Strategic Innovation and SME Resilience in Regional Industrial Clusters: Evidence from the Valencian Textile District during COVID-19

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ABSTRACT:

Small and medium-sized enterprises (SMEs) operating in traditional manufacturing clusters face acute challenges when sudden systemic shocks disrupt established markets and production routines. This article analyses how SMEs embedded in a mature industrial cluster responded to the COVID-19 crisis, focusing on the Valencian textile district in Spain, a Southern European manufacturing ecosystem that remains under-represented in resilience research. Using a mixed-methods design combining survey data from 80 SMEs with complementary managerial interviews, the study examines how dynamic capabilities, strategic innovation behaviours, and organisational characteristics relate to firms' ability to maintain or increase turnover during the crisis.

The results show that product development strategies are most strongly associated with resilience, substantially increasing the likelihood of maintaining or growing turnover. Diversification into technical textiles also displays a positive, though more moderate, relationship with resilience, while conventional R&D indicators exhibit limited short-term explanatory power in this mature manufacturing context. Firm age shows a negative association with resilience, suggesting greater adaptability among younger firms. Gender composition also matters: firms with a higher share of female employees, and to a lesser extent women in management positions, tend to display greater adaptive capacity. Qualitative insights from managerial interviews help explain how strategic agility and organisational diversity enabled rapid adaptation under conditions of extreme uncertainty.

Overall, the findings indicate that during abrupt, demand-driven systemic shocks, agile and market-oriented innovation strategies play a more decisive role in short-term SME resilience than formal R&D investment in traditional industrial clusters. The study offers actionable implications for SME managers and regional policymakers seeking to strengthen cluster resilience through flexible product strategies, selective technical upgrading, and inclusive organisational structures.

KEYWORDS: SME resilience; strategic innovation; regional clusters; COVID-19; territorial development.

JEL CLASSIFICATION: L26; R11.

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Innovación estratégica y resiliencia de las PYME en clústeres industriales regionales: evidencia del distrito textil valenciano durante la COVID-19

Resumen:

Las pequeñas y medianas empresas (PYME) que operan en clústeres industriales manufactureros tradicionales afrontan desafíos especialmente intensos cuando perturbaciones sistémicas repentinas alteran mercados consolidados y rutinas productivas establecidas. Este artículo analiza cómo las PYME integradas en un clúster industrial maduro respondieron a la crisis provocada por la COVID-19, centrándose en el distrito textil valenciano en España, un ecosistema manufacturero del sur de Europa aún poco representado en la literatura sobre resiliencia empresarial. Mediante un diseño de métodos mixtos que combina datos de encuesta de 80 PYMES con entrevistas complementarias a directivos, el estudio examina la relación entre capacidades dinámicas, comportamientos de innovación estratégica y características organizativas, y la capacidad de las empresas para mantener o incrementar su facturación durante la crisis.

Los resultados muestran que las estrategias de desarrollo de producto son las más estrechamente asociadas con la resiliencia, al aumentar de forma significativa la probabilidad de mantener o incrementar la facturación. La diversificación hacia textiles técnicos presenta también una relación positiva, aunque más moderada, con la resiliencia, mientras que los indicadores convencionales de I+D muestran una capacidad explicativa limitada en el corto plazo en este contexto manufacturero maduro. La antigüedad de la empresa se asocia negativamente con la resiliencia, lo que sugiere una mayor capacidad de adaptación entre las firmas más jóvenes. Asimismo, la composición de género resulta relevante: las empresas con una mayor proporción de mujeres en la plantilla, y en menor medida en los puestos directivos, tienden a mostrar una mayor capacidad adaptativa. Los resultados cualitativos de las entrevistas a directivos ayudan a explicar cómo la agilidad estratégica y la diversidad organizativa facilitaron una adaptación rápida en un contexto de elevada incertidumbre.

En conjunto, los hallazgos indican que, ante perturbaciones sistémicas abruptas e impulsadas por la demanda, las estrategias de innovación ágiles y orientadas al mercado desempeñan un papel más decisivo en la resiliencia a corto plazo de las PYME que la inversión formal en I+D dentro de clústeres industriales tradicionales. El estudio ofrece implicaciones prácticas para directivos de PYME y responsables de políticas regionales interesados en reforzar la resiliencia de clústeres con estrategias flexibles de producto, actualización técnica selectiva y estructuras organizativas inclusivas.

