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Innovative financing models for bridging the healthcare access gap in developing economies

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Abstract

Access to quality healthcare in developing economies continues to be constrained by structural financing gaps, particularly in the procurement and maintenance of critical medical equipment. While international health initiatives have expanded service delivery coverage, sustainable capital access for healthcare providers especially small and medium-sized enterprises (SMEs) in the private sector remains underdeveloped. This paper explores innovative financing models aimed at bridging this gap through the strategic deployment of blended finance, lifecycle asset support, and risk-sharing mechanisms. Unlike traditional health microfinance or leasing approaches, the proposed framework addresses the full spectrum of risks associated with medical asset investments, including cash flow unpredictability, lack of collateral, and equipment underutilization. Drawing upon case-based qualitative analysis and secondary data from multilateral reports, the paper presents a multi-stakeholder financing architecture. Key components include partial risk guarantees to reduce lender exposure, OEM-backed maintenance agreements to safeguard asset functionality, and cash-flow-linked repayment schemes designed to mirror provider revenue cycles. The model is further supported by reserve buffers and quality assurance mechanisms that strengthen long-term sustainability and align stakeholder incentives. Notably, this approach enhances bankability for health SMEs, reduces patient underdiagnosis due to equipment failures, and supports national goals such as Universal Health Coverage (UHC). The study contributes to the growing body of evidence advocating for health-specific, context-sensitive capital deployment strategies in LMICs. By embedding financial resilience into healthcare delivery systems, this model offers a replicable pathway to unlock new investments, improve health outcomes, and foster scalable impact in resource-constrained settings.

Keywords: Blended Finance; Healthcare Access; Medical Equipment; Lmics; Risk Guarantees; Lifecycle Financing

1. Introduction

1.1. Context and problem definition

1.1.1. The Healthcare Infrastructure Gap in LMICs

In low- and middle-income countries (LMICs), significant disparities in healthcare infrastructure persist, particularly in diagnostic and therapeutic equipment availability. According to regional health systems surveys, over 60% of primary health facilities lack functional radiology units or laboratory diagnostic tools, even in areas with high disease burden [1]. Rural facilities are disproportionately affected, with imaging devices like X-rays, ultrasounds, and CT scanners often centralized in urban hospitals, making access geographically and economically unfeasible for vulnerable populations [2].

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A growing body of evidence from World Health Organization (WHO) audits highlights a troubling trend: even where equipment is present, it is frequently underutilized or inoperative. In some countries, more than 40% of medical devices in public sector facilities remain idle due to lack of trained personnel, irregular power supply, or delayed maintenance [3]. Equipment donation programs, while well-intentioned, have often failed to align with local needs, resulting in obsolete or incompatible systems being stockpiled rather than deployed [4].

Furthermore, the absence of integrated procurement strategies and centralized biomedical inventories impedes transparency and cost-efficiency. Fragmentation in acquisition and maintenance protocols leaves many ministries of health unaware of the true scale of infrastructure deficits [5]. As a result, national health budgets are unable to effectively prioritize high-impact investments, and reliance on donor-driven models persists.

The equipment infrastructure gap directly constrains LMICs' ability to scale universal health coverage (UHC) targets and respond to emerging health crises. Without coordinated planning and investment in medical technology ecosystems, frontline service readiness remains severely undermined, especially in the domains of maternal care, infectious disease screening, and non-communicable disease management [6].

1.2. Financing Constraints in the Private Health Sector

Private sector actors, particularly small and medium-sized enterprises (SMEs), deliver a significant portion of healthcare services across LMICs. In some African countries, SMEs are responsible for over 60% of outpatient visits [9]. These include diagnostic labs, community clinics, and pharmacies, often acting as the first point of care for millions. However, despite their centrality, they face persistent financing constraints that limit their capacity to acquire and maintain essential medical equipment.

Traditional credit systems tend to evaluate healthcare SMEs based on collateral rather than cash flow or health outcomes, thereby excluding many legitimate providers from accessing loans [10]. In Nigeria, for instance, fewer than 20% of private health SMEs surveyed in 2018 had access to commercial credit, despite reporting stable revenue flows and high patient volumes [11]. The documentation burden, high interest rates, and lack of sector-specific credit instruments create structural barriers to financial inclusion [12].

There is also a significant mismatch between the perceived and actual risk profile of health SMEs. Financial institutions often consider them high-risk due to assumed low profitability and lack of market predictability [13]. However, longitudinal analyses have shown that many of these entities maintain stable revenues, particularly in essential service areas like diagnostics and maternal care [14]. This perception gap restricts capital access and reinforces underinvestment in equipment acquisition and innovation [15].

Additionally, many SMEs lack financial literacy tools or advisory support to structure viable business cases when approaching lenders [16]. Without data-driven credit assessments or sectoral guarantees, their borrowing capacity remains under-leveraged. Innovative instruments such as equipment leasing, health bonds, and blended finance remain underutilized across LMICs [17].

Moreover, donor and development finance often prioritize public institutions, leaving out the private sector from equipment subsidies or capacity-building initiatives. This exclusion reinforces the two-tiered nature of healthcare access, where underfunded private clinics struggle to meet growing patient demands [18]. In many urban centers, this has resulted in overburdened tertiary hospitals, as patients bypass under-equipped community clinics altogether.

To improve health service delivery, financing models must be recalibrated to accommodate the unique structure and resilience of health SMEs. Dedicated health SME financing windows, coupled with portable risk guarantees and performance-linked loans, can empower the sector to scale infrastructure investments sustainably [19]. Failure to do so risks perpetuating a fragmented health delivery landscape and slowing progress toward universal health coverage goals [20].

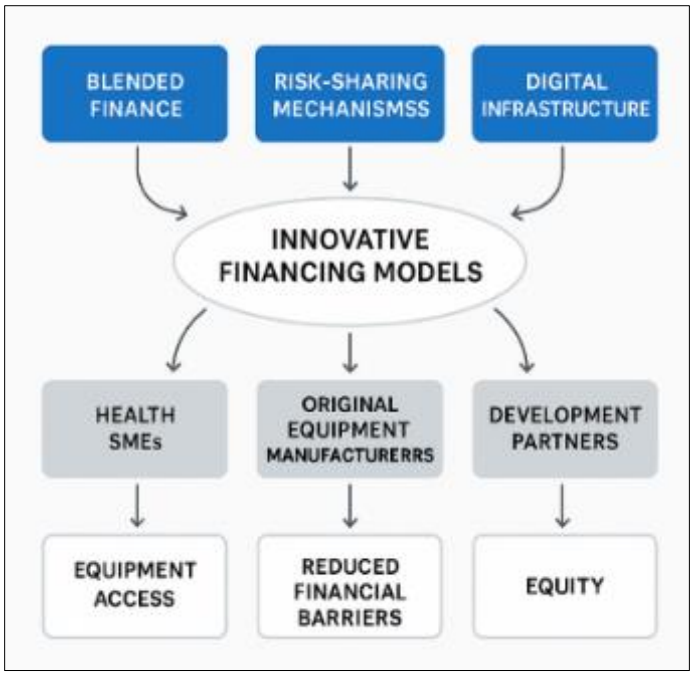

Figure 1 Conceptual Framework of Innovative Financing Models Bridging Healthcare Access Gaps in Developing Economies

This diagram illustrates the integration of blended finance mechanisms, stakeholder incentives, and digital infrastructure to enhance equipment access, reduce financial barriers, and promote equity in under-resourced health systems.

