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The emergence of innovation capabilities supporting technological shifts among SMEs: A mediated moderated model

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ABSTRACT

The adoption of innovations to support technological transitions is widely recognized as a key strategic lever for maintaining competitiveness, but while many studies have explored the general determinants of innovation, less is known about the factors that foster the development of innovation capabilities (ICs)—those competencies that enable a systematic approach to innovation. This knowledge gap is particularly evident in the context of small and medium-sized enterprises (SMEs), despite the significant role they play in many national economies, so understanding how SMEs can systematically pursue innovation is therefore crucial for the competitiveness of these economies. To address this gap, this study proposes and tests an interpretative model aimed at predicting the emergence of ICs within SMEs. The model examines how commonly studied determinants of innovation are moderated by two specific antecedents: organizational tools and procedures. Using partial least squares structural equation modeling (PLS-SEM), the study analyzes a sample of innovation-oriented SMEs, with the results showing that economic objectives, available resources, networking, and corporate culture influence SMEs' decisions to invest in organizational tools and procedures that enhance ICs. In fact, organizational tools play a central mediating role, while excessive procedural formalization may hinder flexibility and limit innovation outcomes. This research contributes to clarifying the antecedents of ICs and offers theoretical, practical, and policy insights that are applicable beyond the specific context investigated.

Introduction

Nowadays, it is widely recognized that the adoption and diffusion of technological changes, aimed at making the production of goods and services more efficient and cost-effective, requires a strong orientation toward innovation. Such an orientation is also a key driver of competitiveness at both the national and company levels, enabling differentiation and cost efficiency (Borodako et al., 2023; Farzaneh et al., 2022; Norris & Ciesielska, 2019).

While the systematic adoption of innovation is considered a strategic lever for business success, research is still lacking on the specific skills and competencies, commonly referred to as "innovation capabilities" (ICs), that enable this propensity, particularly among small and medium-sized enterprises (SMEs) (Dayan et al., 2024; Hurtado-Palomino et al., 2022; Tsakalerou et al., 2025).

This research gap largely stems from the considerable heterogeneity that characterizes SMEs, as they differ not only in structural aspects such as size, sector, age, and legal form but also in behavioral and contextual factors, including owner or manager characteristics, stakeholder pressures, and the surrounding business climate (Fu et al., 2021; Hilmersson & Hilmersson, 2021; Zhang, 2022).

In many Western countries, SMEs form the backbone of the economy, and their ability to remain at the forefront of knowledge and maintain a competitive advantage globally often relies on a dense concentration of innovation-oriented SMEs (Aranitou et al., 2024; Audretsch et al., 2023; Faiz et al., 2024). Thus, understanding the elements that foster the emergence of ICs, and therefore the capacity of SMEs to pursue innovation systematically, is of strategic importance (Chaithanapat et al., 2022; Lee, 2023; Saunila, 2020).

Existing research often fails to clearly distinguish between the adoption of innovation and the development of ICs, a conceptual limitation that has contributed to inconsistencies in findings. This

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distinction is especially critical for SMEs, which tend to be more sensitive to economic fluctuations and external shocks. Without clarity on whether their innovations result from isolated responses or from a deliberate long-term strategy, it becomes difficult to design effective managerial or policy interventions (Bashir et al., 2023; Quintero Sepúlveda & Zúñiga Collazos, 2025; Tsakalerou et al., 2025). On the other hand, the emergence of ICs suggests a systematic, enduring, and internally driven capacity that allows SMEs to consistently transform knowledge into innovation outcomes. This study seeks to clarify existing ambiguities and provide a more robust framework to assist in understanding the antecedents of ICs.

While most studies analyze SMEs as a broad, undifferentiated category, this research focuses on a specific group of SMEs, namely those operating within a defined geographic area and already oriented toward ongoing innovation. To this end, a tailored model is developed and empirically tested based on insights from the literature.

The goal of this study is to identify key determinants and best practices related to ICs, irrespective of environmental factors, which often significantly affect SMEs' behavior (Ryan & Daly, 2019; Vlahović et al., 2025; Zhang, 2022). This approach leads to findings that are generalizable beyond the specific context studied and that hold policy relevance at a broader international level. In doing so, the study contributes to the scientific literature by advancing the understanding of the innovation challenges faced by SMEs and by identifying conditions under which ICs are most likely to emerge and thrive.

The remainder of the paper is structured as follows: Section 2 presents the theoretical framework and research hypotheses; Section 3 outlines the methodology; Section 4 reports the results; Section 5 discusses the findings; and Section 6 offers conclusions, implications, limitations, and suggestions for future research.

The theoretical framework

Innovation capabilities

For several decades, eminent scholars (Drucker, 2002; Porter, 1985; Teece, 2017) have recognized that the introduction of innovations within a company is the result of a long-term process that involves adopting new methodologies across various areas, including business operations and production processes, unlike traditional business practices. Such an approach reduces the risk of top–down innovation failure or misalignment with organizational characteristics (Hurtado-Palomino et al., 2022; Lee, 2023; Ryan & Daly, 2019). At the same time, it highlights the internal dynamics through which companies become aware of how innovation impacts their organizational, managerial, and operational models (Norris & Ciesielska, 2019; Osiyevskyy et al., 2025; Passaro et al., 2023).

Not surprisingly, a significant strand of the management literature has focused on identifying the factors that support the ability to approach innovation systematically rather than sporadically, by regularly engaging in innovative problem solving and opportunity identification. The result of this process is the emergence within companies of so-called "innovation capabilities" (ICs).

ICs are commonly defined as "the ability to continuously transform knowledge and ideas into new products, processes, and systems for the benefit of the firm and its stakeholders" (Lawson & Samson, 2001, p. 384). According to Hogan et al. (2011, p. 1266), ICs reflect a firm's ability to apply its collective knowledge, skills, and resources to innovation activities relating to new products, processes, services, or systems in management, marketing, or work organization, in order to generate value for the firm and its stakeholders. Similarly, Edeh et al. (2025, p. 4) describe ICs as "the firm's ability to mobilize and integrate internal and external knowledge to generate novel ideas and transform them into new products, processes, or services that enhance competitiveness in foreign markets." This capacity enables companies to remain at the frontier of knowledge, boost competitiveness, and access promising new markets, without necessarily increasing managerial or operational risks.

Although this study views ICs as a unified construct, it is important to note that, given the broad competencies involved, ICs may also be considered multidimensional. For instance, Hogan et al. (2011) identify three types of ICs: customer-focused ICs, which reflect the ability to develop innovative solutions for clients' needs; marketing-focused ICs, which support the design and implementation of innovative commercial initiatives; and technology-focused ICs, which involve the development and/or application of technologies that lead to new products or services.

While innovation is essential for all types of enterprises, the strategies and approaches adopted vary significantly depending on firm size and structure (Borodako et al., 2023; Norris & Ciesielska, 2019). Large firms often have complex internal research and development (R&D) departments, while SMEs typically lack such infrastructure and rely more heavily on external sources for both resources and essential know-how, while often being less adaptable in rapidly changing environments (Chaithanapat et al., 2022; Osiyevskyy et al., 2025).

Therefore, although expanding ICs is a strategic priority for all companies, the pathways through which these capabilities emerge tend to differ across organizational types (Tsakalerou et al., 2025; Zhang, 2022). Furthermore, depending on the type of innovation (e.g., product vs. process) and its scope (incremental vs. disruptive), additional variables may influence the development of ICs (Ferraro et al., 2025; Zhang, 2022).

This study focuses specifically on how ICs develop within SMEs, in which context research on ICs has generally followed two main directions. The first explores the outcomes of ICs, such as innovation in organization, management, processes, or products (e.g., Innes, 2024; Saunila, 2020), while the second examines ICs as a process, identifying the internal and external drivers that enhance performance in SMEs (e.g., Castela et al., 2018; Ringo et al., 2023).

This study adopts the second perspective in seeking to identify the main categories of determinants that support the emergence of ICs in economic organizations. It proposes a specific framework and corresponding interpretative model grounded in the defining characteristics of SMEs, as outlined in prior research.

The explicative variables

Building on the literature on ICs in SMEs, this study proposes an interpretative model grounded in four key variables most frequently identified as drivers of the development of ICs. Table 1 summarizes previous studies highlighting how these variables influence SMEs' ability to successfully adopt innovations.

The first variable, economic targets, refers to the perceived benefits, both financial and strategic, of innovation, which motivate SMEs to invest in innovation initiatives. Recent studies (Ferraro et al., 2025; Fu et al., 2021) confirm that SMEs are significantly less reactive in adopting innovations when these benefits are not clearly perceived, even in response to legal requirements—an effect that is more pronounced in

Table 1
The key variables.