Palabras clave: Resiliencia de las PYME; innovación estratégica; clústeres regionales; COVID-19; desarrollo territorial.

Clasificación JEL: L26; R11.

1. Introduction

Business resilience, understood as the organisational capacity to anticipate, absorb, and adapt to external shocks (Conz et al., 2017), has emerged as a critical competence for small and medium-sized enterprises (SMEs) in increasingly turbulent environments. Unlike large corporations, SMEs typically face severe resource constraints, yet they often display remarkable agility and creative adaptation in the face of adversity (Smallbone et al., 2012; Branicki et al., 2017). Recent literature suggests that such resilience is not merely reactive but is rooted in proactive processes related to dynamic capabilities and strategic innovation, which enable firms to reconfigure resources and respond effectively under uncertainty (Teece, 2007; Battisti & Deakins, 2017; Gianiodis et al., 2022; Kyrdoda et al., 2023; Muneeb et al., 2023; Kahveci et al., 2025).

The COVID-19 pandemic constituted a sudden and systemic shock that severely disrupted global supply chains and radically altered market conditions across sectors (Ghomi et al., 2023). Traditional manufacturing industries, including textiles, were particularly exposed due to their established routines, limited slack resources, and strong path dependencies. Nevertheless, evidence from different regions suggests that firms in these sectors demonstrated notable adaptive capacity, particularly through rapid product reorientation and selective market realignment (Castañeda-Navarrete et al., 2021; Islam et al.,

2023; Sarma et al., 2023; Pallás-Rocafull et al., 2024; Zahra et al., 2025). This raises the question of how such adaptation was possible in contexts characterised by structural rigidity. Recent research points to the role of territorial factors in shaping resilience in traditional manufacturing clusters, including institutional support, embedded inter-firm relations, and cluster-specific resources that facilitate coordination and collective learning under crisis conditions (Puig et al., 2022; Schmidt et al., 2022; Gianiodis et al., 2022; Kim et al., 2023; Sargento & Lopes, 2024).

Notwithstanding this emerging body of work, existing empirical research on SME resilience in traditional industrial clusters presents several important limitations. First, much of the literature on Southern European industrial districts has focused on long-term innovation performance, incremental upgrading trajectories, or network structure, often drawing on frameworks developed for advanced regional innovation systems in Northern European countries and technology-intensive contexts that may not apply to mature industries (Tödtling & Trippl, 2005; Aslesen et al., 2019; Isaksen et al., 2020). While valuable, this line of work has paid limited attention to how embedded SMEs in mature manufacturing districts respond to sudden and systemic shocks such as the COVID-19 pandemic. As a result, the mechanisms through which embedded firms mobilise strategic and organisational responses under conditions of extreme uncertainty remain insufficiently understood.

Second, prior studies frequently emphasise formal R&D investment and technological capabilities as primary drivers of resilience, implicitly assuming innovation patterns more characteristic of high-tech sectors. This emphasis risks overlooking more agile and market-oriented innovation strategies, such as rapid product development or diversification, which may be particularly relevant for SMEs operating in traditional manufacturing industries.

Third, existing work often treats clustered SMEs as relatively homogeneous actors, devoting limited attention to firm-level heterogeneity within clusters (Tomás-Miquel et al., 2025). In particular, organisational characteristics such as firm age and gender composition, which have been associated with differences in decision-making quality, strategic responsiveness and firm performance, have received comparatively little empirical scrutiny in the context of resilience in traditional industrial districts (Adams & Ferreira, 2009; Dezső & Ross, 2012; Innayah et al., 2021).

At the same time, while recent empirical evidence from Italian manufacturing firms suggests that firm interconnectedness can enhance resilience to structural shocks (Shaheen et al., 2025), there remains limited understanding of how such territorial relationships interact with firm-level strategies and organisational attributes in shaping resilience outcomes. This gap is particularly relevant in light of current European policy agendas emphasising reindustrialisation, technological upgrading and regional resilience.