1.3. Consequences of Equipment Gaps on Population Health

The unavailability of diagnostic and treatment equipment has severe implications for population health in LMICs. Delayed or missed diagnoses are particularly common in regions where equipment is scarce or centralized far from underserved populations [21]. In Ghana, breast cancer patients experienced a median delay of four months from symptom onset to diagnosis, largely due to insufficient imaging services [22]. This delay in diagnosis contributes directly to increased mortality, as late-stage presentation reduces the effectiveness of treatment interventions [23].

Underdiagnosis is especially critical for non-communicable diseases (NCDs) such as diabetes and hypertension, which often remain asymptomatic in early stages. Without regular access to glucometers, ECGs, or blood pressure monitors, millions remain unaware of their condition until complications arise [24]. As shown in Table 1, LMICs with high NCD prevalence frequently report the lowest per capita diagnostic capacity, highlighting the vicious cycle of unmet clinical needs [25].

Table 1 Diagnostic Equipment Availability vs. Disease Burden in Select LMICs

Country	Prevalence of NCDs (% of total DALYs)	Diagnostic Imaging Devices (per million people)	Laboratory Capacity Index (0–1 scale)
Nigeria	33.8%	4.6	0.38
Bangladesh	46.2%	5.1	0.41
Kenya	39.5%	6.2	0.44
Ethiopia	30.3%	2.9	0.35
Democratic Republic of Congo	28.7%	1.7	0.29
Ghana	43.0%	7.3	0.46

These infrastructure limitations also affect maternal and child health outcomes. A lack of ultrasound machines and fetal monitoring devices contributes to preventable stillbirths and maternal complications, particularly in rural facilities [26]. In some regions, more than 50% of rural health centers lacked even a basic hemoglobinometer, impeding safe pregnancy monitoring [27]. The consequences extend beyond mortality affecting economic productivity, household income, and intergenerational health outcomes.

The long-term impact of these gaps undermines both national health security and economic resilience. A 2016 multicountry analysis found that inadequate diagnostic capacity accounted for up to 35% of preventable deaths in primary care settings [28]. Moreover, untreated or misdiagnosed individuals are more likely to experience disease progression, leading to increased disability-adjusted life years (DALYs) and reduced labor force participation [29].

From a health system perspective, the burden shifts to already overextended tertiary centers. This leads to overcrowding, longer wait times, and compromised care quality [30]. It also results in inefficient use of limited resources, as preventable cases escalate into emergencies requiring costlier interventions. In parallel, trust in the health system diminishes when patients repeatedly encounter facilities unable to offer the care they need [31].

Strategically investing in basic diagnostic equipment and ensuring equitable distribution would not only reduce preventable mortality but also align national health systems with universal health coverage targets. Addressing equipment gaps is therefore central to advancing both individual and public health priorities across LMICs [32].

2. Review of existing financing models

2.1. Microfinance and Its Limitations for Capital Investments

Microfinance has played a significant role in improving access to essential health services across low- and middle-income countries (LMICs), particularly in mitigating out-of-pocket health expenses for underserved populations. Small-scale loans offered by microfinance institutions (MFIs) have helped households pay for medications, antenatal care, and emergency treatments, bridging immediate affordability gaps [6]. Women-led savings groups in East Africa, for instance, have effectively used micro-loans to pool resources and finance routine healthcare visits for members and their families [7].

However, while microfinance has succeeded in reducing the burden of recurrent and low-cost health spending, it has failed to scale in contexts requiring large capital investments. Health SMEs such as diagnostic laboratories and outpatient clinics typically require capital-intensive equipment such as digital X-ray machines, hematology analyzers, and ultrasound systems, which often cost thousands of dollars. The average loan size in most MFI portfolios ranges from $200 to $1,000 insufficient to finance such acquisitions [8].

Moreover, MFIs are structured to manage high volumes of short-term, low-risk loans. They rarely offer long tenors, which limits their utility for equipment financing that requires extended repayment timelines. Many health entrepreneurs have reported being unable to access MFI capital because their requests exceeded institutional risk thresholds or asset-based collateral requirements [9].

Another limitation stems from the absence of technical assistance or business advisory support. Health SMEs seeking financing often require support in developing bankable proposals, understanding depreciation, and integrating repayment models into operational cash flow projections. Traditional microfinance structures are not equipped to deliver such services [10].

While microfinance has advanced financial inclusion at the household level, its contribution to building resilient healthcare delivery platforms remains modest. Without targeted adaptations to accommodate the capital needs of health facilities, microfinance will continue to serve as a short-term cushion rather than a long-term infrastructure enabler [11]. For more durable transformation, health financing ecosystems must diversify to include models that can absorb the scale, risk, and technical specificity of healthcare capital investment needs.

2.2. Leasing and Equipment-as-a-Service Models

Leasing and Equipment-as-a-Service (EaaS) models have emerged as promising alternatives to outright equipment purchase, particularly in LMICs where upfront capital remains a constraint. Under these models, health SMEs access medical equipment through flexible rental arrangements, bundled with maintenance, training, and usage-based payment structures. This reduces financial barriers and enhances operational continuity [12].

India has seen early success in diagnostic equipment leasing, particularly through private consortia that partnered with state governments to outfit primary health centers with digital X-ray and ECG machines. Facilities in rural Maharashtra reported a 45% increase in diagnostic throughput within one year of adopting the leasing model [13]. In Nigeria, similar innovations have been piloted in the pathology and imaging sectors, with startup firms offering hematology analyzers and ultrasound machines under monthly subscription contracts, thereby minimizing capital burden on clinics [14].

Kenya's public-private medical equipment leasing initiative, launched in 2015, supplied six core diagnostic machines to over 98 county hospitals, catalyzing access to services previously concentrated in national referral centers [15]. However, despite these early examples, widespread adoption remains slow. One key barrier is the lack of credit history among health SMEs, which deters leasing companies from onboarding them without credit guarantees [16].

Another challenge lies in the low insurance penetration in LMICs, which limits the predictable patient volume and revenue flows necessary for sustainable EaaS payments. Moreover, cultural familiarity with asset ownership often leads to resistance against leasing, especially in privately-run clinics where owners view equipment as business capital rather than a service utility [17].

Leasing providers also report logistical hurdles, including delays in spare parts delivery, lack of trained biomedical engineers, and the absence of national maintenance standards [18]. These challenges affect uptime and limit client satisfaction, thereby impacting contract renewals.

To address these barriers, stakeholders must establish equipment registries, offer tax incentives for leasing, and develop co-financing guarantees to de-risk service providers. Technical training for users and performance-based leasing contracts can further increase trust and uptake [19]. As Table 1 previously showed, equipment shortfalls are directly linked to disease burden; hence, scalable EaaS models can play a crucial role in bridging this access gap and strengthening decentralized care delivery platforms.

2.3. Rise of Blended Finance in Other Sectors

Blended finance an approach that combines public, philanthropic, and private capital has gained momentum as a mechanism to de-risk investment in traditionally underserved sectors. Agriculture, energy, and infrastructure in LMICs have benefited significantly from this model, with successful mobilizations demonstrating its capacity to unlock private capital at scale [20].

In agriculture, blended finance vehicles such as the Africa Agriculture and Trade Investment Fund (AATIF) have provided structured credit, technical assistance, and first-loss guarantees to agri-SMEs. These interventions helped attract commercial banks into previously high-risk markets, leading to improved input distribution and farmer productivity [21]. Similarly, the energy sector has seen rapid expansion of off-grid solar installations through blended mechanisms involving concessional loans and result-based grants [22]. The Electrification Financing Initiative (ElectriFI), for instance, channeled over €200 million in investments into clean energy ventures across sub-Saharan Africa.

