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Green Financing Strategy Model for Supporting Sustainable Growth Among Women-Owned and Small Enterprises

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Abstract

The Green Financing Strategy Model is developed to strengthen sustainable growth pathways for women-owned and small enterprises that often face structural barriers in accessing affordable capital, adopting clean technologies, and meeting emerging environmental compliance requirements. Traditional financing mechanisms rarely incorporate sustainability metrics, gender-responsive criteria, or capacity-building components, leaving many women-led and small businesses excluded from green economic opportunities. This model provides an integrated approach that combines credit-risk analytics, sustainability scoring, developmental support, and blended finance structures to expand access to environmentally aligned capital. The strategy begins by defining a multi-dimensional green eligibility framework covering resource efficiency, waste reduction, renewable energy adoption, circular practices, and low-carbon operations. These indicators are embedded within a gender-responsive enterprise assessment tool that evaluates managerial capabilities, financial discipline, innovation potential, and social impact. A predictive risk model is applied to stratify enterprises based on historical performance, sector exposure, market volatility, and sustainability-readiness scores, allowing financiers to tailor loan terms, guarantees, and incentives. Blended finance

mechanisms including concessional loans, partial risk guarantees, climate funds, and micro-equity are incorporated to reduce collateral barriers and enable phased greening of enterprise operations. The model further integrates technical assistance modules that provide training on green business practices, digital bookkeeping, carbon measurement, and ESG compliance, ensuring that financed enterprises can meet reporting requirements and achieve environmental improvements. A partnership framework links financial institution, development partners, cooperatives, and local government agencies to facilitate market access, certification, and post-financing monitoring. Data-driven evaluation dashboards track carbon reductions, resource-efficiency gains, revenue growth, job creation, and portfolio-risk trends, enabling continuous refinement of financing instruments. Pilot simulations show that combining gender-sensitive credit scoring with sustainability incentives can significantly increase loan approval rates, reduce default risk, and accelerate the adoption of green technologies among female and small-scale entrepreneurs. The Green Financing Strategy Model thus enhances financial inclusion, strengthens climate resilience, and promotes equitable participation in the green economy by aligning financial decision-making with sustainability outcomes and gender empowerment priorities.

Keywords: Green Financing, Women-Owned Enterprises, Small Enterprises, Sustainability Scoring, Blended Finance, ESG Compliance, Credit-Risk Analytics, Inclusive Growth

1. Introduction

Women-owned and small enterprises sit at the heart of inclusive growth, local job creation, and supply-chain resilience, yet they remain underserved by mainstream finance and seldom receive tailored support to transition toward sustainable operations. Despite mounting investor appetite for environmental, social, and governance outcomes, capital flows rarely reach smaller firms at scale because deal sizes are modest, data is fragmented, and risk perceptions are inflated by thin collateral and limited track records. At the same time, many of these enterprises face rising pressure from buyers, regulators, and customers to decarbonize processes, adopt resource-efficient technologies, and evidence fair labor practices demands that are costly to meet without accessible, affordable, and appropriately structured green finance (Anderson, 2015, Jones, 2014).

This dual gap constrained access to finance and underinvestment in sustainability locks promising businesses out of procurement opportunities, credit upgrades, and productivity gains that would otherwise compound over time. The Green Financing Strategy Model is proposed to close these gaps by linking purpose-built financial instruments with de-risking, technical assistance, and outcome measurement tailored to the realities of women-owned and small enterprises. Its objectives are to lower effective cost of capital for qualified green investments, crowd-in private lenders through guarantees and blended structures, standardize project assessment to reduce transaction friction, and embed sustainability performance improvements such as energy savings, waste reduction, and safer workplaces directly into underwriting, pricing, and post-disbursement support (Kiron, 2017, Zolnowski, Christiansen & Gudat, 2016). The model also seeks to strengthen managerial capabilities through advisory services, enabling borrowers to convert capital into verifiable environmental and commercial results, while generating credible impact data for investors and policy makers.

The scope spans three integrated layers: a financing layer offering instruments such as concessionary loans, revenue-linked repayments, and performance-priced credit; a capacity and verification layer providing diagnostics, implementation support, and independent measurement; and a market-enablement layer aligning public programs, anchor-buyer procurement, and data standards to reduce risk and scale demand (Bishop, 2018, Pugna, Dutescu & Stanila, 2018). It targets growth-oriented women-owned firms and small enterprises across manufacturing, agrifood, light industry, services, and digital commerce, with a focus on bankable use cases like energy-efficient equipment, clean production, circular business models, and inclusive workforce investments. Intended beneficiaries include entrepreneurs seeking affordable capital, lenders requiring structured de-risking and transparent metrics, and communities that gain from cleaner, more competitive local businesses. By orchestrating finance, capability, and credibility in a single strategy, the model aims to convert sustainability from a compliance burden into a durable source of competitive advantage for the smallest, yet most vital, actors in the economy (Seyi-Lande, Oziri & Arowogbadamu, 2018).

2. Literature & Policy Context

Green finance for micro, small, and medium enterprises has evolved from niche pilots into a diversified toolbox that can mobilize private capital toward climate and social outcomes, yet significant design and delivery gaps remain for women-owned and small enterprises. Instruments now include green loans tied to eligible use-of-proceeds, sustainability-linked loans with pricing that ratchets down when borrowers meet environmental or social KPIs, and thematic bonds green, social, and sustainability bonds that channel wholesale funds into portfolios of smaller projects (Appelbaum, Kogan & Vasarhelyi, 2018, Francis, 2011). Credit guarantees and first-loss tranches within blended finance structures de-risk local lenders; energy service company and performance contracting models allow repayment from realized savings;

leasing and pay-as-you-save models remove upfront capital barriers for efficient equipment; and results-based financing pays against verified outcomes such as kilowatt-hours saved, water recycled, or emissions avoided. More recently, transition finance recognizes sectoral pathways rather than binary “green-or-not,” while carbon market instruments and digital MRV platforms can create additional revenue streams for small firms that can quantify reductions or removals (Akinbola & Otokiti, 2012, Dako, *et al.*, 2019, Oziri, Seyi-Lande & Arowogbadamu, 2019). Despite this variety, most structures are calibrated for medium to large borrowers with audited accounts, sophisticated governance, and project sizes that justify due diligence costs; consequently, the smallest firms are left with conventional working-capital loans priced without regard to their sustainability improvements.

Gender-lens investing provides an intentional framework to address inequities in access, allocation, and outcomes by financing women-led businesses, enterprises that improve the lives of women and girls, and companies with gender-equitable practices. However, women entrepreneurs frequently face “missing middle” dynamics: they are too large for microfinance but too small or too informal for commercial banks and private equity. Biases in underwriting, requirements for land or fixed-asset collateral assets women disproportionately lack title to limited credit histories, thinner networks to sponsorship and guarantors, and caregiving burdens that constrain time for compliance all widen the gap (Attaran, Stark & Stotler, 2018, Richins, *et al.*, 2017). Even when capital is available, non-financial support is scarce: structured procurement linkages, performance diagnostics, vendor accreditation assistance, and ESG reporting capacity are rarely bundled with financing. Gender-lens capital is growing, but instruments often mirror mainstream structures and inherit their transaction costs, making delivery to very small ticket sizes uneconomic without standardized origination, pooled vehicles, and shared services for monitoring and verification (Akinrinoye, *et al.* 2019, Didi, Abass & Balogun, 2019, Otokiti & Akorede, 2018).

Barriers to MSME finance are well documented and directly relevant to green investment needs. Lenders grapple with asymmetric information, volatile cash flows, and limited collateral; transaction costs per dollar lent are high due to bespoke assessments; informality complicates KYC, tax documentation, and enforceability; and small ticket sizes impede securitization and secondary market exits. For sustainability-linked use cases, additional hurdles include the perceived technology risk of efficient machinery, uncertainty about payback periods given energy price fluctuations, and the need for installers and after-sales support to assure performance (Copeland, *et al.*, 2012, Simkin, Worrell & Savage, 2018). Measurement of impact adds another layer: even simple baselines for energy, water, or waste are rarely available. Without standardized taxonomies, borrowers cannot signal “green-eligible” pipelines, and lenders cannot aggregate portfolios with confidence. The result is a vicious cycle: few turnkey projects, scarce verifiable data, and premium pricing that keeps adoption low.