Addressing these gaps requires in-depth empirical analysis in mature industrial clusters, where traditional manufacturing dynamics, strategic innovation beyond formal R&D, and organisational heterogeneity intersect. The Valencian textile district, located across the inland counties of La Vall d'Albaida, L'Alcoia, El Comtat and L'Alt Vinalopo, represents one of the most consolidated traditional industrial districts in Southern Europe (Tomás-Miquel et al., 2019). Rooted in a long-standing Marshallian structure, the district combines dense inter-firm networks, specialised labour markets and strong institutional support from organisations such as ATEVAL (Valencian Textile Business Association), AITEX (Textile Research & Innovation Centre) and the Universitat Politècnica de València. This embeddedness creates a unique environment where firms benefit from shared resources and knowledge flows, yet also face risks of overembeddedness and structural inertia (Boschma & Frenken, 2006). Although the region is widely recognised as a Marshallian–Becattini industrial district, in this study we use the broader term "cluster" when analysing firm-level resilience. Following Porter (1998), we define a cluster as a geographically proximate concentration of interconnected firms, specialised suppliers, service providers and associated institutions operating within a related set of industries, whose co-location facilitates knowledge spillovers, coordination and competitive advantage. This terminology allows us to focus on economic concentration and adaptive behaviours without assuming all socio-institutional features traditionally associated with industrial district theory, while still acknowledging the district's historical and territorial foundations.

Against this background, this study examines how SMEs in the Valencian textile district adapted to the COVID-19 crisis through strategic innovation, dynamic capabilities and organisational configurations.

In particular, it critically assesses the short-term role of formal R&D relative to more agile innovation strategies and explores how firm age and gender diversity relate to resilience outcomes. By focusing on a mature Southern European context, the study expands current resilience research beyond its predominant focus on high-tech sectors and globalised value chains, aligning with prior work on how territorial embeddedness shapes firm behaviour (Becattini, 1990). Moreover, the emphasis on resilience within traditional manufacturing contexts contributes to a growing recognition that SMEs' adaptive responses vary by industry and regional characteristics (Smallbone et al., 2012). The mixed-methods design employed here, combining structured survey data from 80 SMEs with complementary qualitative interviews, allows for a nuanced understanding of both the determinants of resilience and the contextual mechanisms through which they operate.

The article contributes to the literature in three ways. First, it provides empirical evidence on SME resilience from a traditional industrial cluster in Southern Europe, a setting often underrepresented in resilience research. Second, it advances theory by linking firm adaptation strategies to an integrated model of dynamic capabilities and strategic innovation while accounting for organisational heterogeneity. Third, it offers practical guidance for SME managers and policymakers seeking to foster resilience in vulnerable manufacturing clusters.

The remainder of the article is structured as follows: Section 2 presents the theoretical framework and hypotheses; Section 3 describes the mixed-methods design and variable operationalisation; Section 4 reports the empirical findings; and Section 5 discusses implications, limitations, and directions for future research.

2. THEORETICAL BACKGROUND: SME RESILIENCE, DYNAMIC CAPABILITIES AND STRATEGIC INNOVATION

Understanding how small and medium-sized enterprises (SMEs) respond to systemic crises requires an integrated and multi-level theoretical approach. This study integrates three key perspectives: organisational resilience, dynamic capabilities, and strategic innovation, framed within the context of industrial clusters. Rather than treating these perspectives as separate explanatory logics, we argue that SME resilience emerges from their interaction: firm-level capabilities and strategic choices are shaped, enabled and constrained by the clustered environments in which SMEs operate, particularly in mature manufacturing sectors characterised by structural rigidity and limited slack resources.

2.1. RESILIENCE IN INDUSTRIAL CLUSTERS

Resilience has become a central concept in entrepreneurship and management research, particularly concerning how SMEs survive and evolve amid external shocks (Williams & Vorley, 2015; Kuckertz et al., 2020). Contemporary approaches increasingly conceptualise resilience not merely as survival or short-term recovery, but as a dynamic and proactive process involving learning, reconfiguration and renewal (Lengnick-Hall et al., 2011; Duchek, 2020). For SMEs, often lacking formal contingency planning and excess resources, resilience depends heavily on flexibility, improvisation and access to relational assets (Herbane, 2010; Battisti & Deakins, 2017).