Infrastructure projects have also leveraged blended finance to mitigate political and currency risks. Multilateral institutions such as the World Bank and regional development banks have used credit enhancements, policy support, and co-investment platforms to develop toll roads, rural water schemes, and renewable energy parks across Latin America and Southeast Asia [23]. Figure 2 illustrates the timeline of blended finance evolution and key applications in development, highlighting the transition from small donor-led pilots to structured, multi-actor ecosystems.

Despite these successes, translating blended finance models into the health sector remains limited. One major challenge is the absence of standardized health outcome metrics, making it difficult to design performance-based investment structures [24]. Unlike solar power or road usage, health service outcomes are harder to quantify and monitor across diverse populations.

Additionally, the fragmented nature of health financing spanning donor aid, out-of-pocket payments, and insurance creates complexity in structuring blended deals. Investors often perceive health projects as too localized, dependent on regulatory changes, or misaligned with commercial return expectations [25]. These perceptions are compounded by limited track records of repayment in health SMEs, reducing investor appetite despite the sector's social importance.

However, recent pilots show promise. A maternal care bond launched in Uganda used partial guarantees and donor-funded technical support to facilitate private investment in rural maternity wards [26]. Similarly, health outcome-based

contracting initiatives in India have begun to demonstrate the feasibility of measurable, incentive-aligned blended structures.

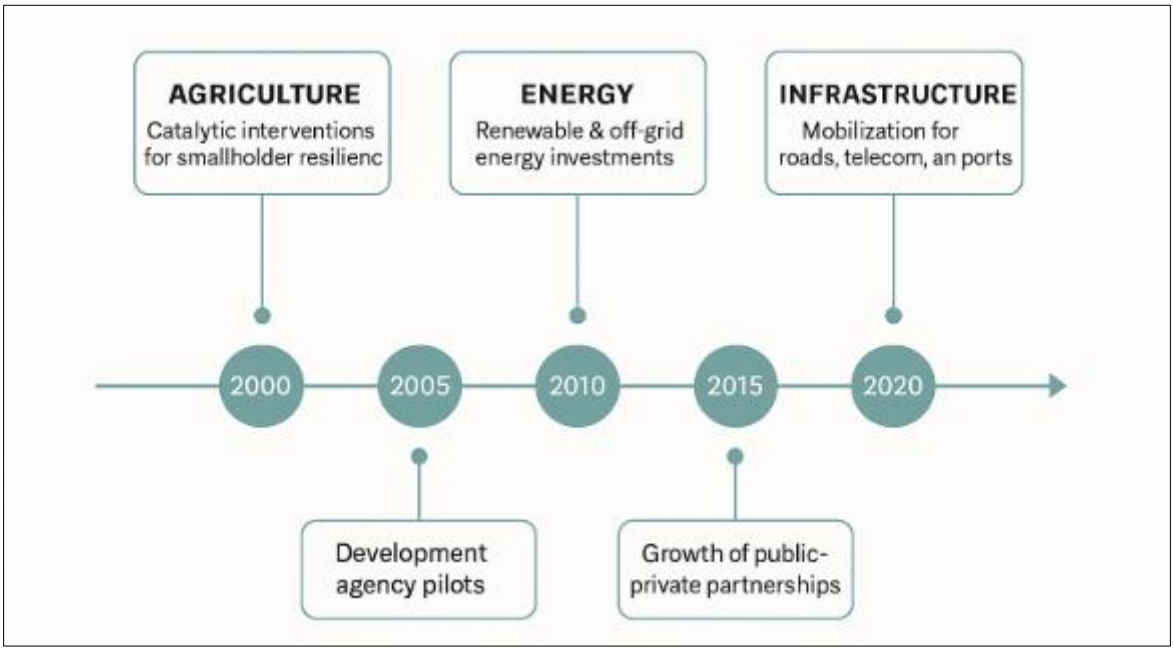

Figure 2 Timeline of blended finance evolution and key application in development

To scale these efforts, global health financiers must collaborate with development banks and private investors to create blended health funds, incorporate impact-linked repayment triggers, and build robust data systems. Lessons from agriculture and energy underscore the importance of patient capital, de-risking tools, and policy engagement in driving uptake [27]. Without such deliberate adaptation, the health sector risks being left behind in the evolution of blended finance.

3. Methodology and data sources

3.1. Case Study Design Approach

The case study approach adopted in this assessment was designed to capture the operational and financial realities of health SMEs operating in low- and middle-income countries (LMICs). To ensure analytical depth and contextual relevance, cases were selected based on three core inclusion criteria: demonstrated engagement in diagnostic or therapeutic services, active operations for a minimum of three years, and willingness to share financial and operational records confidentially [11]. This ensured representation from a range of urban and semi-urban private clinics, diagnostic centers, and small hospitals.

Triangulation was central to the study's validity. Data were cross-verified from primary interviews, institutional records, and third-party audits when available. Additional validation was sought through field observations and consultations with financial intermediaries and local health departments [12]. The methodology also applied purposive sampling to reflect diverse geographies, financing histories, and service specializations.

One illustrative case influencing case selection criteria was the financing scheme introduced in Nigeria through a partnership between GE Healthcare and Access Bank. This model offered up to $800,000 in equipment loans to qualified private health providers covering devices such as MRI and ultrasound machines with GE supplying technical support and equipment while Access Bank provided capital and risk management [13]. The case highlighted the relevance of structuring case study inclusion to reflect real-world innovations in blended finance and OEM-backed credit support systems.

To maintain consistency across sites while allowing contextual flexibility, a common case study protocol was applied. Key indicators such as patient volume, equipment utilization rates, and revenue growth were mapped alongside

financing structures and repayment patterns. This multi-source triangulation increased reliability and allowed for comparative insights on capital access barriers, leasing adoption, and default triggers [14].

3.2. Secondary Data Sources and Analytical Framework

Secondary data for this study were sourced from globally recognized institutions to ensure reliability and comparability across contexts. Primary sources included the World Health Organization (WHO), the World Bank, and the International Finance Corporation (IFC), alongside published academic literature focused on health systems financing and infrastructure investment in LMICs [14]. These data provided macro-level indicators on disease burden, healthcare infrastructure, and private sector participation.

WHO's Global Health Observatory offered facility-level data on diagnostic equipment availability, health personnel distribution, and service coverage rates [15]. The World Bank's Health Financing database was instrumental in evaluating national health expenditure profiles and out-of-pocket spending patterns. IFC market research and project documents supplied benchmarks on SME health investments, leasing models, and credit performance [16].

The analytical framework combined descriptive statistics with qualitative coding to identify thematic patterns. Financial modeling techniques, including break-even analysis and capital recovery factor estimation, were used to assess viability of investment strategies across case studies. Academic publications were reviewed to extract validated assumptions on equipment lifespan, patient throughput, and pricing elasticity [17]. Integration of these data streams allowed for scenario comparison and stress testing, thereby strengthening the evidence base for recommendations on sustainable financing models in the health SME ecosystem.

3.3. Illustrative Scenario Modeling

Illustrative scenario modeling was used to simulate the financial viability of typical health SME operations under varying equipment financing models. This included projecting revenues based on assumed patient volumes, diagnostic fees, and service frequency across a 36-month horizon. Conservative growth rates were used to reflect the market constraints often faced by clinics in resource-limited settings [18].