Policy and regulatory frameworks have advanced in ways that can anchor a fit-for-purpose model. Internationally, the Paris Agreement and the Sustainable Development Goals set

directionality for climate mitigation, adaptation, decent work, and gender equality. Sustainable finance taxonomies such as those of the EU and various emerging markets define eligible activities, while disclosure regimes like TCFD and the ISSB's IFRS S1 and S2 push companies and financial institutions to measure and manage climate-related risks and opportunities. Principles-based frameworks, including the Equator Principles, the UN PRI, the Green Bond Principles, and credible certification schemes, enable the labeling and assurance of instruments (Liu & Vasarhelyi, 2014, Nasri, 2012). At national levels, central banks and supervisory authorities increasingly issue sustainable banking guidelines, encourage climate risk management, establish movable collateral registries, support credit guarantee schemes, and promote digital identity and payments infrastructures. Public

procurement policies that set targets for women-owned suppliers, along with tax incentives for energy-efficient equipment, can create demand pull (Abass, Balogun & Didi, 2020, Didi, Abass & Balogun, 2020, Oshomegie, Farounbi & Ibrahim, 2020). Nevertheless, fragmentation persists: taxonomies may not map cleanly to MSME realities, data architectures are inconsistent across lenders, and guarantees often fail to reward verified sustainability performance. In parallel, consumer protection rules and interest-rate caps, where present, can unintentionally limit product innovation for small-ticket green loans if not paired with cost-sharing or digitized origination. Figure 1 shows Thematic Areas of Recommendations on Climate-Related Financial Disclosure presented by Ferri & Acosta, 2019.



Fig 1: Thematic Areas of Recommendations on Climate-Related Financial Disclosure (Ferri & Acosta, 2019).

The proposed Green Financing Strategy Model addresses these frictions by aligning instruments, de-risking, and data under a unified operating system optimized for small, women-led firms. First, it standardizes project categories and documentation aligned to recognized taxonomies but translated into MSME-ready templates, so loan officers can quickly identify eligible use cases such as high-efficiency motors, cold-chain retrofits, induction cookers for food businesses, solar rooftop kits with storage, water recycling units, and circular inputs. Second, it pools origination through anchor buyers, cooperatives, and fintech marketplaces to create portfolio scale while lowering unit transaction costs (Escobar, Ferrando & Rubtsov, 2017, Tsaih & Hsu, 2018). Third, it embeds a verification and technical assistance layer covering vendor prequalification, baseline diagnostics, installation quality checks, and digital MRV so lenders can price risk to performance rather than to uncertainty. Fourth, it couples guarantees or first-loss capital with performance-pricing features that reward both timely repayment and verified environmental outcomes, aligning incentives across borrower, lender, and guarantor. Fifth, it integrates gender-smart features reduced collateralization where movable assets and purchase orders can be recognized; grace periods

matched to installation timelines; advisory on procurement readiness; and bundled childcare or flexible disbursement schedules during peak caregiving periods so the product design reflects lived constraints rather than penalizing them (Akinola, *et al.*, 2020, Akinrinoye, *et al.* 2020, Balogun, Abass & Didi, 2020).

On the policy interface, the model serves as a conduit rather than a silo. It can map national subsidy and rebate programs into loan calculators, ensuring that borrowers see net effective rates after incentives. It can translate disclosure and taxonomy requirements into one-click templates for lenders, reducing compliance friction. It can surface anonymized portfolio data to supervisors to inform macroprudential views on climate exposure, gender inclusion, and MSME performance (Amenc, *et al.*, 2017, Barber, Bennett & Gvozdeva, 2015). And by generating auditable impact data at scale, it enables banks to issue labeled bonds backed by granular MSME assets, unlocking cheaper wholesale funding. The governance layer can draw on established standards for data privacy and consent, while interoperable APIs reduce duplicative KYC and credit scoring. Figure 2 shows theoretical framework of SMEs, small and medium enterprises presented by Wicaksono, *et al.*, 2021.

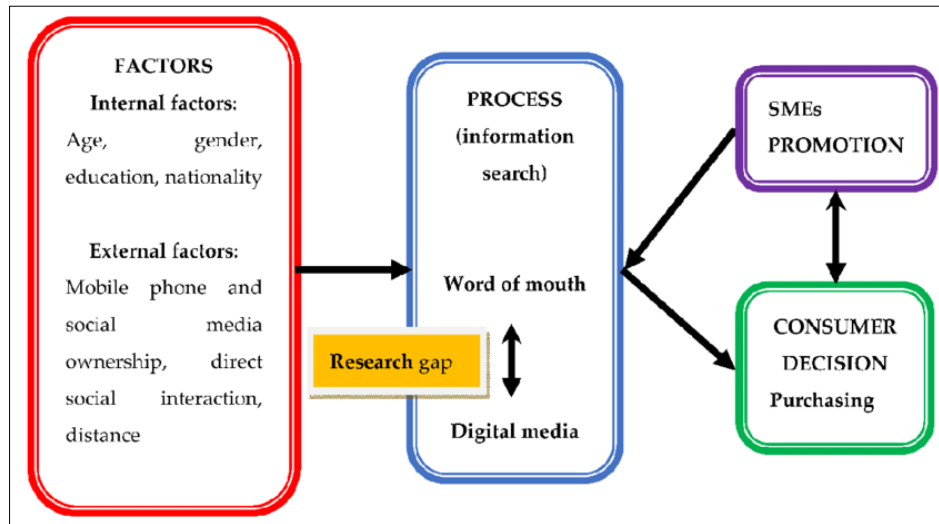


Fig 2: Theoretical framework of SMEs, small and medium enterprises (Wicaksono, *et al.*, 2021).

Remaining gaps the model aims to close include the paucity of verifiable baselines for small enterprises, the absence of standardized small-ticket cash-flow underwriting tied to efficiency savings, the limited supply of vetted vendors and maintenance ecosystems, and the lack of longitudinal data connecting sustainability investments to revenue growth, procurement wins, and job quality. By creating a shared data backbone and a marketplace of pre-approved technologies and service providers, the model reduces adverse selection and moral hazard. By linking pricing to outcomes rather than only to collateral, it improves fairness and expands eligibility. By pairing capital with capability advisory, procurement linkages, and digital tools it raises the probability that each loan converts into durable operational gains (Chow, Li & Shim, 2018, Varsani & Jain, 2018).

In sum, the literature shows that green finance instruments, gender-lens priorities, and MSME policy tools have matured but remain misaligned for the realities of women-owned and small enterprises. The Green Financing Strategy Model proposes a coherent way to stitch these elements together: classify and aggregate small projects; reduce unit costs of origination and verification; price to performance through guarantees and sustainability-linked features; and institutionalize data systems that satisfy regulators, investors, and buyers. This integrated approach reframes sustainability from a compliance cost into a competitiveness strategy, unlocking capital where it has been most constrained and channeling it toward the entrepreneurs who can most efficiently translate it into inclusive, climate-positive growth (Aronsson, Abrahamsson & Spens, 2011, Roy & Hota, 2016).

2.1. Methodology

The study adopts a design-science and quasi-experimental methodology to architect, implement, and iteratively validate a Green Financing Strategy Model tailored to women-owned and small enterprises (WOSEs/SMEs). First, we conduct stakeholder and context mapping to define the functional ecosystem development finance institutions, commercial and microfinance banks, cooperatives, NGOs, and public agencies then segment target markets by sector, formality, geography, and credit history to anchor heterogeneous product design. Drawing on literature in mobile/BI adoption

for SMEs, gender-lens finance, and predictive analytics, we co-create an eligibility and sustainability scoring rubric that integrates environmental indicators (energy and resource efficiency, waste/circularity, emissions) with social and governance signals (women leadership, job quality, compliance). Sectoral benchmarks and weights are calibrated using expert elicitation and historic loan performance.

We design a gender-responsive credit assessment that layers traditional financial ratios with collateral alternatives, acceptance of informal records, and leadership capacity indicators, coupled with bias-detection checks. A blended-finance stack is structured concessional tranches, guarantees, climate funds, micro-equity, and results-based grants to de-risk inclusion while preserving sustainability outcomes. Pricing logic links interest/fee step-downs to verified sustainability scores and milestone KPIs. Parallel to underwriting, we deliver capacity-building modules on green operations, ESG reporting, digital bookkeeping, carbon accounting, procurement readiness, and certification pathways; completion gates inform credit limits and pricing incentives.