Variable	Conceptual meaning	Key references
Economic targets	Strategic and economic benefits perceived as incentives for innovation investments.	Lee, 2023; Passaro et al., 2023; Ferraro et al., 2025
Resources	Tangible and intangible enablers of innovation, including financial availability and staff skills.	Osiyevskyy et al., 2025; S. Hafeez et al., 2025; Edeh et al., 2025
Networking	External relationships that facilitate market access, knowledge transfer, and the mitigation of internal limitations.	Dayan et al., 2024; Fang et al., 2022; Hilmersson & Hilmersson, 2021
Corporate culture	Internal orientation toward change, innovation, and risk-taking.	Bokhari et al., 2024; Chaithanapat et al., 2022; Saunila, 2020

SMEs than in larger corporations (Lee, 2023).

The second variable concerns *resources*, defined as the tangible and intangible assets needed to support innovation efforts. Although SMEs tend to be more agile than large companies, they often suffer from limited financial and human resources (Osiyevskyy et al., 2025), though access to funding has improved through public support schemes and the possible presence of private investors such as venture capitalists and business angels (Passaro et al., 2023).

However, digitalization has increased the importance of internal ICT-related skills, as these are now essential for enhancing competitiveness (Edeh et al., 2025; Faiz et al., 2024). Innovation also depends on absorptive capacity—the ability to adapt to external changes by continuously developing new competencies (S. Hafeez et al., 2025; Hurtado-Palomino et al., 2022); however, given their limited workforce, SMEs often assign multiple roles to the same employees, which does not necessarily foster stronger ICs (Chaithanapat et al., 2022).

As previously mentioned, SMEs rarely have internal R&D functions or significant market power; therefore, *networking*, i.e., building strategic relationships with external actors, is essential, as these networks provide access to external knowledge, guide innovation in response to customer needs, and help in overcoming internal constraints such as limited expertise or financing (Dayan et al., 2024; Franco & Esteves, 2020; Hilmersson & Hilmersson, 2021).

The fourth variable is *corporate culture*, specifically the internal mindset that encourages openness to change, innovation, and risk. Recent studies (Bokhari et al., 2024; Ferraro et al., 2025; Saunila, 2020) show that innovative SMEs often cultivate a climate that encourages experimentation and learning, and this culture promotes the exploration of technological or managerial opportunities and facilitates the development of specialized expertise (Fu et al., 2021). Hence, corporate culture can partly explain interfirm differences in innovation behavior (Bokhari et al., 2024; Lam et al., 2021).

The presence of these four variables can be seen as a *sine qua non* condition for advancing along the innovation path and developing ICs; however, to transform innovations into a systematic and repeatable process, two additional variables are essential. These indicate an SME's commitment to embedding innovation within organizational routines, thus moving from occasional to methodical innovation. That is because the systematic innovation process refers to a series of phases that link planned business processes, from business opportunity identification to technology details to cross-industry application exploitation of newly developed technology, tools, and products (Sheu & Lee, 2010).

The first additional variable is the adoption of *formal procedures* for planning and implementing innovations. Such procedures enable companies to integrate innovation consistently into their business routines, ensuring alignment between current performance goals and future competitiveness Faiz et al., 2024; Lee, 2023).

The second additional variable refers to investment in appropriate *organizational tools* that support innovation management. These include both innovation enabling structures (e.g., internal R&D units) and tools for managing knowledge and workflows, many of which are ICT based (e.g., data warehouses, data modeling tools, and search engines) (Chaithanapat et al., 2022; Dayan et al., 2024).

The model and the hypotheses

As previously specified, most existing studies treat the four key variables (economic targets, resources, networking, and corporate culture) as direct predictors of ICs (Ferraro et al., 2025; Geldres-Weiss et al., 2024; Passaro et al., 2023; Tsakalerou et al., 2025). While this approach identifies conditions that encourage the adoption of innovation, it does not necessarily capture the generation of a systematic and sustained innovation capability, which is a hallmark of true ICs.

This study takes a different approach, as it argues that the four basic variables influence ICs indirectly, by fostering investment in *procedures* and *organizational tools*. These investments reflect a deliberate, strategic intent to pursue innovation not sporadically but as an integrated part of business operations.

Accordingly, the proposed interpretative model (Fig. 1) positions procedures and organizational tools as mediating variables. The four foundational variables are expected to influence these mediators, which in turn drive the emergence of ICs. An exception is made for *corporate culture*, which is theorized to have both direct and indirect effects in fostering innovation. As previously discussed, culture fosters openness to change and internal motivation, traits that support investment in innovation infrastructure as well as the direct development of ICs (Bokhari et al., 2024; Lam et al., 2021). Each of the following hypotheses is derived from the conceptual model and supported by the literature reviewed in Section 2.2 and Table 1.

As a result of the foregoing, the following hypotheses are tested:

H1. Economic targets positively affect procedures.
H2. Economic targets positively affect organizational tools.
H3. Resources positively affect procedures.
H4. Resources positively affect organizational tools.
H5. Networking capabilities positively affect procedures.
H6. Networking capabilities positively affect organizational tools.
H7. Corporate culture positively affects procedures.
H8. Corporate culture positively affects organizational tools.
H9. Corporate culture positively affects innovative capabilities.
H10. Procedures positively affect innovative capabilities.
H11. Organizational tools positively affect innovative capabilities.

Data and methodology

Sample selection

To achieve the objectives of this paper and address the inconsistencies and methodological challenges posed by heterogeneous samples—often found in previous research involving SMEs from diverse contexts and structures—we decided to focus on a uniform, clearly defined population. Specifically, the analysis targets SMEs located in the Lazio region of Italy, which are registered in the national *Innovative SMEs Registry*.

The Lazio region, which covers an area of 17,200 square kilometers and is home to approximately 5.8 million residents, lies in central Italy and includes the capital city, Rome. Statistically, the region is considered representative of the nation in terms of economic development and business density.

The *Innovative SMEs Registry*, which was established in 2015 by the Ministry of Economic Development, includes SMEs that meet strict innovation criteria. Unlike self-declared innovation status, registration in this registry requires SMEs to satisfy at least one among several legally defined criteria, such as: (i) consistent and documented investment in R&D; (ii) ownership of patents or proprietary intellectual property; or (iii) employment of highly qualified personnel (e.g., researchers or PhDs). Compliance with these criteria is subject to official verification, and registered SMEs benefit from various forms of institutional support, including tax incentives, facilitated access to financing, and structured networking opportunities.

The empirical phase of this study was conducted in late 2024, at which time the national registry included over 2900 innovative SMEs, 394 of which were based in Lazio. A random sampling method was applied to ensure a representative sample. SMEs with incomplete contact information ($n = 39$) were excluded, reducing the eligible population to 355 firms. From this refined poll, a random sample of 200 firms was selected—corresponding to approximately 56 % of the regional population of innovative SMEs and ensuring adequate statistical representativeness.

Data were collected using a structured questionnaire, divided into seven sections, encompassing closed-ended items rated on a five-point Likert scale (from 1 = strongly disagree to 5 = strongly agree), thus enabling quantifiable analysis. The questionnaire was rigorously

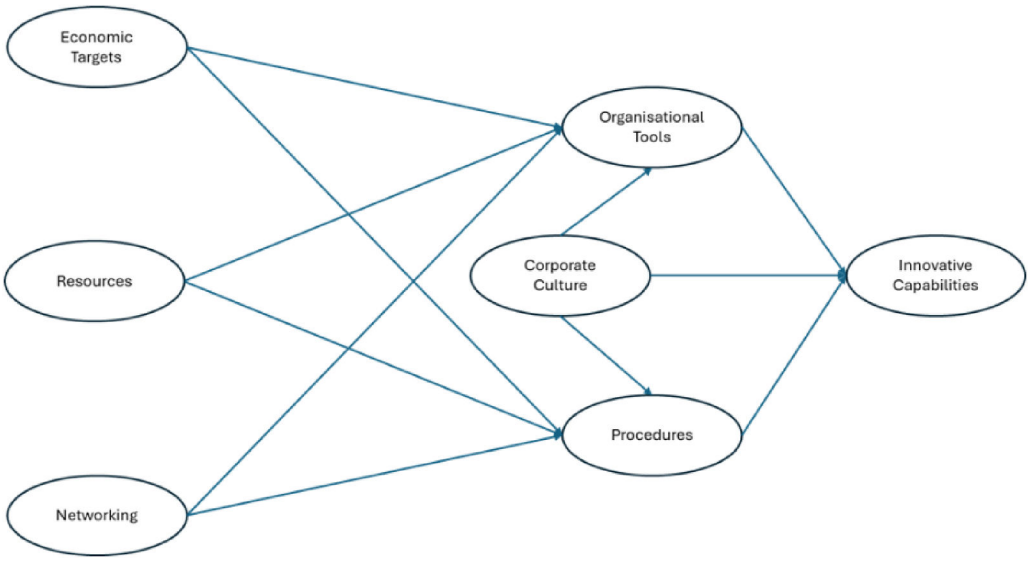

Fig. 1. The interpretative model.

validated by a panel of five experts, consisting of academic scholars and SME executives, and was then further refined through a pilot test with five randomly selected firms to ensure clarity, coherence, and relevance.