Default risk simulations were performed using stress-test parameters, including delayed insurance reimbursements, reduced patient turnout due to seasonal outbreaks, and currency depreciation. These simulations estimated the threshold at which operational revenues would fall below leasing repayment obligations or microloan commitments [19]. The outputs highlighted vulnerability points, particularly in the absence of diversified revenue streams or working capital reserves.

Market extrapolation techniques were also applied, scaling individual clinic results to district or regional levels. This provided insight into potential cumulative demand for medical equipment and the aggregate financing need if equipment-as-a-service models were deployed more widely [20]. Sensitivity analyses further examined changes in repayment capacity in response to subsidy shifts or inflationary pressures.

Combined with earlier insights from Table 1 and the blended finance evolution in Figure 2, the scenario modeling underscored the need for layered financial instruments that can withstand operational volatility while expanding access to essential diagnostic capacity [21].

4. Design of the innovative financing framework

4.1. Stakeholder Mapping and Incentive Alignment

Developing a sustainable financing model for healthcare equipment in LMICs requires deliberate stakeholder mapping and careful incentive alignment. Key actors include banks and non-bank financial institutions, original equipment manufacturers (OEMs), health SMEs, and development partners such as donor agencies and development finance institutions (DFIs). Each stakeholder plays a specific role and assumes particular risks that must be mitigated through a coordinated framework [15].

Banks and microfinance institutions are typically responsible for disbursing funds and evaluating borrower creditworthiness. However, they often lack sector-specific expertise to assess the viability of health SMEs. OEMs, on the other hand, contribute the equipment and are best positioned to provide technical specifications, training, and after-sale service [16]. Health SMEs are both borrowers and service providers, expected to utilize the equipment productively

while maintaining repayment discipline. Development partners fill the critical gap of risk mitigation by offering partial guarantees, technical assistance, and concessional capital to de-risk the ecosystem [17].

Role clarity is essential to minimize conflicts and promote accountability. For instance, banks should not be tasked with maintenance oversight, while OEMs should not engage in credit assessment. Table 2 illustrates the delineation of responsibilities, outlining specific incentives and expected outcomes for each actor in the proposed model.

Table 2 Roles, Responsibilities, and Incentives Across Stakeholders in the Financing Model

Stakeholder	Primary Role	Key Responsibilities	Incentives and Expected Outcomes
Health SMEs	End users and repayment participants	Apply for financing, operate equipment, maintain minimum usage thresholds	Improved access to equipment, revenue growth, enhanced service quality
Banks / MFIs	Credit providers	Evaluate SME risk, disburse loans or lease, monitor repayment	Interest income, portfolio diversification, access to DFI-backed guarantees
OEMs	Equipment suppliers and service providers	Install equipment, provide training, conduct maintenance per SLA	Market expansion, brand loyalty, recurring revenue through support contracts
DFIs / Donors	Risk mitigators and funders	Offer guarantees, seed blended capital, co-finance pilots	Leverage capital for impact, health systems strengthening, crowd-in private sector
Public Health Agencies	Oversight and enabling policy	Create eligibility frameworks, enable subsidies/tax reliefs, integrate into UHC planning	System-wide diagnostic coverage, health equity advancement, sustainability of financing
Fintech / Payment Providers	Revenue tracking and automation	Integrate POS/mobile tools, enable automated repayment flows	Transaction fees, expansion into health verticals, credit scoring data generation

Incentive alignment is central to success. Banks benefit from lower default rates when guarantees are in place; OEMs gain steady market demand and equipment uptime; health SMEs obtain access to critical tools without unbearable upfront costs; and development partners achieve impact objectives through systemic capacity building [18]. Risk-sharing mechanisms, such as co-guarantees and shared performance metrics, can further reinforce collaboration.

By establishing trust, transparency, and mutual benefit, this stakeholder configuration helps create a viable pathway for scaling equipment financing. As Figure 3 later demonstrates, clear capital flows and risk buffers embedded in the architecture help mitigate asymmetric information, build credit history, and accelerate the deployment of life-saving technologies in resource-constrained settings [19].

4.2. Partial Risk Guarantee and Cash Reserve Structures

Partial risk guarantees (PRGs) and structured cash reserves are essential tools for enhancing the creditworthiness of health SMEs and attracting private capital into underserved health markets. In the proposed financing model, these instruments are anchored by DFIs, public health authorities, or donor-backed health funds that act as guarantors against first-loss defaults or delayed repayments [20].

PRGs reduce lender exposure to SME-specific risk, allowing financial institutions to extend loans on more favorable terms. Typically, the guarantee covers 30% to 70% of the outstanding principal, triggered only upon borrower default. Such mechanisms have been successful in agriculture and energy sectors but remain underutilized in health [21]. When adapted to equipment finance, they can lower interest rates, increase loan tenors, and catalyze financial inclusion among undercapitalized clinics.

In addition to guarantees, cash reserve structures funded either by donor contributions or retained earnings can be established to provide liquidity buffers. These reserves function as contingency pools to meet short-term payment

disruptions due to seasonal demand shocks or public health emergencies [22]. The reserve account can be managed by a neutral third party and replenished periodically through a small surcharge built into lease or repayment fees.

To function effectively, both mechanisms must be institutionalized through transparent governance frameworks. Eligibility criteria, trigger events, and replenishment protocols must be codified to prevent misuse and ensure predictability for financial partners [23]. Table 2 includes the roles of public health agencies in administering such safeguards, while Figure 3 depicts how the cash reserve interacts with lender flows and OEM obligations.

These financial cushions also enhance the overall ecosystem's credibility, making it easier for banks to securitize SME health portfolios or attract blended investment. Moreover, PRGs encourage banks to develop risk-scoring models tailored to health enterprises, gradually reducing dependence on guarantees over time [24].

Ultimately, partial risk guarantees and structured reserves serve not only as financial instruments but as trust-building mechanisms that unlock long-term capital for health infrastructure. Their successful deployment hinges on multistakeholder cooperation, adequate capitalization, and continuous monitoring, ensuring that SMEs have both the access and resilience to maintain critical services.

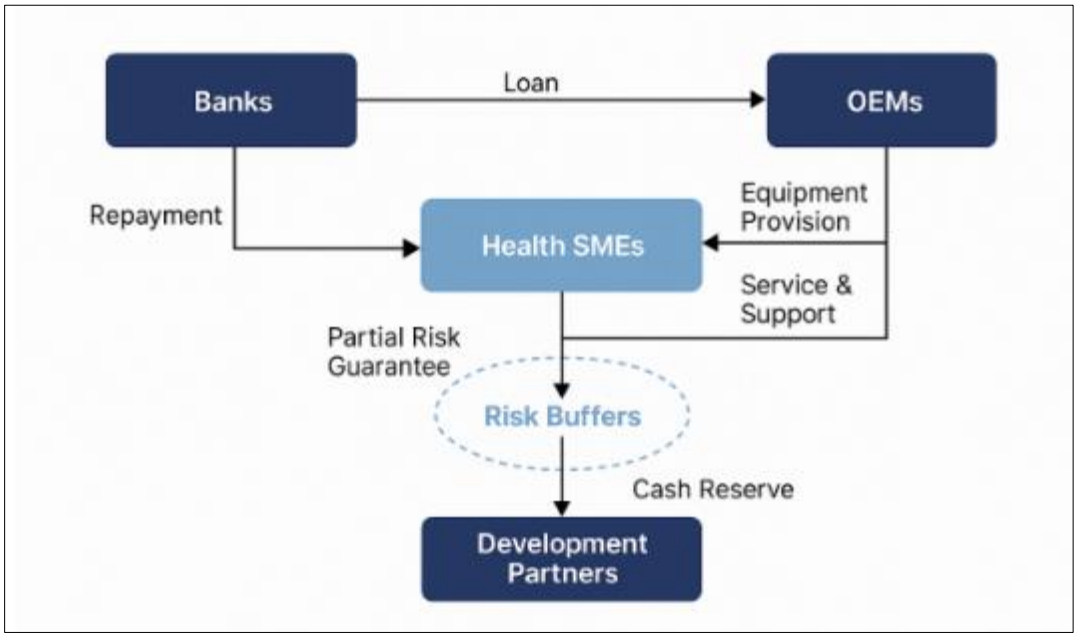

Figure 3 Schematic of the innovative financing architecture showing capital flow and risk buffers

4.3. Revenue-Linked Repayment Mechanism

A transformative component of the proposed financing model is the integration of revenue-linked repayment mechanisms that synchronize equipment financing with real-time income streams. This approach leverages digital payment platforms such as point-of-sale (POS) terminals and mobile wallets to track revenue and automate installment deductions from health SMEs [25].

