

Institutional voids and entrepreneurial generational dynamics in Tunisian corporate sustainability: Multi-method SEM test and comparative analysis (France–Germany–Morocco–UAE), MENA perspective

Mohamed Farhoud

Higher Institute of Management of Tunis – University of Tunis, Department of Management, Human Resources, and Law, Tunisia.
Email: farhoudmohamed@yahoo.fr

ABSTRACT

This article examines the sustainable transition of Tunisian firms in a context of pronounced institutional voids—fragmented regulatory frameworks, limited tax incentives, and restricted access to green finance—and contrasting generational dynamics. We employ a mixed-methods design comprising a firm survey (N = 120, March–June 2024) tested with exploratory factor analysis (EFA) and structural equation modeling (SEM) to assess hypotheses H1–H7, 25 semi-structured interviews, and a parallel module of sustainable entrepreneurs (N = 120). Findings reveal a persistent awareness–action gap: 70% of executives deem sustainability strategic, yet effective adoption remains limited (18% in prior literature; 22% in our sample), concentrated on “quick wins” such as waste reduction and energy efficiency, while eco design, system-level circularity, and structured reporting remain marginal. EFA uncovers three latent dimensions—institutional readiness, generational agility, and transition speed. SEM shows that external barriers depress adoption more than internal constraints, that external and internal levers foster adoption, and that generational dynamics contribute positively; absorptive capacity mediates the effect of external levers, while policy coherence, export orientation, and family ownership intensity moderate these relationships. Adoption improves triple bottom line (TBL) performance. A comparison with Morocco, France, and Germany, complemented by evidence from the United Arab Emirates, highlights shortfalls in green finance and standardization, yet identifies transferable levers including public–private partnerships (PPPs), proportionate implementation of the European Sustainability Reporting Standards (ESRS), and national labels. We recommend establishing a one stop shop for green finance, predictable tax incentives, intergenerational mentoring, capability building, and robust monitoring and evaluation systems (waste/CO₂/energy indicators, sectoral barometers). Despite limitations—cross-sectional design, self-reported data, and an overrepresentation of exporters—the results show that innovation driven by young entrepreneurs, combined with targeted institutional reforms, can transform structural constraints into competitiveness opportunities and accelerate a green and inclusive growth trajectory in Tunisia.



© 2025 The authors. This is an open access article under the Creative Commons Attribution 4.0 International (CC BY 4.0) License.

Keywords:

Sustainable transition, Institutional voids, Generational dynamics, Circular economy, Green finance, Policy mix, Comparative analysis France–Germany–Morocco–UAE, MENA perspective, Tunisia

Article History:

Received: 11 Sep 2025

Accepted: 25 Nov 2025

Available Online: 05 Dec 2025

1. INTRODUCTION

Globally, the shift toward sustainable business models has become a strategic priority in response to environmental degradation, rising societal expectations, and governance demands, with the 2030 Agenda and its SDGs providing a shared framework (UNDP, 2015). This transition requires coordinated mobilization of firms, public authorities, financial institutions, and civil society, and relies on technological and managerial innovations adapted to local realities. Theoretically, sustainable entrepreneurship is rooted in the triple bottom line (TBL) (Elkington, 1997) and shared value (Porter & Kramer, 2011), while the integration of ESG criteria strengthens competitiveness and resilience (OECD, 2024; Schrage et al., 2021; Bhandari et al., 2022). A “just transition” underscores the inclusion of workers in traditional sectors, youth, women, and rural areas (Sachs, 2015; ILO, 2023). The circular economy reconfigures value chains around reuse and recycling (Ellen MacArthur Foundation, 2024). Acceleration also depends on incentive-based public policies, public–private partnerships, the integration of sustainability into education and research, and innovative financial instruments such as green bonds, impact funds, and green microfinance (World Bank, 2024). Finally, evolving consumer preferences and the rise of Generations Y and Z are major levers for adoption (WEF, 2023; AfDB, 2024).

In emerging economies—and in Tunisia in particular—the adoption of sustainable practices remains uneven and often marginal. Although 70% of firms recognize the strategic relevance of sustainability, only 18% effectively integrate it (Azaiez et al., 2020). This gap is explained by “institutional voids”—institutional fragility, fragmented regulatory frameworks, weak enforcement, incoherent public policies, limited access

to green finance, and inadequate infrastructure (El Kassar & Singh, 2019; OECD, 2021; Agrawal et al., 2024)—as well as by post-2011 sociopolitical dynamics marked by exclusive social pacts that have at times curtailed firms’ investment capacity (Heydemann, 2020). The predominance of family businesses, cautious about perceived costs and short-term uncertainty, also slows adoption (Azaiez et al., 2020; Parada et al., 2020). Nevertheless, pioneering initiatives are emerging, often led by start-ups and young entrepreneurs in the circular economy and fintech, demonstrating the compatibility of profitability and responsibility (Caldarola et al., 2024; Halkos, 2023).

The literature on sustainable transitions in developing countries—and specifically in MENA—remains fragmented, particularly regarding the joint articulation of institutional constraints and generational dynamics. This study addresses that gap through a locally anchored analysis—a survey of 120 firms and 25 semi-structured interviews—combined with an international comparative perspective (France, Germany, Morocco, with additional contrastive elements from the UAE) to identify strategic and institutional levers for accelerating the transition to a green and inclusive economy (Touratier Muller & Ortas, 2021). The central question is: in an environment marked by institutional voids and financial constraints, how can Tunisian firms overcome structural, institutional, and cultural obstacles to accelerate their transition while ensuring social inclusion and competitiveness? We propose seven hypotheses: H1, external institutional barriers hinder the transition more than internal constraints; H2, adoption is associated with improved access to green finance instruments; H3, stakeholder awareness is positively correlated with the integration of sustainable practices; H4, young entrepreneurs and start-ups are more likely to adopt than leaders of traditional family firms; H5, absorptive

capacity mediates the effect of external levers on adoption (EL → IL → AD); H6, policy coherence and export orientation moderate SB→AD and EL→AD; H7, adoption improves TBL performance. Empirically, we employ a mixed-methods approach combining a firm survey (N = 120) tested via SEM for H1–H7, a parallel module of sustainable entrepreneurs (N = 120) focused on generational dynamics, 25 semi-structured interviews, and an international comparison (France, Germany, Morocco; elements relating to the UAE) to assess transposability (Sakhraoui et al., 2024).

The article is structured as follows: theoretical framework and literature review; methodology; results on the main institutional, financial, cultural, and innovation-related obstacles and levers, as well as public policies, financial instruments, and generational dynamics; comparative discussion of French, German, and Moroccan experiences, complemented by elements on the UAE; and operational recommendations and a conclusion on pathways to an effective and inclusive transition in Tunisia and, more broadly, in MENA.

2. LITERATURE REVIEW

Corporate sustainability has emerged as a strategic paradigm for value creation and resilience (Dyllick & Muff, 2016; Baumgartner & Rauter, 2017), rooted in the Triple Bottom Line (Elkington, 1997) and updated by the SDGs (UNDP, 2015). Sustainable business models rely on technological, organizational, and social innovation (Bocken & Short, 2016; Geissdoerfer et al., 2018), as well as on governance mechanisms integrating ESG, leadership, and employee engagement (Aguinis & Glavas, 2019; Kiron et al., 2017; Schrage et al., 2021; Ranta et al., 2018; Bhandari et al., 2022). In emerging economies, the transition is complicated by “institutional voids”—fragmented regulation, weak enforcement, limited incentives—and by restricted access to green finance (Sinkovics et al., 2014; El Kassar & Singh, 2019; Singh et al., 2020; OECD, 2021; Agrawal et al., 2024). In Tunisia, only 8% of financial assets are reportedly allocated to green projects versus 19% in the UAE (OECD, 2021), alongside fragmented policies across agencies (Agrawal et al., 2024). Generational dynamics and the economy’s family firm structure shape these trajectories: youth led start ups advance circular solutions, AI for energy efficiency, and the functional economy (leasing, maintenance), yet face conservative industry structures and scarce capital (Azaiez et al., 2020; Halkos, 2023; Caldarola et al., 2024; Bocken & Short, 2016). At the MENA scale, adoption progresses heterogeneously: Morocco shows advances (24% vs 18% in Tunisia), while the UAE illustrates a top down approach and more complete green finance infrastructure (OECD, 2021; Benalcázar et al., 2025). Comparisons with Germany and Sweden underscore the role of standards, technological ecosystems, and green taxation in scaling circular models (Geissdoerfer et al., 2018). The multi level perspective (MLP) highlights co evolution between firms and institutional, technological, and cultural environments, and the need for alignment among innovation niches, sectoral regimes, and socio political landscapes (Geels, 2020; Jamali & Karam, 2018). Recent work confirms the urgency and complexity of sustainable transitions in emerging economies (Caldarola et al., 2024; Halkos, 2023; Akinyele et al., 2025; Saif Alyousfi & Alshammari, 2025) and shows that gains in reputation, loyalty, and financial performance materialize when integration is strategic and coherent (Schrage et al., 2021; Bhandari et al., 2022). In Tunisia, the awareness–implementation gap persists due to institutional and financial barriers and uneven societal demand, despite positive signals linked to younger generations, international standards (ESRS), and multilateral green finance opportunities (World Bank; EIB; OECD, 2024; Touratier Muller & Ortas, 2021).

2.1 Prior Contributions

The literature has established the paradigms and integrative frameworks of TBL and sustainable business models (Elkington, 1997; Dyllick & Muff, 2016; Bocken & Short, 2016; Geissdoerfer et al., 2018) and identified internal mechanisms linking ESG to performance—leadership, culture, innovation (Aguinis & Glavas, 2019; Kiron et al., 2017; Schrage et al., 2021; Bhandari et al., 2022). Institutionally, voids typical of emerging contexts hinder adoption and call for inter agency coordination and targeted incentives (Sinkovics et al., 2014; El Kassar & Singh, 2019; Singh et al., 2020; OECD, 2021; Agrawal et al., 2024). Generational dynamics complement this picture: young entrepreneurs and start ups accelerate circular and digital innovation but face family firm dominance and funding scarcity (Azaiez et al., 2020; Halkos, 2023; Caldarola et al., 2024). Ecosystem approaches and the MLP clarify alignments among niches/regimes/policies, while MENA–EU comparisons underscore the structuring role of standards and green finance (Geels, 2020; Jamali & Karam, 2018; Touratier Muller & Ortas, 2021; OECD, 2021; Benalcázar et al., 2025). Table 1 synthesizes these contributions and their key messages for Tunisia.

Table 1. Synthesis of Major Contributions in the Literature

Domain	Key contributions	References	Message → Tunisia
TBL paradigms and sustainable models	Eco–social–environmental integration; circular business models	Elkington (1997); Dyllick & Muff (2016); Bocken & Short (2016); Geissdoerfer et al. (2018)	Target framework for adoption and evaluation
Internal mechanisms	Leadership, culture, innovation; ESG → performance	Aguinis & Glavas (2019); Schrage et al. (2021); Ranta et al. (2018)	Prioritize dynamic capabilities and skills
Institutional voids	Blurry rules, weak enforcement, low incentives	Sinkovics et al. (2014); El Kassar & Singh (2019); Singh et al. (2020); OECD (2021)	Need for coherence and incentives
MENA/ Tunisia	Fragmented policies; 8% green assets	Ben Jemia & Hammami (2023); OECD (2021)	Reform coordination and green finance
Generational/ start-ups	Youth start-ups as engines; family-firm headwinds	Azaiez et al. (2020); Halkos (2023); Caldarola et al. (2024)	Support ecosystem and patient capital
Standards/ finance	ESRS, EIB/World Bank, PPPs accelerate adoption	Touratier Muller & Ortas (2021); Benalcázar et al. (2025); OECD (2024)	Align reporting and capture funding
Comparisons	Morocco 24% vs Tunisia 18%; UAE top-down	OECD (2021); Benalcázar et al. (2025)	Learn from regional peers
Updates	Urgency and complexity in emerging contexts	Akinyele et al. (2025); Saif Alyousfi & Alshammari (2025)	Strengthen evidence and measurement

2.2 Research Gaps

Micro level mechanisms of adoption remain under specified in low regulation contexts such as Tunisia; the joint articulation of institutional voids and generational/family lenses as moderators is insufficiently integrated, limiting understanding of their combined effects. Methodologically, measures are fragmented for capturing interactions among internal/external levers and barriers; dynamic models with measurable feedback loops are rare; and the transposability of international standards (ESRS) and green finance instruments to Tunisian SMEs is under tooled. Empirical evidence on the functional economy and circular models by Tunisian sector is limited, constraining contextualized operational recommendations. This calls for work combining dynamic modeling and fine grained sectoral surveys.