In clustered environments, resilience is strongly conditioned by territorial embeddedness. Industrial clusters, understood as dense concentrations of interconnected firms and support institutions (Porter, 1998), can enhance resilience by facilitating rapid knowledge exchange, shared problem-solving and collective learning during crises (Martin & Sunley, 2003; Boschma, 2015). Empirical research on manufacturing clusters during COVID-19 suggests that proximity-based networks enabled faster information flows and coordinated responses, particularly in traditional sectors facing sudden demand collapses (Castañeda-Navarrete et al., 2021; Sarma et al., 2023).

However, cluster embeddedness also entails potential downsides. Overembeddedness and strong local path dependencies may constrain experimentation, limit external knowledge sourcing and reinforce

dominant routines that become maladaptive under unprecedented shocks (Boschma & Frenken, 2006; Tripsas & Gavetti, 2017).

Resilience in clusters thus reflects a tension between stabilising forces that support continuity and transformative forces that enable change. This duality underscores the need to analyse resilience as the outcome of interactions between firm-level capabilities and cluster-based resources.

2.2. Dynamic capabilities and strategic innovation

Dynamic capabilities provide a central mechanism through which SMEs translate resilience potential into concrete adaptive responses. Defined as the organisational abilities to sense environmental changes, seize emerging opportunities and reconfigure resources accordingly (Teece, 2007; Helfat & Peteraf, 2009), dynamic capabilities are particularly critical in crisis contexts where rapid and non-routine decision-making is required.

For SMEs operating in mature manufacturing sectors, dynamic capabilities are rarely formalised through extensive R&D infrastructures. Instead, they are often embedded in accumulated experiential knowledge, informal learning processes and incremental innovation routines. Nevertheless, recent crisis-focused research shows that SMEs with pre-existing dynamic capabilities, even when based on modest R&D investments, were better positioned to detect shifts in demand, repurpose production lines and accelerate innovation during the COVID-19 shock (Wenzel et al., 2021; Muneeb et al., 2023; Kyrdoda et al., 2023). Engagement in R&D activities enhances absorptive capacity, enabling firms to process external knowledge and recombine resources under extreme uncertainty (Zahra et al., 2006; Kahveci et al., 2025).

Within industrial clusters, dynamic capabilities are shaped not only internally but also relationally. Inter-firm networks and institutional linkages reduce experimentation costs, facilitate access to specialised knowledge and enable rapid diffusion of technical and market information (Asheim & Coenen, 2005; Molina-Morales et al., 2012; Sargento & Lopes, 2024). However, the activation of these shared resources ultimately depends on firm-level strategic intent and organisational readiness.

Dynamic capabilities manifest empirically through strategic innovation, which is conceptualised as deliberate efforts to redefine products, markets and organisational processes in response to environmental disruption (Miles et al., 1978; Hamel, 2006; Tidd, 2023). In crisis contexts, strategic innovation allows SMEs not only to absorb shocks but to reorient their development trajectories. Recent evidence from manufacturing clusters highlights that firms capable of rapid product pivoting, market redeployment and diversification exhibited higher survival and performance outcomes during and after COVID-19 (Castañeda-Navarrete et al., 2021; Pallás-Rocafull et al., 2024; Zahra et al., 2025).

In the textile industry, the pandemic generated a dual shock: the collapse of traditional fashion demand and the surge in demand for medical and technical textiles. Resilient SMEs responded by engaging in product development, market development and diversification strategies, often moving into unrelated or semi-related niches. Ansoff's Matrix (Ansoff, 1958) provides a useful framework to categorise these strategic responses. In particular, diversification into technical textiles has been identified as a key upgrading pathway within mature textile clusters, enabling both short-term crisis response and longer-term transformation (Belso-Martínez et al., 2020).

Based on this literature, we conceptualise dynamic capabilities through two commonly used empirical proxies: (i) R&D intensity, measured as the proportion of turnover allocated to R&D activities, and (ii) engagement in R&D projects during the crisis period. Accordingly, we propose:

- **H1:** SMEs that allocate a greater proportion of their turnover to R&D activities are more likely to be resilient during crises.
- **H2:** SMEs involved in a greater number of R&D projects during the crisis are more likely to be resilient.

Strategic innovation is operationalised through product development, market development and diversification strategies. We therefore hypothesise:

- **H3:** SMEs that pursue product development strategies during crises are more likely to be resilient.
- **H4:** SMEs that pursue market development strategies are more likely to be resilient.
- **H5:** SMEs that diversify through technical textile production are more likely to be resilient.

