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Governing Digital and Green Transformations in Small and Medium-Sized Enterprises: Balancing Business Performance, Transition Costs and Sustainable Value

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ABSTRACT: Digital and green transformations require small and medium-sized enterprises (SMEs) to reconcile business performance, transition costs and sustainable value under resource constraints. This study uses a structured selective literature review, thematic analysis and evidence comparison to examine complementarities, trade-offs and conditions shaping twin-transition decisions. The synthesis suggests that complementarity between digital capabilities and greening activities does not necessarily translate into direct economic benefits, while transition expenditures and sustainability outcomes may materialize at different times. Combining the resource-based view (RBV) and attention-based view (ABV), the article proposes a dynamic balancing framework that distinguishes investment conditions, three outcome categories and feedback-driven decision adjustment. Its contribution is an evidence-informed, conditional governance logic rather than a universal optimal investment prescription. The proposed framework is conceptual and requires empirical validation.

KEYWORDS: twin transition, small and medium-sized enterprises, transition costs, business performance, sustainable value.

1. INTRODUCTION

Digital and green transformations are increasingly central to productivity, market adaptation and environmental objectives in SMEs. Yet pursuing both agendas simultaneously places pressure on finance, human resources and managerial attention. OECD [11] documents distinctive barriers to SME technology adoption, while Pissareva et al. [12] identify the interdependence of digital, green and business skills. The management question therefore concerns not only whether technologies should be adopted, but also the scale, sequencing and coordination of investment under constrained resources.

Evidence challenges the assumption that digitalization necessarily generates green or financial gains. Kesidou et al. [5] identify an association between advanced digitalization and net-zero-oriented innovation adoption in UK SMEs. In Vietnamese food-and-beverage SMEs, Le et al. [7] report mediating roles for green innovation and green supply chain management. Conversely, Miranda et al. [10] find no statistically significant direct association between digitalization and economic sustainability in their sample. These studies address different populations, mediators and outcomes; their findings should not be treated as directly contradictory or pooled into a single effect.

Research has examined organizational twin-transition frameworks [14], sustainability-oriented technology selection [4] and phased investment economics [3]. However, evidence concerning operating performance, expenditure and sustainability is assessed with different units and time horizons. This study therefore aims to (i) identify conditional complementarities and trade-offs; (ii) distinguish the mechanisms and timing of transition costs, business performance and sustainable value; and (iii) synthesize conditional governance principles for selecting and revising twin-transition activities. The contribution is an integrative conceptual explanation, not a tested investment optimization model.

2. RESEARCH CONTENT

2.1. Conceptual foundations and research methodology

2.1.1. Twin transition and theoretical perspectives

The twin transition denotes the coordinated pursuit of digital and green transformation in organizational strategy and operations. Digital monitoring, integrated information and value-chain coordination may facilitate environmental improvements; in turn, environmental objectives can redirect technology choices and business models. Tabares et al. [14] distinguish enabling conditions, implementation practices and outcomes, underscoring that transformation is an organizational change process rather than the acquisition of software or equipment.

The resource-based view (RBV) explains potential complementarities through the combination of valuable capabilities, managerial knowledge and innovation practices [1]. The attention-based view (ABV) explains how managerial priorities, decision rules and finite attention shape choices and potential trade-offs [16]. Taken together, they suggest that digital capacity may support greening only when appropriate complementary resources can be mobilized, whereas competing demands for finance and attention may delay or diminish realization of benefits. Investment, implementation and observed outcomes remain analytically distinct levels.

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2.1.2. Review protocol and evidence assessment

A structured selective review was conducted through Scopus, Web of Science and Google Scholar between 26 September and 2 October 2026, prioritizing publications from 2020–2026 and including earlier foundational works when theoretically relevant. Search expressions combined "SMEs" or "small and medium-sized enterprises" with "digital transformation" or "digitalization" and "green transition", "twin transition" or "sustainability". Additional searches addressed trade-offs, transition costs, business performance and investment decisions; reference tracking and DOI verification supplemented database retrieval.