2.3 Theoretical Contribution of this Research

We integrate generational dynamics and institutional voids within a single framework to explain firm level sustainable transition in Tunisia. The model is adaptive and cyclical, capturing organization–environment co evolution: institutional constraints and external resources shape adoption trajectories, while internal choices and performance reconfigure conditions of action.

It finely links micro level adoption to meso/macro regulations and markets, explicitly positioning young entrepreneurs and family firms. At its core, mediating mechanisms—absorptive capacity and dynamic capabilities—convert external levers (green finance, standards, partnerships) into adoption through the activation of internal levers (leadership, culture, innovation, circular skills). Contextual moderators—policy coherence and institutional quality, family ownership intensity, export orientation, stakeholder pressure—condition these effects. Feedback loops connect sustainable performance, organizational legitimacy, access to finance, and the progressive reduction of barriers, describing cumulative improvement.

The contribution is operationalizable, with indicators and testable hypotheses, enabling empirical validation on Tunisian firm data and regional comparisons. Figure 1 presents the theoretical model; Figure 2 depicts the feedback loops; Table 2 summarizes the hypotheses.

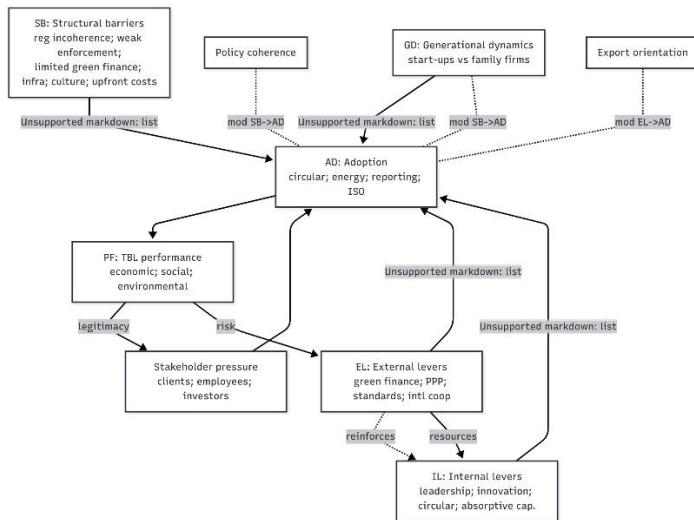


Figure 1. Theoretical Model of the Sustainable Transition of Tunisian firms

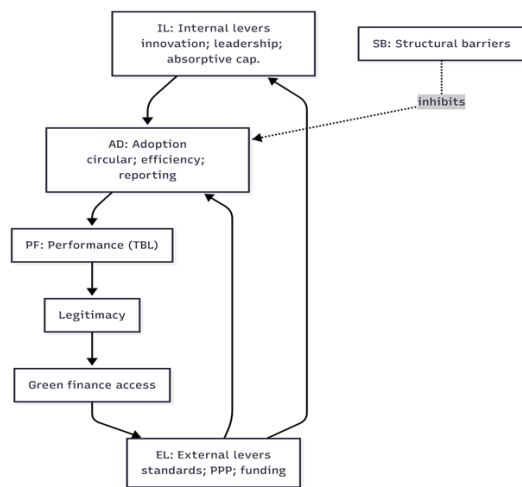


Figure 2. Feedback Loops

Table 2. Hypotheses/Propositions and Expected Signs

Code	Formulation	Expected sign
H1	Structural barriers reduce the adoption of sustainable practices (SB → AD)	–
H2	External levers increase adoption (EL → AD)	+
H3	Internal levers increase adoption (IL → AD)	+
H4	Young leaders/start-ups adopt more than family firms (GD → AD)	+
H5	Absorptive capacity mediates the effect of external levers on adoption (EL → IL → AD)	Mediation +
H6a	Policy coherence attenuates the negative effect of barriers (PC moderates SB → AD)	Attenuation
H6b	Export orientation strengthens the effect of external levers (EXP moderates EL → AD)	Reinforcement
H6c	Family ownership intensity strengthens the negative effect of barriers (Family moderates SB → AD)	Reinforcement
H7	Adoption improves TBL performance (AD → PF)	–

2.4 Theoretical Positioning and Originality

We combine four theoretical traditions to propose an integrated explanatory framework for sustainable transitions under institutional voids. First, institutional theory (North; Scott) clarifies how formal and informal “rules of the game” structure organizational behavior; in emerging economies, weak regulative, normative, and cognitive pillars manifest as voids—fragmented regulation, uneven enforcement, limited

incentives—that raise transaction costs and hinder adoption (H1). Second, the dynamic capabilities approach (Teece) conceptualizes internal levers (IL) as sensing–seizing–reconfiguring routines through which firms transform external resources (EL: green finance, standards, PPPs) into adoption (AD) and performance (PF) (H2–H3–H5–H7). Third, the stakeholder pressure/institutional logics angle formalizes coercive, normative, and mimetic pressures (export customers, donors, sectoral peers) that create alignment imperatives, particularly when transnational norms (ESRS/GRI) diffuse via value chains. Fourth, diffusion/contagion network theories explain the “hub effect” (clusters, centers of excellence, techno-parks) that accelerates practice propagation through learning and structured imitation. The originality lies in explicitly integrating generational dynamics as a “front of the field” mechanism that modulates the weight of voids: at the micro level, young leaders and start-ups mobilize digital agility, institutional bricolage, alternative finance, and open collaboration, attenuating frictions and converting EL into AD more effectively (H4–H5); at the meso level, their anchoring in innovation networks strengthens contagion and imitation; at the macro level, the coherence of the policy mix conditions amplification. This coupling—“institutional voids × generational dynamics × dynamic capabilities × networks”—offers a processual reading: under stakeholder pressure, firms sense opportunities (norms/finance), seize them via pilots/labels, then reconfigure routines (reporting, eco design, responsible sourcing) toward higher performing equilibria (PF). We also specify the “how” and “when” boundary conditions of generational moderation: GD’s moderating effect is stronger when policy coherence is medium/high (H6a), export orientation is strong (H6b), family ownership is moderate (H6c), firms are embedded in hubs/clusters, and sectoral technology is modular; by contrast, highly concentrated family ownership, weak export pressure, and network isolation weaken the buffering effect, while mediation through IL operates primarily via EL → IL and IL → AD. Three contributions follow: (1) theoretical, integrating institutional voids and dynamic capabilities with generational moderation and network amplification—an “institutional capabilities network view” for transitions in emerging contexts; (2) mechanisms, specifying a testable causal chain—stakeholder pressures → EL → IL → AD → PF—moderated by GD and contextual conditions; (3) transferability, showing that transposing policy mixes (national labels, hubs/centers of excellence, guaranteed green credit lines, proportionate ESRS) is effective only when these conditions hold, explaining cross case variability (France/Germany/Morocco/MENA) and delineating levers in Tunisia.

3. METHODOLOGY

This study employs a convergent mixed-methods design (Creswell, 2014) combining a two-pronged quantitative pillar—a firm survey (N = 120) with hypotheses H1–H7 tested via structural equation modeling (SEM) and a parallel module of sustainable entrepreneurs (N = 120) focused on generational dynamics—25 semi-structured interviews with executives and stakeholders, and an international comparative analysis (France, Germany, Morocco; MENA perspective). This design tests and contextualizes the theoretical model linking structural barriers, internal/external levers, generational dynamics, adoption, and triple bottom line (TBL) performance, with contextual moderators (policy coherence, export orientation, family ownership intensity, stakeholder pressure). Figure 3 summarizes the design and triangulation.

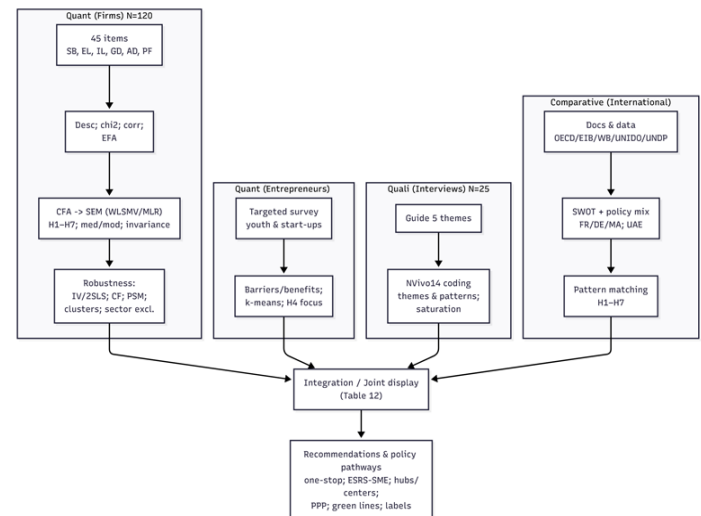


Figure 3. Mixed-Methods Design and Triangulation

3.1 Quantitative Survey

3.1.1 Firm Survey (N = 120)

We conducted a stratified random survey (sector $\times$ size) between March and June 2024, including firms with >10 employees and >5 years of operation. Six transition relevant sectors are covered (Table 3): renewable energy, sustainable agriculture, recycling/waste management, social entrepreneurship, green services, and sustainable tourism.

Table 3. Sectoral Distribution (Firm Sample, N = 120)

Sector	Number	%
Renewable energy	32	26.7
Sustainable agriculture	28	23.3
Recycling / waste management	20	16.7
Social entrepreneurship	18	15.0
Green services (consulting, tech)	14	11.7
Sustainable tourism	8	6.6
Total	120	100

The instrument comprises 45 Likert type items (1–5) (Sinkovics et al., 2014; Kiron et al., 2017; Geissdoerfer et al., 2018) covering: (i) institutional/structural barriers; (ii) internal levers (pro ESG leadership, innovation, functional economy); (iii) external levers (green finance, PPPs, ESRS); (iv) generational dynamics (top management age, family ownership, succession); (v) adoption (circularity, energy efficiency, reporting); (vi) TBL performance. A pretest with 10 firms was conducted; common method variance was mitigated ex ante and tested ex post (Harman's single factor test). Missing values (<5%) were treated via parsimonious imputation. Reliability and convergent/discriminant validity indices are reported in the Appendix M (Measures; Tables M2–M5), and the full 45-item instrument is provided in Appendix Q (Research Questionnaire).

3.1.2 Parallel Module—Sustainable Entrepreneurs (N = 120, independent sample)

To capture generational dynamics, an independent module surveyed 120 project holders and young sustainable ventures across Greater Tunis, Center, South, and Northwest. The sociodemographic profile reflects entrepreneurial renewal ($\approx 40\%$ women; over half under 35). Quantitative syntheses of barriers, benefits, and innovation profiles are reported in Section 3.2.

