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Factors Affecting Innovation in Small and Medium-Sized Enterprises in Hanoi in the Context of Digital Transformation: Current Conditions and a Proposed Research Model

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Abstract

Innovation has become a practical condition for the survival and upgrading of small and medium-sized enterprises (SMEs), yet the mechanisms through which digital transformation improves innovation remain unevenly understood in emerging urban economies. This article examines the current conditions of Hanoi's SME sector and develops an integrated model of the factors affecting firm-level innovation. The study combines an integrative review of resource-based, dynamic-capability, absorptive-capacity, network, and institutional perspectives with a structured synthesis of recent official statistics, policy documents, local innovation and digital-transformation indices, and a Hanoi-specific survey of 534 SMEs. The current-state analysis reveals a conversion gap. Hanoi leads Vietnam's Provincial Innovation Index and Digital Transformation Index and possesses strong human-capital, research, and market inputs; however, business sophistication, innovation linkages, knowledge diffusion, and the integration of digital tools inside SMEs remain comparatively weak. A substantial share of surveyed firms had discontinued digital solutions, most digitalization was confined to separate administrative functions, and advanced data analysis and automation were rare. The proposed model therefore treats innovation performance as the outcome of eight complementary determinants: innovation-oriented leadership, digital capability, absorptive capacity, human capital, collaboration-network capability, financial resource availability, institutional and policy support, and digital-transformation maturity. Digital maturity is also expected to strengthen the effects of digital capability and absorptive capacity on innovation. The article specifies eleven testable hypotheses, an item pool, and a staged validation design using interviews, a stratified survey, and partial least squares structural equation modelling. Its contribution is to connect Hanoi's strong ecosystem-level conditions with the firm-level capabilities required to convert those conditions into product, process, marketing, organizational, and business-model innovation.

Keywords: Absorptive Capacity, Digital Capability, Digital Transformation, Hanoi, Innovation Performance, Small and Medium-Sized Enterprises

1. Introduction

For a small or medium-sized enterprise, innovation is rarely a separate laboratory activity. It is more often a sequence of practical decisions: whether to redesign a service, automate a recurrent task, use customer data to refine an offer, cooperate with a technology provider, reorganize a workflow, or enter a new market. Digital technologies can lower the cost and time of those experiments, but access to software does not by itself produce innovation. The firm must be able to recognize useful knowledge, select and integrate technologies, reorganize routines, finance implementation, and learn from customers and partners. This distinction between technology adoption and organizational conversion is especially important in emerging economies, where infrastructure may advance faster than managerial and absorptive capabilities.

Hanoi provides a consequential setting in which to examine that conversion problem. The capital is Vietnam's largest concentration of active enterprises and a national centre of universities, research institutes, government agencies, finance, and business services. SMEs account for the overwhelming majority of registered firms and make a substantial contribution to employment and the city's gross regional domestic product (GRDP) (Hanoi People's Committee, 2025) [10]. At the ecosystem level, Hanoi ranked first in Vietnam's 2025 Provincial Innovation Index (PII) for the third consecutive year and also ranked

first in the 2024 provincial Digital Transformation Index (DTI) (Ministry of Science and Technology [MST], 2025a, 2025b) [20, 21]. These results suggest an environment rich in knowledge and digital infrastructure. National assessments nevertheless emphasize that infrastructure and adoption must be paired with firm capability, innovation linkages, and organizational change if digitalization is to support higher-value growth (OECD, 2021; World Bank, 2026) [25, 35].

The firm-level picture is less settled. A Hanoi survey of 534 SMEs found that digital use was fragmented across functions, advanced analytics and automation were exceptional, and investment budgets were frequently inadequate (Nguyen *et al*., 2023) [24]. The 2025 PII similarly shows that Hanoi's strongest scores lie in human capital, research and development, and market sophistication, while business sophistication—particularly innovation linkages—lags well behind. Thus, a high-performing local ecosystem can coexist with shallow or discontinuous transformation inside many firms. Explaining this coexistence requires a model that includes resources, capabilities, leadership, inter-organizational relationships, and the institutional environment rather than a narrow inventory of technologies.

Existing research offers several relevant explanations but remains fragmented. The resource-based view emphasizes valuable and difficult-to-imitate resources (Barney, 1991) [1]; dynamic-capability theory explains how firms sense opportunities, seize them, and reconfigure assets (Teece *et al*., 1997) [29]; absorptive-capacity research focuses on acquiring, assimilating, transforming, and exploiting external knowledge (Cohen & Levinthal, 1990; Zahra & George, 2002) [4, 36]; and network and institutional perspectives explain access to complementary knowledge, legitimacy, finance, and public support. Digital-transformation research adds that value arises when digital technologies alter organizational structures, processes, and value creation rather than merely digitizing existing information (Vial, 2019; Warner & Wäger, 2019) [31, 34]. Vietnamese evidence confirms the importance of information-technology capability, dynamic capabilities, government support, innovation, and organizational resilience, but most studies use national or multi-regional samples and do not reconcile those constructs with Hanoi's current local conditions (Mai *et al*., 2024; Trieu *et al*., 2025; Vo Thai *et al*., 2024; Walsh *et al*., 2023) [18, 30, 32, 33].

This article has three objectives. First, it provides an evidence-bounded assessment of the current innovation and digital-transformation conditions of Hanoi SMEs. Second, it develops an integrated research model explaining firm-level innovation performance through eight determinants and two contextual mechanisms. Third, it translates the model into testable hypotheses, indicative measures, and a feasible empirical design. The guiding questions are: (1) What does the available evidence reveal about the present capacity of Hanoi SMEs to innovate in a digitally transforming economy? (2) Which internal and external factors are most likely to explain variation in innovation performance? and (3) How should those relationships be tested without confusing ecosystem-level rankings with firm-level maturity?