Survey invitations were emailed, accompanied by a comprehensive description of the objectives of the study and a link to the online questionnaire. Participants were instructed to assign completion of the questionnaire to the individual most knowledgeable about the SME's innovation strategies, typically the owner or the top manager. Several follow-up messages were sent to increase the response rate. Ultimately, 163 SMEs completed the survey, yielding a response rate of 46 %. The respondents included R&D managers (62 %), chief executive officers (21 %), and chief financial officers (17 %), ensuring a well-rounded and informed sample. Some of the structural features of the sample are presented in Table 2.

Methodology

To empirically validate the proposed theoretical model and test the hypothesized relationships between constructs, partial least squares structural equation modeling (PLS-SEM) was employed using SmartPLS 4. PLS-SEM is a powerful multivariate analysis technique widely used for modeling complex relationships among observed and latent variables. It is particularly well suited to exploratory research, especially in early-stage theory development (Hair et al., 2023). The method distinguishes between two key components: the measurement model and the structural model. The measurement model specifies the relationships between latent constructs and their observed indicators, where each latent construct is an unobserved variable inferred from a set of measured items. These items are encompassed within the latent construct and collectively represent its conceptual domain, enabling the assessment of construct reliability and validity. In this study, the latent constructs correspond to the key factors previously identified and theoretically grounded in the literature. In contrast, the structural model captures the hypothesized causal relationships among the latent constructs themselves. PLS-SEM is also robust to nonnormal data and performs well with smaller samples (Hair et al., 2023).

Table 2
Features of SMEs.

	Frequency (n.)	*Percentage (%)*
Sector		
Trade	12	7.36
Manufacturing	27	16.57
Service	124	76.07
Total	163	100.00
Turnover (thousands of euros)		
0 - 1000	128	78.53
1001 - 5000	28	17.18
>5000	7	4.29
Total	163	100.00
Employees		
0 - 9	102	62.58
10 - 49	54	33.13
50 - 250	7	4.29
Total	163	100.00
Capital		
<100,000	129	79.14
100,001 – 1000,000	27	16.56
>1000,001	7	4.30
Total	163	100.00

This approach was particularly appropriate given the complexity of the model, which incorporates second-order constructs and potentially collinear indicators; however, a standard limitation of PLS-SEM is its treatment of endogeneity, which can lead to biased parameter estimates when an explanatory variable correlates with the error term of the dependent variable.

In this study, we explicitly address the endogeneity of networking, recognizing its dual role as both a cause and an effect of organizational tools and procedures. To mitigate this risk, we applied a Gaussian copula approach: a robust control technique recently adapted for use in PLS-SEM (Sarstedt et al., 2016). This method enables the modeling of potential endogeneity without requiring instrumental variables, which are often difficult to justify in organizational research.

Given that PLS-SEM is a nonparametric estimation method and does not require assumptions about the underlying data distribution, we employed a bootstrapping procedure to assess the statistical significance of the path coefficients. Specifically, bootstrapping with 5000 resamples was performed to generate robust standard errors and confidence intervals, thereby enabling a reliable evaluation of the model's structural relationships (Hair et al., 2023).

Results

Measurement model evaluation

Before analyzing the structural model, we assessed the quality of the reflective measurement models by evaluating reliability and validity indicators.

Internal consistency and indicator reliability

All the considered constructs exhibited strong internal consistency reliability, as evidenced by Cronbach's alpha and composite reliability (CR) values, which exceeded the commonly accepted threshold of 0.70 (Nunnally & Bernstein, 1994). These metrics confirm that the items within each construct consistently represent the same underlying latent variable.

While most outer loadings exceeded the recommended threshold of 0.70, a few items (e.g., Q3, Q8, and Q22) fell within the 0.40–0.70 range. These items were retained for two main reasons: First, they capture theoretically essential dimensions of the constructs, thereby safeguarding content validity and preventing an excessively narrow operationalization of the latent variables; and second, their inclusion did not undermine measurement quality, as all constructs exhibited composite reliability (CR) values above 0.70 and average variance extracted (AVE) values above 0.50, confirming convergent validity. Discriminant validity was likewise preserved, as demonstrated by both the Fornell–Larcker criterion and HTMT ratios (all of which were below 0.85).

In line with established methodological guidance, indicators with loadings between 0.40 and 0.70 may be retained in exploratory research when they are conceptually meaningful and when the overall reliability and validity benchmarks are satisfied (Hair et al., 2019, 2023; Hulland, 1999; Nunnally & Bernstein, 1994). Accordingly, retaining these items ensures the conceptual completeness of the constructs without compromising the robustness of the measurement model.

Convergent validity

Convergent validity was assessed using the AVE, which reflects the

Table 3
Measurement model quality criteria.

Latent construct	*Manifest indicators*	*Loading / weight*	*Cronbach's α*	*CR*	*AVE*	*VIF*	*HTMT* (max)
Corporate culture			0.824	0.868	0.513		0.71
	Q1	0.924				2.98	
	Q3	0.456				1.72	
	Q4	0.938				1.65	
	Q5	0.590				1.51	
	Q6	0.501				1.32	
	Q7	0.928				3.4	
	Q8	0.436				1.21	
Economic targets			0.686	0.808	0.514	1.62	0.69
	Q2	0.782				1.51	
	Q13	0.620				1.54	
	Q17	0.703				1.72	
	Q26	0.751				1.87	
Networking			0.835	0.858	0.418		0.72
	Q9	0.469				1.55	
	Q10	0.665				1.67	
	Q11	0.472				1.32	
	Q12	0.830				1.35	
	Q14	0.662				1.72	
	Q15	0.830				2.09	
	Q16	0.662				1.45	
	Q48	0.717				1.98	
Procedures			0.996	0.997	0.997		0.67
	Q41	0.934				3.22	
	Q42	0.924				2.98	
	Q43	0.947				1.72	
	Q44	0.877				1.87	
	Q50	0.896				2.03	
	Q51	0.935				3.02	
	Q52	0.915				2.93	
Resources			0.956	0.915	0.830		
	Q34	0.664				1.24	
	Q36	0.942				2.94	
	Q37	0.955				3.2	
	Q38	0.925				2.84	
	Q39	0.906				1.72	
	Q40	0.945				2.43	
Organisational tools			0.893	0.915	0.506		
	Q27	0.580				1.34	
	Q28	0.449				1.53	
	Q29	0.454				1.48	
	Q31	0.717				1.72	
	Q32	0.760				1.68	
	Q33	0.706				1.96	
	Q35	0.507				1.86	
	Q45	0.865				1.32	
	Q46	0.865				1.92	
	Q47	0.860				1.64	
	Q49	0.865				1.87	
Innovation capabilities			0.825	0.871	0.515		0.69
	Q19	0.897				1.49	
	Q20	0.782				1.32	
	Q21	0.889				1.54	
	Q22	0.277				1.72	
	Q23	0.587				1.63	
	Q24	0.643				1.93	
	Q25	0.611				1.23	

extent to which a latent construct explains the variance of its observed indicators. All constructs exceeded the recommended AVE threshold of 0.50, indicating that each construct accounts for more than half of the variance in its associated items (Fornell & Larcker, 1981). This confirms that the indicators exhibit a high degree of shared variance and effectively capture the underlying conceptual dimensions they are intended to represent.

Discriminant validity

Discriminant validity was evaluated using two complementary approaches: the Fornell–Larcker criterion and the Heterotrait–Monotrait ratio of correlations (HTMT). According to the former, the square root of each construct's AVE exceeded its correlations with all other constructs, indicating that each latent variable shares more variance with its own indicators than with those of other constructs (Fornell & Larcker, 1981). Additionally, HTMT values for all construct pairs were below the conservative threshold of 0.85, as recommended by Henseler et al. (2015), providing further support for the empirical distinctiveness of the constructs. Together, these results confirm that the latent variables in the model are not only conceptually but also statistically discriminable, which is essential for the validity of the structural path estimations.

Multicollinearity and formative indicator assessment

Multicollinearity among indicators was assessed using the variance inflation factor (VIF). All VIF values were well below the conservative threshold of 3.3, as proposed by Kock and Lynn (2012), indicating an absence of problematic collinearity among indicators and supporting the stability of the measurement model estimates. This suggests that the indicators contribute uniquely to their respective constructs without inflating standard errors or distorting regression weights. In the presence of any formative constructs, indicator weights were examined alongside their significance levels and multicollinearity diagnostics to ensure both theoretical relevance and statistical robustness. This comprehensive assessment affirms the reliability of construct specifications and supports the validity of subsequent structural model inferences.