3.1.3 Measures and Data

Beyond self reports, we integrated objective indicators: ISO certifications (14001/50001), energy consumption documentation (quarterly bills/statements), ESG/GRI/ESRS labels/reports, and export buyers' environmental clauses; a voluntary subsample underwent document checks ($\pm 10\%$ tolerance). These indicators served to validate AD and PF constructs and to run robustness analyses (weighted estimates; specifications restricted to "documented" firms). The sampling frame triangulated INS, APII, CEPEX, UTICA, and sector federations, excluding inactive entities and micro firms (<10 employees). Contacts were made via email/phone with three scheduled follow ups. Nonresponse bias was assessed using Armstrong & Overton tests: early vs. late respondents on SB, EL, IL, AD, PF (no significant differences, $p > 0.10$ after multiplicity correction) and a brief phone survey of nonrespondents (standardized mean gaps < 0.10), suggesting stratum conditional randomness. Post stratification weighting (raking) aligned sector $\times$ size $\times$ region margins to official benchmarks, with bounded weights (0.6–1.8). On the qualitative side (Section 2.2), interviews were systematically triangulated with documents (CSR reports, labels, financing agreements, energy audits, tenders) to anchor key quotes. Data quality/protection included an audit trail, 1% winsorization of outliers when justified, parsimonious imputation (<5%; within scale means or FIML for SEM), complete variable dictionaries (reverse coded items, composite construction), and secure pseudonymized archiving.

3.2 Qualitative Inquiry: 25 Semi Structured Interviews

We conducted 25 interviews (April–July 2024) with eight CEOs/executives, six CSR managers, three public advisers, three NGO representatives, and five ecosystem experts/actors. Sessions lasted 60 minutes (in person/virtual), were recorded and fully transcribed with consent, and followed strict anonymity/confidentiality.

The guide covered five axes: perceptions of sustainability; strategies and practices (circular economy, energy efficiency, reporting); internal/external constraints; stakeholder roles; and forward looking perspectives.

Analysis used inductive thematic coding (NVivo 14), analyst triangulation, and thematic saturation. Detailed qualitative results and a sectoral diffusion schema are presented in Section 3.3 (Figure 5).

3.3 International Comparative Analysis (SWOT)

We conducted a SWOT based comparative analysis to situate Tunisia against regional/international referents and identify transferable practices. The corpus included national strategies/decrees, policy evaluation reports, peer reviewed publications, and reports from international organizations (OECD, UNIDO, UNDP). Documents, selected for sectoral relevance and timeliness, were coded along the four SWOT dimensions. Results are discussed in Section 3.4.

3.4 Construct Operationalization, Analysis Plan, and Limitations

Operationalization relies on latent constructs capturing firm level determinants and outcomes of the sustainable transition: structural barriers (SB), external levers (EL), internal levers (IL, including absorptive and dynamic capabilities), generational dynamics (GD), adoption (AD), and TBL performance (PF). Moderators capture context effects: policy coherence, export orientation, family ownership intensity, and stakeholder pressure. Table 4 summarizes constructs and indicative measures.

Table 4. Operationalization of Constructs

Construct	Possible indicators/measures	Indicative sources
Structural barriers (SB)	Regulatory incoherence index; authorization lead times; sector green-asset share; perceived enforcement; upfront costs of green investments	OECD (2021); Ben Jemia & Hammami (2023)
External levers (EL)	Amount/access to green credit lines (WB/EIB); PPP presence; ESRS readiness/compliance; international partnerships	World Bank/EIB; ESRS
Internal levers (IL)	Leadership orientation (Likert); green R&D/skills investment; certifications (ISO 14001); functional economy (% revenue in services); absorptive capacity (R&D, training)	Baumgartner & Rauter (2017); Bocken & Short (2016)
Generational dynamics (GD)	Top management age; family ownership (%); presence of a sustainability officer; density of sustainable start-ups	Azaiez et al. (2020); World Bank (2024)
Adoption (AD)	Rate of circular initiatives; waste/energy reductions; reporting coverage; ESRS/GRI compliance	Bhandari et al. (2022)
TBL performance (PF)	Adjusted margin/ROA; CO ₂ per unit; energy intensity; green jobs/inclusion	Schrage et al. (2021); Geissdoerfer et al. (2018)
Moderators	Policy coherence (index); export orientation (% exports); stakeholder pressure (surveys)	OECD (2021); Jamali & Karam (2018)

Analytical plan. Beyond EFA, H1–H7 are tested via hierarchical regressions and, optionally, PLS SEM (mediations/moderations). Controls include firm size, sector, and age; we report multicollinearity diagnostics and sensitivity checks (subsamples). Figure 4 (factor structure of practices) is part of the results and appears in Section 3.2.

3.5 Ethics, Quality, and Limitations

We followed strict ethical principles. Informed consent was obtained; participants were briefed on objectives, participation modalities, rights (anonymity, withdrawal without cause, data access/amendment), and research use. Quantitative and qualitative data (including verbatim excerpts) were anonymized upon transcription and pseudonymized for analysis; identifying information was removed or aggregated. Scientific quality and bias mitigation were pursued throughout: triangulation (survey, interviews, documentary analysis), instrument pretest, common method variance reduction and Harman's test, audit trail, and targeted member checking. Limitations include self-reported data (social desirability risk), sectoral heterogeneity (reduced cross-firm comparability), and a cross-sectional design (limited causal inference). We mitigated these via triangulation, dedicated subsamples (e.g., start-ups vs. family firms; SMEs vs. large firms), and robustness analyses. Longitudinal extensions (panels or repeated waves) and further confirmatory SEM (CFA/structural) would strengthen external validity and refine mechanism identification.

4. RESULTS AND DISCUSSION

Consistent with the Abstract and Introduction, the findings confirm a persistent gap between high levels of awareness and still partial, fragmented implementation. The diffusion of practices appears to be driven more by exogenous pressures (international supply chains, donors) than by domestic incentives (Kittinun, 2024; OECD, 2021). Institutional obstacles—constrained access to green finance, regulatory ambiguity, and limited tax incentives—weigh particularly on SMEs and young firms, whereas pioneers, often start-ups led by younger leaders, exhibit more

dynamic adoption trajectories, in line with the theoretical framework linking institutional voids, internal/external levers, and generational dynamics.

4.1 Contribution to the Literature

This study enriches the MENA corpus by articulating at the firm (micro) level the interplay between institutional voids and a generational lens. It shows, first, how regulatory and financial gaps hinder adoption (Sinkovics et al., 2014) while also catalyzing creative circumventions—crowdfunding, international cooperation, adherence to ESRS—especially among young entrepreneurs; second, it revisits the triple bottom line (TBL) in a context where the economic dimension remains predominant and the social and environmental dimensions are unevenly integrated, supporting a contextualized TBL in emerging economies.

It also uncovers an intergenerational/sectoral “infection” mechanism whereby innovations seeded in urban hubs and start-ups diffuse to established firms (Hahn et al., 2016), and it positions Tunisia within a comparative perspective (Morocco/EU), clarifying the conditions under which instruments—labels, PPPs, reporting, and green finance—are transferable.

4.2 Quantitative Results

Among 120 firms, 38% report having a CSR/sustainability policy; 22% of those publish a sustainability report (8% of the full sample).

Most prevalent practices are “quick wins”: waste reduction (31%, average reduction 15%) and energy efficiency (25%, with 12% of the full sample reporting 10–20% emissions cuts); 22% have adopted energy sobriety technologies with an average 8% reduction in consumption.

Structuring practices remain marginal—eco design (12%) and formal stakeholder engagement (14%)—reflecting high entry costs and limited institutional support (Opferkuch et al., 2022; Hanna et al., 2023) (Table 5).

Table 5. Sustainability Practices: Adoption Frequency and Perceived Impact

Practice	Adoption (% Firms)	Perceived impact (summary)
Waste reduction	31	Operational gains; compliance with export clients
Energy efficiency	25	Cost/emissions reduction (10–20% for 12% of full sample)
Energy-sobriety technologies	22	–8% average consumption (self-reported)
Eco-design	12	Long-term advantage; low diffusion due to limited support
Stakeholder engagement	14	Reputation; alignment with donors/clients
Sustainability reporting	8 (full sample)	Targeted transparency (buyers/clients)

Inter-dimension correlations confirm complementarities across sustainability pillars: governance–environment $r = 0.45$, governance–social $r = 0.32$, environment–social $r = 0.61$.

EFA identifies three latent factors—Institutional readiness (34%), Generational agility (28%), and Transition speed (16%)—explaining 78% of variance (supporting H1 and H4).

A k-means typology distinguishes Innovators (20%), Followers (majority), and Traditionals, each with distinct support needs (finance, skills, normative alignment).

4.2.1 Measurement Model Validation (CFA)

We estimate a CFA with WLSMV on polychoric correlations (MLR robustness estimates are similar) for six reflective constructs (SB, EL, IL, GD, AD, PF).

All standardized loadings are significant ($p < 0.001$) and mostly > 0.60 ; no cross-loading > 0.40 after dropping any weak items.

The six-factor model fits well and outperforms 1–3 factor alternatives (Table M1).

Internal reliability is high ($\alpha, \omega \geq 0.80$) and convergent validity is established ($CR \geq 0.70$; $AVE \geq 0.50$; Table M2).

Discriminant validity is confirmed (Fornell–Larcker, Table M3, Appendix M; HTMT < 0.85 , Table M4, Appendix M).

Figure 4 (EFA structure) is consistent with the CFA and the three dominant factors.

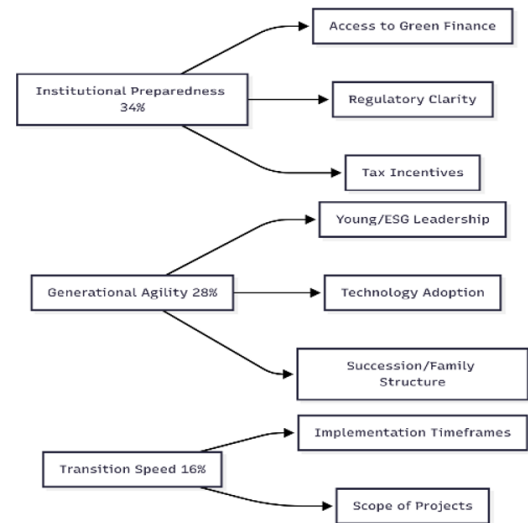


Figure 4. Factor Structure (EFA) of Sustainability Practices

Table M1. Comparative Fit of Measurement Models (CFA)

Model	χ^2 (df)	χ^2/df	CFI	TLI	RMSEA [90% CI]	SRMR
6 factors (SB, EL, IL, GD, AD, PF)	1426.3 (663)	2.15	0.953	0.947	0.051 [0.047–0.055]	0.046
3 factors (Institutions; Capabilities; Outcomes)	2441.8 (681)	3.59	0.837	0.824	0.073 [0.069–0.077]	0.085
1 factor (common method)	5178.9 (690)	7.50	0.616	0.589	0.121 [0.118–0.124]	0.131

Table M2. Reliability and Convergent Validity

Construct	Items (kept)	Loadings (min–max)	α	Ω	CR	AVE
SB	7	0.70–0.86	0.87	0.88	0.89	0.55
EL	6	0.71–0.88	0.86	0.87	0.89	0.56
IL	8	0.66–0.89	0.90	0.91	0.92	0.59
GD	5	0.63–0.82	0.80	0.81	0.84	0.51
AD	9	0.68–0.86	0.92	0.93	0.93	0.58
PF	6	0.67–0.85	0.88	0.89	0.90	0.57

4.2.1.1 Multi Group Invariance Tests

To ensure comparability of constructs, we test configural, metric, and scalar invariance across (i) start ups/young leaders vs. family firms and (ii) SMEs vs. large firms, using nested model comparisons ($\Delta CFI \leq 0.01$; $\Delta RMSEA \leq 0.015$). Scalar invariance holds in both cases, allowing comparisons of latent means and structural relations (see Tables M5a–M5b, Appendix M).