The article is conceptual and diagnostic rather than a report of a new primary survey. Its "results" are the findings of a structured current-state analysis using secondary evidence. The proposed causal relationships have not yet been estimated and are presented as hypotheses for subsequent validation. This separation is deliberate: it preserves the value of recent official and local evidence while avoiding unsupported firm-level causal claims.

2. Analytical Approach and Scope

2.1 Evidence Strategy

The analysis follows an integrative conceptual-review design. Peer-reviewed research was selected to cover five explanatory traditions: the resource-based view and dynamic capabilities; organizational learning and absorptive capacity; digital capability and transformation; collaboration networks and open innovation; and financial and institutional constraints. Priority was given to seminal theory, well-established measurement sources, systematic conceptual work, and recent empirical studies of Vietnamese SMEs. Innovation is interpreted in accordance with the Oslo Manual as a new or improved product or business process that differs significantly from the firm's previous products or processes and has been introduced to users or brought into use (OECD & Eurostat, 2018) [26].

The contextual evidence includes: Hanoi's official enterprise and socio-economic statistics; the 2025 PII report; the 2024 DTI announcement; Hanoi's SME support decisions and 2026–2030 digital-transformation plan; and a published 2023 survey of 534 Hanoi SMEs. The most recent business-flow indicators available at the time of writing cover the first half of 2026. Each indicator is used for the level at which it was measured. Provincial indices describe ecosystem conditions; enterprise-registration data describe market entry and exit; and the 534-firm survey provides indicative, not population-census, evidence of organizational practice.

2.2 Unit of analysis and SME boundary

The proposed empirical unit is the legally registered enterprise operating in Hanoi. SME eligibility should follow Vietnam's Decree No. 80/2021/ND-CP, which classifies micro, small, and medium-sized enterprises by employment together with revenue or capital thresholds that differ between agriculture/industry/construction and trade/services (Government of Vietnam, 2021) [7]. Household businesses are economically important but should not be mixed into the main sampling frame unless they have converted to enterprise status; their reporting systems, governance, and policy eligibility can differ materially.

The focal outcome is firm-level innovation performance, not city-level innovativeness, digital adoption alone, or general financial performance. The respondent should therefore be an owner, chief executive, or senior functional manager who can evaluate innovation decisions and outcomes over a defined period, preferably the preceding three years.

2.3 Evidence boundaries

Three boundaries govern interpretation. First, descriptive indicators do not establish causality. A strong PII or DTI score cannot demonstrate that a particular SME is innovative. Second, the Hanoi digital-transformation survey was conducted in 2023 and does not represent a live estimate for every firm in 2026; it is best treated as a detailed baseline that identifies recurring organizational bottlenecks. Third, policy targets—such as numbers of firms to be supported—are commitments, not achieved outcomes. These distinctions prevent an ecological fallacy and define

the empirical work still required.

3. Theoretical Foundations

3.1 Innovation performance in a digital setting

Innovation is both an outcome and a capability-dependent process. Product and service innovation changes what the firm offers; process innovation changes how it creates or delivers value; marketing innovation changes how it reaches, prices, or engages customers; organizational innovation changes structures and routines; and business-model innovation changes the architecture through which value is created, delivered, and captured. The determinants and effects of these forms operate at several organizational levels and vary with context (Crossan & Apaydin, 2010; Damanpour, 1991) [5, 6]. For SMEs, the forms often overlap. A cloud-based customer system, for example, may initially be a process change, then enable personalized services, new sales channels, and subscription-based revenue.

Digital innovation differs from conventional information-technology investment because digital artifacts are editable, recombinable, data-generating, and capable of connecting multiple actors (Nambisan *et al*., 2017) [23]. Yet digitalization remains an enabling condition, not the dependent variable. A firm may purchase an enterprise-resource-planning module without changing decisions, experimenting, or producing a meaningful new output. Conversely, an SME can innovate through low-cost digital combinations without owning sophisticated infrastructure. The model must therefore distinguish digital capability—the ability to mobilize digital resources—from digital-transformation maturity—the extent to which digital logic is integrated across strategy, processes, people, data, and governance.

3.2 Resources and dynamic capabilities

The resource-based view proposes that performance differences arise from heterogeneous resources whose value cannot be reduced to market availability alone (Barney, 1991) [1]. Human expertise, organizational routines, data, relationships, and reputation can be strategically valuable. However, the resource-based view is less explicit about how a firm renews those assets during technological change. Dynamic-capability theory addresses that problem by emphasizing the processes through which managers sense opportunities and threats, seize opportunities through commitment, and transform the asset base (Teece *et al*., 1997) [29].

This logic is particularly suitable for SMEs. Their limited slack can constrain experimentation, but short decision chains can also make them agile. Leadership attention becomes a scarce allocation mechanism; digital capability supports sensing and coordination; and financial resources create room for experimentation. The relevant question is not only what an SME owns, but whether it can combine and reconfigure what it owns quickly enough to create an innovation.

3.3 Absorptive capacity, human capital, and learning

Absorptive capacity is the ability to recognize the value of external knowledge, assimilate it, and apply it commercially (Cohen & Levinthal, 1990) [4]. Zahra and George (2002) [36] later distinguished potential absorptive capacity—acquisition and assimilation—from realized absorptive capacity—transformation and exploitation. The distinction matters in Hanoi because proximity to universities, research institutions, technology vendors, and government programmes may improve access without guaranteeing use. Knowledge must pass through people and routines before it becomes a new product or process.