2.3. ORGANISATIONAL CHARACTERISTICS AND DEMOGRAPHICS

While capabilities and strategies are central to crisis adaptation, organisational characteristics shape how effectively these mechanisms are deployed. Firm age and human capital composition influence learning processes, decision-making structures and flexibility under stress (Linnenluecke, 2017; Duchek, 2020).

Firm age presents a well-documented trade-off. Older firms benefit from accumulated experience, established networks and reputational assets, reducing the liability of newness. However, they are also more prone to structural inertia, rigid routines and cognitive lock-in, which can hinder rapid adaptation to unprecedented shocks (Hannan & Freeman, 1984; Uzzi, 1997; Tripsas & Gavetti, 2017). In context of COVID-19 where existing market channels and routines became abruptly obsolete, the liability of aging may have outweighed experience advantages. Younger firms, characterised by flatter structures and fewer legacy constraints, may therefore have been better positioned to pivot quickly (Shepherd et al., 2017). We thus hypothesise:

- **H6:** Younger firms are more likely to be resilient during systemic crises.

Beyond age, organisational resilience is increasingly linked to workforce and leadership diversity. Crisis management literature highlights the 'diversity advantage', whereby heterogeneous teams draw on broader cognitive repertoires, improving problem-solving under uncertainty (Gianiodis et al., 2022). Gender diversity, in particular, has been associated with more participatory leadership styles, enhanced communication and stronger relational cohesion, attributes that are in high-stress crisis environments (Bear et al., 2010; Carter et al., 2010; Hoogendoorn et al., 2013; Innayah et al., 2021; Kim et al., 2023).

Recent empirical studies suggest that gender-diverse teams and management structures can mitigate groupthink, support organisational agility and facilitate the implementation of radical strategic shifts during crises, including in manufacturing contexts (Innayah et al., 2021; Kahveci et al., 2025). Accordingly, we posit:

- **H7:** Firms with a higher percentage of female employees are more likely to be resilient.
- **H8:** Firms with a higher percentage of women in management positions are more likely to be resilient.

2.4. CONCEPTUAL MODEL

Building on the preceding discussion, Figure 1 presents the conceptual model underpinning this study. The model posits that SME resilience, defined as the ability to maintain or increase turnover during the COVID-19 crisis, is influenced by three interrelated dimensions: dynamic capabilities, strategic innovation behaviours, and organisational characteristics.

Dynamic capabilities capture the firm's ability to sense, seize, and reconfigure resources under crisis conditions and are operationalised through R&D intensity and engagement in R&D projects (Zahra et al., 2006). Strategic innovation reflects how firms reoriented their product and market strategies through product development, market development and diversification into technical textiles (Hamel, 2006; Wenzel, Stanske & Lieberman, 2021). Finally, organisational characteristics, including firm age and gender composition of the workforce and management, shape the effectiveness with which capabilities and strategies are deployed.

The model assumes direct effects of each dimension on resilience, while acknowledging their complementarity within clustered environments. It provides an integrated analytical framework that guides variable operationalisation and empirical testing in Section 3.

Conceptual model of SME resilience drivers during systemic crises
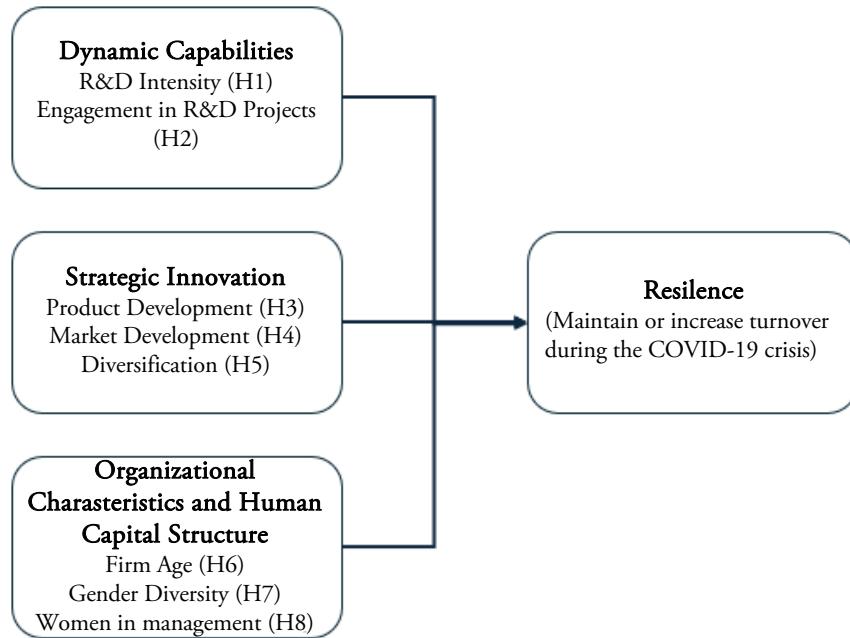
3. Methodology

