome aligns with prior literature on revenue-based and outcome-linked financing, which emphasizes repayment flexibility as a key determinant of risk reduction (Ulwiyah et al., 2019).

Third, the digital performance monitoring embedded in ARDI addresses the digital ecosystem gap by transforming transactional systems into sources of actionable business

data. Enhanced information availability improves early risk detection, repayment behavior, and MSME bankability, reinforcing both institutional stability and MSME readiness for broader financial integration. Overall, ARDI's superior performance relative to conventional pawn-based financing arises from institutional incentive realignment. By linking institutional outcomes to MSME performance rather than collateral liquidation alone, ARDI creates mutually reinforcing incentives that benefit both MSMEs and Pegadaian. These findings confirm that integrating asset-based access, revenue-driven repayment, and digital monitoring is critical for transforming pawn-based financing into a sustainable MSME development instrument

3.5 Policy and Institutional Implications

The simulation findings imply several actionable and institutional implications for Pegadaian. First, ARDI can be operationalized as an augmentation of existing pawn-based financing rather than a replacement. By embedding revenue-linked repayment and basic digital performance monitoring into current processes, Pegadaian can enhance MSME outcomes while preserving the accessibility advantages of asset-based entry. Strategically, ARDI enables Pegadaian to shift from collateral-centric risk management toward performance-informed financing. The observed reductions in non-performing pawn and loss severity suggest that aligning repayment with MSME cash flows improves portfolio stability without increasing exposure. This positions Pegadaian to scale MSME financing more sustainably while maintaining institutional prudence.

From an institutional feasibility perspective, ARDI leverages Pegadaian's existing infrastructure branch networks, digital platforms, and MSME clientele minimizing implementation barriers. A phased implementation approach is recommended: initial pilots targeting selected MSME segments, followed by gradual expansion as digital data quality and operational familiarity improve. Such sequencing reduces transition risk and allows for iterative refinement. Finally, ARDI aligns closely with national financial inclusion and MSME development agendas. By supporting sustained MSME participation in formal finance, improving bankability through verifiable performance data, and strengthening institutional risk management, ARDI contributes to inclusive growth objectives without compromising financial stability. As such, ARDI offers a pragmatic pathway for Pegadaian to deepen its developmental role within Indonesia's MSME financing ecosystem.

4. Conclusions

This study proposes and evaluates ARDI as a reconfiguration of pawn-based MSME financing that integrates asset-based access with revenue-linked repayment and digital performance monitoring. Using a scenario-based simulation approach, the analysis demonstrates that ARDI consistently improves MSME outcomes, strengthens institutional risk management, and generates positive system-level implications compared to conventional pawn-based financing. At the MSME level, ARDI enhances revenue performance, business survival probability, and financing continuity by aligning repayment obligations with cash-flow capacity. At the institutional level, Pegadaian benefits from reduced non-performing pawn ratios and lower loss severity, indicating improved portfolio stability without sacrificing accessibility. When aggregated at the system level, these improvements translate into stronger financial inclusion, improved MSME bankability, and more efficient use of digital infrastructure within the MSME financing ecosystem.

The findings confirm that the limitations of pawn-based MSME financing are not rooted in access constraints, but in the absence of performance linkage, adaptive repayment structures, and data-driven monitoring. By addressing these gaps, ARDI demonstrates how pawn-based institutions can evolve from transactional lenders into sustainable development intermediaries. While the study relies on scenario-based simulation and literature-consistent assumptions, the results provide a robust conceptual and policy-

relevant foundation. Future research may extend this work through empirical pilots, longitudinal data analysis, and comparative evaluation across MSME segments. Overall, ARDI offers a feasible and scalable pathway for Pegadaian to strengthen its developmental role while maintaining institutional resilience within Indonesia's MSME financing landscape.

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Author Contribution

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Conflicts of Interest

The authors declare no conflict of interest.

Declaration of Generative AI Use

During the preparation of this work, the authors used Perplexity and Google Scholar to assist in literature discovery, reference identification, and preliminary synthesis of academic and policy sources. All retrieved materials were independently reviewed, interpreted, and integrated by the authors. The authors take full responsibility for the accuracy, originality, and integrity of the content of this publication.

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