Human capital supports that passage. Employees' technical, analytical, creative, and collaborative skills shape the firm's capacity to evaluate information and conduct experiments. Learning orientation encourages shared interpretation, questioning of established assumptions, and the institutionalization of lessons (Calantone *et al*., 2002) [2]. In small firms, a few key employees may carry a disproportionate share of organizational knowledge, making both skill development and retention consequential.

3.4 Networks, finance, and institutions

SMEs frequently innovate beyond their boundaries because they cannot maintain every specialist capability internally. Networks with customers, suppliers, large firms, universities, research institutes, business associations, digital-platform providers, and consultants can supply market signals, technical knowledge, facilities, and routes to commercialization. Empirical research has linked cooperation networks with SME innovation performance, although the benefit depends on the firm's ability to absorb and govern external knowledge (Zeng *et al*., 2010) [37].

Financial constraints operate differently from knowledge constraints. Innovation is uncertain, difficult to collateralize, and often front-loaded, which can restrict external finance and cause otherwise capable firms to scale down projects (Hottenrott & Peters, 2012) [15]. Digital solutions can reduce some experimentation costs, but integration, cybersecurity, data preparation, training, and process redesign still require resources. Finance is therefore expected to enable innovation, while capability determines the productivity of that finance.

Institutional and policy support can reduce information and transaction costs through grants, credit guarantees, tax incentives, standards, shared infrastructure, consulting, training, and brokerage. The effect depends on accessibility, relevance, continuity, and the firm's ability to use support. Vietnamese studies report that government policy can strengthen information-technology capability and innovation, while innovation and resilience transmit part of the performance effect of technology adoption (Mai *et al*., 2024; Trieu *et al*., 2025) [18, 30]. Institutional support is thus neither a substitute for capability nor a background constant; it is an external resource whose usefulness varies across firms.

3.5 Integrated explanatory logic

The proposed framework treats innovation as a conversion process. Leadership supplies direction and tolerance for experimentation. Human capital, digital capability, and absorptive capacity supply the internal means of sensing, learning, and implementation. Networks provide external knowledge and complementary assets. Finance supplies slack and implementation capacity. Institutions lower selected barriers and coordinate the ecosystem. Digital-transformation maturity determines whether digital tools remain isolated applications or become an integrated operating architecture. This complementarity explains why a firm can possess one resource—funding, software, or access to a university—yet still innovate weakly, a central

mechanism in the innovation paradox observed in developing economies (Cirera & Maloney, 2017) [3].

4. Current Conditions of Hanoi SMEs

4.1 Scale, economic role, and business dynamics

Hanoi's SME population is large enough for relatively small capability differences to have material aggregate consequences. By the third quarter of 2025, the city had 422,212 registered enterprises, of which 223,580 were active. SMEs represented 98.2% of registered enterprises, employed 55.1% of the enterprise workforce, and contributed more than 40% of Hanoi's GRDP (Hanoi People's Committee, 2025) [10]. The figures underline two points. First, the typical Hanoi enterprise is an SME, so productivity and innovation policy cannot be confined to a small group of large technology firms. Second, the active-to-registered difference cautions against using the registration stock as a sampling frame without verifying operating status.

The market is also highly dynamic. During the first six months of 2026, Hanoi recorded 19,000 newly established enterprises with VND 397.9 trillion in registered capital, increases of 21.0% and 2.5 times, respectively, from the same period of 2025. Another 7,400 enterprises resumed operation. At the same time, 21,200 temporarily suspended operations and 5,800 dissolved, up 10.0% and 39.0%, respectively (Hanoi Statistics Office, 2026) [12]. Entry and capital formation are therefore recovering, but churn remains pronounced. Among manufacturing enterprises surveyed for the second quarter of 2026, 27.0% reported more difficult conditions than in the preceding quarter, while 25.2% reported improvement and 47.8% stability.

These flows are relevant to innovation in two ways. New entry can increase experimentation and competitive pressure, whereas suspensions and dissolutions may shorten planning horizons and reduce the cash available for uncertain projects. A model that ignores resource slack and environmental pressure would therefore be incomplete. The data also suggest the need to control for enterprise age and to test whether younger firms convert digital opportunities differently from established SMEs.

Table 1: Current-state evidence on Hanoi SMEs and the local innovation environment

Dimension	Current evidence	Interpretation for innovation research
Enterprise base	422,212 registered and 223,580 active enterprises by Q3 2025	Verify active status when constructing a survey frame.
SME weight	98.2% of registered enterprises; 55.1% of enterprise employment; more than 40% of Hanoi GRDP	SME innovation is central to citywide productivity and employment.
New entry	19,000 new enterprises and VND 397.9 trillion registered capital in H1 2026	Recovery expands the population of potential innovators.
Churn	21,200 temporary suspensions and 5,800 dissolutions in H1 2026	Financial resilience and time horizon may condition innovation.
Innovation ecosystem	PII 2025 score 65.68; first nationally for the third year	Strong local conditions do not automatically imply firm-level conversion.
Innovation inputs/outputs	Input score 67.01; output score 64.34	The 2.67-point gap is consistent with a conversion challenge.
Digital ecosystem	DTI 2024 score 0.8241; first among 34 provinces/cities after administrative consolidation	Digital public and ecosystem readiness is high, but firm maturity must be measured separately.
SME digital baseline	In a 2023 survey of 534 Hanoi SMEs, 39.45% had digitized data/processes and 1.58% had mastered analytics/automation	Adoption was concentrated at early stages; advanced use was rare.
Digital finance constraint	43.8% had an insufficient digital-transformation budget and 20.0% had no budget estimate	Financial resources and investment discipline remain plausible determinants.