This study adopts a mixed-methods research design to test the theoretical model presented in Section 2 and assess how various organisational, strategic, and innovation-related factors influence SME resilience in the face of a systemic shock. The integration of quantitative and qualitative data allows for both statistical validation and a contextualized interpretation of the mechanisms underpinning firm adaptation during the COVID-19 crisis. Mixed methods are particularly appropriate for studying organisational resilience, a complex and context-dependent construct where numerical patterns often require qualitative insights to be fully understood (Puig et al., 2022).

The theoretical framework hypothesizes that resilience outcomes are shaped by three interrelated constructs: dynamic capabilities (proxied by R&D investment and project engagement), strategic innovation behaviours (product development, market repositioning, and technical textile diversification), and organisational characteristics (including firm age and gender composition). While organisational resilience is multidimensional, in this study it is operationalized as a firm's ability to maintain or increase turnover during the COVID-19 period. This performance-based proxy offers a consistent and measurable indicator of business continuity and adaptability under extreme uncertainty, aligning with resilience conceptualisations rooted in survival and financial viability (Duchek, 2020).

3.1. Sample

Primary data were collected between March and May 2021 through semi-structured interviews with SME managers, centred on a structured questionnaire and complemented by qualitative prompts, jointly developed by researchers at UPV and ATEVAL. The dataset was revalidated in early 2024 to ensure the temporal reliability of key variables.

The data collection process unfolded in three stages. First, exploratory qualitative interviews were conducted with three firm managers and representatives from AITEX, ATEVAL, and UPV to identify perceived crisis impacts, emerging strategic responses, and key sectoral dynamics, and to inform the design of the research instrument. Second, based on these insights, a mixed-methods interview protocol

combining structured survey items with semi-structured qualitative prompts was designed and piloted with a panel of experts to ensure clarity, sectoral relevance, and alignment with the theoretical framework. Finally, the finalised instrument was administered through a semi-structured interview format to a target sample of firms affiliated with ATEVAL, filtered from an initial population of 248 to 110 firms after excluding micro-enterprises and purely commercial actors. The final sample included 80 SMEs, resulting in a response rate of 72.7%.

Each participating firm was represented by a single respondent, typically the general manager or owner, ensuring access to reliable data on strategy, performance, and internal organisational characteristics. The sample preserved the cluster's heterogeneity in terms of size, product specialisation, and innovation intensity.

In consultations with ATEVAL and AITEX, the final sample of 80 firms was confirmed as accurately reflecting the active manufacturing segment of the cluster, that is, the set of firms with substantive production activity after excluding micro-enterprises and purely commercial actors. Beyond institutional validation, the representativeness of the final sample was further assessed through descriptive and statistical comparisons of its structural characteristics with available cluster-level information provided by ATEVAL. The distribution of firms by core activity, size class, and firm age in the sample closely matches the known composition of the cluster's active manufacturing population, supporting the representativeness of the achieved sample.

To assess potential non-response bias, early and late respondents were compared in terms of firm size, core activity, and firm age, with no statistically significant differences detected. Although the data rely on self-reported information, bias was mitigated by the fact that respondents were owners or general managers and by the inclusion of objective indicators such as turnover variation and technical textile output.

3.2. Data collection, variables and procedures

The main data collection instrument was a mixed-methods interview protocol (see Appendix A for an overview of the instrument). The structured component captured both pre- and post-pandemic indicators related to innovation investment, product and market strategies, human capital characteristics, and firm performance, all aligned with the theoretical framework presented in Section 2. The semi-structured component included open-ended prompts designed to elicit managers' perceptions, decision rationales, and contextual constraints related to the COVID-19 crisis. Interviews were conducted in person or by telephone by trained technicians. Each interview lasted approximately 50 to 60 minutes. The same informant, typically the owner or general manager, responded to both the quantitative and qualitative sections, ensuring internal consistency across data sources.