Table 3 presents the quality criteria of the measurement model. The reported loadings refer to reflective indicators, and the corresponding item labels are detailed in Appendix 1.

As recommended by Hair et al. (2019), indicator loadings are evaluated in conjunction with Jöreskog's CR (Jöreskog, 1971) to assess the internal consistency of reflective constructs. Higher CR values generally indicate a greater degree of shared variance among the indicators and hence stronger measurement reliability. In exploratory research contexts, CR values between 0.60 and 0.70 are deemed acceptable, whereas values in the range of 0.70 to 0.90 are considered satisfactory to good (Hair et al., 2023). However, values approaching or exceeding 0.95 may signal item redundancy, suggesting that the indicators are overly similar and potentially compromise the construct's content validity (Diamantopoulos et al., 2012; Drolet & Morrison, 2001). Excessively high reliability can indicate that the measurement model lacks conceptual breadth, capturing only narrow aspects of the construct rather than its full theoretical domain.

Structural model analysis and endogeneity treatment

To evaluate the structural model, both the explained variance (R^2) of endogenous constructs and the significance of hypothesized relationships were assessed (Table 4). Given that PLS-SEM is a nonparametric estimation method, a bootstrapping procedure with 5000 resamples was employed to generate robust standard errors and confidence intervals (Hair et al., 2023). This approach enables the statistical testing of path coefficients without relying on distributional assumptions, making it particularly suitable for complex models and smaller sample sizes (Table 5).

Table 4
Explained variance (R^2 and adjusted R^2) of endogenous constructs.

Latent construct	R^2	*Adjusted* R^2
Innovative capabilities	0.844	0.841
Procedures	0.918	0.915
Organisational tools	0.933	0.932

The results of the hypothesis testing are summarized in Table 5, which reports standardized path coefficients (β), associated t-values, and significance levels. These coefficients indicate the strength and direction of the relationships between latent variables, and their significance determines whether the hypothesized paths are empirically supported. Although nine of the eleven coefficients are statistically significant, the coefficients for H5 and H10 display signs contrary to those predicted by the theoretical expectations. For this reason, these hypotheses can be considered only partially confirmed.

Copula correction for endogeneity

In the context of this model, *networking* poses a plausible risk of endogeneity due to its conceptual and empirical positioning as both an antecedent and a potential consequence of internal organizational mechanisms. Endogeneity in structural equation models arises when an explanatory latent variable is correlated with the disturbance term in the structural equation, resulting in biased and inconsistent parameter estimates (Antonakis et al., 2010; Hult et al., 2018). In the present model, such bias may stem from simultaneity (e.g., recursive effects between networking activity and procedural or organizational tools), omitted variable bias (e.g., unobserved firm-level capabilities or leadership dynamics influencing both networking and structural alignment), or measurement error inherent in behavioral constructs (Rigdon, 2012).

To address this concern, we implemented a Gaussian copula correction as outlined by Park and Gupta (2012) and subsequently extended to the PLS-SEM framework by Sarstedt et al. (2016). This semiparametric method constructs a copula term by applying the inverse normal transformation to the empirical cumulative distribution function of the residuals obtained from a first-stage regression of the endogenous construct on its predictors. The resulting copula term, under regularity conditions (Sklar, 1959), captures the nonlinear dependency structure between the endogenous regressor and the error term in the structural model without requiring external instruments, thus providing a robust alternative to traditional methods based on instrumental variables, particularly in research domains where valid instruments are difficult to identify (Lewbel, 2012).

In our empirical specification, the copula term for *networking* was incorporated into the structural model as an exogenous covariate. The inclusion of this term did not substantively alter the magnitude, direction, or statistical significance of the associated path coefficients. Specifically, the inverse association between *networking* and *procedures* formalization ($\beta = -0.188, p = 0.018$), as well as its positive relationship with *organizational tools* ($\beta = 0.420$, $p < 0.001$), remained robust and statistically significant after correction. The copula coefficient itself ($\beta = 0.072$, $p = 0.008$) further substantiates the presence of endogenous feedback, affirming the necessity of such correction in latent variable modeling where mutual causation or unobserved confounding is theoretically plausible.

This analytical step enhances the internal validity of the model by mitigating potential estimation bias, thereby strengthening the causal interpretability of the paths involving *networking*. Moreover, it aligns with best-practice recommendations for advanced SEM applications in the presence of endogenous constructs (Benitez et al., 2020; Carrión et al., 2017). The empirical robustness of the findings post-correction lends additional credibility to the hypothesized mechanisms through which external relational assets interact with intraorganizational design and innovation performance.

Table 5
Path coefficients.

		Original sample	*Standard deviation*	*T statistics*	*P values*	*Confirmed / Not Confirmed*
H1	Economic Targets → Procedures	−0.029	0.050	0.583	0.560	*Not Confirmed*
H2	Economic Targets → Organisational Tools	0.245	0.048	5.111	0.000	*Confirmed*
H3	Resources → Procedures	1.068	0.054	19.856	0.000	*Confirmed*
H4	Resources → Organisational Tools	0.449	0.058	7.720	0.000	*Confirmed*
H5	Networking → Procedures	−0.188	0.080	2.359	0.018	*Partially Confirmed*
H6	Networking → Organisational Tools	0.420	0.066	6.372	0.000	*Confirmed*
H7	Corporate Culture → Procedures	0.106	0.060	1.755	0.079	*Confirmed*
H8	Corporate Culture → Organisational Tools	−0.037	0.057	0.654	0.513	*Not Confirmed*
H9	Corporate Culture → Innovative Capabilities	0.755	0.071	10.582	0.000	*Confirmed*
H10	Procedures → Innovative Capabilities	−0.170	0.086	1.964	0.050	*Partially Confirmed*
H11	Organisational Tools → Innovative Capabilities	0.336	0.121	2.775	0.006	*Confirmed*

Indirect effects

The analysis of indirect effects in the PLS-SEM model provides important insights into the internal mechanisms through which the four antecedents (*resources, corporate culture, networking*, and *economic targets*) shape ICs in innovative SMEs. Notably, the findings underscore the central mediating role of organizational tools in translating strategic inputs, such as resource endowments, networking activities, and economic targets, into innovation outcomes (Table 6).

The evidence suggests that the presence of *organizational tools* (such as knowledge management systems, performance monitoring frameworks, and innovation tracking mechanisms) enhances the company's ability to harness its resources for innovation. This aligns with recent scholarship on dynamic capabilities (Al Dhaheri et al., 2024; Farzaneh et al., 2022; Teece, 2017), which emphasizes not only the possession of resources but also the organizational capacity to integrate, reconfigure, and leverage those resources to support innovation in rapidly changing environments.

Table 6
Estimated indirect effects.

Indirect Effects	*Original sample*	*Standard deviation*	*t-statistics*	*P values*	*Confirmed/ Not Confirmed*
Resources → Procedures → Innovation Capabilities	−0.181	0.091	1.992	0.046	*Confirmed*
Corporate Culture → Organizational Tools → Innovation Capabilities	−0.012	0.021	0.580	0.562	*Not Confirmed*
Corporate Culture→ Procedures → Innovation Capabilities	−0.018	0.014	1.251	0.211	*Not Confirmed*
Networking → Organizational Tools → Innovation Capabilities	0.141	0.060	2.364	0.018	*Confirmed*
Economic Targets → Organizational Tools → Innovation Capabilities	0.082	0.036	2.289	0.022	*Confirmed*
Networking → Procedures → Innovation Capabilities	0.032	0.021	1.485	0.138	*Not Confirmed*
Economic Targets → Procedures → Innovation Capabilities	0.005	0.010	0.495	0.620	*Not Confirmed*
Resources → Organizational Tools → Innovation Capabilities	0.151	0.053	2.839	0.005	*Confirmed*

The significant mediating role of *organizational tools* in the relationship between *networking* and innovation reinforces findings in the open innovation literature, which show that external knowledge is most valuable when internal systems are in place to absorb and apply it (Hurtado-Palomino et al., 2022; Lam et al., 2021). In SMEs, where resource constraints are more acute, such tools are essential for capturing value from external relationships and translating it into innovation-relevant practices.

Similarly, the path from *economic targets* through *organizational tools* suggests that the former alone are insufficient unless supported by internal capabilities that allow those goals to be operationalized. This reflects the need for alignment between strategic aims and organizational tools, as emphasized in contemporary studies of innovation governance in SMEs (Chaithanapat et al., 2022; Dayan et al., 2024).

Conversely, the results do not support the effectiveness of *procedures* as mediators in the same relationships. Paths involving *culture, networking*, and *economic targets* through procedures did not yield significant effects on ICs, which may indicate that while formalized procedures play a role in ensuring consistency and standardization, they may not be sufficiently dynamic or flexible to support the iterative and exploratory nature of innovation (Al Dhaheri et al., 2024; Farzaneh et al., 2022). In some cases, the presence of rigid procedures might even hinder the creative processes necessary for innovation to occur—particularly in smaller companies.