4.2 A strong innovation ecosystem with weak conversion links

Hanoi scored 65.68 in the 2025 PII and ranked first nationally for the third consecutive year, leading 18 of 52 component indicators (MST, 2025a) [20]. Its input score of 67.01 exceeded its output score of 64.34. The gap is not large enough to imply failure, but the composition is revealing. Human capital and research and development scored 85.27, and market sophistication scored 82.99. In contrast, business sophistication scored only 47.34. Within that pillar, knowledge workers scored 74.22, knowledge absorption 48.78, and innovation linkages only 19.00 (MST, 2025c) [22]. The pattern suggests that Hanoi possesses educated people, research capacity, and market access, but connections among enterprises, research institutions, and other innovation actors are not yet commensurate with those assets. Fig 1 displays the uneven pillar profile behind Hanoi's first-place overall position.

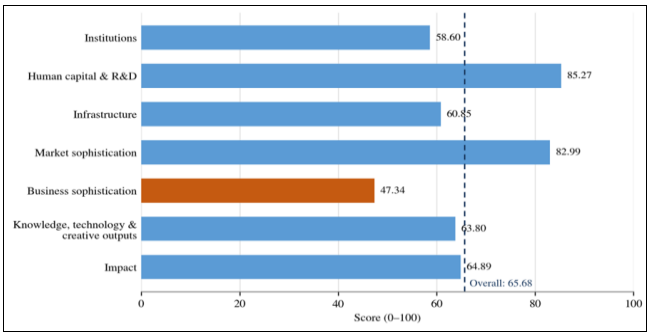

Fig 1: Hanoi's 2025 Provincial Innovation Index pillar scores

The output side reinforces this interpretation. Knowledge creation was very strong, but knowledge diffusion scored 33.43. The production and business impact sub-pillar scored 42.97, far below the socio-economic impact score of 86.81 (MST, 2025c) [22]. These differences should not be treated as

firm-level coefficients; the PII aggregates multiple indicators and institutional levels. Nevertheless, they identify a coherent diagnostic problem: knowledge exists, but its movement into business relationships, operating routines, and scalable commercial results is uneven.

The label "conversion gap" is therefore more precise than "innovation shortage." Hanoi does not primarily lack universities, research activity, skilled labour, or market depth. The weaker elements are the mechanisms that connect them to ordinary SMEs: collaboration quality, absorptive routines, technology integration, commercialization competence, and managerial prioritization. This diagnosis motivates the inclusion of network capability and absorptive capacity alongside digital and financial resources.

4.3 Digital readiness at city level, fragmented transformation at firm level

Hanoi's 2024 DTI score was 0.8241, the highest among 34 provinces and centrally governed cities following administrative consolidation (MST, 2025b) [21]. The city led several dimensions, including digital awareness, digital institutions, digital-economy activity, and digital-society activity. This is an important enabling condition: digital public services, infrastructure, awareness, and market participation can lower transaction costs for firms.

However, a city-level DTI cannot substitute for a firm-level maturity measure. The Hanoi survey conducted by Nguyen *et al*. (2023) [24] illustrates the difference. Among 534 SMEs, 35.75% reported that they had previously used one or more digital-transformation solutions but no longer did so; 39.45% had digitized data and processes; and only 1.58% had mastered management technologies or software for data analysis and automation. The discontinuation rate is as important as the adoption rate. It implies that implementation fit, skills, governance, and realized value—not merely initial access—shape the sustainability of digital change.

Digital use was also functionally uneven. Accounting was the most digitized activity, with nearly 40% of firms reporting high or frequent use. By contrast, 64% reported very little or infrequent software use in vehicle and freight management, and only 18.25% used such software frequently. More than 40% reported no or very little software use in inventory, order, customer, and human-resource management. This pattern is consistent with "islands of digitization": firms automate compliance-oriented or easily standardized tasks while operational and customer data remain disconnected.

Budget evidence points to both scarcity and weak portfolio planning. Fewer than 26.45% of surveyed firms reported a medium-to-fully adequate budget for transformation and external advice. Another 43.8% had prepared a budget but found it insufficient, while 20% had no digital-transformation budget at all (Nguyen *et al*., 2023) [24]. A simple capital-shortage interpretation would be incomplete. An SME that cannot define a transformation roadmap may underbudget because it cannot specify the required process changes, skills, integration, and expected benefits. Financial availability and innovation-oriented leadership should consequently enter the model as separate constructs.

4.4 Policy momentum and the implementation question

Hanoi has moved from general digital awareness to a more structured support agenda. Plan No. 232/KH-UBND, issued on 18 June 2026, sets a 2026–2030 programme for SME digital transformation, including readiness assessment, trial access to solutions, consulting, training, and support for the use of digital platforms, technology, and artificial intelligence (Hanoi People's Committee, 2026) [11]. The programme aims to reach at least 120,000 SMEs by 2030. Decision No. 5418/QD-UBND similarly frames SME support for 2026–2030 around the sector's employment and GRDP contribution (Hanoi People's Committee, 2025) [10].

These initiatives strengthen the plausibility of an institutional-support effect, but programme availability should not be confused with programme additionality. Empirical validation should measure whether a firm knows about relevant support, can access it without disproportionate cost, considers it appropriate to its stage and sector, and changes an innovation decision because of it. Counting training attendance alone may overstate impact if firms lack complementary leadership, staff, data, or finance.