Data engineering establishes a secure pipeline that merges core banking, loan-servicing, and ESG evidence streams via APIs/ELT/CDC into a loan-and-impact data mart. Process-mining views and early-warning rules track disbursement, portfolio health, and KPI attainment. A monitoring and evaluation framework defines primary indicators (approval rates for women and micro borrowers, default and loss rates, carbon reduction, revenue and jobs created or safeguarded) and secondary metrics (TA participation, certification uptake). We run a controlled pilot across two to three regions, baseline KPIs, and compare cohorts using difference-in-differences and survival/PD analyses. Feedback loops enable score recalibration, product redesign, supplier enablement, and policy engagement (e.g., recognition of alternative collateral or green-tag reporting). Governance is formalized with a RACI, audit trails, role-based access, and model-risk controls. Scale-up follows a playbook: expand partners, replicate data connectors, adjust pricing ladders, and extend the TA catalogue, with quarterly reviews to lock in learning and ensure inclusive, resilient, and growth-oriented outcomes for women-owned and small enterprises.

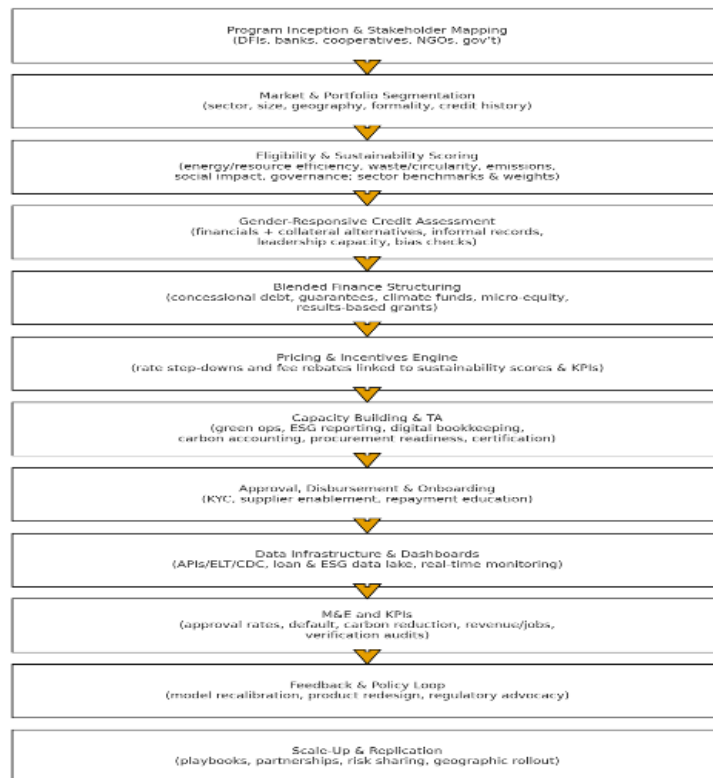


Fig 3: Flowchart of the study methodology

2.2. Eligibility & Sustainability Scoring Framework

The eligibility and sustainability scoring framework translates policy intent into bankable decisions by combining clear entry criteria with a transparent, weighted score that captures environmental performance, social impact for women entrepreneurs, and governance maturity. Eligibility serves as a gate: borrowers must be women-owned or women-led or demonstrate a minimum threshold of women’s participation in ownership, management, or workforce, and the financed activity must align to an approved catalogue of green use cases such as energy-efficient equipment, on-site renewables, water-saving technologies, low-emission logistics, circular inputs, and pollution prevention (Ritala, *et al.*, 2013, Witkowski, 2017). Once eligible, each application is evaluated across harmonized indicators grouped into energy and resource efficiency, emissions performance, waste and circularity, social impact, and governance. Scores are normalized to a 0–100 scale using sector benchmarks and sized by weights that reflect both climate materiality and the program’s gender and MSME inclusion mandate.

Energy and resource efficiency measures the expected reduction in electricity, fuels, and water per unit of useful output relative to a baseline. For manufacturing, the benchmark is kWh or MJ per unit produced; for food and hospitality, kWh per cover or per kilogram processed; for agrifood, liters per hectare or per ton; for retail and services, kWh per square meter or per customer served. The indicator rewards absolute and intensity improvements, assigns higher points to interventions with verifiable measurement and durable savings, and adjusts for rebound effects (Kritchanchai, 2014, Lega, Marsilio & Villa, 2013). Emissions performance estimates annualized scope 1 and 2 reductions and, where feasible for small firms, critical scope

3 elements like upstream materials or downstream logistics. Because many women-owned MSMEs rely on the grid, the model differentiates between activity-based reductions (e.g., efficient motors) and location-based factors (grid emission intensity), preventing undue penalization for geography while still incentivizing on-site renewables and clean fuels (Seyi-Lande, Oziri & Arowogbadamu, 2019).

Waste and circularity evaluate material efficiency, substitution, and end-of-life outcomes. Points are allocated for reducing process scrap, extending product life, increasing recycled content, and establishing take-back or repair services. Sector baselines anchor expectations: apparel and textiles reference kilograms of waste per unit, construction references diversion rates from landfill and recycled aggregates, food businesses use edible food loss rates and organic waste valorization. Preference is given to solutions that build circular partnerships, for example, selling by-products to local processors or using refill systems in retail. Social impact centers women’s economic empowerment and job quality (Alssayah & Krishnamurti, 2013, Guzman & Stiglitz, 2016). The score recognizes improvements in female employment, wage equity, advancement pathways, flexible scheduling, and safe workplaces; it also rewards products and services that improve outcomes for women customers or suppliers, such as efficient cookstoves, cold-chain for women farmers, or water technologies that reduce time poverty. To balance ambition with feasibility, thresholds scale by firm size: micro and small enterprises can earn high marks through practical interventions like childcare stipends, pay transparency, and vendor capacity building, while larger SMEs are expected to embed formal policies and targets. Figure 4 shows Scaling up Green Finance G20’s View presented by Ferri & Acosta, 2019.



Fig 4: Scaling up Green Finance G20's View (Ferri, G., & Acosta, B. A. (2019).

Governance captures the systems that make green and social outcomes durable: basic environmental management routines, data logging for energy and water, preventive maintenance schedules, supplier codes of conduct, complaint mechanisms, and board or owner oversight for ESG. Given informality in MSMEs, the framework prioritizes “minimum viable governance” that is right-sized yet auditable simple checklists, documented procedures, and designated responsible persons (Fastenrath, Schwan & Trampusch, 2017, Jacque, 2013). To discourage box-ticking, governance points are weighted toward evidence of use over time, such as maintenance logs, invoices from calibration, or worker feedback records.

Weights reflect dual priorities of climate impact and inclusive growth while keeping the instrument practical for small tickets. A balanced configuration assigns 25% to energy and resource efficiency, 20% to emissions performance, 15% to waste and circularity, 20% to social impact, and 10% to governance, with two cross-cutting modifiers: 5% for additionality (whether financing enables an improvement unlikely to occur without concessional features or technical assistance) and 5% for data quality (tiered MRV confidence) (Duffie, 2018, Hsin Chang, Tsai & Hsu, 2013). The base indicators sum to 90; additionality and data quality adjust the composite to 100. Programs operating in highly carbon-intensive grids may shift 5% from waste to emissions; those targeting female employment specifically may add 5% to social impact while reducing governance by the same amount, but any change must be disclosed ex-ante and held constant within a lending window to ensure fairness (Abass, Balogun & Didi, 2019, Ogunsola, Oshomegie & Ibrahim, 2019, Seyi-Lande, Arowogbadamu & Oziri, 2018).

Normalization and benchmarking are critical to comparability across sectors. Each indicator uses a three-part scheme: a sector baseline derived from published intensity ranges or aggregated program data; a target band representing the upper quartile of efficient peers; and a stretch band representing best-available technologies for MSMEs. Scores interpolate linearly between baseline (score 30), target (score 70), and stretch (score 90), with additional points up to 100 reserved for documented co-benefits (e.g., particulate filtration adding health benefits) or for open-data

commitments that improve market transparency. Where baselines are absent, the framework initiates with proxy values and shifts to empirically calibrated baselines after two portfolio cycles, ensuring the model learns without penalizing early applicants (Hassan, Nabil & Rady, 2015, Nair, Jayaram & Das, 2015).