Interestingly, a marginal effect was observed in the relationship between *resources* and ICs via *procedures*, though the direction of this effect suggests that formalization might introduce inefficiencies or constraints in how resources are leveraged for innovation. This finding resonates with very recent critiques of overformalization in SME innovation, which argue that procedures can sometimes create inertia or reduce responsiveness (Tsakalerou et al., 2025; Zhao et al., 2025).

Overall, the pattern of results underscores the central role of *organizational tools* in enabling SMEs to convert strategic inputs into innovation outcomes. It also draws attention to the limited—or potentially adverse—role of overly formalized *procedures* in supporting innovation, highlighting the need for striking a balance between structure and flexibility in organizational design (Bokhari et al., 2024; Innes, 2024).

Discussion

A novel aspect of the proposed model is that the four fundamental factors, namely *economic targets, resources, networking*, and *corporate culture*, which are typically considered antecedents of ICs, have been examined in relation to their ability to influence specific investments in *procedures* and *organizational tools* for innovation. In the model, the relationship is not direct (except in the case of corporate culture), as the focus is on how these factors influence the development of *procedures* and *tools* that support the systematic emergence of ICs in SMEs.

This implies that while any of the four antecedent variables could influence the decision to adopt one or more innovations (often mediated by procedures and organizational tools), there is no conclusive evidence

that they directly impact the emergence of ICs. This is because ICs, as defined in the literature, refer to the ability "to continuously transform knowledge and ideas into new products, processes and systems…" (Lawson & Samson, 2001: 384) or "to mobilise and integrate internal and external knowledge to generate novel ideas and transform them into new products, processes or services that enhance competitiveness…" (Edeh et al., 2025, p. 4).

Given that ICs represent skills that evolve over time through learning and systematization processes within an economic organization, we argue that organizational tools and procedures act as critical enablers of ICs rather than innovation per se. ICs entail the internal development of absorptive capacity, enabling SMEs to adapt to a changing external environment; such capacity is nurtured through a systematic orientation toward innovation (S. Hafeez et al., 2025; Hurtado-Palomino et al., 2022). Accordingly, we did not consider it appropriate to test the direct effects of three of the four variables on ICs.

In a nutshell, nine of the eleven hypotheses were supported by findings revealing an intricate interplay between cultural, strategic, and organizational components; therefore, H5 and H10 are only partially confirmed.

The negative—albeit marginal—effect of *procedures* on innovation ($\beta = -0.170$) raises a critical theoretical point: Procedural formalization may enhance consistency, but potentially at the expense of strategic agility and experimentation, both of which are essential for habitual innovation. This finding aligns with the ambidexterity literature, which emphasizes the need for a balance between exploitation and exploration (Ceptureanu et al., 2025; Farzaneh et al., 2022).

On the other hand, it is not surprising that *corporate culture* is significantly associated with ICs, as it reinforces the assumptions underlying the proposed interpretative model—particularly the distinction between the possibility of adopting innovations and developing the organizational capacity to sustain them. An innovation-oriented culture stimulates internal change within SMEs and supports the pursuit of strategic and organizational pathways conducive to adopting innovation, which explains why the significance of *corporate culture* in relation to *procedures for planning and implementing innovations* is consistent with expectations.

The dominant role of *corporate culture* in driving innovation is unequivocal, both statistically and theoretically ($\beta = 0.755$, $p < 0.001$). This is consistent with literature emphasizing trust, openness, and a learning orientation as fundamental enablers of innovation (Bokhari et al., 2024; Tsakalerou et al., 2025). Interestingly, the influence of *culture* on procedures and *organizational tools* was relatively weak or insignificant, suggesting that *culture* acts primarily through behavioral norms and informal coordination, rather than by reshaping formal systems (Faiz et al., 2024).

More specifically, the insignificance of the influence of *corporate culture* on *organizational tools* reinforce the interpretations proposed above. While an innovation-oriented culture may be expected to influence staff mindset and steer the organizational and management model of SMEs towards the systematic adoption of innovations, it does not necessarily ensure that the firm will invest in the corresponding organizational tools. Such investments appear to depend more directly on the presence of the other three antecedent variables considered.

As regard to *networking*, when endogeneity is considered, it plays a dual role—positively influencing *organizational tools* but negatively affecting *procedures*. This finding is conceptually coherent, as external interactions often introduce complexity and novelty, requiring flexible responses that may conflict with rigid internal routines (Ryan & Daly, 2019). The possible tensions between internal structure and external openness are crucial: While *networking* provides access to valuable knowledge and resources, it also introduces demands and cutting-edge procedures that may require flexible solutions. For SMEs, this external complexity can sometimes clash with the application of formalized internal procedures, leading to inefficiencies or resistance from staff. This rationale supports the hypothesis that *networking* capabilities may negatively impact the formalization of *procedures* (H5), as overreliance on external relationships may prevent the company's innovation processes from becoming routine. This interpretation is in line with recent research (Raalskov et al., 2024), which suggests that overly standardized processes can hinder the ability of SMEs to quickly adapt to opportunities driven by external networks.

Similarly, the negative effect on ICs (H10) can be explained by considering the trade-off between standardization and flexibility in SMEs. Although formalized processes ensure consistency, they may impede responsiveness and creativity, two critical attributes for innovation. SMEs frequently compete based on agility, quick adaptation, and informal coordination rather than economies of scale (Bokhari et al., 2024; Ryan & Daly, 2019). Bureaucratic inertia caused by excessive formalization may slow decision-making and discourage exploratory efforts, which is consistent with the ambidexterity literature (Ceptureanu et al., 2025; Raalskov et al., 2024). When resources are limited and markets are changing quickly, overreliance on rigid processes can impede experimentation, limit flexibility, and undermine the company's ability to maintain innovation. Therefore, our results suggest that while *procedures* are important for maintaining coherence, they should remain flexible to avoid interfering with the innovative orientation and dynamic learning processes of SMEs (Tsakalerou et al., 2025; Zhao et al., 2025).

Economic targets were found to impact *organizational tools*, but not *procedures*, which suggests that while strategic clarity drives investments in enabling technologies, it does not necessarily influence the organization of innovative activities, perhaps indicating a gap between vision and implementation.

Resources were found to be significant predictors of both *procedures* and *organizational tools*, highlighting their critical role in supporting the infrastructure and processes necessary for innovation. This aligns with the resource-based view theory, which posits that tangible and intangible resources are central to developing competitive capabilities.

In a nutshell, the proposed model demonstrates high statistical validity in the empirical analysis of *innovative SMEs*. These companies, which are inherently oriented towards innovation, provide strong support for the idea that developing ICs requires a favorable internal environment, shaped over time and driven by a robust cultural foundation. This environment must be supported by adequate tangible and intangible resources, a strong network that compensates for internal limitations, and the motivational drive provided by potential innovation-related benefits. Our findings thus reinforce a well-established perspective in the literature (S. Hafeez et al., 2025; Zhao et al., 2025).

Ultimately, the proposed interpretative framework offers a clear understanding of how innovative SMEs develop the ICs necessary for systematically implementing innovations. This differs from studies that focus on identifying the generic determinants of innovation adoption, which tend to be of an opportunistic nature and not necessarily reflective of a sustained orientation towards innovation as embodied in ICs.

Conclusions

This study proposed an interpretative framework to explain how innovative SMEs develop ICs that support a systematic orientation towards innovation and technological change. It examines the influence of four basilar factors, namely *economic targets, resources, networking*, and *corporate culture*, on SMEs' investments in *procedures* and *organizational tools*, which, in turn, contribute to the emergence of ICs. The study differentiates between the determinants that influence innovation adoption and the structural and cultural conditions that enable the systematic development of ICs.

The findings reveal that *corporate culture* plays a central role in sustaining ICs, while *organizational tools* serve as key mediators in translating strategic and relational inputs into innovation outcomes. In contrast, excessive reliance on formalized *procedures* may impede the

flexibility and dynamic learning needed for innovation in SMEs.

This study makes two primary contributions to the existing literature. First, it clarifies the distinction between innovation adoption and the emergence of ICs: Innovation adoption can be sporadic or reactive, while ICs represent the structural and cultural foundations that support systematic innovation. This clarification helps explain the mixed findings in prior research. Second, by focusing on a homogeneous sample of innovation-oriented SMEs, this study offers a pathway that other SME populations in different contexts or sectors could potentially follow. The study also offers multiple implications for both theory and practice.

Theoretical implications

This study focused on the difference between general innovation adoption and the emergence of ICs. While innovation adoption may occur occasionally or in response to outside circumstances, ICs represent the organizational capacity for sustained innovation in a systematic way. This distinction, often overlooked in prior studies, helps explain the mixed results in the literature regarding the determinants of innovation. Many earlier studies did not account for the difference between sporadic adoption and long-term capability building, a distinction that our model explicitly incorporates.