The initial search identified 58 records: 12 from Scopus, 18 from Web of Science, 22 from Google Scholar and six through reference tracking. Removal of 19 duplicates left 39 titles and abstracts for screening; 15 were excluded. Of 24 items assessed for relevance and accessible content, eight were excluded, resulting in 16 works for synthesis. Inclusion required verifiable publication details and relevance to SME governance, sustainability, transition costs or resource allocation. Purely technical studies without relevant management implications and unverifiable sources were not retained.

Each study was coded by context, sample, design, analytical approach, focal variables, findings and limitations, then classified into three themes: complementarity/trade-offs; cost, performance and sustainability mechanisms; and conditional investment decisions. Evidence was distinguished as direct, indirect, or theoretical/contextual support. Methodological clarity and applicability to Vietnamese SMEs were assessed separately. Coding was performed by one author; no inter-coder reliability coefficient was calculated. This is neither an exhaustive systematic review nor a meta-analysis, and cross-study differences preclude a pooled effect size.

To preserve the evidentiary meaning of each source, the synthesis uses an explicit claim-to-evidence distinction. A theoretical proposition concerning complementarity is not interpreted as proof of a positive effect on profit or emissions; an observed association is not treated as a causal estimate; and a tested mediation pathway is interpreted only for the outcome and sample examined. The literature is also heterogeneous in its units of observation, including SMEs, manufacturing establishments and single investment projects. Consequently, cross-study comparisons concern explanatory mechanisms and boundary conditions, not numerical equivalence of estimated coefficients or performance gains. This rule is particularly important when translating evidence from UK, Spanish, Indian and Turkish contexts into conditional implications for Vietnamese enterprises [3]–[5], [8], [10].

The review process has limitations that affect reproducibility. The reported screening counts document the narrowing of the source set, but a selective review cannot claim complete capture of all relevant literature. Coding by a single researcher does not permit estimation of inter-coder agreement. Further, studies with limited access to full text can support only claims that are independently verifiable from the accessible material. These limitations are addressed by retaining the direction, measurement context and stated qualifications of reported findings rather than constructing a pooled quantitative conclusion. The resulting framework is thus an analytical synthesis and a basis for future testing, not a validated general law of twin-transition investment.

Table 1. Selected studies: evidence and limitations

Study	Design / context	Relevant finding	Evidence and limitation
Kesidou et al. [5]	Survey of 964 UK SMEs	Advanced digitalization associated with higher net-zero innovation adoption	Direct for association; not profits or emissions
Le et al. [7]	405 responses; Vietnamese food/beverage SMEs	Green innovation and green SCM act as mediators	Direct for tested pathway; sector-specific
Merín-Rodrigáñez et al. [8]	434 innovative Spanish SMEs	Business-model innovation partly mediates performance	Indirect for twin transition; no direct green measure
Miranda et al. [10]	Empirical MSME study	No statistically significant direct digitalization–economic sustainability relation	Direct for tested model; not evidence of harm
Jamwal et al. [4]	233 Indian manufacturing SMEs; fuzzy methods	Identifies sustainability-oriented technology enablers	Indirect; context- and method-dependent ranks
Gül Özdamar & Ersöz [3]	Turkish metal-processing SME case	Cost–benefit analysis of phased digital investment	Indirect; not the entire twin transition
Tabares et al. [14]	Conceptual organizational study	Twin-transition implementation framework	Theoretical; effectiveness untested

The seven studies in Table 1 illustrate the heterogeneous evidence base. The other nine selected works provide foundational theory, policy context, systematic reviews or investment-decision perspectives. Not all 16 sources are treated as direct empirical evidence of twin-transition outcomes.