Data quality tiers protect integrity without excluding thin-file borrowers. Tier 1 relies on self-reported estimates and vendor datasheets with post-installation plausibility checks; Tier 2 adds utility bills or smart-meter snapshots; Tier 3 incorporates continuous sub-metering, IoT sensors, or third-party verification. The 5% data quality modifier allocates +0, +2.5, or +5 points for Tiers 1–3 respectively, encouraging progressive MRV without making it a hard barrier. Similarly, additionality evaluates whether concessional pricing, guarantees, or technical assistance were decisive in unlocking the project; projects that simply refinance already-installed equipment receive no bonus, whereas first-time adopters or firms in credit-constrained segments can earn the full 5% (Luzzini, Caniato & Spina, 2014, Mutai & Okello, 2016).

To operationalize decisions, the composite score maps to four eligibility bands linked to pricing and technical support. Bronze (60–69) indicates eligibility with standard pricing and required capacity-building actions; Silver (70–79) unlocks modest pricing benefits and lighter post-disbursement audits; Gold (80–89) earns enhanced pricing, faster turnaround, and access to pooled procurement; Platinum (90–100) qualifies for flagship recognition, extended tenors, and potential participation in labeled securitizations. Applications below 60 are not rejected outright; instead, they receive a remediation plan detailing two to three specific actions such as swapping motor classes, adding a basic water-recirculation system, or adopting a wage transparency policy that can raise the score upon resubmission (Coleman & Robb, 2012, Emrich, 2015).

Because risk and impact are intertwined in small-ticket lending, the framework embeds safeguards against unintended bias. Collateral surrogates purchase orders, movable assets, and performance guarantees from pre-vetted vendors are recognized so that lack of titled land does not suppress access for women entrepreneurs. Social impact points cannot compensate for unsafe equipment or negligible

emissions improvements; minimum floors for environmental indicators must be met irrespective of high social scores (Butler, 2017, Kimanzi, 2016). Where sectors differ markedly in materiality, sector-specific weightings are applied within bounded ranges for example, manufacturing may set 30% efficiency and 25% emissions, while services may set 20% and 15% respectively with higher governance weight yet the composite rules remain consistent so that pricing and eligibility are predictable.

Implementation hinges on a simple, auditable scoring worksheet integrated into loan origination. Applicants select their sector and use case from a drop-down list that auto-loads baselines and documentation requirements. The tool computes estimated savings and reductions using standardized calculators, flags data quality tier, and proposes a preliminary band and term sheet. Underwriters see a clear breakdown of indicator scores, assumptions, and required evidence. Post-disbursement, the same structure powers monitoring: a quarterly light-touch check for Bronze and Silver, semiannual checks for Gold, and annual third-party spot checks for Platinum portfolios. Portfolio dashboards track average composite scores, indicator dispersion, and progression of borrowers across bands, feeding a virtuous cycle in which benchmarks are refined and technical assistance targets the weakest indicators by sector (Ahmad & Muhammad Arif, 2015, Lenz & Hahn, 2015).

Finally, governance of the scoring framework ensures credibility and evolvability. An independent technical committee reviews weights annually, approves sector baselines, and audits random files. Any changes to weights or thresholds are versioned, with effective dates stamped on credit files to preserve comparability over time. Borrowers and lenders can appeal indicator assessments with additional evidence, and all model artifacts calculators, baselines, and rules are published to foster trust. In this way, the eligibility and sustainability scoring framework becomes not only a gatekeeper but a growth enabler, channeling capital at scale to women-owned and small enterprises while ensuring that every financed dollar delivers measurable, verifiable, and durable green impact (Janse van Rensburg, 2014, Plant & Padotan, 2017).

2.3. Gender-Responsive Credit Assessment

A gender-responsive credit assessment for green financing begins with the premise that risk in women-owned and small enterprises is frequently mismeasured, not inherently higher. The integrated model therefore combines orthodox financial analysis with gender-sensitive evidence sources and green project performance drivers, producing a probability-of-default and loss-given-default view that is both predictive and equitable. Traditional metrics remain foundational historical and projected cash flows, gross margins, operating expense discipline, debt service coverage ratio, leverage and liquidity, seasonality patterns, customer concentration, and covenant headroom (Coetzee & Lubbe, 2014, Pitt, 2014). These are complemented by project-level indicators specific to the financed green asset or activity: expected energy and water savings, emissions reductions, technology maturity, vendor reliability, installation quality, maintenance burden, and payback profile. Because many women-owned MSMEs operate with thinner formal documentation and collateralizable fixed assets, the model expands evidence channels to capture true performance: mobile-money ledgers, POS exports, inventory rotation logs, purchase orders, signed

delivery notes, tax receipts, utility bills, supplier statements, community savings-group passbooks, and verified e-commerce sales histories. Each source is tagged with a confidence tier and mapped to cash-flow proxies, allowing statistically robust inference even when audited statements are absent (Llave, 2017, Puklavec, Oliveira & Popović, 2018).

Collateral evaluation shifts from immovable property toward reliable substitutes. The model recognizes movable asset registries, equipment pledges with serial-number verification, inventory and receivables financing with dilution controls, purchase-order financing protected by assignment of proceeds, and performance guarantees from pre-vetted green vendors. A collateral adequacy score blends asset liquidity, legal enforceability, depreciation profile, and monitoring ease. For micro and small tickets, partial guarantees and first-loss capital are modeled explicitly in LGD, ensuring pricing reflects real mitigants rather than blunt rejections. Where legal systems constrain enforcement, the framework elevates repayment culture indicators historical adherence to group savings rules, repayment timeliness in digital credit histories, and community reputation checks converted into ordinal variables that improve calibration (Adeyure, Kalema & Bwalya, 2018, Pulka, Ramli & Bakar, 2017).

Leadership capacity is treated as a primary risk driver rather than an anecdotal note. A structured assessment captures the owner-manager's track record, domain expertise, decision velocity, financial literacy, and resilience strategies. Evidence includes certificates from vocational or supplier training, participation in accelerators, tenure in current line of business, employee retention rates, and the presence of delegated controls such as dual sign-offs or inventory cycle counts. Psychometric and scenario-based questionnaires focus on planning rigor, cash-buffer norms, and willingness to seek advice (Adeyure, Kalema & Bwalya, 2018, Omopariola, 2017). To avoid bias, the model privileges observable behaviors and outcomes over style or personality; it also debiases scoring by comparing women-owned enterprises to peer medians in the same sector, size, and region. Leadership capacity enters the PD model as a composite latent factor estimated through regularized regression or gradient boosting with monotonic constraints to preserve interpretability.

Green project viability links directly to repayment by quantifying savings-to-debt ratios. The assessment converts projected kWh, fuel, or water savings into monthly cash flow increments using conservative baselines, verified tariffs, and maintenance allowances; where production lifts are plausible (e.g., cold-chain reducing spoilage), the uplift is separately modeled with a haircut to guard against optimism. A project readiness index checks vendor track record, warranty coverage, installation timeline, and MRV plan quality. Because women-owned firms often benefit from technical assistance, the model includes an execution support flag and adjusts PD downward when experienced partners are contracted and milestones are escrow-linked (Carvalho & Fidélis, 2013, Hanley, *et al.*, 2017). Sensitivity analyses simulate tariff shocks, downtime, and demand dips to generate worst-case DSCRs that drive covenants and reserve requirements.

The scorecard architecture blends these elements into transparent, additive components: financial strength (30%), cash-flow consistency and seasonality (15%), collateral and

recoverability (15%), leadership and governance capacity (15%), green project viability and MRV quality (20%), and market and policy context (5%). Each component is computed from features with documented transformations: winsorized ratios, trailing-twelve-month volatility measures, Gini-weighted customer concentration, on-time payment indices, and text-mined vendor risk from contracts (Hegazy & Nahass, 2011, Johnson, *et al.*, 2018). Gender-sensitive adjustments are never hidden uplifts; instead, they are the inclusion of valid predictors historically excluded from underwriting. For example, a six-month POS feed with low refund rates may substitute for audited sales, while consistent utility bill payments may proxy discipline and business continuity. Where formal collateral is lacking, strong recurring receivables from anchor buyers, verified by e-invoices, raise the recoverability score and enable assignment-of-proceeds structures (Akinola, Fasawe & Umoren, 2021, Evans-Uzosike, *et al.*, 2021, Uddoh, *et al.*, 2021).