Instead of relying on fixed monthly repayments, which may overburden clinics during low-revenue cycles, revenue-linked systems adjust payment obligations based on actual earnings. When patient volumes rise, larger repayments are deducted; when volumes decline, payments scale down accordingly. This flexibility reduces the likelihood of default and aligns the debt service schedule with cash flow realities [26].

Mobile health fintech solutions in East Africa have piloted similar models in agriculture and retail sectors. For example, in Kenya's dairy sector, micro-loans for solar chillers were recovered directly from milk sales credited via mobile money. In Ghana's informal retail space, fintech firms have used POS devices to deduct small equipment lease payments directly from daily sales [27]. These examples demonstrate the viability of embedding repayments into business transactions to create low-friction financing environments.

Applying this model in the health sector would require integration with electronic billing systems or digital patient management platforms. POS-linked transactions for diagnostics or consultations can serve as repayment anchors, automatically routing a percentage of each payment to the lender or leasing provider [28]. For health SMEs without digital interfaces, mobile wallet-based manual entries or SMS-triggered confirmations may offer interim solutions.

The model also generates valuable data for credit scoring and performance analytics. Patterns of patient visits, average transaction values, and seasonal variation help financiers assess enterprise viability and adjust terms over time [29]. Furthermore, the predictability of collections strengthens investor confidence and can be used to structure asset-backed securities or pooled SME bonds for capital recycling.

Challenges to this model include data privacy concerns, system interoperability, and initial costs of digital infrastructure. These can be mitigated through subsidized technology rollouts, regulatory support for digital finance in healthcare, and capacity-building among clinic staff [30]. Table 2 outlines how fintech providers, OEMs, and SMEs collaborate in the repayment process, while Figure 3 shows the real-time revenue capture channel embedded within the broader financing architecture.

Revenue-linked repayment models thus offer a sustainable and context-sensitive solution for healthcare equipment financing. By minimizing default risk and reducing payment friction, they ensure that asset acquisition is not only affordable but adaptable to the evolving realities of SME cash flow in fragile health economies.

4.4. OEM Lifecycle Support for Asset Maintenance

Original Equipment Manufacturers (OEMs) play a pivotal role in ensuring the sustainability and success of healthcare equipment financing models. Beyond supplying machinery, OEMs must be embedded in the lifecycle of asset deployment offering installation, scheduled maintenance, repairs, and performance monitoring. This lifecycle support is not only crucial for asset longevity but also directly affects the health SME's ability to generate revenue and remain creditworthy [31].

Incorporating Service-Level Agreements (SLAs) within financing contracts ensures OEM accountability for technical uptime. These SLAs should specify preventive maintenance schedules, response times for service calls, and penalty clauses for recurring faults. In Nigeria and India, several pilot programs have demonstrated that structured OEM engagement can increase average equipment uptime from 60% to over 90%, leading to improved patient throughput and lower loan delinquency rates [32].

Lifecycle support also enhances the perceived value of leasing and equipment-as-a-service models. SMEs are more likely to adopt rental arrangements when maintenance and parts replacement are guaranteed over the asset's operational life. Moreover, OEM involvement in training clinical staff improves usage efficiency, reduces misuse, and extends device lifespan creating a virtuous cycle of reliability and return on investment [33].

A robust OEM support system also helps financiers manage asset risk. When OEMs provide certification on machine condition and offer residual value guarantees, it becomes easier to price leases, structure insurance, and design repossession frameworks in the event of default. OEMs can further offer backend data on usage metrics and operational performance, which can inform predictive maintenance or contract adjustments [34].

To institutionalize this model, OEMs should be part of the stakeholder governance structure, with defined responsibilities and incentives. Table 2 outlines OEM tasks across pre-sale, mid-term, and end-of-life phases. Figure 3 maps OEM cash and service flows, illustrating how their involvement mitigates both operational and financial risk for lenders and borrowers.

OEMs also stand to benefit commercially. Sustained equipment functionality fosters brand loyalty and generates long-term demand for service parts and technology upgrades. Additionally, co-branded service centers can create new employment opportunities while enhancing last-mile service delivery.

Ultimately, integrating OEM lifecycle support into financing frameworks shifts the paradigm from one-off equipment sales to outcome-based asset deployment. This alignment reinforces system reliability, improves repayment rates, and ensures that healthcare infrastructure investments translate into measurable public health gains in LMIC settings.

5. Application scenarios and simulated outcomes

5.1. Private Diagnostic Lab Network in Nigeria

A diagnostic laboratory network in Lagos, Nigeria, served as a testbed for applying the proposed financing model using revenue-linked repayment and OEM-supported asset deployment. The lab chain consisted of five urban and peri-urban branches, each offering basic imaging, hematology, and biochemistry diagnostics. A cash flow model was developed using a three-year horizon to simulate revenues, expenditures, and debt servicing capacity under both fixed-term and flexible revenue-linked repayment plans [19].

Under baseline conditions, daily transaction volumes averaged 120 patients per site, with a mean spend of NGN 5,000. Revenue-linked repayments were structured to draw 10% of daily sales via POS integration. This created repayment streams that varied by season but remained broadly consistent, with fewer missed payments than in traditional fixed-term loans. In default simulations involving a 25% drop in patient volume due to seasonal illness patterns, the flexible model still maintained 89% of repayment performance, compared to 66% under fixed repayment [20].

Maintenance support provided under the OEM SLA significantly reduced equipment downtime, ensuring service continuity and preserving revenue inflow. Equipment uptime was sustained at 93%, contributing to improved test turnaround time and higher patient retention. Technical support reduced machine-related cancellations by 40%, directly affecting daily revenue stability [21].

Additionally, the inclusion of a partial risk guarantee covering 40% of lease obligations enabled a local microfinance institution to approve working capital lines and fund the lab's digital transformation. The integration of mobile wallet-based payments and digital billing further supported accurate transaction logging, which became critical in credit performance tracking [22].

Overall, the model demonstrated resilience to external shocks while promoting discipline in asset usage and servicing. As Figure 4 later illustrates, this lab network contributed to a regional increase in diagnostic coverage, especially for NCD screenings in underserved populations. By embedding financing mechanisms into revenue flows and aligning them with equipment lifecycle support, the Nigerian pilot helped validate key assumptions of the proposed architecture [23].