4.2.2 Structural Model and Hypothesis Tests (SEM)

We estimate a structural model via covariance based SEM (MLR, robust SEs), complemented by PLS SEM for prediction. Global fit is satisfactory (MLR: $\chi^2(689) = 1514.8$; $\chi^2/df = 2.20$; CFI = 0.949; TLI = 0.943; RMSEA = 0.052 [0.048–0.056]; SRMR = 0.057). Results (Table S1) confirm H1–H4 and H7: SB $\rightarrow$ AD $\beta = -0.27$ (SE 0.08; $p = 0.001$; 95% CI [–0.43; –0.11]); EL $\rightarrow$ AD $\beta = +0.29$ (0.07; $p < 0.001$; [0.15; 0.43]); IL $\rightarrow$ AD $\beta = +0.31$ (0.06; $p < 0.001$; [0.19; 0.43]); GD $\rightarrow$ AD $\beta = +0.14$ (0.05; $p = 0.012$; [0.04; 0.24]); AD $\rightarrow$ PF $\beta = +0.39$ (0.07; $p < 0.001$; [0.25; 0.53]). EL $\rightarrow$ IL is significant ($\beta = +0.43$; SE 0.06; $p < 0.001$; [0.31; 0.55]), supporting H5 with an indirect effect EL $\rightarrow$ IL $\rightarrow$ AD = +0.13 (bootstrap 5,000; 95% CI [0.07; 0.21]; $p = 0.001$), consistent with partial mediation. Moderation effects support H6 (Table S3, Appendix R): SB $\times$ PC $\rightarrow$ AD $\beta = +0.08$ (95% CI [0.01; 0.15]; $p = 0.028$); EL $\times$ Export $\rightarrow$ AD $\beta = +0.09$ ([0.02; 0.16]; $p = 0.013$); SB $\times$ Family $\rightarrow$ AD $\beta = -0.11$ ([–0.19; –0.03]; $p = 0.009$). Explained variances are substantial: $R^2(AD) = 0.56$; $R^2(PF) = 0.37$. For prediction and robustness, PLS SEM (5,000 bootstraps; orthogonalized interactions) confirms signs and magnitudes: f^2 on AD—SB 0.07; EL 0.12; IL 0.14; GD 0.03; interactions 0.02–0.03; on PF, AD $f^2 = 0.23$; PLSpredict $Q^2(AD) = 0.33$; $Q^2(PF) = 0.22$; SRMR PLS = 0.058. PLS MGA shows no major structural differences post invariance, aside from a slightly stronger GD $\rightarrow$ AD among start ups ($\Delta\beta \approx +0.06$; $p \approx 0.09$, trend).

Table S1. Structural Model Results (Direct Effects, CB-SEM MLR)

Relation	β (std)	SE	p	95% CI
SB $\rightarrow$ AD (H1, -)	-0.27	0.08	0.001	[-0.43; -0.11]
EL $\rightarrow$ AD (H2, +)	+0.29	0.07	<0.001	[0.15; 0.43]
IL $\rightarrow$ AD (H3, +)	+0.31	0.06	<0.001	[0.19; 0.43]
GD $\rightarrow$ AD (H4, +)	+0.14	0.05	0.012	[0.04; 0.24]
AD $\rightarrow$ PF (H7, +)	+0.39	0.07	<0.001	[0.25; 0.53]
EL $\rightarrow$ IL	+0.43	0.06	<0.001	[0.31; 0.55]

The main barriers reported by established firms are in Table 6.

Table 6. Barriers to Adoption in Firms

Barrier	% of firms
Limited access to green finance	45
Lack of internal skills	40
Resistance to change	35
Constraints/unclear regulations	25

To capture generational dynamics, the parallel “sustainable entrepreneurs” module (N = 120) summarizes constraints and benefits in Tables 7 and 8.

Table 7. Barriers (Sustainable Entrepreneurs, N = 120)

Barrier	%
Access to finance	68.3
Administrative delays	57.5
Lack of specific skills	41.7
Weak public support	38.3
Difficult market access	35.8
Insufficient tax incentives	27.5

Table 8. Perceived Benefits and Innovation Profiles (Entrepreneurs)

Domain	Indicator	%
Perceived benefits	Social value	73.3
	Image/reputation	62.5
	New markets	59.2
	Business longevity	54.2
	Long-term cost reduction	46.7
Innovation	Digitalization	51.7
	Green technologies	48.3
	AI/IoT	22.5
	Collaborative platforms	17.5

This barrier profile confirms the salience of institutional and capacity constraints in adoption trajectories, particularly for younger and often under capitalized actors. Despite obstacles, perceived benefits are high and multifaceted: social value (73.3%), improved image (62.5%), access to new markets (59.2%), longevity (54.2%), and long term cost reduction (46.7) (Table 8). Stakeholder priorities appear in Table 9.

Table 9. Stakeholder Strategic Priorities

Priority	% of respondents
Awareness/Training	80
Image/Reputation	65
Renewable energy	60
Advanced innovations (AI/IoT, circularity)	35

Differences between youth-led start-ups and traditional firms are summarized in Table 10.

Table 10. Young Ventures vs. Traditional Firms

Indicator	Traditional firms	Youth-led start-ups
ESG officer in post	9%	68%
Circular economy adoption	12%	41%
Main green-finance channel	14% banks	9% crowdfunding

These gaps confirm H4 (generational effect) and suggest that external levers (alternative finance, standards, PPPs) interact with absorptive capacity (IL) to drive adoption (AD), consistent with the EL $\rightarrow$ IL $\rightarrow$ AD mediation.

4.2.3 Endogeneity and Robustness (IV/2SLS, CF, PSM)

To limit simultaneity and omission biases, we complement SEM with three integrated strategies: instrumental variables/two stage least squares (IV/2SLS), control function (CF), and propensity score matching (PSM). Two threats motivate these designs: (i) simultaneity/bidirectionality between adoption (AD) and access to green finance (a component of external levers, EL), as more engaged firms more easily attract funding; (ii) reciprocity between AD and TBL performance (PF), as more performant firms have greater scope to invest in sustainability. In the adoption equation, EL is treated as potentially endogenous and instrumented using export client pressure (export share

and ESG labeling/reporting requirements from international buyers) and exposure to public green programs (eligibility/participation in subsidized green credit lines; subsidized energy audits); these instruments are relevant and plausibly exogenous conditional on covariates (SB, IL, GD, size, sector, age, region), affecting AD only through access/incentives. In the performance equation, AD is instrumented by the same variables (export pressure; program exposure), controlling for EL, IL, SB, and firm characteristics, to identify AD's effect beyond shared financing or policy shocks. Diagnostics (Table E1, Appendix E) confirm instrument strength (Kleibergen–Paap rk Wald F > 16), exogeneity (non significant Sargan–Hausman), and endogeneity of targeted regressors (significant Durbin–Wu–Hausman). In the control function approach, the first stage residual ($\hat{EL}$ – observed EL) enters the AD equation; its significance ($p < 0.05$) indicates EL endogeneity and validates CF; analogously for AD in the PF equation, the CF residual is significant ($p < 0.05$), confirming bias correction. With PSM, we estimate the average treatment effect of high adoption ($AD \geq 3.5/5$) on PF: the score is modeled on SB, EL, IL, GD, size, sector (dummies), firm age, region, export, and family ownership, then matched 1:3 nearest neighbor with caliper 0.10; balance is achieved (standardized mean gaps < 0.08; variance ratios ≈ 1) and ATT on PF is 0.14 SD (95% CI [0.06; 0.22]), robust to kernel matching. Rosenbaum bounds suggest a substantial hidden bias ($\Gamma \approx 1.6$) would be required to overturn significance. Additional checks confirm robustness: a placebo outcome (supplies expense ratio/sales) is not explained by AD ($\beta = 0.02$; $p = 0.57$); a pseudo random instrument (e.g., CEO's last name initial) has no predictive power ($F < 2$) and leaves inference unchanged; omitted variable sensitivity (Oster) yields $\delta = 1.7$ for AD $\rightarrow$ PF, consistent with robustness to moderate omissions.

4.2.4 Detailed Results (SEM) and Robustness

Estimates converge across frameworks (OLS, CB SEM, IV/2SLS, CF; Table R1): structural barriers reduce adoption (SB $\rightarrow$ AD), external and internal levers increase it (EL/IL $\rightarrow$ AD), generational dynamics are positive (GD $\rightarrow$ AD), and adoption improves TBL performance (AD $\rightarrow$ PF). Magnitudes are stable (OLS vs. CB SEM differences contained; IV/2SLS slightly attenuates AD $\rightarrow$ PF without changing sign or significance). Explained variance remains substantial ($R^2(AD) = 0.56$; $R^2(PF) = 0.37$), and structural fit is satisfactory (Table R2, Appendix R: CFI/TLI = 0.95; RMSEA = 0.05; SRMR = 0.06). Robustness checks confirm results: sectoral exclusions affect coefficients by ± 0.02 (Table R3, Appendix R); clustering SEs by sector/region leaves inference unchanged (Table R4, Appendix R); alternative interaction specifications (centering/orthogonalization) lead to the same conclusions (Table R5, Appendix R). Taken together (R1–R4), H1–H3, H4, and H7 are robust to estimator choice, sectoral composition, and intra cluster correlation, motivating subgroup heterogeneity analysis (3.2.5).

Table R1. Summary of Estimates (OLS, CB-SEM, 2SLS/IV, Control Function)

Relation	OLS β (SE)	CB-SEM β (SE)	2SLS/IV β (SE)	CF β (SE)
SB $\rightarrow$ AD	-0.25 (0.08)	-0.27 (0.08)	-0.24 (0.09)	-0.26 (0.08)
EL $\rightarrow$ AD	+0.28 (0.07)	+0.29 (0.07)	+0.27 (0.08)	+0.28 (0.07)
IL $\rightarrow$ AD	+0.30 (0.06)	+0.31 (0.06)	+0.29 (0.07)	+0.30 (0.06)
GD $\rightarrow$ AD	+0.13 (0.05)	+0.14 (0.05)	+0.12 (0.06)	+0.13 (0.05)
AD $\rightarrow$ PF	+0.41 (0.07)	+0.39 (0.07)	+0.34 (0.09)	+0.37 (0.07)

4.2.5 Multi Group Heterogeneity Analyses

Heterogeneity is analyzed via multi group comparisons along three splits: (i) export oriented vs. non exporting firms, (ii) highly vs. lightly regulated sectors, and (iii) coastal vs. inland regions. With scalar invariance established (3.2.1.1), we compare structural coefficients with equality constraints ($\Delta\chi^2$; ΔCFI).

Results (Table H1; Table H2, Appendix R) show a significantly stronger EL $\rightarrow$ AD effect among exporters ($\Delta\beta \approx +0.08$; $p < 0.05$), a more negative SB $\rightarrow$ AD effect in highly regulated sectors ($\Delta\beta \approx -0.07$; $p \approx 0.06$), and a slightly higher GD $\rightarrow$ AD effect in coastal regions ($\Delta\beta \approx +0.05$; $p \approx 0.10$, trend).