Model training uses pooled portfolios with stratified sampling to avoid majority-group dominance. Fairness diagnostics check for equalized odds and demographic parity gaps; if adverse impact is detected after controlling for sector and size, the team refines features, applies reweighting, or enforces monotonic constraints that prevent proxies for gender from driving risk upward. Out-of-time validation is performed across vintage cohorts and geographies. Explainability is delivered through SHAP value summaries at portfolio level and reason codes at file level, so credit officers can see that “cash-flow consistency improved PD by 1.8 percentage points based on POS stability and seasonality mitigation,” while “customer concentration worsened PD by 0.7 percentage points (Jiang, *et al.*, 2016, Odoni, *et al.*, 2015).”

Pricing and limits flow from PD/LGD/EAD outputs, but the instrument also embeds incentive mechanisms aligned with green outcomes. If MRV confirms realized savings within a tolerance band for two consecutive quarters, the loan margin steps down automatically, and limits on revolving facilities may expand. Conversely, if MRV or covenant breaches persist, the system triggers coaching before punitive actions, consistent with developmental objectives. Early-warning rules combine operational and behavioral signals declining transaction velocity, inventory stockouts, abnormal energy use, or lapsed maintenance contracts to surface accounts for proactive outreach. Because women entrepreneurs may shoulder disproportionate care burdens, the framework offers hardship rescheduling rules with transparent, pre-approved criteria to prevent discretionary bias while preserving portfolio health (Papenfuss & Friedrich, 2016, Warnell, Olander & Mason, 2018).

Workflow design ensures that gender-responsive practices are operationalized rather than aspirational. Origination checklists explicitly list acceptable alternative documents; loan officers receive nudges in the system when a customer profile suggests unexploited evidence sources. Vendor marketplaces and pooled procurement lower equipment costs and standardize warranties, improving both LGD and borrower cash flows. Legal documentation includes simplified pledge agreements for movables and template assignment of proceeds, cutting cycle time and uncertainty (Arayici, Onyenobi & Egbu, 2012, Zhang, *et al.*, 2016). A parallel TA workstream offers bookkeeping setups, cash-flow coaching, and MRV onboarding; completion feeds back

into leadership capacity scores, creating a virtuous loop where support tangibly lowers modeled risk.

Portfolio governance treats gender as a portfolio objective with risk co-benefits, not a quota. Dashboards disaggregate approval rates, pricing, arrears, restructures, and realized PD gaps by gender, sector, and ticket size. Statistical tests check whether predicted and realized defaults align across groups; where deviations appear, the model is recalibrated or process fixes are introduced, such as broadening acceptable evidence for specific sectors. Stress tests model shocks tariff hikes, droughts affecting agrifood, currency swings while tracking whether women-owned micro and small firms exhibit different sensitivities; mitigation options include currency-hedged vendor pools, efficiency TA targeted to high-intensity sectors, or guarantee top-ups (Afriyie, 2017, Siddiqi, 2017). The result is an integrated credit approach in which orthodox financial discipline coexists with inclusive evidence, leadership realism, and the economics of green upgrades. It recognizes that a well-installed efficient motor or solar freezer can transform cash conversion cycles as surely as a new contract, and that legally sound movable pledges can protect recovery nearly as well as land titles in certain contexts. By codifying these truths in features, weights, covenants, and workflows and by auditing fairness continuously the model makes timeline-reliable, competitively priced green credit available to women-owned and small enterprises at scale, while preserving the lender’s prudence and the integrity of environmental impact claims (Amaral, *et al.*, 2018, Kuenkaikaw & Vasarhelyi, 2013).

2.4. Financial Architecture & Instruments

The financial architecture for a green financing strategy directed at women-owned and small enterprises must solve three simultaneous problems: reduce risk to unlock private capital at scale, align incentives so that sustainability performance improves enterprise resilience, and simplify access for borrowers who face documentation, collateral, and price barriers. The core design is a blended finance stack that layers concessional and commercial capital through a purpose-built special purpose vehicle or fund-of-vehicles that on-lends via local financial institutions and mission-aligned fintechs. At the foundation sits catalytic, first-loss capital provided by climate funds, philanthropic donors, or public development programs (Brownlow, *et al.*, 2015, Curuksu, 2018). This tranche absorbs initial portfolio-level losses up to a defined cap to de-risk the entry of senior private investors. Above it, a mezzanine tranche, often from development finance institutions or impact investors, earns a capped return and shares losses after the first-loss is exhausted, smoothing volatility while preserving leverage. Senior capital banks, institutional investors, pension trustees, and treasury desks provides warehouse lines and term financing at scale, secured by the underlying receivables and supported by portfolio guarantees. Together, these layers compress the all-in cost of funds, enabling end-borrower pricing that is competitive with conventional loans despite higher origination and monitoring intensity for green projects (Mbaluka, 2013, Moro, Cortez & Rita, 2014).

Guarantee instruments are the workhorses that convert policy ambition into bankable credit. Partial credit guarantees cover a specified percentage of principal on a first-loss or *pari passu* basis, often differentiated by technology class to reflect heterogeneous risk (e.g., higher coverage for first-time solar cold-chain adopters than for high-efficiency motors with long

operating history). Portfolio guarantees, rather than deal-by-deal approvals, accelerate scale by delegating underwriting within a pre-agreed credit box that encodes gender eligibility, ticket sizes, sectors, and measurable green outcomes (Mohieldin, *et al.*, 2015, Zolnowski, Christiansen & Gudat, 2016). Complementary performance guarantees from vetted vendors backed by warranty insurance address technology risks and reduce loss-given-default by ensuring reliable service, spare parts, and diagnosable failure modes. To address currency mismatch where senior funding is hard-currency and borrower revenues are local, the stack includes an FX hedge sleeve, either via local currency facilities from DFIs, cross-currency swaps arranged with hedge providers, or a reserve-based pass-through priced transparently; hedge costs are partially offset by concessional coupons and, where justified, by time-bound FX subsidy from climate windows for micro-tickets.

On the equity side, micro-equity and revenue-based financing (RBF) instruments complement debt for enterprises with thin collateral and lumpy growth. Micro-equity takes minority, time-limited positions with pre-agreed buyback formulas tied to cash flow rather than valuation gymnastics, protecting founders from dilution shocks and preserving control. RBF advances capital in exchange for a small percentage of gross receipts up to a repayment cap, aligning investor returns with seasonal revenue while protecting borrowers during downturns (Demirgüç-Kunt, *et al.*, 2015, Gomber, *et al.*, 2018). For green assets that raise productivity (e.g., efficient milling, irrigation pumps, solar refrigeration), RBF is particularly apt because cash-flow uplift is measurable and can be verified through digital sales and utility data. Blending these instruments within one facility allows structuring around borrower heterogeneity: working-capital-dominant businesses receive short-tenor, inventory-tethered loans with revolving limits, while capex-heavy transitions receive longer-tenor amortizing debt paired with small micro-equity slivers to maintain prudent leverage.

Results-based grants close the viability gap for public-good spillovers and early adoption. These grants disburse against independently verified outcomes kilowatt-hours saved, tons of CO₂-equivalent avoided, liters of water conserved, waste diverted to circular uses, or documented improvements in women's employment and leadership shares. By paying for outcomes, not inputs, grants protect integrity and enable lenders to price loans closer to risk without overburdening borrowers (Arner, Buckley & Zetzsche, 2018, Ozili, 2018). Structurally, results-based grants can reduce the initial principal ("capital buydown"), fund interest rate rebates upon verified performance windows, or finance monitoring, reporting, and verification (MRV) infrastructure so that micro and small borrowers are not taxed by compliance overheads. For women-owned enterprises, a targeted results-bonus can recognize the broader social returns of female entrepreneurship, provided it is transparently rule-based and coupled with technical assistance that sustains performance after grant sunset.

Pricing must be a living instrument that signals and rewards sustainability. Each borrower carries a composite sustainability score derived from a transparent scoring framework energy and resource efficiency, waste and circularity, emissions intensity, social impact (quality jobs, gender equity, community benefits), and governance controls. The loan margin steps down automatically when the score crosses pre-set thresholds and remains there for as long

as verified performance persists. A typical structure might include a base margin M linked to the borrower's risk grade and a ladder of incentives: a 50–150 basis point reduction for achieving a "silver" sustainability tier within two quarters, a further 25–75 basis point reduction for "gold," and the possibility of limit expansion or tenor extension if performance is maintained for four consecutive quarters (Lenz & Hahn, 2015, Vasarhelyi & Halper, 2018). Conversely, a persistent drop in performance causes a step-up, with a cure period and technical assistance offered before repricing to avoid punitive whiplash. The key is automation: pricing changes are triggered by MRV data feeds (smart meters, utility bills, IoT telemetry, certified audits) and attested vendor reports rather than discretionary committee judgments, ensuring fairness and predictability.