2.2. Results and discussion

2.2.1. Conditional complementarity and trade-offs

The reviewed evidence does not support the binary proposition that digital and green transformations always reinforce or always compete with one another. RBV predicts that digital monitoring and coordination can enable green innovation when resources are complementary. ABV suggests that scarce finance, personnel and managerial attention can generate competing priorities. Kesidou et al. [5] report an association between digitalization and net-zero innovation adoption, but their evidence does not establish causality, higher profits, lower total emissions or economic synergy between two specific investments.

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Indirect pathways are important. Le et al. [7] identify mediation through green innovation and green SCM, whereas Merín-Rodrigáñez et al. [8] identify partial mediation through business-model innovation for firm performance. Miranda et al. [10] find no statistically significant direct relationship in their estimated model, illustrating the relevance of measurement and organizational mediation. Conceptual complementarity, empirical association, statistical interaction and incremental economic synergy are four different claims; the latter requires comparative evidence on joint versus separate investments after accounting for costs.

A further distinction concerns the time horizon of observed relationships. Investments in data integration, energy monitoring or workforce training may raise short-run expenditure before process changes generate operational savings; environmental improvements may be registered in physical units before being reflected in monetary results. In addition, digital technology can facilitate measurement of emissions without itself lowering emissions. A credible assessment should therefore separate improvements in measurement capability from changes in production technology, work practices or resource intensity. The evidence on mediation and heterogeneous direct effects [7], [8], [10] supports examining these possible pathways, but it does not establish their prevalence or magnitude across all SMEs.

2.2.2. Separating transition costs, business performance and sustainable value

The proposed assessment distinguishes three non-interchangeable outcomes. Transition costs include initial investment, training, implementation, incremental operations, adjustment and opportunity costs, measured over the periods in which they occur. Business performance captures economic or operational results such as labour productivity, unit cost, margins and cycle time. Sustainable value is operationalized here as environmental and social outcomes not already counted in business performance, including emissions intensity (kg CO_2e per unit), energy intensity (kWh per unit) and working conditions. This separation is analytical: sustainability in its broader sense also encompasses economic performance.

A firm or clearly specified project should be assessed against a pre-investment baseline and follow-up periods appropriate to its context, such as 12 and 24 months. Variables of different units must not be added mechanically. Electricity savings may appear as monetary savings within business performance and as reduced kWh in environmental outcomes, but they cannot be counted twice as financial value. Likewise, an investment already recorded as capital expenditure should not be charged again to operating cost. These indicators and time horizons are proposed measures, not validated thresholds.

Operationalization requires an explicit comparison design. At project initiation, the enterprise should document the process boundary, the baseline observation period, planned digital and green interventions, responsibilities for data collection and any concurrent changes in production volume or product mix. Subsequent measurements should report absolute values and intensities separately: for example, total electricity consumption alongside kWh per unit of output, or total emissions alongside kg CO_2e per unit. Where product specifications change, direct before-and-after comparisons can be misleading unless results are stratified or adjusted for production mix. Financial assessment should distinguish capital expenditure, recurring expenditure, avoided costs and benefits that have not yet been monetized. These procedures are recommendations derived from the framework, not measurements collected in this review.

Table 2. Evidence matrix for twin-transition governance

Dimension	Research basis	Proposed interpretation	Qualification
Business performance	Le et al. [7]; Merín-Rodrigáñez et al. [8]	Productivity, unit costs and profitability, separately measured	Mediation evidence; context-specific
Transition costs	Gül Özdamar & Ersöz [3]	Up-front, operating, training, adjustment and opportunity costs by period	Indirect support; full cost taxonomy proposed here
Sustainable value	Zaman et al. [15]; Le et al. [7]	Environmental and social outcomes beyond business metrics	Conceptual and indicator-specific support
Digital–green complementarity	Kesidou et al. [5]	Digital resources may facilitate green practices	Association, not verified economic synergy
Heterogeneous findings	Miranda et al. [10]	Consider context, mediation and measurement	Null direct result is not proof of negative effect
Resource constraints	Bindeeba et al. [2]	Finance and technological capabilities condition investment decisions	Transfer to Vietnam remains conditional

Table 2 makes explicit which statements are empirical findings and which are the author's synthesis. Benefits may materialize after substantial expenditures and may differ by firm size, supply-chain position, customer requirements and financing access. The evaluation of a twin transition therefore requires repeated measurement rather than treating immediate adoption or investment completion as success.