Table H1. Group-Wise Coefficients (CB-SEM)

Relation	Export	Non-ex port	Regulated sectors	Less-re gulated sectors	Coastal regions	Inland regions
SB $\rightarrow$ AD	-0.24	-0.30	-0.31	-0.24	-0.25	-0.29
EL $\rightarrow$ AD	+0.34	+0.26	+0.28	+0.30	+0.30	+0.27
IL $\rightarrow$ AD	+0.30	+0.31	+0.32	+0.30	+0.31	+0.30
GD $\rightarrow$ AD	+0.15	+0.12	+0.13	+0.14	+0.16	+0.11
AD $\rightarrow$ PF	+0.40	+0.37	+0.38	+0.39	+0.40	+0.36

Overall, these differences—consistent with H6 (policy coherence/export pressure) and the role of generational dynamics—

indicate that export orientation strengthens the conversion of external levers into adoption (H6b), sectoral regulatory pressure amplifies the negative effect of barriers (H1/H6a), and greater exposure to norms and innovation networks in coastal ecosystems marginally increases the GD effect.

4.3 Qualitative results

The 25 interviews confirm a willingness to transition that is hampered by the absence of a clear policy framework (tax incentives, one-stop shop), restricted access to green finance, and weak inter-agency coordination. Anonymized quotes illustrate these constraints: “Pressure from European clients without adequate local support”; “Sustainability is still perceived as a cost among SMEs”; “Public–private coordination is crucial.” Intergenerational tensions coexist with fruitful collaborations (mentoring, co-design of solutions). Diffusion mechanisms (“contagion”) from urban hubs accelerate the uptake of practices (e.g., a waste-reduction tool replicated by about a dozen actors within a year). The functional economy emerges as a low-capex lever particularly relevant for SMEs. Figure 5 illustrates sectoral diffusion patterns observed in the interviews, highlighting the role of urban hubs in propagating innovations to established sectors.

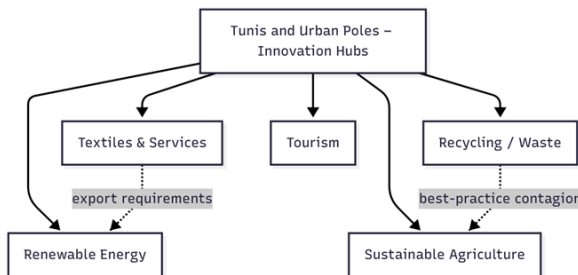


Figure 5. Sectoral Diffusion of Sustainable Practices from Urban Hubs

4.4 Comparative Case Study Framed by a Policy Mix (Structured SWOT)

To move beyond a purely descriptive SWOT, we conduct a multiple-case study (Yin, 2014) guided by the “policy mix for sustainability transitions” framework (Figure 6, multi-level comparative framework Tunisia–MENA–UAE). The framework assesses the coherence and intensity of public instruments, their complementarity with market norms (ESRS/GRI, sustainable public procurement), and their targeting of SMEs/start-ups.

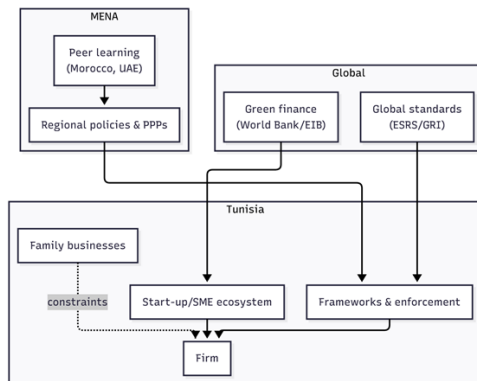


Figure 6. Multi-Level Comparative Framework (Tunisia–MENA–UAE)

Four units are analyzed with respect to the levers linking structural barriers (SB), external levers (EL), internal levers (IL), generational dynamics (GD), and adoption (AD) to performance (PF) in line with H1–H7: France (logistics/sustainable transport – FRET21), Germany (manufacturing/ESRS/Industry 4.0), Morocco (renewables – SNDD/Noor), and MENA/UAE (regional, top-down approaches). The policy mix is operationalized along six dimensions—internal coherence (complementarity/absence of contradictions), external coherence (alignment with norms/export value chains), financial intensity (green credit lines/guarantees), multi-level governance (PPPs, decentralization, implementation capacity), SME/start-up targeting (access, coaching, vouchers), and standardization/reporting (ESRS/ISO/national labels). Sources combine strategies/decrees, program evaluations, OECD/EIB/World Bank/UNDP/UNIDO reports, peer-reviewed literature, and indicators (green-finance intensity, circular/reporting adoption, R&D

expenditures) (Appendix C). Each case is matched to our model via pattern matching and synthesized in a comparative matrix (detailed SWOT and coding grids in Appendices A and B). Mechanisms differ across cases. In France (FRET21), a coherent policy mix combining voluntary commitments, technical assistance, reporting, and sustainable public procurement achieves –37% emissions on pilot perimeters, with strong EU financial intensity and ESRS/GRI external coherence, while framework contracts and national labels reduce uncertainty and structure adoption (H2–H3–H7). In Germany, R&D ecosystems (Fraunhofer), robust financial instruments, advanced standardization (ESRS/ISO), centers of excellence, and innovation vouchers support clean technologies and reporting despite heterogeneous SME uptake, strengthening IL and absorptive capacity (H3–H5). In Morocco (SNDD/Noor), a voluntarist strategy (PPPs/Noor) raises renewables to 38% of the electricity mix in 2022, though uneven coordination and centralization limit diffusion; territorial PPPs and dedicated green funds effectively convert EL into AD with local spillovers (H2–H5). In MENA/UAE, growing resources and markets coexist with often top-down policy mixes and institutional voids; adoption is pulled by imported norms (EU, lead buyers) and multilateral finance, but requires SME intermediation (one-stop shops, national labels) (H1–H6). Table 11 synthesizes instruments, coherence, SME/start-up targeting, financial intensity, norms/reporting, intermediate results, H1–H7 patterns, and transferable levers.

Table 11. Comparative Policy-Mix Matrix by Case and Transferable Levers

Country/sector	France/logistics (FRET21)	Germany/manufacturing	Morocco/renewables (SNDD/Noor)	MENA/UAE (regional)
Core instruments of the policy mix	Voluntary commitments; technical assistance; sustainable public procurement; targeted incentives	R&D/innovation (Fraunhofer); financial instruments; ISO/ESRS standardization	Territorial PPPs; green funds; strategic planning	Multilateral lines; top-down frameworks
Coherence/complementarity	High (internal/external)	Good; SME heterogeneity	Good (centralized)	Variable, often low
SME/start-up targeting	Moderate (labels + coaching)	Moderate (vouchers/centers)	Low to moderate	Low without intermediation
Green-finance intensity	High (EU, guarantees)	High	Moderate	Variable
Norms/reporting	ESRS/GRI diffusion; national labels	ESRS/ISO integrated	Targeted norms	Imported norms (EU)
Intermediate results (AD)	–37% CO ₂ (pilot scopes); increased reporting	Efficient tech adoption; IL strengthened	↑ RES share (38%); PPP diffusion	AD pulled by lead buyers/export
H1–H7 pattern	H2/H3/H7	H3/H5/H7	H2/H5	H1/H2/H6
Transferable levers to Tunisia	Sector framework contracts; “circular” labels; ESRS coaching for SMEs	SME R&D hubs; green vouchers/guarantees; centers of excellence	Territorial PPPs; SME/MSE-dedicated funds; one-stop shops	Norm harmonization; one-stop shops; SME intermediation

Pattern matching confirms H1 in MENA/UAE and, to a lesser extent, in Morocco (centralized frameworks/uneven coordination); H2–H3 are strong in France/Germany and in Morocco via PPPs/dedicated funds; H5 is robust in Germany (vouchers/centers) and transferable to Tunisian SMEs; H6 is illustrated by policy coherence attenuating SB (France/Germany), export orientation strengthening EL (France/Germany), and family ownership intensity potentially constraining adoption (MENA); H7 manifests as CO₂/cost/reputation gains in France/Germany and, in Morocco, as supply security and territorialization. Three priority, transferable levers emerge, subject to contextualization in Tunisia: normalize and signal (national “circular economy/sustainable enterprise” labels and proportionate ESRS coaching for SMEs to lower entry costs and boost credibility); build and pool capabilities (regional hubs/centers of excellence for SME R&D, circular design, reporting, backed by innovation vouchers and training to strengthen IL/absorptive capacity); and finance and intermediate (one-stop shops, EIB/World Bank-guaranteed green credit lines, territorial PPPs in energy, waste, and agri-industry) to efficiently convert EL into AD.

These cross-case lessons directly feed Section 3.5's recommendations—framework contracts and national labels, mentoring hubs/centers of excellence, one-stop shops and guaranteed green lines, ESRS-SME proportionality—and, combined with a coherent policy, can attenuate SB (H6a), reinforce EL and IL (H2–H3), and accelerate AD → PF (H7).

4.5 Linking Results and Recommendations

Stakeholder priorities (awareness/training, image/reputation, renewables) and measured barriers (finance, skills, regulation) call for a targeted action bundle: a green-finance one-stop shop; tax credits/bonuses for audits and green investments; national “circular economy” labels; intergenerational mentoring anchored in hubs; proportionate norms/reporting (ESRS for SMEs); and national indicators on waste/CO₂/energy linked to a “just transition” index (Httich, 2024). Table 12 presents the quant/qual joint display connecting constructs, observations, and implications, and Table 13 synthesizes Tunisian observations, recommendations, and international inspirations (EIB/World Bank; DE/FR practices; EU ESRS experiences—Filho et al., 2025; FRET21; SNDD; EU clusters/hubs; Noor).

Table 12. Joint Display of Quant/Qual Integration

Construct	Quantitative results	Qualitative elements	Implications
Barriers (SB)	Finance 45%; regulation 25%	“Export pressure without adequate local support”	Prioritize green lines/one-stop shop
Dynamics (GD)	Start-ups more prone to adopt	“Perceived competitive edge among youth”	Targeted programs for youth/SMEs
Adoption (AD)	Env–soc correlation 0.61	Cases of eco-design and source separation	Accelerate circular economy
External levers (EL)	ESRS/PPPs associated with AD	Need for normative alignment	Harmonization and national labels

Table 13. Tunisian Observations, Recommendations, and International Inspirations

Observation	Recommendation	Reference/inspiration
Limited access to green finance	One-stop shop + SME-dedicated lines	EIB/World Bank; DE/FR practices
Weak reporting culture	Proportionate ESRS + coaching	EU ESRS experiences (Filho et al., 2025)
Regulatory delays/fragmentation	Simplification/harmonization + national labels	FRET21 (FR); SNDD (MA)
Generational gaps	Mentoring programs and mixed hubs	EU clusters/hubs; Moroccan ecosystems
Low circular adoption	Fiscal incentives (eco-design, reuse)	EU frameworks; Moroccan projects (Noor)

The results confirm H1 (weight of external barriers) and H4 (generational effect), support mediation through internal levers via absorptive capacity (H5), and the role of moderators (policy coherence, export, family ownership). Combining incentives, proportionate standardization, and capability building can transform structural constraints into competitiveness levers, accelerate alignment with international markets, and strengthen a just transition; “quick wins”—one-stop shop, tax credits for audits, national labels—can trigger virtuous legitimacy–finance–capability–performance loops.