To make this architecture operable in real markets, intermediation and origination must be designed for speed and inclusion. A central program vehicle arranges capital, sets underwriting standards, and manages MRV, while last-mile partners MFIs, cooperatives, women's business networks, agricultural aggregators, and fintech lenders originate and service loans, earning performance-based fees (Johnstone, Li & Rupley, 2011, Moeller, 2013). Origination checklists accept alternative data, including mobile-money histories, POS exports, and supplier statements, in lieu of audited accounts; collateral frameworks embrace movable asset registries, receivables assignment, and escrowed purchase-order flows. Vendor marketplaces standardize equipment, installation quality, and warranty terms; pooled procurement lowers unit costs and ensures compatibility with MRV devices. For ticket sizes below conventional bank thresholds, embedded finance models at point of sale leverage vendor KYC and installation milestones, with the program vehicle providing a backstop guarantee and refinancing via a revolving warehouse.

Portfolio-level liquidity and scale arrive through securitization once a seasoning threshold is met. Originated green MSME loans, screened for sustainability scores and payment performance, are pooled into asset-backed securities with clear eligibility and substitution criteria. Senior tranches attract local institutional investors pensions and insurers by providing credit enhancement from retained junior pieces, overcollateralization, and external guarantees. Because many women-owned enterprise loans are small and short-tenor, static pools amortize quickly, reducing duration risk while providing data for future pricing. Over time, a green-label or taxonomy-aligned designation can widen the investor base and improve execution (Hermanson, Smith & Stephens, 2012, Rubino & Vitolla, 2014).

Governance and incentives align across actors through contracts and data. Lenders receive premium share for achieving disbursement and performance targets in underserved regions and among women-owned borrowers while maintaining portfolio quality. Vendors are paid in tranches tied to installation and performance verification, with clawback clauses for systematic underperformance. Borrowers consent to data sharing for MRV in exchange for pricing benefits and access to maintenance marketplaces (Asata, Nyangoma & Okolo, 2020, Bukhari, *et al.*, 2020, Essien, *et al.*, 2020). The program discloses aggregated performance dashboards default rates, realized sustainability outcomes, geographic reach, and gender disaggregation to anchor trust and attract new capital. Fairness and consumer-protection guardrails cap step-ups, ban opaque fees, and

require plain-language term sheets; grievance mechanisms and ombud services are funded from program overheads. Finally, technical assistance is hard-wired, not an afterthought. Pre-loan TA helps borrowers select right-sized technologies and build basic cash-flow tools; post-loan TA focuses on operations and maintenance, recordkeeping, and route-to-market improvements that translate efficiency into revenue. TA funding comes from results-based grants and a small carve-out of concessional capital; its ROI is captured in reduced delinquency and higher sustainability scores that trigger pricing step-downs. Over time, as portfolios mature and data improves, concessional layers can taper, guarantees can resize, and senior capital can dominate, proving that women-owned and small enterprises are not perpetual special cases but reliable engines of green growth when finance measures what matters and prices it fairly (Abass, Balogun & Didi, 2020, Amatare & Ojo, 2020, Imediegwu & Elebe, 2020).

2.5. Capacity Building & Technical Assistance

Capacity building and technical assistance are the flywheel of the green financing strategy, translating affordable capital into durable performance gains for women-owned and small enterprises. The program therefore embeds a structured, cohort-based technical assistance pathway that begins before loan origination and continues through the life of the facility, with content modularized and stackable so firms can enter at different maturity levels and still attain verifiable improvements (Adesanya, *et al.*, 2020, Oziri, Seyi-Lande & Arowogbadamu, 2020). The core design principle is “finance + know-how + data,” meaning every lending product is paired with a tailored bundle of training, advisory, and digital tools that make green upgrades measurable, auditable, and profitable. Delivery mixes synchronous workshops, self-paced micro-learning on low-bandwidth devices, one-to-one clinics, and field coaching, reinforced by a helpdesk and a vetted marketplace of service providers. Each module has competency targets, practical assignments mapped to the borrower’s operating context, and clear evidence requirements so learning translates into bankable improvements, not paperwork.

The green operations module focuses on turning sustainability targets into day-to-day routines that lower costs and raise throughput. Content begins with resource efficiency diagnostics using simple walk-through audits and checklists to baseline electricity, fuel, water, and material use per unit of output. Participants learn how to identify the top three loads or waste streams driving costs and emissions, and to map quick wins such as power factor correction, right-sizing motors and pumps, switching to high-efficiency refrigeration, heat recovery on process lines, and preventive maintenance that reduces downtime (Akinrinoye, *et al.* 2015, Bukhari, *et al.*, 2019, Erigha, *et al.*, 2019). Practical toolkits include standard operating procedures for equipment start-up and shut-down, leak detection and repair, clean-in-place schedules, and inventory rotation that minimizes spoilage. For agrifood, cold-chain integrity and post-harvest handling practices are emphasized; for retail and services, HVAC tuning, lighting retrofits, and plug-load management feature prominently. The module teaches how to set monthly resource intensity targets, compute payback periods, and embed these in staff scorecards, closing the loop between investment, behavior, and savings.

The ESG reporting module converts disparate practices into

a coherent disclosure narrative that unlocks incentives and market access. Training demystifies frameworks by offering an MSME-sized “minimum viable ESG” that aligns with widely used standards while staying practical. Participants build a materiality snapshot to prioritize indicators relevant to their sector and size, draft a simple policy pack (ethics, health and safety, grievance, non-discrimination), and assemble evidence logs (photos, invoices, meter readings, training rosters) (Adesanya, *et al.*, 2020, Seyi-Lande, Arowogbadamu & Oziri, 2020). The curriculum shows how to produce a two-to-four page ESG fact sheet that mirrors key data points from GRI and SASB industry standards and anticipates emerging IFRS sustainability disclosure themes without imposing enterprise-grade overhead. Emphasis is placed on worker well-being, gender equity, and community engagement, with templates for tracking recruitment, pay equity, flexible schedules, and childcare support where feasible. Because disclosure should enable benefits, the module links ESG fact sheets to lender pricing step-downs, buyer prequalification, and public recognition, aligning effort with tangible rewards.

Digital bookkeeping is the backbone that makes outcomes traceable and creditworthy. The module helps enterprises migrate from notebooks and ad-hoc spreadsheets to simple, mobile-first accounting tools or POS systems that capture sales, purchases, costs, and cash movements reliably. Participants create a streamlined chart of accounts tagged to green interventions so savings and revenues from upgrades are visible in monthly profit-and-loss statements. Practical exercises include digitizing supplier invoices, reconciling mobile-money and bank statements, tracking inventory turns, and setting up customer and vendor ledgers (Asata, Nyangoma & Okolo, 2020, Essien, *et al.*, 2020, Imediegwu & Elebe, 2020). For micro and informal businesses, the program accepts alternative records such as SMS receipts and aggregator statements, then guides owners to standardize these into monthly summaries lenders can underwrite. The training pairs bookkeeping with management dashboards that visualize gross margin, operating margin, days payable and receivable, and cash conversion cycle, giving owners the insight to service debt confidently and to time re-orders and promotions.

Carbon accounting equips borrowers to measure impacts and earn results-based incentives. The module teaches activity-based emission estimation using accessible templates: electricity consumption multiplied by grid emission factors for scope 2, fuel use for generators and vehicles for scope 1, and basic scope 3 categories where data exists, such as upstream logistics for key inputs. Participants learn to convert invoices and meter readings into monthly CO₂e, calculate intensity metrics per unit of product or revenue, and attribute reductions to specific interventions. Where IoT meters or smart plugs are available, the program shows how to stream data securely into dashboards for automated reporting; where not, it emphasizes disciplined monthly logging and photo evidence (Ajayi, *et al.*, 2018, Bukhari, *et al.*, 2018, Essien, *et al.*, 2019). The pedagogy stresses conservative assumptions and transparent documentation, recognizing that credibility matters more than precision for small firms. Carbon results then link to pricing rebates, grant disbursements, and marketing narratives that differentiate green products with verified claims.