Furthermore, the proposed model distinguishes between factors that support innovation itself and those that foster the foundational conditions for SMEs to develop autonomous ICs, such as procedures and organizational tools. The presence of these two elements reflects a company's commitment to approaching innovation in a systematic way. This conceptual distinction addresses a gap in existing research, which often confuses innovation arising from embedded ICs with opportunistic responses to external events.

The study also contributes to the literature by validating the model using a population of innovative SMEs, which are likely to have already developed the necessary mindset, procedures, and capabilities to enhance internal ICs. As a result, the proposed model can serve as a potential benchmark for comparison with other SME samples, providing a foundation for future research that separates the general determinants of innovation from those specifically related to sustaining innovation.

From a methodological perspective, the research demonstrates the importance of using Gaussian copula corrections within PLS-SEM to account for endogeneity, which is a significant concern in studies involving behavioral constructs and reciprocal causality.

From a theoretical standpoint, the results affirm that innovation thrives more on cultural alignment than on formal procedures. Networking plays a critical yet ambivalent role, offering access to resources while potentially disrupting internal order. Managers should therefore cultivate a culture of trust and experimentation, leverage external networks judiciously, and maintain flexible structures that enable—rather than constrain—innovation.

The nature of SMEs devoted to systemic innovation presupposes the presence of continuously renewing ICs. Trying to imitate the paths followed by these SMEs as well as understanding the processes involved in renewing skills represents an unprecedented strand of studies, which is clearly separated from the extension of approaches applied by large companies with different resources, objectives, and contractual power.

Practical implications

From a managerial and policy perspective, this research offers several actionable recommendations intended to support the emergence of ICs in SMEs. It is advisable to encourage innovation-oriented corporate cultures through organizational development and leadership training, which will help managers support innovative ideas and cultivate a mindset conducive to continuous learning. SMEs can also implement incentive programs that reward staff for creative solutions, such as career development opportunities, profit-sharing plans, and recognition awards.

It is important to foster creativity through informal structures, and for smaller companies, activities like weekly brainstorming sessions or informal cross-functional workshops can achieve this. Medium-sized SMEs, however, may benefit from more structured approaches, such as collaborative digital platforms for co-creation and knowledge sharing.

SMEs should be encouraged to invest in digital systems and knowledge management solutions that facilitate innovation. Networking opportunities are also important, as they provide access to valuable knowledge and act as incentives for skills development. Furthermore, SMEs should also be encouraged to maintain a strategic focus on innovation outcomes, especially in situations where financial resources are limited.

As regards context-specific strategies, these recommendations should be tailored to the size and sector of the SME—for example, micro and small businesses may benefit from low-cost cloud-based tools, while medium-sized SMEs could invest in more advanced ICT systems or create internal innovation teams. Manufacturing SMEs might focus on process-oriented systems, while service SMEs could prioritize customer-oriented tools.

From a social and policy standpoint, the findings align with existing measures that support SME innovation, such as tax credits for R&D expenditures and digital innovation hubs that make it easier for SMEs to access technological know-how. These programs can remove barriers to acquiring resources and promote cultural shifts that support innovation.

Policymakers should ensure that these measures cater to the structural diversity of SMEs, from micro-scale businesses needing flexible solutions to larger SMEs requiring more formalized innovation infrastructures.

Finally, networking emerged as a key strategic lever for innovation in SMEs. Given the interconnectedness of the factors studied, we hypothesize that improving ICs requires a balanced approach that integrates internal organizational tools and external relationships.

A consequence of the above assumptions is that to increase the degree of internal ICs, management must raise employees' awareness of the importance of systematic innovations, including by equipping itself with adequate internal procedural or organizational tools, but without necessarily involving tangible investments or the creation of a research and development function. Frugal innovation is a typical alternative to more structured modes of innovation and is therefore not always suitable for all small and very small enterprises. A second finding is that the continuous monitoring of stakeholders can be the first aspect that determines or stimulates the introduction of changes in a broad sense in the company. These changes often translate into real innovations. A third finding underlines the responsibilities of public institutions in promoting cultural models conducive to innovation and change in general, given the crucial importance of corporate culture highlighted in this study. Table 7 summarizes possible managerial and policy-oriented implications.

Limitations and future research

Although the study benefits from a homogeneous and internally consistent sample of Italian innovative SMEs, this limits the generalizability of the findings. Cultural and institutional factors, such as national policies supporting innovation, the strength of regional innovation ecosystems, or prevailing managerial attitudes toward risk, may significantly influence the emergence of innovation capabilities in other contexts. Consequently, while the findings provide valuable insights into the Italian SME setting, caution is needed when applying these findings to different institutional environments. Additionally, the proposed model does not consider the temporary stimuli or compliance obligations introduced by policymakers, which could influence SMEs' behavior.

Another limitation lies in the breadth and consistency of the foundational factors identified in the literature. For instance, some interpretations of resources may exclude financial capital, while

Table 7
Actionable implications for SMEs by company size.

SME size	Organisational culture and leadership	Organisational tools and resources	Networking and policy support
Micro (<9 employees)	- Promote participatory decision making involving all staff - Encourage informal brainstorming sessions - Provide basic leadership training in creativity and experimentation	- Adopt low-cost cloud-based tools for collaboration - Use simple digital platforms for knowledge sharing	- Participate in local clusters - Leverage regional grants and vouchers for digitalization
Small (10–49 employees)	- Recognise internal reward for innovative ideas - Organise targeted training on innovation management - Encourage cross-functional teamwork	- Invest in lightweight knowledge management systems - Use open-source project management tools	- Join innovation networks - Access EU funded programs
Medium (50–250 employees)	- Establish dedicated innovation teams - Develop structured leadership programs emphasizing ambidexterity - Introduce innovation key performance indicators in performance evaluation	- Invest in advanced ICT systems for R&D and data analytics - Implement formalised project management methodologies	- Implement strategic alliances with universities and research centers - Access tax credits and R&D incentives promoted by national governments

networking might focus on economic actors but neglect the role of public institutions like universities and research centers.

Additionally, this study views ICs as a unitary phenomenon, whereas other researchers argue that ICs could be disaggregated into multiple components, each varying in importance depending on the type of innovation. Furthermore, the differences between SMEs and larger firms in their approach to ICs suggest that the model may not be suitable for larger companies.

Future research should seek to replicate the model in different territorial contexts, taking into consideration both homogeneous and heterogeneous characteristics, to evaluate the model's applicability to SMEs in different settings. Expanding the framework to capture the internal processes of different SME types (distinguished by sector, size, legal form, etc.) would enhance its relevance. Cross-national studies could improve external validity and offer valuable insights for policymakers working in diverse environments.

CRediT authorship contribution statement

Giovanna Ferraro: Writing – review & editing, Writing – original draft, Validation, Software, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Giuseppe Scandurra:** Writing – review & editing, Writing – original draft, Validation, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Antonio Thomas:** Writing – review & editing, Writing – original draft, Visualization, Validation, Methodology, Investigation, Formal analysis, Conceptualization.

Declaration of competing interest

In relation to the paper titled: "The emergence of innovation capabilities supporting technological shifts among SMEs: a mediated moderated model" by Giovanna Ferraro, Giuseppe Scandurra, Antonio Thomas, submitted to Journal of Innovation & Knowledge, the authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Questionnaire items

Construct	Item	Statement (5-point Likert scale)
Corporate culture	Q1	The company personnel have an inclination for innovation.
	Q2	Increasing turnover and financial ratios is an explicit strategic goal.
	Q3	The company is constantly oriented towards shared goals among personnel.
	Q4	The company encourages staff proposals.
	Q5	The company is open to strategic changes.
	Q6	The company critical analysis of its own weaknesses.
	Q7	The company is prone toward risk-taking.
	Q8	The company provides incentives to staff for innovation changes and new ideas.
	Q13	Meeting customer loyalty is a primary driver of the company activities.
	Q17	Innovation initiatives are aimed at improving competitiveness.
	Q26	Innovation investments are guided by economic and financial benefits.
Resources	Q34	The staff have the competencies required to support innovation.
	Q36	The company constantly reviews its resource requirements.
	Q37	The company develops the capacity to manage risks associated with innovation.
	Q38	The company dedicates stable financial resources to innovation.
	Q39	Staff is encouraged to improve its competencies.
	Q40	The company checks the availability of grants and subsidies to innovations.
Networking	Q9	The management regularly interacts with suppliers.
	Q10	The management analyse customer needs when designing products/services.
	Q11	Customer feedback is regularly collected and analyzed.
	Q12	The management continuously monitors innovation providers (R&D centers).
	Q14	Marketing policies are oriented towards supporting innovation.
	Q15	The management actively searches for new market areas opportunities.
	Q16	The company maintains relationships with competitors.
	Q48	The management collaborates with support services providers.