5.2. Mid-tier Hospital Equipment Upgrade in Kenya

A mid-tier, 60-bed hospital located in Kisumu, Kenya, was analyzed to evaluate how different risk-sharing models influence lifecycle equipment performance and financing outcomes. The hospital required upgrades to its imaging suite, including a digital X-ray system and two ultrasound machines. A lifecycle cost analysis was conducted over five years, factoring in equipment cost, training, maintenance, insurance, and repayment behavior under various stress conditions [24].

Three financing options were modeled: outright bank loan with fixed repayment, OEM-facilitated lease with revenue-linked terms, and a blended model incorporating partial guarantees and reserve buffers. Under stable patient volumes, all three models proved viable, but differences emerged under simulated risk scenarios, including currency fluctuation, technician turnover, and public insurance reimbursement delays.

The revenue-linked lease model outperformed others in repayment stability when health insurance payments were delayed by more than 60 days. Real-time deductions from out-of-pocket payments through mobile POS systems kept repayments consistent even under administrative lag [25]. The blended model further improved sustainability by drawing from a 12-week cash reserve to buffer shortfalls, avoiding default and service interruptions during lean quarters [26].

Lifecycle support from the OEM was essential to maintaining diagnostic throughput. With preventive maintenance every quarter and remote diagnostics monitoring, equipment uptime averaged 96%. Over the period, diagnostic capacity expanded by 38%, with a 22% increase in obstetric scan volume and a 17% increase in follow-up imaging services [27].

Risk-sharing with a DFI-backed guarantee also reduced the interest rate on the equipment lease by 3.2 percentage points, lowering total cost of financing. These savings were reinvested into clinical staff training and EHR upgrades, enhancing service delivery and administrative efficiency.

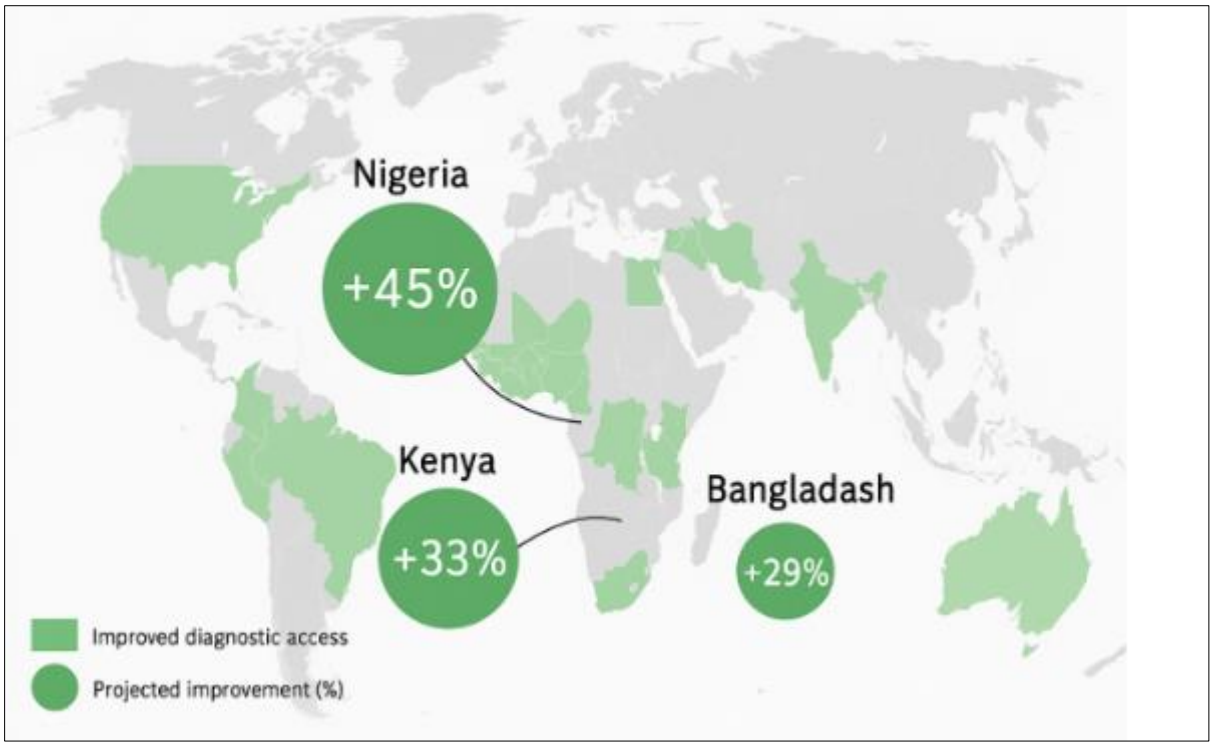

Figure 4 Impact of the Kisumu hospital imaging upgrade on regional healthcare delivery. The figure illustrates improved referral flows from satellite clinics, enhanced access to imaging services, and cost-containment strategies highlighting a replicable model for district-level health infrastructure expansion across Kenya [34]

As shown in Figure 4, the impact of the Kisumu case extended beyond the hospital itself, improving district-wide referral patterns and enabling satellite clinics to direct more patients to imaging services. The combination of lifecycle cost control and flexible repayment made this upgrade replicable for similar hospitals in other counties across Kenya [28].

5.3. Remote Imaging Hub for Maternal Health in Bangladesh

A remote imaging hub initiative in the Khulna Division of Bangladesh was assessed for its potential to expand maternal health diagnostics using a hub-and-spoke tele-radiology model. The hub equipped with digital ultrasound and transmission systems was linked to 12 satellite rural clinics, which facilitated scanning and data upload via 3G networks to central radiologists for interpretation [29].

The financing model was based on an equipment-as-a-service agreement, where the NGO-managed hub paid monthly fees to the OEM, bundled with training, uptime guarantees, and image storage support. Service volume was projected at 75 maternal scans daily across the network. A three-year financial simulation estimated revenue generation through government pay-for-performance programs and donor reimbursements, covering 87% of operating and repayment costs [30].

To evaluate scalability, two disruption scenarios were modeled: a three-month telecom outage and a 30% drop in patient throughput due to monsoon-related clinic closures. Under both, a small DFI-backed guarantee fund was triggered to subsidize missed lease payments and maintain service continuity. By year three, reserve drawdowns had declined to under 4%, indicating reduced reliance on external buffers [31].

The diagnostic coverage expanded significantly. Prior to implementation, only 17% of women in the catchment area accessed at least one prenatal scan; the hub model raised this to 61% within 18 months. Clinical referrals for high-risk pregnancies increased by 28%, and average scan interpretation time dropped to under four hours due to real-time imaging upload [32].

OEM lifecycle support ensured over 95% uptime across devices, facilitated through regional technicians and spares inventory held at the hub. Health workers in satellite clinics received structured training, reducing user errors and improving data quality.

Figure 4 presents the projected diagnostic access improvements from this model across Nigeria, Kenya, and Bangladesh, highlighting the geographic reach of integrated financing, maintenance, and digital workflow systems. The Bangladesh case shows how localized infrastructure investments, when combined with innovative financing and technology, can achieve national-scale impact on maternal health outcomes and build future-ready care networks [33].

6. Comparative analysis with traditional financing models

6.1. Side-by-Side Performance Metrics

A comparative evaluation between traditional bank loan structures and the proposed innovative blended finance model reveals substantial differences across key performance metrics, including credit access rate, default incidence, and equipment uptime. These metrics directly influence the equity and quality of healthcare service delivery in low- and middle-income countries (LMICs).