2.2.3. Conditional governance and investment sequencing

Three complementary governance principles follow. First, assess absorptive capacity before selection: data quality, staff competence, technical compatibility, financial headroom and the ability to maintain new routines. Second, sequence investment according to binding constraints and expected information gains. Smaller, reversible improvements can establish baseline data before undertaking capital-intensive interventions. Third, coordinate digital and green investments when credible complementarities exist, but retain the option to pause, redesign or discontinue activities when evidence does not support continuation. Jamwal et al. [4] inform the selection of enabling factors, while the phased investment analysis of Gül Özdamar and Ersöz [3] illustrates the importance of financial flexibility.

Two hypothetical scenarios clarify application without purporting to report enterprise observations. A financially constrained manufacturer with limited digital capability but high energy pressure might first collect energy-use data for a small production area, then evaluate

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cost and kWh per unit before expansion. A more digitally mature firm facing customer environmental requirements might integrate production and energy records, comparing margins, operating productivity and kg CO_2e per unit. In either case, deviations from agreed targets, unreliable data or affordability constraints trigger a review of technology, sequencing or scale. These triggers must be established for each project; they are not empirically optimized thresholds.

The sequencing decision can be framed as a set of revisable gates rather than a single technology ranking. A preparation gate checks whether the firm can describe the problem and establish a credible baseline. A feasibility gate examines available financing, staff capability, data interoperability, supplier dependence and operational disruption. A pilot gate defines the intended improvement, comparison period, acceptable downside risk and responsibility for interpreting evidence. An expansion gate is passed only after the firm reviews realized expenditure and performance against its original objectives. Thresholds should be established locally before implementation; assigning universal thresholds or arbitrary criterion weights would overstate what the reviewed studies demonstrate. This staged logic is compatible with resource constraints and with the literature on technology enablers and phased investment [3], [4], [12].

2.2.4. Proposed dynamic balancing framework

The proposed framework combines investment conditions (digital–green capability, financial resources and management attention), conditional decisions (scope, sequencing and coordination) and three separately monitored outcome categories. RBV underpins the expected benefits of resource combination; ABV explains why scarcity and managerial priorities can constrain conversion of capabilities into results. Performance evaluation feeds back into decisions when observed costs or results depart from objectives. The framework is sensitive to sector, firm size, access to finance, technology readiness and environmental obligations.

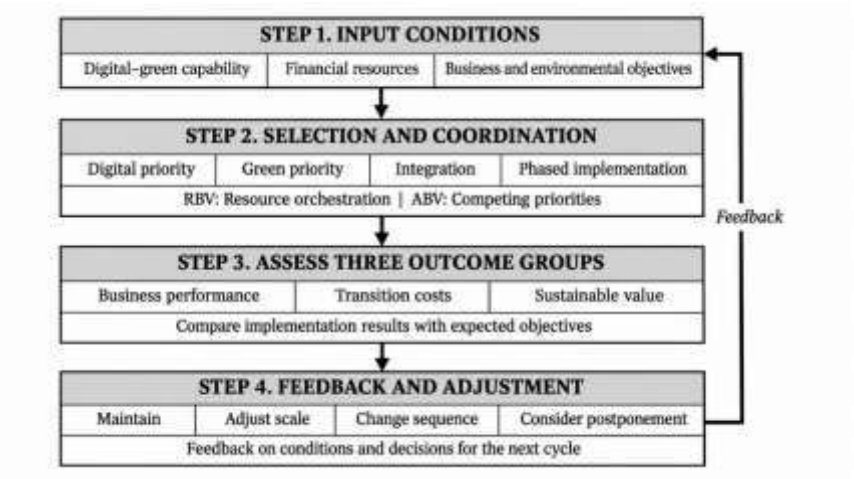

Figure 1. Dynamic balancing framework for managing the twin transition in SMEs
Source: Author's synthesis informed by Tabares et al. [14], Kesidou et al. [5], Jamwal et al. [4], and Gül Özdamar and Ersöz [3].