(*continued on next page*)

(*continued*)

Procedures	Q41	There are structured processes for generating innovative ideas.
	Q42	Clear procedures are placed to select and adopt innovations.
	Q43	The company develops commercialization plans for innovations.
	Q44	The company systematically analyse the potential of innovation projects.
	Q50	There are formal procedures for managing innovative ideas.
	Q51	Innovation projects are managed through formalized procedures.
	Q52	The management conducts ex-post analyses of innovation projects effectiveness
Organizational tools	Q27	Dedicated teams are established to manage innovation initiatives.
	Q28	Responsibilities for innovation are clearly delegated and assigned.
	Q29	The organizational structure supports innovation.
	Q31	The company has a clear know-how management policy.
	Q32	Knowledge management tools are used to support innovation.
	Q33	Tools for protecting intellectual property are in place.
	Q35	The company has a R&D function.
	Q45	The company conducts time-to-market analyses for new projects.
	Q46	The company continuously adopts improvement practices.
	Q47	Resource requirements are analyzed in advance.
	Q49	Specific resources are dedicated to supporting innovation.
Innovation capabilities	Q19	The company routinely transform ideas into new products, processes, or services.
	Q20	The company is able to monitor market developments.
	Q21	The company adopts business models oriented towards innovation.
	Q22	The company pursues a strategic planning aimed at innovation.
	Q23	The company constantly updates its business model.
	Q24	The company uses tools to support innovation.
	Q25	The company encourages internal capabilities enrichment.

References

Al Dhaheri, M. H., Ahmad, S. Z., & Papastathopoulos, A. (2024). Do environmental turbulence, dynamic capabilities, and artificial intelligence force SMEs to be innovative? *Journal of Innovation & Knowledge, 9*(3), Article 100528. https://doi.org/10.1016/j.jik.2024.100528

Antonakis, J., Bendahan, S., Jacquart, P., & Lalive, R. (2010). On making causal claims: A review and recommendations. *The Leadership Quarterly, 21*(6), 1086–1120. https://doi.org/10.1016/j.leaqua.2010.10.010

Aranitou, V., Manioudis, M., & Angelakis, A. (2024). *The economic impact of small and medium-sized enterprises, analytical approaches to growth and innovation challenges amid crises in europe*. Macmillan Cham: Palgrave. https://doi.org/10.1007/978-3-031-74554-6

Audretsch, D. B., Belitski, M., Caiazza, R., & Phan, P. (2023). Collaboration strategies and SME innovation performance. *Journal of Business Research, 164*, Article 114018. https://doi.org/10.1016/j.jbusres.2023.114018

Bashir, M., Alfalih, A., & Pradhan, S. (2023). Managerial ties, business model innovation & SME performance: Moderating role of environmental turbulence. *Journal of Innovation & Knowledge, 8*(1), Article 100329. https://doi.org/10.1016/j.jik.2023.100329

Benitez, J., Henseler, J., Castillo, A., & Schuberth, F. (2020). How to perform and report an impactful analysis using partial least squares: Guidelines for confirmatory and explanatory IS research. *Information & Management, 57*(2), Article 103168. https://doi.org/10.1016/j.im.2019.05.003

Bokhari, S. A. A., Ali, M., Yaqub, M. Z., Salam, M. A., & Park, S. Y. (2024). Moderating role of national culture on the association between organizational culture and organizational commitment among SME's personnel. *Journal of Innovation & Knowledge, 9*(4). https://doi.org/10.1016/j.jik.2024.100623

Borodako, K., Berbeka, J., Rudnicki, M., & Łapczyński, M. (2023). The impact of innovation orientation and knowledge management on business services performance moderated by technological readiness. *European Journal of Innovation Management, 26*(7), 674–695. https://doi.org/10.1108/EJIM-09-2022-0523

Castela, B. M., Ferreira, F. A., Ferreira, J. J., & Marques, C. S. (2018). Assessing the innovation capability of small-and medium-sized enterprises using a non-parametric and integrative approach. *Management Decision, 56*(6), 1365–1383. https://doi.org/10.1108/MD-02-2017-0156

Carrión, G. C., Nitzl, C., Roldán, J. L., & Latan, H. (2017). Mediation Analyses in Partial Least Squares Structural Equation Modeling: Guidelines and Empirical Examples. In R. Noonan (Ed.), *Partial least squares path modeling*. Cham: Springer. https://doi.org/10.1007/978-3-319-64069-3_8.

Ceptureanu, S., Ceptureanu, E., Ferraro, G., & Thomas, A. (2025). Investigating the link between eco-innovation ambidexterity and performances in low-end markets. Does frugal innovation matter?. *Business strategy and the environment*. Wiley. https://doi.org/10.1002/bse.70212

Chaithanapat, P., Punnakitikashem, P., Oo, N. C. K. K., & Rakthin, S. (2022). Relationships among knowledge-oriented leadership, customer knowledge management, innovation quality and firm performance in SMEs. *Journal of Innovation & Knowledge, 7*, Article 100162. https://doi.org/10.1016/j.jik.2022.100162

Dayan, M., Di Benedetto, C. A., Dayan, B., Al Rumaithi, E., & Al Zahmi, R. (2024). Roles of the degree of internationalization and organizational unlearning on the joint innovation capabilities-exploratory innovation relationship. *Journal of Innovation & Knowledge, 9*(4), Article 100614. https://doi.org/10.1016/j.jik.2024.100614

Diamantopoulos, A., Sarstedt, M., Fuchs, C., Wilczynski, P., & Kaiser, S. (2012). Guidelines for choosing between multi-item and single-item scales for construct measurement: A predictive validity perspective. *Journal of the Academy of Marketing Science, 40*(3), 434–449. https://doi.org/10.1007/s11747-011-0300-3

Drolet, A. L., & Morrison, D. G. (2001). Do we really need multiple-item measures in service research? *Journal of Service Research, 3*(3), 196–204. https://doi.org/10.1177/10946705013300

Drucker, P. F. (2002). The discipline of innovation. *Harvard Business Review, 80*(8), 95–102.

Edeh, J., Olarewaju, A. D., & Kusi, S. Y. (2025). What drives SME export intensity in transition economies? The role of infrastructure, digitalisation and innovation capabilities. *Technological Forecasting & Social Change, 215*, Article 124123. https://doi.org/10.1016/j.techfore.2025.124123

Faiz, F., Viet, L., & Masli, E. K. (2024). Determinants of digital technology adoption in innovative SMEs. *Journal of Innovation & Knowledge, 9*(4), 1–20. https://doi.org/10.1016/j.jik.2024.100610

Fang, G. G., Qalati, S. A., Ostic, D., Shah, S. M. M., & Mirani, M. A. (2022). Effects of entrepreneurial orientation, social media, and innovation capabilities on SME performance in emerging countries: A mediated–moderated model. *Technology analysis & strategic management, 34*(11), 1326–1338. https://doi.org/10.1080/09537325.2021.1957816

Farzaneh, M., Wilden, R., Afshari, L., & Mehralian, G. (2022). Dynamic capabilities and innovation ambidexterity: The roles of intellectual capital and innovation orientation. *Journal of Business Research, 148*, 47–59. https://doi.org/10.1016/j.jbusres.2022.04.030

Ferraro, G., Passaro, R., Quinto, I., & Thomas, A. (2025). The process supporting the emergence of the environmental innovation capabilities within small businesses: An empirical investigation. *Business strategy and the environment*. Wiley. https://doi.org/10.1002/bse.4015

Fornell, C., & Larcker, D. F. (1981). Evaluating Structural Equation Models with Unobservable Variables and Measurement Error. *Journal of Marketing Research, 18*(1), 39–50. https://doi.org/10.2307/3151312

Franco, M., & Esteves, L. (2020). Inter-clustering as a network of knowledge and learning: Multiple case studies. *Journal of Innovation & Knowledge, 5*(1), 39–49. https://doi.org/10.1016/j.jik.2018.11.001

Fu, Q., Sial, M. S., Arshad, M. Z., Comite, U., Thu, P. A., & Popp, J. (2021). The Inter-Relationship between Innovation Capability and SME Performance: The Moderating Role of the External Environment. *Sustainability, 13*(16), 9132. https://doi.org/10.3390/su13169132

Geldres-Weiss, V. V., Monreal-Pérez, J., & Massa, N. P. (2024). Exploring exporting firms' adaptability and competitiveness configurations in relation to export customer satisfaction in COVID-19 Times. *Journal of Competitiveness, 16*(2), 1–19. https://doi.org/10.7441/joc.2024.02.02

Hafeez, S., Shahzad, K., & De Silva, M. (2025a). Enhancing digital transformation in SMEs: The dynamic capabilities of innovation intermediaries within ecosystems. *Long Range Planning, 58*(3). https://doi.org/10.1016/j.lrp.2025.102525

Hafeez, S., Shahzad, K., Helo, P., & Faraz Mubarak, M. (2025b). Knowledge management and SMEs' digital transformation: A systematic literature review and future research agenda. *Journal of Innovation & Knowledge, 10*(3). https://doi.org/10.1016/j.jik.2025.100728

Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European Business Review, 31*(1), 2–24. https://doi.org/10.1108/EBR-11-2018-0203

Hair, J. F., Sarstedt, M., Ringle, C. M., & Gudergan, S. P. (2023). *Advanced issues in partial least squares structural equation modeling* (2nd ed.). Thousand Oaks, CA: SAGE Publications. ISBN: 9781071862513.

Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A New Criterion for Assessing Discriminant Validity in Variance-Based SEM. *Journal of the Academy of Marketing Science, 43*(1), 115–135. https://doi.org/10.1007/s11747-014-0403-8

Hilmersson, F. P., & Hilmersson, M. (2021). Networking to accelerate the pace of SME innovations. *Journal of Innovation & Knowledge, 6*(1), 43–49. https://doi.org/10.1016/j.jik.2020.10.001

Hogan, S. J., Soutar, G. N., McColl-Kennedy, J. R., & Sweeney, J. C. (2011). Reconceptualizing professional service firm innovation capability: Scale development. *Industrial Marketing Management, 40*(8), 1264–1273. https://doi.org/10.1016/j.indmarman.2011.10.002

Hulland, J. (1999). Use of partial least squares (PLS) in strategic management research: A review of four recent studies. *Strategic Management Journal, 20*(2), 195–204. https://doi.org/10.1002/(SICI)1097-0266(199902)20:2<195. AID−MJ13>3.0.CO;2-7.

Hurtado-Palomino, A., De la Gala-Velásquez, B., & Ccorisapra-Quintana, J. (2022). The interactive effect of innovation capability and potential absorptive capacity on innovation performance. *Journal of Innovation & Knowledge, 7*(4), Article 100259. https://doi.org/10.1016/j.jik.2022.100259

Hult, G. T. M., Hair, J. F., Proksch, D., Sarstedt, M., Pinkwart, A., & Ringle, C. M. (2018). Addressing endogeneity in international marketing applications of partial least squares structural equation modeling. *Journal of International Marketing, 26*(3), 1–21. https://doi.org/10.1509/jim.17.0151

Innes, M. L. (2024). Exploring individual foresight: Implications for organizational learning and innovation in firms. *Journal of Innovation & Knowledge, 9*(4), 100604. https://doi.org/10.1016/j.jik.2024.100604

Jöreskog, K. G. (1971). Simultaneous factor analysis in several populations. *Psychometrika, 36*(4), 409–426. https://doi.org/10.1007/BF02291366

Kock, N., & Lynn, G. S. (2012). Lateral collinearity and misleading results in variance-based SEM. *Journal of the Association for Information Systems, 13*(7), 546–580. https://doi.org/10.17705/1jais.00302

Lam, L., Nguyen, P., Le, N., & Tran, K. (2021). The relation among organizational culture, knowledge management, and innovation capability: Its implication for open innovation. *Journal of Open Innovation: Technology, Market, and Complexity, 7*(1), 66. https://doi.org/10.3390/joitmc7010066

Lawson, B., & Samson, D. (2001). Developing Innovation Capability in Organisations: A Dynamic Capabilities Approach. *International Journal of Innovation Management, 5*(3), 377–400. https://doi.org/10.1142/S1363919601000427

Lewbel, A. (2012). Using heteroscedasticity to identify and estimate mismeasured and endogenous regressor models. *Journal of Business & Economic Statistics, 30*(1), 67–80. https://doi.org/10.1080/07350015.2012.643126

Lee, J.-W. (2023). Influence of technological innovation characteristics on the survival period of SMEs in the service industry: Evidence from Korea. *Journal of Innovation & Knowledge, 8*(4), Article 100422. https://doi.org/10.1016/j.jik.2023.100422

Norris, D., & Ciesielska, M. (2019). Towards a framework for innovation orientation within business and management studies: A systematic review and paths for future research. *Journal of Organizational Change Management, 32*(1), 123–144. https://doi.org/10.1108/JOCM-02-2018-0051

Nunnally, J. C., & Bernstein, I. H. (1994). *Psychometric theory* (3rd ed.). McGraw-Hill.

Osiyevskyy, O., Sinha, K., Shirokova, G., & Shtepa, S. (2025). Innovation capabilities decoded: Risks and rewards in small and medium enterprise performance. *European Management Journal*. https://doi.org/10.1016/j.emj.2025.01.011

Park, S., & Gupta, S. (2012). Handling endogenous regressors by joint estimation using copulas. *Marketing Science, 31*(4), 567–586. https://doi.org/10.1287/mksc.1120.0718

Passaro, R., Quinto, I., Scandurra, G., & Thomas, A. (2023). The drivers of eco-innovations in SMEs: A systematic literature review and research directions. In *Business strategy and the environment, 32*. https://doi.org/10.1002/bse.3197

Porter, M. E. (1985). Technology and Competitive Advantage. *Journal of Business Strategy, 5*(3), 60–78. https://doi.org/10.1108/eb039075

Quintero Sepúlveda, I. C.&, & Zúñiga Collazos, A. (2025). Innovation capabilities, innovation strategies and performance: An empirical analysis in SMEs. *Technology Analysis & Strategic Management, 37*(1), 19–34. https://doi.org/10.1080/09537325.2023.2280523

Raalskov, J., Schlichter, J., Haug, A., & Klyver, K. (2024). The incompatibility of entrepreneurial orientation and process improvement. *Entrepreneurship & Regional Development, 36*, 7–8. https://doi.org/10.1080/08985626.2024.2310112

Ryan, J. C., & Daly, T. M. (2019). Barriers to innovation and knowledge generation: The challenges of conducting business and social research in an emerging country context. *Journal of Innovation & Knowledge, 4*(1), 47–54. https://doi.org/10.1016/j.jik.2017.10.004

Rigdon, E. E. (2012). Rethinking partial least squares path modeling: In praise of simple methods. *Long Range Planning, 45*(5–6), 341–358. https://doi.org/10.1016/j.lrp.2012.09.010

Ringo, D. S., Tegambwage, A. G., & Kazungu, I. (2023). Innovation capabilities and export performance of SMEs: Does managers' risk-taking propensity matter? *Journal of Money and Business, 3*(1), 74–88. https://doi.org/10.1108/JMB-10-2022-0053

Sarstedt, M., Hair, J. F., Ringle, C. M., Thiele, K. O., & Gudergan, S. P. (2016). Estimation issues with PLS and CBSEM: Where the bias lies! *Journal of Business Research, 69*, 3998–4010. https://doi.org/10.1016/j.jbusres.2016.06.007

Saunila, M. (2020). Innovation capability in SMEs: A systematic review of the literature. *Journal of Innovation & Knowledge, 5*(4), 260–265. https://doi.org/10.1016/j.jik.2019.11.002

Sheu, D. D., & Lee, H. K. (2010). A proposed process for systematic innovation. *International Journal of Production Research, 49*(3), 847–868. https://doi.org/10.1080/00207540903280549

Sklar, A. (1959). Fonctions de répartition à n dimensions et leurs marges. *Publications de l'Institut Statistique de l'Université de Paris, 8*, 229–231.

Teece, D. J. (2017). Towards a capability theory of (innovating) firms: Implications for management and policy. *Cambridge Journal of Economics, 41*(3), 693–720. https://doi.org/10.1093/cje/bew063

Tsakalerou, M., Abil, A., Ribiere, V., Lukhmanov, Y., & Tynybayeva, N. (2025). The innovation capability equation: A systematic review of global determinants of SME's success. *Journal of Innovation & Knowledge, 10*(4), Article 100757. https://doi.org/10.1016/j.jik.2025.100757

Vlahović, O., Aleksić, D., Černe, M., Hernaus, T., & Škerlavaj, M. (2025). Chicken or the egg: The interplay of non-technological and technological innovations in a high-tech high-growth context. *Journal of Innovation & Knowledge, 10*(5), Article 100767. https://doi.org/10.1016/j.jik.2025.100767

Zhang, H. (2022). Does combining different types of innovation always improve SME performance? An analysis of innovation complementarity. *Journal of Innovation & Knowledge, 7*(3), Article 100192. https://doi.org/10.1016/j.jik.2022.100192

Zhao, R., Xu, J., Zhao, Y., & Feng, Y. (2025). Resource allocation pattern to green technology innovation efficiency: Synergy between environmental resource orchestration and firms' digital capabilities. *Journal of Innovation & Knowledge, 10*(4), Article 100760. https://doi.org/10.1016/j.jik.2025.100760