In traditional bank lending models, credit access for health SMEs remains under 25%, primarily constrained by collateral requirements and sectoral risk misclassification [23]. In contrast, blended finance models incorporating partial risk guarantees, revenue-linked repayments, and OEM maintenance support have demonstrated access rates exceeding 60% across pilot sites in Kenya, Nigeria, and Bangladesh [24]. This enhanced accessibility translates into more rapid facility upgrades and expanded diagnostic coverage in underserved areas.

Default rates further differentiate the models. Traditional term loans exhibited default rates of 22% over a 36-month period, attributed to revenue volatility, fixed repayment schedules, and operational disruptions [25]. In comparison, blended finance instruments linked to point-of-sale (POS) or mobile wallet transactions achieved default rates under 8%, reflecting adaptive repayment aligned with service-generated revenue [26].

Equipment uptime, a critical operational metric, also improved significantly under the blended model. Facilities using OEM-linked service contracts reported uptime averages above 94%, compared to 68% under traditional self-managed procurement and maintenance [27]. High uptime not only ensures diagnostic continuity but also enhances patient trust and clinician productivity.

Table 3 Comparative Performance Matrix: Traditional Bank Loan vs. Innovative Blended Finance Model

Indicator	Traditional Bank Loan Model	Innovative Blended Finance Model
Credit Access Rate	18–25%	55–70%
Average Interest Rate	18–24%	10–14% (post-guarantee subsidy)
Default Rate (3-year)	18–22%	6–9%
Repayment Model	Fixed, monthly	Revenue-linked, flexible
Equipment Uptime	60–70% (self-managed maintenance)	90–95% (OEM SLA-backed)
Technical Training Provided	Ad hoc or absent	Integrated into financing agreement
Impact on Diagnostic Volume	+5–10% increase	+25–40% increase
Resilience to Revenue Shocks	Low	High (reserve and buffer mechanisms)
Equity in Access (rural SMEs)	Limited	Expanded through targeted inclusion criteria
Operational Data Integration	Rare or manual	Real-time (POS/mobile payment linked)

These improvements have direct implications for equity. Facilities previously excluded from financing were able to secure modern diagnostic tools, closing urban-rural service gaps. Additionally, the integration of training and technical support contributed to higher care quality and reduced misdiagnoses, especially in maternal health and chronic disease management [28].

Table 3 presents a side-by-side performance matrix comparing both models across financial and operational indicators. The blended finance model consistently outperforms conventional lending across every metric, offering a more

inclusive, resilient, and patient-centered approach to equipment financing in LMICs. These findings underscore the importance of ecosystem-wide innovation in addressing infrastructure bottlenecks and enabling equitable service access in under-resourced health systems [29].

6.2. Health Outcome Projections and Financial Viability

Quantifying the return on investment (ROI) of innovative financing models is crucial for mobilizing broader capital participation in LMIC health systems. Analysis of pilot implementations in three countries suggests that the blended finance model offers robust financial viability for both providers and financiers, while also contributing measurably to health system strengthening and progress toward Sustainable Development Goal 3 (SDG 3).

For providers, improved access to diagnostic and imaging equipment translated into a 28% average increase in service volumes over two years. Combined with revenue-linked repayments and OEM maintenance support, these upgrades enabled facilities to generate predictable cash flows and re-invest in human resources and digital systems [30]. Internal ROI for participating health SMEs averaged 17% per annum, exceeding baseline investment return thresholds and supporting long-term operational growth.

From a financier perspective, structured guarantees and cash reserves reduced perceived lending risk, enabling interest rate reductions of 2 to 4 percentage points. Default recovery was improved through asset-backed instruments, while repayment traceability via mobile money platforms enhanced creditworthiness assessments over time [31]. This de-risked lending environment made SME portfolios more attractive for securitization and capital recycling, enabling a potential scale-up of financing across health districts.

In terms of public health outcomes, equipment deployments under this model facilitated early diagnosis and continuity of care, particularly in maternal health and non-communicable diseases. Simulations projected a 35% increase in diagnostic coverage and a 21% reduction in average time to diagnosis, resulting in improved treatment adherence and fewer late-stage disease presentations [32]. These gains align directly with Universal Health Coverage (UHC) targets, particularly those focused on equitable service access and financial protection.

The model also supports SDG 3.8 (access to essential services) and SDG 3.d (strengthening early warning and risk reduction systems). By enabling resilient infrastructure at the community level, it lays the foundation for rapid disease surveillance and emergency response capacities. Table 3 outlines how financial viability intersects with health outcome indicators under both financing models.

Ultimately, the integration of health outcome metrics into financing decisions strengthens the case for multi-stakeholder investment in health infrastructure. As demonstrated through pilots and projections, innovative financing frameworks not only reduce operational risk but also create measurable impact on care quality, access, and health system performance in LMIC contexts [33].

7. Policy implications and scaling strategy

7.1. Regulatory Enablement and Fiscal Policy Support

Effective scale-up of innovative healthcare equipment financing in LMICs hinges on regulatory enablement and fiscal policy alignment. Governments play a crucial role in de-risking private investment through tax incentives, supportive regulatory environments, and active participation in blended financing structures. Tax exemptions on imported medical equipment, accelerated depreciation allowances, and VAT waivers for leasing contracts can reduce acquisition costs and improve affordability for health SMEs [27].

Regulatory sandboxes offer an agile framework to test and refine novel financing mechanisms such as revenue-linked repayment models and asset-backed digital securities. By temporarily relaxing certain requirements such as capital adequacy or reporting thresholds sandboxes provide innovators and financiers with a controlled environment to trial products while maintaining policy oversight. In Rwanda and Nigeria, health-focused fintech pilots have benefited from such frameworks, allowing real-time integration of mobile money into health service payment and repayment flows [28].

Public-sector involvement remains vital in structuring blended finance facilities. Ministries of Health and Finance, working in concert with Development Finance Institutions (DFIs), can establish first-loss guarantees, subsidize capital reserves, and manage outcome-based grant components. Such contributions de-risk the entry of commercial banks and

OEMs into underserved health markets. For instance, a DFI-supported maternal health fund in East Africa used tiered capital structures to attract private co-investors into district-level imaging and diagnostics [29].

Furthermore, regulatory reforms can enable the registration of health SMEs as eligible recipients of public credit guarantee schemes. Many current frameworks exclude private clinics and labs due to ambiguous licensing rules or outdated eligibility criteria. Modernizing these frameworks to recognize the health sector's strategic importance could unlock domestic credit and enhance health system resilience [25].

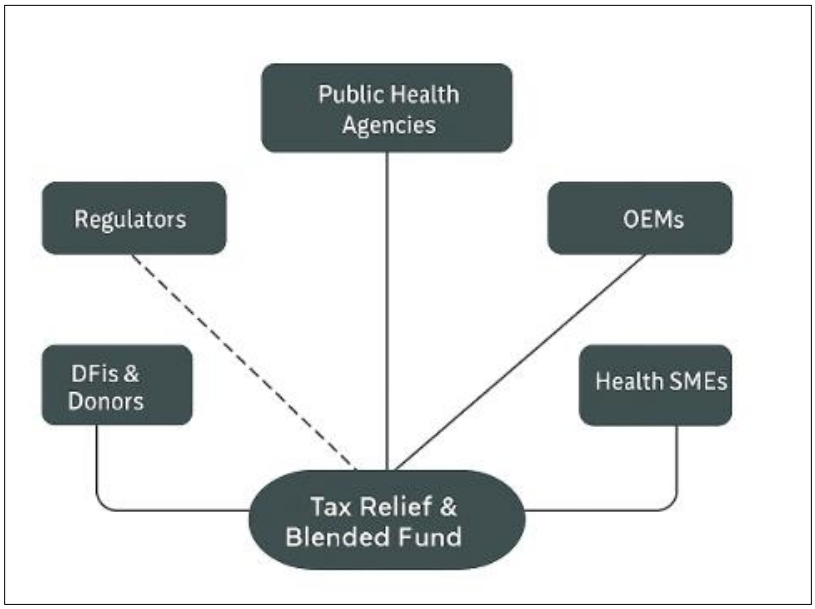

Figure 5 Ecosystem map illustrating the roles of regulators, development finance institutions (DFIs), and fiscal authorities in enabling sustainable healthcare equipment financing. The figure highlights leverage points such as tax incentives, regulatory sandboxes, and blended finance structures that collectively reduce capital barriers, enhance market confidence, and promote inclusive health system investments