The framework yields three testable conceptual propositions: P1-digital-green resource coordination is positively associated with green transition outcomes when absorptive capability is adequate; P2-financial limitations and competing managerial attention weaken the conversion of complementary capabilities into outcomes; and P3-larger discrepancies between realized costs/results and targets increase the likelihood of revising investment scope or sequence. These propositions are derived from the theoretical lenses and reviewed evidence; none is tested with primary data in this article.

The feedback arrow in Figure 1 is a governance mechanism rather than evidence that learning automatically occurs. After each review cycle, managers should record what assumptions were supported, which estimates were contradicted, whether data quality was sufficient and why the intervention was retained, changed or discontinued. This makes the process auditable and reduces the risk of continuing a costly project solely because investment has already occurred. The framework also implies that an enterprise may legitimately postpone one component of the twin transition when liquidity, capabilities or information are inadequate. Such postponement is a conditional managerial response, not a conclusion that digital or green transformation lacks value.

An empirical test of the three propositions would require observations from multiple enterprises or projects rather than illustrative cases alone. Researchers could operationalize resource coordination through documented cross-functional planning and interoperable production–environmental data; managerial attention through recorded priorities or decision processes; and outcomes through separately observed costs, business performance and environmental indicators. A longitudinal design could compare pre-intervention and post-intervention trajectories while accounting for sector, firm size, baseline digital maturity and market changes. Where feasible, comparison groups with similar operations but different investment sequences would strengthen inference. Interaction or moderation hypotheses should be estimated explicitly, and any economic synergy claim would require comparing joint and separate investment alternatives net of their respective costs. No such tests are reported in the present study.

3. CONCLUSIONS AND RECOMMENDATIONS

3.1. Conclusions

Managing the twin transition in SMEs requires more than evaluating technology availability or the forecast benefits of individual projects. The synthesis reveals conditional complementarities between digital capability and greening, heterogeneous economic pathways and the importance

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of resource constraints and investment flexibility. A core contribution is the conceptual separation of business performance, transition costs and sustainable value, together with a feedback mechanism linking these outcomes to subsequent investment decisions. The framework offers a structure for analysis, not a universally optimal investment sequence.

3.2. Recommendations and limitations

SMEs should assess technology absorption and financial readiness, create verifiable baselines, and evaluate up-front and recurring expenses separately. Investment can be staged or coordinated where complementary data, capabilities and objectives are demonstrable. Policymakers and support bodies should improve access to combined digital–green skills, trustworthy technology information and appropriate financing. The review is selective, includes heterogeneous contexts and contains sources for which only verifiable abstracts or publication information were accessible. A single researcher coded the evidence, and the model has not been empirically validated. Future multi-sector or longitudinal studies should operationalize each construct, compare investment pathways and test the proposed conditional relationships.

At the institutional and policy level, support programs should distinguish diagnostic assistance from subsidies for equipment purchase. Practical support may include access to reliable information on technologies, training that combines process management with data and environmental measurement, and mechanisms for sharing non-sensitive lessons from completed pilots. For enterprises, governance responsibilities should be allocated across financial, production, environmental and digital functions so that no single performance indicator dominates the decision. Project reviews should record both intended and unintended effects, including data-security exposure, operational interruptions and changes in work organization. Such arrangements may improve the quality of decisions, although their effectiveness remains a hypothesis to be evaluated rather than a result established by this paper.

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