4.5 Results of the current-state analysis

Five findings emerge from the evidence synthesis. First, Hanoi has a large, economically important, and fluid SME base. Innovation policy therefore faces heterogeneous needs and high turnover, not a stable population of uniformly capable firms. Second, the city's innovation system is input-rich: human capital, research and development, market conditions, and digital readiness are comparative strengths. Third, the weakest bridge is organizational and relational. Low innovation-linkage, knowledge-absorption, and knowledge-diffusion scores align with firm-level evidence of disconnected software and limited analytical use. Fourth, digital transformation is often shallow or discontinuous. The problem is not simply whether a tool was purchased, but whether it became embedded in strategy, data, workflows, skills, and governance. Fifth, finance matters, but it is intertwined with managerial clarity and capability. These findings provide the empirical context for the model developed below.

5. Proposed Research Model and Hypotheses

5.1 Dependent construct: innovation performance

Innovation performance is defined as the degree to which an SME has introduced meaningful improvements and achieved results from product/service, process, marketing, organizational, and business-model innovation during the preceding three years. The construct should capture both breadth and realized outcome. Merely generating ideas is insufficient; items should assess implementation, novelty relative to the firm, speed, market or operating contribution, and the share of sales or cost improvement attributable to recent innovations where records permit. A multidimensional specification reduces bias toward manufacturing patents and better reflects Hanoi's service-heavy enterprise structure.

5.2 Innovation-oriented leadership

In SMEs, owners and senior managers often determine technology budgets, external relationships, staffing, and the tolerance for failure. Innovation-oriented leadership is the extent to which leaders articulate an innovation direction, allocate attention and resources, encourage evidence-based experimentation, and coordinate change across functions. Transformational leadership has been associated with

creativity and organizational innovation because it raises intrinsic motivation and shared purpose (Gumusluoglu & Ilsev, 2009) [8]. In a digital setting, leadership must also translate technology possibilities into a sequence of business problems and learning milestones. Without that translation, digital purchases can remain isolated administrative tools.

H1. Innovation-oriented leadership has a positive effect on the innovation performance of Hanoi SMEs.

5.3 Digital capability

Digital capability refers to the firm's ability to select, combine, integrate, secure, and use digital technologies and data in support of business objectives. It includes interoperable systems, data quality and access, analytical competence, cybersecurity discipline, and the ability to work with external technology providers. Research distinguishes the possession of technology from the organizational capability to deploy it; digital capability has been linked with innovation and performance through faster information processing and reconfiguration (Khin & Ho, 2019; Mikalef & Pateli, 2017) [16, 19]. In Hanoi, the functional fragmentation documented in the 534-firm survey makes integration capacity especially salient.

H2. Digital capability has a positive effect on the innovation performance of Hanoi SMEs.

5.4 Absorptive capacity

Absorptive capacity enables an SME to recognize valuable external knowledge, acquire and assimilate it, combine it with existing know-how, and exploit it commercially. Hanoi's dense knowledge environment may increase potential access, but firms vary in search routines, technical language, cross-functional communication, experimentation, and retention. The low PII scores for knowledge absorption and innovation linkages imply that these conversion routines deserve direct measurement rather than being assumed from location.

H3. Absorptive capacity has a positive effect on the innovation performance of Hanoi SMEs.

5.5 Human capital

Human capital comprises employees' relevant technical, digital, managerial, problem-solving, and collaborative knowledge together with the firm's ability to develop and retain it. Skilled employees increase the range of feasible experiments and improve communication with suppliers, consultants, and research organizations. Intellectual capital can support different types of innovation capability, but its value depends on how knowledge is organized and shared (Subramaniam & Youndt, 2005) [28]. For micro and small firms, dependence on a few individuals also makes training and retention critical.

H4. Human capital has a positive effect on the innovation performance of Hanoi SMEs.

5.6 Collaboration-network capability

Collaboration-network capability is not simply the number of contacts a firm possesses. It is the ability to identify suitable partners, establish trust and governance, exchange useful knowledge, coordinate joint work, and appropriate value fairly. Effective relationships with customers and suppliers improve problem definition and feedback; relationships with universities and technology providers can provide specialized knowledge; and ties to large enterprises can provide standards, demand, and routes into supply chains. Prior SME research finds positive innovation effects from cooperation networks, subject to internal capacity and relationship quality (Zeng *et al*., 2010) [37].

H5. Collaboration-network capability has a positive effect on the innovation performance of Hanoi SMEs.

5.7 Financial resource availability

Financial resource availability is the firm's ability to fund experimentation, technology acquisition, process redesign, skills development, intellectual-property protection, and commercialization without placing routine operations at unacceptable risk. Innovation finance is difficult because returns are uncertain and intangible investments offer limited collateral. Hanoi's digital-baseline evidence shows that inadequate or absent budgets remain common. Financial availability should therefore improve the scale, continuity, and speed of innovation activity, although it is expected to be less productive where leadership and absorptive capacity are weak.

H6. Financial resource availability has a positive effect on the innovation performance of Hanoi SMEs.

5.8 Institutional and policy support

Institutional and policy support captures the accessibility, relevance, quality, and continuity of public or publicly enabled assistance for innovation and digital transformation. It includes information, training, consulting, testing facilities, standards, credit support, tax incentives, procurement opportunities, and partner brokerage. Vietnamese evidence suggests that government support can reinforce information-technology capability and innovation, but uptake and effect vary (Mai *et al*., 2024; Trieu *et al*., 2025) [18, 30]. A perception-based measure should be complemented, where possible, with objective indicators of programme participation and the type and value of support received.

H7. Accessible and relevant institutional and policy support has a positive effect on the innovation performance of Hanoi SMEs.