5. CONCLUSION

The findings confirm a gap between broad awareness and still partial adoption, more driven by exogenous pressures than by domestic incentives, with institutional voids weighing on SMEs and favoring quick wins over deeper transformations, while more dynamic trajectories emerge among pioneers—often youth-led start-ups—who leverage innovation, standards, and alternative finance. Grounded in a mixed-methods design (firm survey N = 120, entrepreneur module N = 120, 25 interviews) and SEM, the study confirms the negative effect of external barriers and the positive effects of internal/external levers and generational dynamics on adoption, mediation through absorptive capacity, and moderation by policy coherence, export orientation, and family ownership intensity, as well as the adoption–TBL performance link, clarifying the EL → IL → AD → PF mechanism. The France–Germany–Morocco–UAE comparison in a MENA perspective identifies transferable levers and supports a policy mix combining a coherent national strategy, structured green finance (dedicated lines, public guarantees, green microfinance, recognition of alternative channels), capability building (training, eco-design, LCA, reporting, intergenerational mentoring), territorial ecosystem animation,

and signaling instruments (labels, sustainable public procurement). The effectiveness of these measures requires robust monitoring and evaluation mechanisms (national dashboard, sectoral barometers, participatory audits). Scientifically, the contribution clarifies the role of institutional voids, contextualizes the TBL, integrates generational dynamics, and formalizes performance–legitimacy–finance feedback loops. Longitudinal extensions, secondary data, and multi-wave SEM validations will further strengthen external validity and extend insights to micro-enterprises and under-resourced territories.

List of Acronyms and Abbreviations

1. UNDP: United Nations Development Programme.
2. OECD: Organisation for Economic Co-operation and Development.
3. UNIDO: United Nations Industrial Development Organization.
4. INS: National Institute of Statistics
5. APII: Tunisian Investment Promotion Agency
6. CEPEX: Export Promotion Centre
7. UTICA: Tunisian Union of Industry, Trade and Handicrafts

REFERENCES

- Agrawal, R., Agrawal, S., Samadhiya, A., Kumar, A., Luthra, S., and Jain, V. 2024. Adoption of green finance and green innovation for achieving circularity: An exploratory review and future directions. *Geoscience Frontiers*. 15(4). 101669. <https://doi.org/10.1016/j.gsf.2023.101669>.
- Aguinis, H., and Glavas, A. 2019. On Corporate Social Responsibility, Sensemaking, and the Search for Meaningfulness through Work. *Journal of Management*. 45: 1057–1086. <https://doi.org/10.1177/0149206317691575>.
- Akinyele, O., Lawal, T., Bako, P., and Al-Faryan, M.A.S. 2025. Enhancing Environmental Sustainability in Emerging Economies: Do the Roles of ICT and Institutional Structure Matter?. *Future Business Journal*. 11(141). <https://doi.org/10.1186/s43093-025-00564-0>
- Saif-Alyousfi, A.Y.H. and Alshammari, T.R. 2025. Environmental Sustainability and Climate Change: An Emerging Concern in Banking Sectors. *Sustainability*. 17(3): 1040. <https://doi.org/10.3390/sui17031040>
- Azaiez, H., Gabtni, H., and Chabaane, A. 2020. Geophysical study of Hammam Sidi Maamar geothermal site in Central Tunisia for sustainable development. *Journal of African Earth Sciences*. 170. <https://doi.org/10.1016/j.jafrearsci.2020.103897>
- Baumgartner, R.J., and Rauter, R. 2017. Strategic Perspectives of Corporate Sustainability Management to Develop a Sustainable Organization. *Journal of Cleaner Production*. 140: 81–92. <https://doi.org/10.1016/j.jclepro.2016.04.146>.
- Benalcázar, M.C.A., Paredes, M.F.J., and Hidalgo, O.M.R. 2025. Sustainable Entrepreneurship in Emerging Economies: The Role of Financial Planning, Environmental Consciousness, and Artificial Intelligence in Ecuador—A Cross-Sectional Study. *Sustainability*. 17(14): 6533. <https://doi.org/10.3390/sui17146533>
- Bocken, N.M.P., and Short, S.W. 2016. Towards a sufficiency-driven business model: Experiences and opportunities. *Environmental Innovation and Societal Transitions*. 18: 41–61. <https://doi.org/10.1016/j.eist.2015.07.010>.
- Caldarola, B., Mazzilli, D., Patelli, A., and Sbardella, A. 2024. Economic complexity and the sustainability transition: a review of data, methods, and literature. *Journal of Physics: Complex*. 5. <https://doi.org/10.1088/2632-072X/ad4f3d>
- Creswell, J. W. 2014. *Research Design: Qualitative, Quantitative and Mixed Methods Approaches*. Fourth Edition. Thousand Oaks. CA. Sage.
- Dyllick, T., and Muff, K. 2016. Clarifying the meaning of sustainable business: Introducing a typology from business-as-usual to true business sustainability. *Organization and Environment*. 29(2): 156–174. <https://doi.org/10.1177/1086026615575176>
- El-Kassar, A.N., and Singh, S.K. 2019. Green innovation and organizational performance: The influence of big data and the moderating role of management commitment and HR practices. *Technological Forecasting and Social Change*. Elsevier. 144(C): 483–498. <https://doi.org/10.1016/j.techfore.2017.12.016>.
- Elkington, J. 1997. The triple bottom line. *Environmental Management: Readings and cases*. 2: 49–66.
- Filho, W.L., Wall, T., Williams, K., Dinis, M.A.P., Martin, R.M.F., Mazhar, M., and Gatto, A. 2025. European sustainability reporting standards: An assessment of requirements and preparedness of EU companies.

- Journal of Environmental Management.* 380(9). <https://doi.org/10.1016/j.jenvman.2025.125008>.
- Geissdoerfer, M., Savaget, P., Bocken, N.M.P., and Hultink, E.J. 2018. The circular economy – A new sustainability paradigm?. *Journal of Cleaner Production.* 143: 757–768. <https://doi.org/10.1016/j.jclepro.2016.12.048>.
- Geels, F.W. 2020. Micro-foundations of the multi-level perspective on socio-technical transitions: Developing a multi-dimensional model of agency through crossovers between social constructivism, evolutionary economics and neo-institutional theory. *Technological Forecasting and Social Change.* 152. 119894. <https://doi.org/10.1016/j.techfore.2019.119894>.
- Hahn, T., Pinkse, J., Preuss, L., and Figge, F. 2016. Ambidexterity for corporate social performance. *Organization Studies.* 37(2): 213–235. <https://doi.org/10.1177/0170840615604506>.
- Halkos, G. 2023. The drivers of sustainability in transitional and emerging economies Economic Change and Restructuring, Springer. 56(5): 3217–3221. <https://doi.org/10.1007/s10644-023-09549-x>.
- Hanna E., Harri K., Petrus K., and Topi T. 2023. Analysing regulatory instruments in sustainability transitions: A combined intervention points and roles of law approach to the European Union's Ecodesign framework. *Sustainable Production and Consumption.* 42: 125–137. <https://doi.org/10.1016/j.spc.2023.09.013>.
- Heydemann, S. 2020. Rethinking social contracts in the MENA region: Economic governance, contingent citizenship, and state-society relations after the Arab uprisings. *World Development.* 135. <https://doi.org/10.1016/j.worlddev.2020.105019>.
- Httich, M., Krylová, P., and Harmáček, J. 2024. Just Transition Score: Measuring the relative sustainability of social progress. *Environmental and Sustainability Indicators.* 23. <https://doi.org/10.1016/j.indic.2024.100440>.
- Jamali, D., and Karam, C. 2018. Corporate Social Responsibility in Developing Countries as an Emerging Field of Study. *International Journal of Management Reviews.* 20: 32–61. <https://doi.org/10.1111/ijmr.12112>.
- Kiron, D., Unruh, G., Reeves, M., Kruschwitz, N., Rubel, H., and ZumFelde, A. M. 2017. Corporate sustainability at a crossroads. *MIT Sloan Management Review.* 58(4): 1–28. <https://sloanreview.mit.edu/wp-content/uploads/2017/05/d6d6b55daa.pdf>.
- Kittinun, M. 2024. Sustainability in supply chains: strategies and practices for a greener future. *RMUTT Global Business Accounting and Finance Review.* 8(1): 85–108. <https://doi.org/10.60101/gbafr.2024.273498>.
- Bhandari, K.R., Ranta, M., and Salo, J. 2022. The resource-based view, stakeholder capitalism, ESG, and sustainable competitive advantage: The firm's embeddedness into ecology, society, and governance. *Business Strategy and the Environment.* 31(4): 1525–1537. <https://doi.org/10.1002/bse.2967>.
- Opferkuch, K., Caeiro, S., Salomone, R., and Ramos, T.B. 2022. Circular economy disclosure in corporate sustainability reports: The case of European companies in sustainability rankings. *Sustainable Production and Consumption.* 32: 436–456. <https://doi.org/10.1016/j.spc.2022.05.003>.
- Porter, M.E., and Kramer, M.R. 2011. Creating Shared Value. *Harvard Business Review.* 89(1-2): 62–77. <https://www.hbs.edu/faculty/Pages/item.aspx?num=39071>.
- Parada, M.J., Gimeno, A., Samara, G., and Saris, W. 2020. The adoption of governance mechanisms in family businesses: an institutional lens. *Journal of Family Business Management.* <https://doi.org/10.1108/JFBM-07-2019-0054>.
- Ranta, V., Aarikka-Stenroos, L., and Mäkinen, S.J. 2018. Creating value in the circular economy. *Journal of Cleaner Production.* 201: 988–1000. <https://doi.org/10.1016/j.jclepro.2018.08.072>.
- Report of Ellen MacArthur Foundation (EMF). 2024. The Global Commitment 2024. <https://www.ellenmacarthurfoundation.org/global-commitment-2024/overview>.
- Report of The African Development Bank (AfDB). 2024. Annual Report 2024. <https://www.afdb.org/en/documents/annual-report-2024>.
- Report of The European Investment Bank (EIB). 2024. European Investment Bank Group Activity Report 2024. <https://www.eib.org/en/publications/online/all/activity-report-2024>.
- Report of The International Labour Office (ILO). 2023. World Employment and Social Outlook: Trends 2023 (ISBN Print: 9789220366509). <https://www.ilo.org/publications/flagship-reports/world-employment-and-social-outlook-2023-value-essential-work>.
- Report of the Organisation for Economic Co-operation and Development (OECD). 2021. The MENA-OECD Competitiveness Programme. <https://www.oecd.org/mena/competitiveness/>.
- Report of the Organisation for Economic Co-operation and Development (OECD). 2024. OECD Economic Outlook. *OECD Publishing.* 2024: 2. Paris. https://www.oecd.org/en/publications/oecd-economic-outlook-volume-2024-issue-2_d8814e8b-en.html.
- Report of the United Nations Development Programme (UNDP). 2015. Transforming our world: the 2030 Agenda for Sustainable Development. United Nations. https://unctad.org/system/files/official-document/ares70d1_fr.pdf.
- Report of The World Bank (WB). 2024. World Development Report 2024. The Middle-Income Trape. <https://www.worldbank.org/en/publication/wdr2024>.
- Report of The World Economic Forum (WEF). 2023. Annual Report 2023-2024. <https://www.weforum.org/publications/annual-report-2023-2024/>.
- Sakhraoui, K., Agadi, R., Hirschhausen, K., and Ege, G.S. 2024. Energy policy in morocco: Analysis of the national energy strategy's impact on sustainable energy supply and transformation. *Next Research.* 1(2). <https://doi.org/10.1016/j.nexres.2024.100072>.
- Sachs, J.D. 2015. The Age of Sustainable Development. New York, *Journal of the American Planning Association.* 81(3): 241–242. <https://doi.org/10.1080/01944363.2015.1077080>.
- Schrage, M., Pring, B., Kiron, D., and Dickerson, D. 2021. Leadership's Digital Transformation: Leading Purposefully in an Era of Context Collapse. *MIT Sloan Management Review and Cognizant.* <https://sloanreview.mit.edu/projects/leaderships-digital-transformation/>.
- Singh, S.K., Del Giudice, M., Chierici, R., and Graziano, D. 2020. Green innovation and environmental performance: The role of green transformational leadership and green human resource management. *Technological Forecasting and Social Change.* 150. 119762. <https://doi.org/10.1016/j.techfore.2019.119762>.
- Sinkovics, N., Sinkovics, R.R., and Yamin, M. 2014. The role of social value creation in business model formulation at the bottom of the pyramid – Implications for MNEs?. *International Business Review.* 23(4): 692–707. <https://doi.org/10.1016/j.ibusrev.2013.12.004>.
- Touratier-Muller, N., and Ortas, E. 2021. Factors driving shippers' compliance with a voluntary sustainable freight programme in France. *Journal of Cleaner Production.* 318. <https://doi.org/10.1016/j.jclepro.2021.128397>.