Procurement readiness ensures that enterprises can access high-quality technologies and services on fair terms. This

module introduces vendor vetting, comparative quotation analysis, and total cost of ownership evaluation, including warranty terms, spare-parts availability, energy consumption, and expected lifetime. Participants practice drafting simple technical specifications for items like solar freezers, efficient motors, induction cookers, or wastewater units; they learn to read datasheets, ask for performance guarantees, and structure milestone-based payments tied to installation and performance verification (Akinrinoye, *et al.* 2020, Essien, *et al.*, 2020, Imediegwu & Elebe, 2020). The module explains how to leverage the program's vendor marketplace, pooled procurement, and framework agreements to reduce unit prices and delivery times. It also covers basic contract law and risk allocation, clarifying acceptance criteria, liquidated damages for delays, and responsibilities for permits and interconnections. Because many women-owned firms face bias in supply chains, the training integrates negotiation confidence, red-flag identification, and escalation pathways to the program's ombud service.

Certification pathways convert operational progress into market signals. The module maps affordable routes to recognized labels and management systems, prioritizing those with MSME-friendly tiers. Participants receive roadmaps for environmental management (e.g., ISO-aligned practices), energy management, green building lite certifications where relevant, and inclusive business seals that recognize gender equity and decent work. The curriculum breaks certification into bite-sized steps policy adoption, baseline measurement, target setting, internal audits and provides document templates to cut consulting costs (Akinrinoye, *et al.* 2020, Bukhari, *et al.*, 2020, Elebe & Imediegwu, 2020). For product claims (organic, fair trade, recycled content), the training clarifies chain-of-custody requirements and typical audit evidence. The program may subsidize pre-assessments and share costs for first-time certifications, recouped through performance bonuses as firms convert credentials into sales growth.

To ensure learning sticks, the technical assistance model uses a phased journey. A pre-disbursement "readiness sprint" focuses on digital bookkeeping setup, baseline resource and emissions measurement, and procurement plans; completion is a loan condition but is supported by coaches so it does not become a barrier. A post-disbursement "implementation block" runs for three to six months, during which enterprises execute upgrades, adopt SOPs, and publish their first ESG fact sheet. A "performance maturation" phase then shifts to optimization: fine-tuning settings, scheduling maintenance, negotiating better input prices, and preparing for certification audits. Throughout, peer circles convene owners by sector to exchange hacks and vendor reviews, and a digital portal houses micro-lessons, templates, and a ticketed helpdesk for on-demand support (Ajayi, *et al.*, 2019, Bukhari, *et al.*, 2019, Oguntegbe, Farounbi & Okafor, 2019).

Gender-responsive design is embedded across modules. Schedules accommodate caregiving responsibilities with evening and weekend options, travel stipends are available for in-person sessions, and childcare is provided at hubs when feasible. Training materials feature women practitioners and case studies; mentorship pairs newer founders with experienced peers. Assessments ensure voice: quizzes are complemented by practical demonstrations and narrative reflections so participants who are less test-confident still succeed. Where social norms inhibit mixed-gender discussion, women-only cohorts are offered without reducing

technical depth (Ajayi, *et al.*, 2019, Bayeroju, *et al.*, 2019, Sanusi, *et al.*, 2019).

Monitoring and continuous improvement tie assistance to outcomes. Each enterprise has a capability scorecard spanning the modules; coaches update it quarterly alongside financial and sustainability KPIs such as on-time repayment, revenue growth, energy intensity, waste diversion, and employee retention. Data informs adaptive coaching, identifies common pain points for curriculum updates, and supports evidence-based budget decisions about which services deliver the greatest ROI. Providers auditors, trainers, vendors are paid partially on outcomes to align incentives with the program's goals (Asata, Nyangoma & Okolo, 2020, Essien, *et al.*, 2020, Elebe & Imediegwu, 2020). Crucially, technical assistance is financed upfront through concessional capital carve-outs and results-based grants, so borrowers are not deterred by fees; over time, as portfolio performance improves, the unit cost of TA declines and can be sustained by modest success-based contributions.

By making green operations, ESG reporting, digital bookkeeping, carbon accounting, procurement readiness, and certification concrete and achievable, the technical assistance platform reduces perceived risk, lifts productivity, and creates a common language between borrowers, lenders, and buyers. This is how capital becomes capability, and capability becomes sustained, measurable, and investable green growth for women-owned and small enterprises (Asata, Nyangoma & Okolo, 2020, Essien, *et al.*, 2019, Elebe & Imediegwu, 2020).

2.6. Partnerships, Data Infrastructure & M&E

Partnerships, data infrastructure, and monitoring and evaluation are the connective tissue that transform a green financing model from a portfolio of loans into an ecosystem that compounds benefits for women-owned and small enterprises. The partnership architecture aligns capital, capability, market access, and public legitimacy. Commercial banks originate and service loans at scale, but their role extends beyond underwriting into co-designing green products with transparent incentive mechanics tied to verified sustainability performance. They host relationship managers trained in gender-responsive practices, operate pre-screening clinics to convert informal records into credit-usable data, and embed green pricing step-downs and grace-period logic into core systems (AdeniyiAjonbadi, *et al.*, 2015, Didi, Abass & Balogun, 2019, Umoren, *et al.*, 2019). Development finance institutions provide first-loss guarantees, liquidity lines, and outcome-based grants that buy down risk while crowding in local lenders; they also act as standard setters for measurement, verification, and learning agendas so evidence accumulates across markets. Cooperatives, savings groups, and MFIs serve as last-mile distribution and credit formation nodes, bundling demand among micro-firms, supervising group guarantees, and maintaining high-frequency records on savings, repayments, and business milestones that feed upstream into the data pipeline. NGOs and accelerators contribute technical assistance delivery, outreach to underserved communities, and social safeguards; they host sector cohorts, screen vendors, and facilitate grievances and remedial action. Local agencies ministries, standards bodies, and municipal programs supply policy alignment, green public procurement signals, and access to incentives such as tax rebates, net-metering, or simplified permitting for rooftop solar and energy-efficient retrofits. Buyers and offtakers,

from supermarkets to export aggregators, sit alongside this core, pre-qualifying certified suppliers and offering revenue anchors through forward purchase agreements linked to sustainability milestones.

The data infrastructure treats each enterprise as a data-producing partner, not merely a reporting obligation. A lightweight pipeline begins at the source: mobile-first loan applications, POS and ledger connectors, utility and fuel receipts captured by camera, and optional IoT meters on key loads such as refrigeration, motors, and pumps. Data is validated at ingestion with format, range, and duplication checks, and every record is tagged with the borrower ID, time, location, and evidence provenance so audits are possible (Ajonbadi, Mojeed-Sanni & Otokiti, 2015, Evans-Uzosike & Okatta, 2019, Oguntegbe, Farounbi & Okafor, 2019). A canonical data model unifies credit events (application, approval, disbursement, restructuring), operational outcomes (sales, cost of goods sold, payroll, inventory turns), and sustainability indicators (kWh, liters, kilograms, CO₂e) at monthly granularity, with optional weekly snapshots for high-volatility sectors like food processing. Interoperability is achieved by adopting open schemas and standardizing emission factors by grid and fuel type, while privacy is protected through role-based access, tokenization of personal identifiers, and opt-in data sharing for market linkage programs. An extract-load-transform workflow streams cleaned data to a cloud warehouse; curated “gold” tables power dashboards, automated alerts, and model training. A rules engine performs outcome calculations energy intensity per unit output, waste diversion rate, and variance-to-plan then stores both raw and derived metrics along with confidence flags so users can see data quality in real time.

Dashboards are designed for action at three levels. At the enterprise level, owners see cash, margin, receivables, and payables alongside resource intensity and emission trends, with traffic-light thresholds that flag anomalies such as sudden load spikes or margin compression. At the portfolio level, lenders visualize origination funnels, approval rates disaggregated by gender, sector, and region, time-to-cash from application to disbursement, and risk leading indicators like missed check-ins or abnormal IoT silence. Sustainability and inclusion panels show carbon reduction by cohort, share of loans to women-led firms, average sustainability score change since origination, and uptake of technical assistance modules (Akinbola, *et al.*, 2020, Balogun, Abass & Didi, 2020). At the ecosystem level, DFIs and public agencies view aggregated, anonymized indicators: credit flow to priority sectors, jobs sustained and created, percentage of suppliers meeting buyer green criteria, and geographic coverage against inclusion targets. Drill-downs preserve audit trails, linking each KPI to underlying transactions and evidence artifacts.