5.9 Digital-transformation maturity

Digital-transformation maturity describes how deeply digital logic is embedded in strategy, leadership, processes, data, people, customer engagement, and governance. It differs from digital capability in level and scope. Capability asks whether the firm can deploy digital resources; maturity asks whether transformation is coordinated, institutionalized, and sustained across the organization. The distinction is supported by Hanoi's coexistence of strong city-level digital readiness and fragmented firm-level use.

Maturity should have a direct effect because integrated data and processes improve visibility, coordination, experimentation, and scaling. It should also strengthen selected capability effects. Digital capability is more likely to generate innovation when systems and data are aligned with strategic priorities. Similarly, absorptive capacity should be more productive when external knowledge can move through connected workflows, shared data, and decision routines.

H8. Digital-transformation maturity has a positive effect on the innovation performance of Hanoi SMEs.

H9a. Digital-transformation maturity positively moderates the relationship between digital capability and innovation

performance, such that the relationship is stronger at higher levels of maturity.

H9b. Digital-transformation maturity positively moderates the relationship between absorptive capacity and innovation performance, such that the relationship is stronger at higher levels of maturity.

5.10 Relative importance and heterogeneity

The current-state analysis implies that money and infrastructure alone cannot close the conversion gap. An internal capability bundle—leadership, digital capability, absorptive capacity, and human capital—should collectively explain more variance in innovation than financial availability alone. This is a comparative hypothesis about predictive contribution, not a claim that finance is unimportant.

H10. The joint contribution of innovation-oriented leadership, digital capability, absorptive capacity, and human capital to innovation performance is greater than the contribution of financial resource availability alone.

Firm size and sector can alter both constraints and feasible innovation forms. Micro firms may rely on the owner and external vendors, while medium-sized firms can support specialized roles and formal routines. Manufacturers may emphasize process and product innovation, whereas service firms may innovate through customer experience, channels, and business models. The structural model should therefore test, rather than assume away, heterogeneity.

H11. The structural relationships in the proposed model differ significantly across enterprise-size and sector groups. Fig 2 summarizes the proposed direct, moderating, comparative, and multi-group relationships.

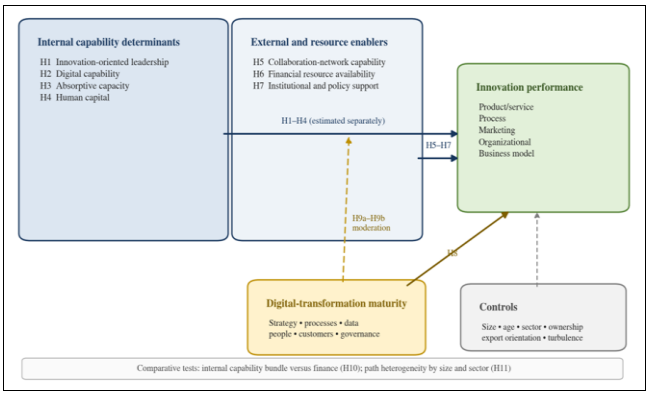

Fig 2: Proposed model of SME innovation in Hanoi's digital-transformation context

Table 2: Summary of proposed hypotheses

Hypothesis	Proposed relationship	Core rationale
H1	Innovation-oriented leadership → innovation performance (+)	Direction, attention, resource commitment, and tolerance for disciplined experimentation
H2	Digital capability → innovation performance (+)	Integration, data use, speed, and scalable recombination of digital resources
H3	Absorptive capacity → innovation performance (+)	Acquisition, assimilation, transformation, and exploitation of external knowledge
H4	Human capital → innovation performance (+)	Technical, digital, managerial, and collaborative competence
H5	Collaboration-network capability → innovation performance (+)	Access to complementary knowledge, standards, demand, and commercialization channels
H6	Financial resource availability → innovation performance (+)	Continuity and scale of experimentation, implementation, and commercialization
H7	Institutional/policy support → innovation performance (+)	Lower information, capability, financing, and coordination barriers
H8	Digital-transformation maturity → innovation performance (+)	Organization-wide integration of strategy, processes, data, people, and governance
H9a	Digital maturity × digital capability → innovation performance (+)	Maturity turns technical capability into coordinated organizational use
H9b	Digital maturity × absorptive capacity → innovation performance (+)	Connected routines accelerate the use of external knowledge
H10	Internal capability bundle > finance alone	Conversion capability should be more predictive than resource volume by itself
H11	Path heterogeneity by size and sector	Resource structures and feasible forms of innovation differ across groups

6. Proposed Empirical Validation

6.1 Staged Design

A two-stage design is recommended. The first stage should consist of 15–20 semi-structured interviews with owners or senior managers from micro, small, and medium enterprises in manufacturing/construction and trade/services, together with selected experts from business associations, technology providers, universities, financial institutions, and public support agencies. The interviews should test construct relevance, identify Hanoi-specific language, clarify the discontinuation of digital tools, and surface sector-specific innovation outcomes. Coding should combine deductive categories from the model with inductive themes, and a decision log should document item changes.

The second stage should be a stratified cross-sectional survey, with a limited time separation between predictors and innovation outcomes if access allows. The sampling frame should contain active enterprises and apply the Decree No. 80/2021/ND-CP thresholds. Proportional or disproportionate stratification can be used by size and broad sector; oversampling medium enterprises and manufacturing firms may be necessary to permit multi-group analysis. Geographic spread across central and peri-urban districts should be monitored because access to networks, logistics, and support organizations may vary.

A target of at least 500 completed questionnaires, with no fewer than 400 usable cases after quality screening, is realistic for a model of this complexity and permits holdout prediction and subgroup comparisons. Statistical power should also be calculated ex ante for the smallest expected

path and the smallest comparison group. One knowledgeable respondent per firm is acceptable for a first test, but a subsample with two respondents or objective indicators would improve validation.