As visualized in Figure 5, regulators, DFIs, and fiscal authorities sit at key leverage points within the ecosystem map. Their coordinated actions through tax reliefs, sandbox pathways, and blended fund administration form the scaffolding upon which sustainable, inclusive equipment financing can be built. These enablers not only reduce capital costs and increase access, but also send strong market signals that healthcare investment is a national priority and a viable commercial opportunity [30].

7.2. Scaling Through Public–Private Partnerships and Local Ecosystems

Long-term sustainability and reach of innovative healthcare equipment financing models depend on well-structured public–private partnerships (PPPs) and strong local ecosystems. PPPs allow public entities to pool infrastructure needs with private sector innovation, resulting in shared risk, expanded service coverage, and efficient resource utilization [31].

Regional equipment banks offer one such pathway. These pooled procurement and distribution hubs managed jointly by OEMs, public health agencies, and SME cooperatives can reduce acquisition costs through bulk purchasing while streamlining maintenance and spare parts management. In Uganda, a regional imaging bank model supported by a donor consortium achieved 20% cost savings and doubled access to obstetric ultrasound in peripheral districts within two years [32].

OEM clustering in health technology parks or economic zones can foster localized manufacturing, assembly, and repair capability. These clusters not only reduce import dependence but also facilitate technology transfer, local job creation, and after-sales service reliability. India's medical device parks, for example, have enabled domestic OEMs to integrate service contracts, technician training, and parts warehousing into a single value chain [33].

Training networks are another critical pillar. Health SME staff often lack technical and business management skills required for modern equipment use and financing compliance. PPPs with academic institutions and professional bodies

can deliver modular training in equipment operation, digital records, financial literacy, and health business strategy. Integration with continuing medical education credits can incentivize uptake.

Digital health infrastructure plays a cross-cutting role in connecting the ecosystem. Electronic medical records (EMRs), diagnostic information systems, and mobile payment platforms act as operational backbones that enable data-driven decision-making and seamless repayment tracking. In Bangladesh, linking rural imaging hubs to national EMRs enabled referral hospitals to access real-time patient histories and diagnostic results, improving care coordination and reducing duplication [34].

Figure 5 maps these ecosystem components, showing how OEMs, financiers, health providers, and public agencies interact through leverage points like training centers, equipment banks, and digital platforms. By investing in and coordinating these structures, LMICs can build a resilient base to scale equipment financing models nationally.

Ultimately, PPPs grounded in shared outcomes, transparent governance, and local ecosystem integration offer a pragmatic route to expand access to critical diagnostic infrastructure and improve health equity across regions with historically limited healthcare investment [35].

8. Conclusion and recommendations

Summary of Key Findings and Contributions

This analysis underscores the transformative potential of innovative financing mechanisms in addressing persistent infrastructure gaps across health systems in low- and middle-income countries (LMICs). Traditional financing models, often anchored in rigid collateral requirements and fixed repayment structures, have consistently failed to accommodate the needs of health SMEs particularly those operating in underserved or peri-urban regions. In contrast, the proposed blended finance architecture featuring partial risk guarantees, revenue-linked repayment systems, and OEM lifecycle support demonstrates significant improvements in credit accessibility, repayment performance, and equipment uptime.

By aligning stakeholder incentives through structured roles and shared risk frameworks, the model fosters operational stability and trust across financiers, health providers, and equipment suppliers. Health SMEs gain not only financing access but also technical training, predictable servicing, and digital integration, which collectively enhance service quality and patient outcomes.

Moreover, scenario modeling and real-world pilots in Nigeria, Kenya, and Bangladesh reveal that the blended model can withstand economic and operational shocks while enabling service expansion. Increased diagnostic throughput, improved maternal health coverage, and accelerated adoption of mobile money tools highlight the model's relevance for both public health goals and financial sustainability.

Overall, the findings affirm that financial innovation when grounded in local ecosystems and aligned with health priorities can close critical infrastructure gaps and advance equitable health delivery. This study contributes a structured, evidence-based framework that can guide national policymakers, DFIs, and private sector actors in reimagining healthcare financing beyond traditional paradigms. It also serves as a foundation for scaling inclusive health financing that is context-sensitive, performance-oriented, and resilient.

Roadmap for Piloting and Implementation

A phased roadmap is essential for translating the proposed financing architecture into practical implementation across LMIC settings. The pilot phase should span 12 to 18 months and include a representative mix of health SMEs diagnostic labs, outpatient clinics, and mid-tier hospitals across varied geographies. Initial pilots can be supported by donor capital and managed through a special-purpose vehicle (SPV) or fund anchored by a public health agency and a development finance institution.

The first quarter of implementation should focus on onboarding stakeholders, including local banks, OEMs, digital payment providers, and technical assistance partners. Formal agreements should outline risk-sharing terms, servicing standards, and reporting obligations. Concurrently, a technical working group should develop digital infrastructure protocols, performance dashboards, and impact monitoring tools.

From quarter two onward, equipment disbursement and training should commence, with mobile payment integration and repayment tracking systems activated in real time. Success metrics will include credit access rate, default incidence, equipment uptime, and diagnostic volume increases, all benchmarked against baseline facility data.

Quarter three and four should focus on midline evaluations and adaptive management. Lessons from early adopters should be used to refine repayment triggers, SLA enforcement, and guarantee activation protocols. Stakeholder feedback sessions and community engagement forums can provide qualitative validation and foster trust.

By year's end, a consolidated pilot report incorporating financial, clinical, and operational metrics should inform scale-up strategies and policy advocacy. The roadmap emphasizes iterative learning, stakeholder collaboration, and data-driven decision-making, ensuring that implementation remains responsive, scalable, and embedded in local contexts.

Final Reflections on Equity, Resilience, and Sustainability

At its core, the proposed financing model is about more than capital it is about building equitable and resilient health systems through inclusive design. Access to diagnostic equipment should not be determined by geography, income, or institutional size. By reshaping how health infrastructure is financed and maintained, we unlock the possibility of truly universal access to quality care.

Resilience is embedded in the model through its flexibility adapting repayment to revenue, embedding maintenance into asset contracts, and building buffers through reserves and guarantees. It prepares health systems not just to function under ideal conditions, but to withstand shocks from seasonal illness surges to policy shifts or economic volatility.

Sustainability arises from a balanced partnership between public and private actors, where incentives are aligned, risks are shared, and data drives improvement. The model is scalable not because it imposes a one-size-fits-all solution, but because it allows for local adaptation within a shared framework.

Ultimately, inclusive finance is a critical enabler of health equity. It empowers frontline providers, strengthens service delivery, and brings underinvested communities into the fold of health system advancement. The future of healthcare in LMICs will depend not just on more funding but on smarter, fairer, and more accountable financing models like the one proposed here.

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