The monitoring and evaluation framework anchors learning and accountability through a concise set of key performance indicators aligned to the program theory of change. Access indicators include application volume, conversion rate from pipeline to approval, and approval rates by gender, collateral type, and formality status. Affordability and efficiency are tracked through average interest rate after green rebates, average time from complete application to disbursement, and share of loans bundled with technical assistance (Akinrinoye, *et al.*, 2020, Farounbi, Ibrahim & Abdulsalam, 2020).

Portfolio quality metrics cover on-time repayment rate, portfolio-at-risk at 30 and 90 days, restructuring incidence, and default rate, alongside statistical comparison to conventional micro and SME portfolios in the same markets. Sustainability outcomes record absolute and intensity-based carbon reduction, energy and water savings, waste diverted, and adoption of clean technologies, normalized by sector benchmarks. Enterprise performance tracks revenue growth, gross and operating margin shifts, asset utilization, and cash conversion cycle, complemented by jobs indicators such as total jobs sustained and created, share of female employees, and quality markers like contracts, social protection, and training hours. Inclusion metrics monitor the share of capital reaching women-owned businesses, average loan size relative to peers, geographic spread across underserved districts, and complaint resolution times. Capacity-building outcomes capture completion rates of modules, pre/post competency scores, and the proportion of enterprises producing credible ESG fact sheets within six months of disbursement.

Feedback loops convert data into course corrections. At the case level, an early-warning engine combines repayment behavior, operational volatility, and sustainability telemetry to trigger light-touch interventions such as coaching calls, payment holidays, or vendor troubleshooting. At the product level, A/B tests compare pricing step-down thresholds, grace-period structures, and TA bundling options; results inform rapid iteration through a product governance forum where banks, DFIs, and NGOs vote on changes with pre-agreed decision rules (Ajonbadi, Otokiti & Adebayo, 2016, Didi, Abass & Balogun, 2019). At the policy interface, aggregated insights on bottlenecks such as delays in net-metering approvals or customs clearance for efficient equipment are escalated to local agencies with evidence packs and proposed fixes, then monitored for resolution with public dashboards that enhance accountability. At the ecosystem level, learning reviews every six months test the causal chain using quasi-experimental methods, comparing matched treated and untreated firms to quantify additionality in access, performance, and environmental outcomes.

Roles and incentives are aligned through performance contracts. Banks earn fee uplifts for meeting inclusion and sustainability origination targets and for achieving superior portfolio quality after adjusting for risk mix. DFIs release guarantee tranches and technical assistance funds in proportion to verified outcomes, with partial clawbacks for persistent underperformance unaccompanied by credible remediation (Balogun, Abass & Didi, 2019, Otokiti, 2018, Oguntegbe, Farounbi & Okafor, 2019). Cooperatives receive stipends tied to data completeness and repayment quality, encouraging disciplined record-keeping. NGOs transition from hourly billing to milestone payments linked to capability score improvements at the firm level and verified adoption of green practices. Local agencies partner through memoranda of understanding that exchange data and streamline permits; in return, the program produces quarterly public scorecards that credit agencies for improvements that unlock private investment.

Data governance enshrines trust. A multi-stakeholder data council defines indicator dictionaries, audit protocols, and consent language; it approves any new data use and oversees periodic security testing. Beneficiaries can view and correct their data, download machine-readable copies, and opt into

sharing with buyers seeking green suppliers. Independent verifiers audit a sample of outcomes quarterly, triangulating IoT logs, invoices, and site visits; verification results calibrate confidence weights in the analytics so noisy data does not distort decisions. Over time, an open-data subset properly anonymized supports research and public accountability while protecting commercial interests (Ajonbadi, *et al.*, 2014, Didi, Balogun & Abass, 2019, Farounbi, *et al.*, 2019).

When these elements operate in concert, the model becomes self-improving. Banks gain clearer risk signals and lower unit costs, DFIs see credible, scalable impact, cooperatives strengthen financial discipline, NGOs professionalize TA against measurable outcomes, and local agencies receive timely, actionable evidence to refine policy. Most importantly, women-owned and small enterprises experience a financing relationship that is fair, responsive, and developmental: capital arrives on time, costs downshift as verified improvements accrue, markets open through green procurement, and capabilities compound through continuous learning. This is how partnerships, data infrastructure, and M&E turn sustainability rhetoric into bankable, inclusive growth (Akinrinoye, *et al.* 2020, Balogun, Abass & Didi, 2020, Oguntegebe, Farounbi & Okafor, 2020).

3. Conclusion

The green financing strategy model presented here is designed to shift women-owned and small enterprises from sporadic access to capital toward a predictable, performance-linked pathway for inclusive, resilient, and sustained growth. Expected outcomes are threefold. First, inclusion improves as approval rates for credit-constrained segments rise through gender-responsive scoring, collateral alternatives, and concessional risk cover; disaggregated indicators track capital flows by gender, region, and sector to ensure underserved groups are not left behind. Second, resilience strengthens as firms adopt energy- and resource-efficient technologies, diversify suppliers and buyers through green procurement linkages, and build managerial capabilities in ESG reporting, digital bookkeeping, and carbon accounting; the model rewards verified improvements with pricing step-downs and larger subsequent ticket sizes. Third, growth accelerates as reductions in energy, water, and material intensity release cash flow, productivity gains lift margins, and access to climate-aligned value chains unlocks new markets; portfolio-level KPIs monitor revenue, jobs, and emissions intensity to validate that growth and sustainability move together rather than in trade-off.

Key risks are recognized and mitigated by design. Data quality and verification risk is addressed through standardized evidence collection (utility data, POS connectors, IoT meters where feasible), audit trails, and independent spot checks that calibrate confidence scores on metrics before incentives are paid. Credit and concentration risk is mitigated with blended finance first-loss guarantees, liquidity lines, and results-based grants paired with staged disbursements and early-warning rules that trigger light-touch restructuring and technical assistance. Implementation risk, including low TA uptake or “checkbox” compliance, is reduced by integrating TA milestones into loan covenants,

co-designing sector-specific playbooks with industry associations, and aligning disbursements to outcomes rather than activity counts. Policy and regulatory risk such as delays in net-metering, equipment certification, or customs clearance is contained through MOUs with agencies, time-bound service-level agreements, and public dashboards that surface bottlenecks and accountability.

Scalability follows a practical roadmap. Phase one pilots the full stack (eligibility scoring, gender-responsive credit, TA, and incentives) in two to three priority sectors with high emissions abatement or adaptation potential (e.g., food processing, retail cold chain, light manufacturing). Phase two expands geographically via partner banks and cooperatives using a “reference architecture” and open indicator dictionary to keep interoperability intact; a shared data warehouse with tenant-level isolation ensures each lender benefits from common tooling without losing competitive confidentiality. Phase three institutionalizes model risk management with periodic back-testing, feature drift monitoring, and fairness audits, then introduces performance securitization or green SME bonds to recycle capital at scale. Throughout, a marketplace of verified vendors and certified service providers grows around the program so adoption costs fall and procurement becomes turnkey.

Policy recommendations mainstream the model beyond pilots. Regulators should formalize alternative collateral regimes (e.g., movable asset registries and receivables financing) and permit tiered KYC for low-risk MSME products to reduce onboarding friction. Central banks and ministries of finance can issue guidance that recognizes sustainability-linked MSME lending as a priority sector, enabling capital relief, guarantee top-ups, or refinancing windows tied to verified outcomes. Standards bodies should adopt simplified sectoral benchmarks and pragmatic measurement protocols so micro and small firms can credibly report progress without prohibitive costs; accreditation pathways for auditors, TA providers, and IoT vendors will stabilize quality. Public procurement can create durable demand by awarding scoring advantages to suppliers with verified sustainability performance, with special carve-outs that ensure women-owned MSMEs can qualify with proportionate documentation. Donors and DFIs should shift from fragmented grants to programmatic results-based instruments that co-finance guarantees, TA, and data infrastructure on a multi-year horizon, contingent on transparent KPIs and open-data commitments. Finally, consumer protection and data privacy rules must enshrine informed consent, portability, and redress so enterprises retain agency over their data while participating in outcome-based finance.

Taken together, these measures enable a finance-operations-learning flywheel: better data underpins cheaper and smarter capital; cheaper and smarter capital accelerates adoption of green practices; verified outcomes unlock market access and policy support; and the resulting growth compounds inclusion and resilience. With disciplined governance and continuous improvement, the model can move from promising pilot to national and regional scale, making sustainable finance the default pathway for women-owned and small enterprises.

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