6.2 Questionnaire development and measurement

Items should be adapted from validated scales, translated from English to Vietnamese, independently back-translated, and reviewed by a panel familiar with SME management and digital transformation. Cognitive interviews should examine whether owners interpret terms such as "automation," "analytics," "innovation," and "policy support" consistently. A pilot with 30–50 firms should test completion time, missingness, scale reliability, floor or ceiling effects, and whether sensitive financial questions should be expressed as bands.

All perception items may use a five-point agreement scale for respondent accessibility, while innovation outcomes can use a five-point comparison with major competitors. Wherever feasible, the survey should add objective markers: number of new or significantly improved products, percentage of sales from offerings introduced during the previous three years, process lead-time reduction, training expenditure, digital-investment share, patents or utility solutions, and programme participation. Objective indicators require clear reference periods and "not available" options to avoid fabricated responses.

Table 3: Construct domains and measurement anchors

Construct	Operational domain	Suggested source anchors
Innovation performance	Product/service, process, marketing, organizational and business-model implementation and outcomes	OECD & Eurostat (2018) [26]; Crossan & Apaydin (2010) [5]
Innovation-oriented leadership	Direction, resource commitment, experimentation, cross-functional coordination	Gumusluoglu & Ilsev (2009) [8]; dynamic-capability literature
Digital capability	System integration, data quality/use, analytics, cybersecurity, vendor orchestration	Khin & Ho (2019) [16]; Mikalef & Pateli (2017) [19]
Absorptive capacity	Acquisition, assimilation, transformation, exploitation	Cohen & Levinthal (1990) [4]; Zahra & George (2002) [36]
Human capital	Technical/digital skill, problem solving, learning, retention, knowledge sharing	Subramaniam & Youndt (2005) [28]; Calantone *et al.* (2002) [2]
Collaboration-network capability	Partner search, trust, knowledge exchange, coordination, value appropriation	Zeng *et al.* (2010) [37]
Financial availability	Ability to finance experiments, integration, training, protection and commercialization	Hottenrott & Peters (2012) [15]; Madrid-Guijarro *et al.* (2009) [17]
Institutional/policy support	Awareness, accessibility, fit, quality, continuity, additionality	Mai *et al.* (2024) [18]; Trieu *et al.* (2025) [30]
Digital-transformation maturity	Strategic, process, data, people, customer and governance integration	Vial (2019) [31]; Warner & Wäger (2019) [34]

6.3 Bias control and data quality

Several procedural remedies should be built into fieldwork. The questionnaire should protect confidentiality, state that there are no preferred answers, separate predictor and outcome sections, vary scale anchors where appropriate, and use concise, behaviorally specific wording. If possible, collect predictors and outcomes from different respondents or at two points in time. Response-time checks, straight-lining, contradictory answers, excessive missingness, and duplicate firm identifiers should be screened using pre-specified rules.

Non-response bias can be assessed by comparing early and late respondents and, where frame data are available, respondents and non-respondents on size, sector, district, and age. Common-method variance should not be dismissed solely through Harman's single-factor test. A combination of procedural controls, a marker variable, confirmatory checks, and full-collinearity diagnostics is more defensible (Podsakoff *et al.*, 2003) [27]. The analysis should report exactly which remedies were used and their limitations.

6.4 Structural-model assessment

Partial least squares structural equation modelling (PLS-SEM) is appropriate for the proposed initial test because the study is prediction-oriented, includes moderation, may specify higher-order capability constructs, and requires comparisons across heterogeneous SME groups. The choice should not be justified by small sample size alone. Confirmatory composite analysis should establish the measurement model before structural conclusions are drawn (Hair *et al.*, 2022) [9].

Reflective constructs should be assessed through indicator loadings, internal consistency (rho_A and composite reliability), convergent validity through average variance extracted, and discriminant validity through the heterotrait–monotrait ratio (Henseler *et al.*, 2015) [13]. If innovation performance is modelled as a formative higher-order construct, indicator collinearity, weight significance, relevance, and content coverage must be examined. Structural assessment should report variance inflation factors, standardized path coefficients, bootstrapped confidence intervals based on 10,000 resamples, R-squared, effect sizes, predictive relevance, and out-of-sample prediction using PLSpredict.

Moderation should use standardized or mean-centred product indicators as appropriate, with simple-slope plots at meaningful maturity levels. H10 can be evaluated through incremental predictive contribution, dominance or relative-importance analysis, and nested model comparison rather than by comparing raw path coefficients alone. Before multi-group tests for H11, measurement invariance of composites should be assessed; only then should permutation tests or PLS multi-group analysis compare paths across size and sector (Henseler *et al.*, 2016) [14].

Robustness checks should include alternative innovation specifications, controls for firm age, size, sector, ownership, export orientation, market turbulence, and prior performance, and an assessment of potential endogeneity. A holdout sample or repeated cross-validation should be used for predictive claims. Because cross-sectional data limit causal inference, a follow-up panel after 18–24 months would provide a stronger test of whether capability

development precedes innovation outcomes.

7. Discussion

7.1 Theoretical contribution

The model advances a conversion-based explanation of SME innovation. It does not treat digital transformation as a universal input with an automatic return. Instead, it separates digital capability from transformation maturity and positions both alongside leadership, learning, people, relationships, finance, and institutions. This separation helps reconcile Hanoi's strong provincial rankings with weak firm-level integration: ecosystem readiness increases opportunity, but organizational capabilities determine whether an SME captures it.