APPENDICES

Appendix Q – Survey Questionnaire

Title: Survey on the Sustainable Transition of Firms in Tunisia
Consent: By responding to this questionnaire, you consent to the anonymous collection of data for research purposes. You may stop at any time. No identifying information will be published.

Instructions: Please indicate your level of agreement with each statement based on the past 12–24 months.

Scale: 1 = Strongly disagree; 2 = Disagree; 3 = Neither agree nor disagree; 4 = Agree; 5 = Strongly agree.

Research note: Items marked (R) are reverse-scored.

Section A – Profile (not counted in the 45 items)

- ☐ Organization type: Established firm / Start-up or young venture
- ☐ Sector: Renewable energy; Agriculture; Recycling/waste; Green services/tech; Social entrepreneurship; Tourism; Other: ...
- ☐ Headcount: 10–49; 50–249; 250+
- ☐ Years in operation: [] <3 (start-up) [] 3–4 [] 5–9 [] 10–19 [] 20+
- ☐ Share of sales exported: 0; 1–24%; 25–49%; 50–74%; 75–100%
- ☐ Family ownership (% of equity): 0; 1–25; 26–50; 51–75; 76–100
- ☐ Region: Coastal / Inland
- ☐ Current certifications: ISO 14001; ISO 50001; Other: ...; None
- ☐ (Start-ups) Status: incubated/accelerated (Yes/No); Stage: ideation / MVP / client pilot / initial rollout / scaling

Section B – Institutional and structural barriers (SB) [8 items]

- ☐ SB1. Regulations applicable to our activity are fragmented or inconsistent.
- ☐ SB2. Enforcement by authorities is uneven and unpredictable.
- ☐ SB3. Authorization lead times (environment/energy/urban planning) slow our projects.
- ☐ SB4. Green tax incentives or subsidies are insufficient or difficult to access.
- ☐ SB5. Support infrastructure/services (recycling, collection, labs/testing) are insufficient.
- ☐ SB6. Access to public information and support (one-stop desks, guides) is limited.
- ☐ SB7 (R). Rules and procedures are clear and stable.
- ☐ SB8. Connection costs and delays for infrastructure (water, electricity, waste) are a major constraint.

Section C – External levers (EL) [7 items]

- ☐ EL1. We have access to green finance (lines/loans/guarantees) or relevant alternative instruments (grants, competitions, incubators/accelerators, crowdfunding, impact investors).
- ☐ EL2. We benefited from a green audit/investment program or from incubation/acceleration over the past 24 months.
- ☐ EL3. Public–private partnerships (PPPs) or agreements with local authorities/donors support our sustainability projects.
- ☐ EL4. We collaborate with external partners (universities, technical centers, NGOs, donors) on green projects.
- ☐ EL5. Requirements from clients/lead buyers/investors (notably for export) facilitate our move to action.
- ☐ EL6. Our readiness for sustainability/impact reporting (GRI/ESRS if applicable) is advanced (tools, processes, skills).
- ☐ EL7. We benefit from export support schemes that integrate sustainability requirements (labels, coaching).

Section D – Internal levers (IL) [9 items]

- ☐ IL1. Management communicates clear, measurable sustainability/ESG objectives.
- ☐ IL2. Sustainability is integrated into investment and budgeting decisions.
- ☐ IL3. A person (or committee), even part-time, is in charge of sustainability/impact.
- ☐ IL4. We invest regularly in R&D/training for green skills/technologies.
- ☐ IL5. Our processes enable rapid sensing–seizing of green finance/partnerships.
- ☐ IL6. We systematically measure energy, waste and/or emissions with dedicated tools.
- ☐ IL7. Our model includes “functional economy” services (maintenance, leasing, subscription, performance contracts), current or in development.

- ☐ IL8 (R). Cultural resistance to change slows our sustainability projects.
- ☐ IL9. We have established routines to scale successful pilots across the organization.

Section E – Generational dynamics (GD) [6 items]

- ☐ GD1. A majority of the top management team is under 45.
- ☐ GD2. The leadership team has prior start-up or innovative entrepreneurial experience.
- ☐ GD3. We have a sustainability officer reporting to top management.
- ☐ GD4. Management values experimentation (test-and-learn) and measured risk-taking.
- ☐ GD5. Expectations of Generations Y/Z (employees/clients) effectively influence our decisions.
- ☐ GD6. A leadership succession occurred within the last five years.

Section F – Adoption of sustainable practices (AD) [9 items]

- ☐ AD1. We have a formal sustainability/CSR policy approved by management.
- ☐ AD2. We have defined KPIs that are monitored periodically.
- ☐ AD3. We have implemented energy-efficiency actions (optimization, retrofits, monitoring).
- ☐ AD4. We have reduced waste or increased valorization rates over the last 12 months.
- ☐ AD5. We have introduced eco-design principles in our products/services.
- ☐ AD6. We practice responsible sourcing (ESG criteria in supplier selection/evaluation).
- ☐ AD7. We have established sorting, traceability, and internal recycling of materials.
- ☐ AD8. We publish (or are preparing) sustainability/impact reporting for clients, donors, or investors (GRI/ESRS if applicable).
- ☐ AD9. We hold (or actively seek) a relevant certification/label (ISO 14001/50001, national label, impact/start-up label).

Section G – Triple Bottom Line performance (PF) [6 items]

- ☐ PF1. Our sustainability initiatives improved economic performance (margin, productivity, revenues/traction).
- ☐ PF2. Our energy costs and/or consumption have measurably decreased.
- ☐ PF3. The carbon intensity (CO₂ per unit) of our activities has decreased.
- ☐ PF4. Waste valorization rates and/or circularity of flows have improved.
- ☐ PF5. Our reputation and access to new markets have strengthened thanks to sustainability.
- ☐ PF6 (R). Our sustainability initiatives have had no perceptible impact on our stakeholders.

Appendix G – Interview Guide

Objectives and logistics

- **Objective:** understand perceptions, practices, barriers/levers, stakeholder roles, and forward-looking perspectives on sustainability in Tunisia.
- **Duration:** 60 minutes.
- **Consent:** remind anonymity, audio recording (if agreed), right to withdraw.
- **Context:** specify sector, size, export share, family ownership.

Respondent profile (3–5 min)

- Role, tenure, scope of responsibility.
- Firm size, sector, export share, ownership structure (family), average TMT age.
- Certifications/labels (ISO 14001/50001, others), systems in place (CSR policy, reporting).

Axis 1 – Perceptions of sustainability (8–10 min)

1. How do you define “sustainability” in your context?
Prompts: economic/social/environmental dimensions; risks/opportunities; strategic alignment.
2. To what extent is sustainability a priority for your leadership today?
Prompts: formal vs. informal objectives; triggers (export clients, energy costs, regulation, talent attraction).
What benefits do you expect or already observe?
3. What benefits do you expect or already observe?
Prompts: costs, revenues, reputation, market access, talent, financing.

Axis 2 – Strategies and practices (circular economy, energy efficiency, reporting) (12–15 min)

4. Do you have a formal sustainability strategy/policy? What are the key priorities?
Prompts: governance, committees, roles, budget.
5. Practices implemented to date:
Circular economy: eco-design, repair/reuse, responsible purchasing, industrial symbiosis.
Energy efficiency: audits, monitoring, ISO 50001, self-generation (solar/PPA), retrofits.
Reporting: GRI/ESRS, scope, frequency, tools.
Prompts: pilots, rollout, KPIs (CO₂, energy, waste), quantified results if possible.
6. Innovation and digital:
Do you use green/digital technologies (IoT, AI, platforms) to support these practices?
Prompts: use-cases, ROI, technical obstacles.

Axis 3 – Internal and external constraints (10–12 min)

7. Internal barriers encountered
Prompts: skills, culture, resistance to change, information systems, data availability, budget trade-offs.
8. External barriers encountered
Prompts: rule clarity/stability, administrative delays, tax incentives, access to green finance (banks, public guarantees, microfinance), infrastructure (recycling/collection, labs), availability of support (one-stops, guides).
9. If you had to prioritize three major obstacles, which and why?
Prompts: impact, concrete examples, costs/delays.

Axis 4 – Stakeholder roles (8–10 min)

10. Which stakeholders most influence your sustainability decisions?
Prompts: clients (esp. export), suppliers, employees/unions, investors/banks, regulators, NGOs, universities/tech centers, clusters/hubs.
11. How do you engage with them?
Prompts: consultations, co-design, audits, purchasing clauses, committees, training, public reporting.
12. A case where a stakeholder changed a decision
Prompts: what changed (acceleration, brake, objectives), lessons learned, adjustments.

Axis 5 – Forward-looking perspectives (8–10 min)

13. Priority projects or changes over 12–24 months and at 3 years
Prompts: investments, labels/certifications, ESRS rollout, new markets, functional economy.
14. What would you need to go faster/further?
Prompts: skills/training (eco-design, LCA, reporting), tools, financing (green lines, guarantees, PPPs), support (hubs/centers of excellence), one-stop shop.
15. Which public policy changes would be most helpful?
Prompts: regulatory simplification/stability, tax incentives, proportionate ESRS for SMEs, national labels, sustainable public procurement.
16. Which indicators will you track (TBL)?
Prompts: CO₂ per unit, energy intensity, waste valorization, margin/ROA, market access, green jobs/inclusion.

Cross-cutting prompts (as relevant)

- Generational dynamics (GD): leadership age/renewal; succession; managerial style (experimentation); sustainability officer; intergenerational mentoring; perceived effect on adoption speed.
- Green finance and export (EL): experience with banks/EIB/World Bank/microfinance; eligibility criteria; export client requirements (labels, reporting).
- Internal capacities (IL): key skills; sensing–seizing–reconfiguring routines; measurement systems; scaling of pilots.
- Comparisons: Tunisian peers vs. Morocco/EU; what is or is not transferable.

Closing (2–3 min)

- Any important question we did not ask?
- Willing to share reference documents (CSR policy, ISO certificates, reporting excerpts, anonymized energy bill) for triangulation?
- Thanks and possible “member checking” arrangements.