The framework also connects absorptive capacity and network capability rather than treating external collaboration as a sufficient condition. A connection to a university, supplier, or large enterprise creates an information channel; absorptive routines determine what passes through that channel and becomes usable. This is consistent with the PII pattern of strong knowledge creation but weak innovation linkages and diffusion. Finally, H10 makes complementarity empirically visible by asking whether an internal capability bundle contributes more than finance alone. The comparison is important for policy because subsidy-centred interventions may disappoint when firms lack leadership clarity, data foundations, or learning routines.

7.2 Managerial implications

For SME managers, the first priority is to define innovation problems before selecting technology. A useful sequence is to identify a customer or operating constraint, establish a baseline, run a limited experiment, evaluate value and risk, and then integrate the successful solution into routine work. This approach reduces the likelihood of purchasing disconnected tools that are later abandoned.

Second, managers should build a minimal data architecture. Even a small firm benefits from consistent customer, order, inventory, supplier, and financial definitions; clear ownership; access controls; and simple dashboards tied to decisions. Integration does not always require an expensive enterprise system, but it does require common identifiers and disciplined processes. The large gap between accounting digitalization and operational or customer-management use in the Hanoi survey indicates that the next gains may come from connecting existing data rather than adding another standalone application.

Third, human and absorptive capacity should be managed deliberately. SMEs can appoint a cross-functional transformation lead, pair operational staff with external specialists, document lessons from pilots, and allocate time for employees to interpret new information. Training should be connected to a live business problem and followed by use; generic attendance is a weak proxy for capability. Fourth, partnership portfolios should be small enough to govern but diverse enough to combine market, technical, and financial knowledge. Clear goals, data-sharing rules, intellectual-property expectations, milestones, and exit conditions can reduce collaboration risk.

Finally, investment decisions should include the full cost of change: data cleaning, integration, cybersecurity, training, workflow redesign, temporary productivity loss, and vendor dependence. A staged investment case with measurable learning milestones is more appropriate for an uncertain innovation than a single technology-purchase budget.

7.3 Policy implications for Hanoi

The current evidence supports a shift from broad awareness to capability conversion. Hanoi's 2026–2030 programme already includes assessment, consulting, trials, and training; implementation should segment firms by maturity, sector, and ambition. An early-stage micro firm needs a different pathway from a medium manufacturer connecting production data to suppliers. Standardized readiness diagnostics can route firms into distinct support packages, but the diagnostic must lead to a practical roadmap and not become a compliance exercise.

Support should be milestone-based. Initial vouchers could fund diagnosis and a small pilot; later support could depend on evidence of adoption, staff use, data governance, or performance improvement. This structure reduces the risk of subsidizing software purchases that are discontinued. Co-financing can preserve managerial commitment while scaled rates protect micro firms from exclusion.

The PII evidence makes brokerage a priority. Hanoi can fund professional intermediaries who translate between SMEs, universities, research institutes, technology providers, large enterprises, and financial institutions. Brokerage outcomes should be measured by completed problem definitions, prototypes, contracts, supply-chain entry, licensing, and commercialized solutions rather than event attendance. Shared testbeds and demonstration facilities can lower the fixed cost of experimentation for manufacturers and service firms alike.

Policy evaluation should distinguish reach, adoption, capability, innovation, and business outcome. The number of firms trained or given accounts is a reach metric. Continued use, integrated processes, improved skill, new products, shorter lead times, and sales from recent innovation are progressively stronger outcome metrics. A linked but privacy-preserving longitudinal database would allow Hanoi to compare supported firms with similar non-participants and learn which intervention bundles work for which SME groups.

8. Limitations and Future Research

This article has four principal limitations. First, its contextual results rely on sources with different units, dates, and methodologies. Triangulation improves diagnosis but does not create a unified dataset. Second, the detailed Hanoi digital-transformation survey reflects 2023 conditions; rapid technology diffusion and policy change may have altered adoption by 2026. Replication with a probability-based or carefully stratified sample is necessary.

Third, the model is deliberately broad. Although this breadth reflects the conversion problem, it may obscure industry-specific mechanisms. Future research should compare knowledge-intensive services, retail and hospitality, traditional manufacturing, construction, and technology firms. It should also examine whether business-model innovation behaves differently from incremental process improvement. Fourth, a single-respondent cross-sectional survey cannot fully resolve common-method bias, reverse causality, or survival bias. Multi-respondent designs, administrative outcomes, and longitudinal waves should be added where feasible.

Further work can test mediation and configurational effects after the core model is established. Institutional support may work partly through digital capability; networks may yield innovation only when absorptive capacity exceeds a threshold; and different combinations of leadership, finance, and maturity may produce comparable outcomes. Longitudinal PLS-SEM, panel regression, or set-theoretic analysis can evaluate these extensions without overloading the first validation study.

9. Conclusion

Hanoi enters the next stage of digital transformation from a position of ecosystem strength. It leads national innovation and digital-readiness rankings, possesses substantial human and research capital, and has a large and economically important SME sector. Yet the available evidence points to a firm-level conversion gap: innovation linkages and knowledge diffusion are weak, digital tools are often fragmented or discontinued, advanced analytics and automation are rare, and investment budgets are frequently inadequate.

The proposed model explains that gap through eight complementary determinants—innovation-oriented leadership, digital capability, absorptive capacity, human capital, collaboration-network capability, financial resource availability, institutional and policy support, and digital-transformation maturity. It further proposes that maturity amplifies the innovation value of digital and absorptive capabilities and that structural effects vary by size and sector. The framework turns a general call for "more digital transformation" into a testable account of how Hanoi SMEs can convert knowledge, technology, relationships, and public support into implemented innovation. Its value will ultimately depend on rigorous field validation, transparent reporting, and a refusal to equate technology adoption with innovation outcomes.

10. References

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