Appendix M – Measures**Table M3.** Discriminant Validity (Fornell–Larcker): $\sqrt{\text{AVE}}$ (diagonal) and Correlations

	SB	EL	IL	GD	AD	PF
SB	0.741					
EL	–0.33	0.748				
IL	–0.42	0.51	0.768			
GD	–0.21	0.29	0.34	0.714		
AD	–0.41	0.47	0.54	0.36	0.761	
PF	–0.34	0.40	0.46	0.28	0.51	0.755

Table M4. HTMT Ratios

Pairs	HTMT
SB–EL	0.39
SB–IL	0.51
SB–GD	0.26
SB–AD	0.47
SB–PF	0.42
EL–IL	0.70
EL–GD	0.36
EL–AD	0.73
EL–PF	0.62
IL–GD	0.43
IL–AD	0.77
IL–PF	0.68
GD–AD	0.44
GD–PF	0.36
AD–PF	0.79

Table M5a. Invariance (Start-ups/Young Leaders vs. Family Firms)

Step	χ^2 (df)	CFI	RMSEA	ΔCFI	ΔRMSEA	Decision
Configural	2168.4 (1348)	0.951	0.049	—	—	Accepted
Metric	2211.7 (1384)	0.949	0.050	0.002	0.001	Accepted
Scalar	2283.5 (1420)	0.947	0.050	0.002	0.000	Accepted

Table M5b. Invariance (SMEs vs. Large Firms)

Step	χ^2 (df)	CFI	RMSEA	ΔCFI	ΔRMSEA	Decision
Configural	2102.9 (1348)	0.953	0.048	—	—	Accepted
Metric	2140.6 (1384)	0.951	0.049	0.002	0.001	Accepted
Scalar	2188.2 (1420)	0.950	0.049	0.001	0.000	Accepted

Appendix R – Results**Table S2.** Mediations (Bootstrap 5,000, CB-SEM)

Indirect path	Indirect effect	95% CI	p	Conclusion
EL → IL → AD (H5)	+0.13	[0.07; 0.21]	0.001	Partial mediation confirmed

Table S3. Moderations (Interactions) and Conditional Effects

Interaction	β (std)	95% CI	p	Conditional effect low (–1 σ)	Conditional effect high (+1 σ)
SB × PC → AD (H6a)	+0.08	[0.01; 0.15]	0.028	–0.35 (p = 0.001)	–0.19 (p = 0.012)
EL × Export → AD (H6b)	+0.09	[0.02; 0.16]	0.013	+0.20 (p = 0.021)	+0.38 (p < 0.001)
SB × Family → AD (H6c)	–0.11	[–0.19; –0.03]	0.009	–0.16 (p = 0.048)	–0.38 (p < 0.001)

Table R2. Fit Indices of Structural Models (CB-SEM, MLR)

Model	χ^2 /df	CFI	TLI	RMSEA [90% CI]	SRMR	R ² (AD)	R ² (PF)
Main H1–H7	2.20	0.949	0.943	0.052 [0.048–0.056]	0.057	0.56	0.37
Without interactions (H6)	2.28	0.946	0.940	0.054 [0.050–0.058]	0.059	0.54	0.35

Table R3. Robustness by Sector Exclusions ($\Delta\beta$, CB-SEM)

Exclusion	$\Delta(\text{SB} \rightarrow \text{AD})$	$\Delta(\text{EL} \rightarrow \text{AD})$	$\Delta(\text{IL} \rightarrow \text{AD})$	$\Delta(\text{GD} \rightarrow \text{AD})$	$\Delta(\text{AD} \rightarrow \text{PF})$
Remove RE	+0.01	-0.01	0.00	+0.01	-0.01
Remove agriculture	0.00	+0.01	-0.01	0.00	+0.01
Remove recycling	+0.02	-0.01	0.00	0.00	0.00

Table R4. Clustered Standard Errors by Sector and Region (CB-SEM)

Relation	"Robust" SE	Sector-cluster SE	Region-cluster SE	Conclusion
SB $\rightarrow$ AD	0.08	0.09	0.09	unchanged ($p < 0.05$)
EL $\rightarrow$ AD	0.07	0.08	0.08	unchanged ($p < 0.01$)
IL $\rightarrow$ AD	0.06	0.07	0.07	unchanged ($p < 0.01$)
GD $\rightarrow$ AD	0.05	0.06	0.06	unchanged ($p < 0.05$)
AD $\rightarrow$ PF	0.07	0.08	0.08	unchanged ($p < 0.01$)

Table R5. Robustness of Moderation Effects: Alternative AD Model Specifications

Specification	SB $\times$ PC (H6a)	EL $\times$ Export (H6b)	SB $\times$ Family (H6c)
Main (centering)	+0.08** [0.01; 0.15]	+0.09** [0.02; 0.16]	-0.11** [-0.19; -0.03]
Orthogonalization	+0.09** [0.02; 0.16]	+0.09** [0.03; 0.17]	-0.10** [-0.18; -0.02]
Without controls (size, age)	+0.07* [0.00; 0.14]	+0.08** [0.01; 0.15]	-0.10** [-0.19; -0.02]

Table H2. Equality Tests of Coefficients (Inter-Group Constraints)

Comparison	Tested relation	$\Delta\chi^2$ (Δdf)	ΔCFI	p	Decision
Export vs Non-export	EL $\rightarrow$ AD	4.8 (1)	0.004	0.028	Significant difference
Regulated vs less-regulated	SB $\rightarrow$ AD	3.6 (1)	0.003	0.058	Marginal difference
Coastal vs inland	GD $\rightarrow$ AD	2.7 (1)	0.002	0.101	Non-significant trend

Appendix E – Endogeneity

Table E1. Endogeneity Diagnostics and 2SLS Results (Summary)

Tested relation	Instrument(s)	KP first-stage F	Sargan p-value	DWH p-value	β_{OLS}	β_{2SLS}	Conclusion
AD $\leftarrow$ EL (EL endogenous)	Export-client pressure; Exposure to public green programs	17.3	0.28	0.032	0.33	0.29	EL endogeneity corrected; effect confirmed
PF $\leftarrow$ AD (AD endogenous)	Export-client pressure; Exposure to public green programs	16.2	0.31	0.036	0.39	0.34	AD $\rightarrow$ PF robust, slightly attenuated

Appendix A – SWOT Details by Country and Sector

A.1. SWOT – France (Logistics/FRET21)

- **Strengths:** Coherent policy mix (FRET21 voluntary commitments + technical assistance + sustainable public procurement); strong external coherence (ESRS/GRI); high financial intensity (EU channels and guarantees); effective multi-level governance; widespread national standards/labels.
- **Weaknesses:** Regulatory complexity; compliance costs for SMEs; heterogeneous access to coaching/reporting by territory.
- **Opportunities:** Greening value chains; diffusion of framework contracts; scaling ESRS-SME coaching; embedding low-carbon logistics in public procurement.
- **Threats:** Energy price volatility; “compliance-only” risk without operational gains; capacity constraints in smaller firms.

A.2. SWOT – Germany/Manufacturing

- **Strengths:** R&D ecosystems (Fraunhofer); robust financial instruments; advanced standardization (ESRS/ISO); hubs/centers of excellence; high innovation intensity.
- **Weaknesses:** Heterogeneous SME mobilization (capacity barriers); dispersion across Länder/sectors.
- **Opportunities:** Innovation vouchers and ESRS coaching for SMEs; export of clean technologies; linking Industry 4.0 and energy efficiency.
- **Threats:** Exposure to energy prices/supply risks; potential territorial inequalities in access to instruments.

A.3. SWOT – Morocco/Renewables (SNDD/Noor)

- **Strengths:** Strategic vision (SNDD); structuring PPPs (Noor Ouarzazate); RES share at 38% of electricity mix in 2022.
- **Weaknesses:** Uneven public–private coordination; centralization; limited SME/MSE integration.
- **Opportunities:** Territorial PPPs; SME/MSE-dedicated green funds; technology transfer; labels and reporting intermediation.
- **Threats:** Financing and climate volatility; institutional dependency risks.

A.4. SWOT – MENA/UAE (Regional)

- **Strengths:** Natural resources; growing markets; emblematic initiatives (UAE).
- **Weaknesses:** Institutional voids; fragmentation; weak SME targeting; reliance on imported norms.
- **Opportunities:** Regional norm harmonization; one-stop shops; multilateral green lines (EIB/World Bank) earmarked for SMEs; guarantee/TA mechanisms.
- **Threats:** Geopolitical risks; regulatory volatility; institutional capture.

Appendix B – Coding Grids and Protocol

B.1 Code Tree (Policy Mix and Mechanisms)

- COH_INT: Internal coherence of instruments (complementarity, absence of contradictions)
- COH_EXT: External coherence/market alignment (ESRS/GRI, sustainable procurement, export)
- FIN_INT: Green financial intensity (lines, guarantees, volume, access)
- GOV_ML: Multi-level governance (PPPs, decentralization, implementation capacity)
- SME_TGT: SME/start-up targeting (access, coaching, vouchers, proportionate labels)
- NORM_REP: Standardization/reporting (ESRS/ISO/national labels)
- MECA_EL_IL: Conversion of external levers into internal capabilities (sensing–seizing–reconfiguring)
- AD_INT: Adoption (eco-design, circularity, efficiency, reporting)
- PF_INT: Performance (economic/social/environmental; CO₂; costs; reputation)

Table B.1. Codebook (Extract)

Code	Definition	Inclusion	Exclusion	Example (source)
COH_INT	Intra-mix coherence (complementarity/non-contradictory instruments)	Articulated programs (support + incentive + label)	Isolated initiatives without articulation	FRET21 + sustainable public procurement (FR)
COH_EXT	Alignment with norms/export chains	ESRS/GRI; sustainable purchasing clauses	CSR communication without external requirement	EU client requirements (FR/DE)
FIN_INT	Green finance scope/access	Dedicated lines; guarantees; preferential rates	Non-green finance	EIB/WB lines (FR/DE/MA/MENA)
GOV_ML	PPPs and implementation capacity	Territorial PPPs; operational agencies	Purely central governance without execution	Noor (PPP) – MA

SME_TGT	SME/start-up targeting	Vouchers; coaching; proportionate labels	Schemes reserved for large firms	R&D vouchers (DE)
NORM_REP	Norms/reporting	ESRS; ISO; national labels	Non-audited internal charter	National “circular” label (FR)
MECA_EL_IL	EL→IL conversion	Centers of excellence; hubs; training	Equipment without training/organization	Fraunhofer (DE)
AD_INT	Practice adoption	Eco-design; circularity; efficiency	Isolated, non-durable actions	–37% CO ₂ logistics (FR)
PF_INT	TBL performance	CO ₂ , costs, reputation, green jobs	Output volume without TBL link	Cost + reputation gains (FR/DE)

Table B.2. Inter-Coder Reliability (Cohen’s κ , Summary)

Code	κ
COH_INT	0.82
COH_EXT	0.79
FIN_INT	0.76
GOV_ML	0.74
SME_TGT	0.72
NORM_REP	0.80
MECA_EL_IL	0.77
AD_INT	0.84
PF_INT	0.81

Appendix C: Documentary Sources and Indicators

Table C.1. Source Typology

Type	Examples
National strategies/decrees	SNDD (MA), energy/climate laws (FR/DE), PPP decrees
Policy evaluations	Cour des comptes/IGF reports (FR), ministerial evaluations (DE/MA)
International organizations	OECD (Policy Mix, Green Finance), EIB/World Bank (green lines), UNDP/UNIDO
Academic literature	Peer-reviewed articles on ESRS, circularity, PPPs
Data/indicators	RES share, R&D spending, green-line volumes, reporting adoption (GRI/ESRS), ISO 14001/50001

Table C.2. Indicator Dictionary

Indicator	Definition/Computation	Source/Unit
RES share	Percentage of renewables in the national electricity mix	Energy reports (MA/FR/DE)
Green-finance intensity	Annual volume of green lines/guarantees over GDP (%) or per firm	EIB/WB/public banks
Circular adoption	% of firms reporting circular practices (eco-design, reuse)	Sector surveys/GRI
Reporting coverage	% of firms with GRI/ESRS reporting	Registers/professional associations
ISO 14001/50001	Number/share of certified firms	ISO/national bodies
Vouchers/SMEs	Number of SME beneficiaries/year	Ministries/innovation agencies
Sustainable public procurement	Share of tenders including sustainability criteria	Public procurement reports