Organisational resilience, the dependent variable, was operationalised pragmatically as turnover maintenance or growth during the COVID-19 period. Firms that maintained or increased their turnover during the 2020 fiscal year compared to 2019 were coded as '1' (Resilient), while those reporting a decrease were coded as '0' (Non-resilient). This operationalisation was adopted for three reasons: it provides a clear and objectively measurable indicator across a heterogeneous sample of SMEs; it captures business continuity and financial viability, which are central to survival under systemic shocks; and it enables robust quantitative testing under conditions of extreme uncertainty.

Although resilience is a multidimensional construct, alternative dimensions such as workforce stability, product portfolio changes, market entry, technical textile output, and employment adjustments were also captured through the survey instrument. While these indicators were not used as formal dependent variables, they inform the interpretation of adaptive capacity in Sections 4 and 5.

Independent variables were grouped according to the theoretical model. Dynamic capabilities were measured through self-reported R&D intensity (percentage of turnover allocated to R&D) and the number of active R&D projects during the crisis. Although mature sectors like textiles typically prioritize non-R&D innovation (e.g., design, fashion trends), these formal metrics were included to test whether the magnitude of the COVID-19 shock necessitated a shift towards deeper technological capabilities or if firms

relied primarily on traditional adaptive mechanisms. Strategic innovation was captured through declared product development initiatives, entry into new markets, and the share of production dedicated to technical textiles. Organisational characteristics included firm age and gender composition at both workforce and management levels.

Given the factual and objective nature of most variables (e.g., turnover variation, firm age, share of technical textile production), constructs were operationalised using single-item indicators. This approach is appropriate when variables represent concrete organisational attributes or observable outcomes rather than latent constructs.

Qualitative information was generated at two stages of the research process. First, exploratory interviews conducted with managers and cluster institutions informed construct selection and instrument refinement. Second, qualitative insights obtained through open-ended prompts in the semi-structured interviews with the 80 firms were used to contextualise and interpret the quantitative findings, thereby supporting the embedded mixed-methods integration by linking statistical patterns to managerial perceptions and strategic reasoning.

3.3. DATA ANALYSIS

Quantitative analysis was conducted using SPSS. After computing descriptive statistics, inferential analysis was used to test the hypotheses outlined in Section 2. Specifically, Mann-Whitney U tests were applied to compare resilient and non-resilient firms across non-normally distributed variables. Chi-square tests were used to examine associations between categorical predictors and resilience outcomes. Binary logistic regression models were then estimated to assess the simultaneous influence of multiple predictors on the likelihood of resilience.

In addition to the quantitative analysis, complementary qualitative information was drawn from semi-structured interviews with firm managers. This qualitative material was not treated as an independent analytical method, but as a contextual and interpretive resource used to support and enrich the interpretation of the quantitative results. Interview notes were reviewed and organised deductively using pre-defined categories derived from the theoretical framework (e.g., product adaptation, diversification strategies, perceived constraints). The qualitative evidence was used to contextualise statistically significant and marginal findings and to provide illustrative examples regarding how managers perceived the crisis, justified strategic decisions, and mobilised organisational resources.

Overall, the methodological design, centred on quantitative hypothesis testing and complemented by qualitative insights, provides a robust basis for testing the proposed model and explaining SME resilience dynamics in a traditional industrial ecosystem under crisis conditions.

4. RESULTS

This section presents the results of the empirical analysis, integrating descriptive statistics and hypothesis testing to examine the determinants of SME resilience during the COVID-19 crisis. The findings are structured according to the eight main hypotheses derived from the theoretical framework.

The analysis presented in this section follows the theoretical model outlined in Figure 1. Each group of variables, dynamic capabilities, strategic innovation, and organisational characteristics is examined in turn to test the hypotheses and assess their relative contributions to SME resilience.

4.1. SAMPLE CHARACTERISTICS

The sample consisted of 80 SMEs in the Valencian textile cluster. Firms primarily engaged in fabric manufacturing and medical equipment production (each 35%), while 32.5% operated in other textile-related markets (Figure 2).

FIGURE 2.
Distribution of business activities in the sampled SMEs (N=80). Data highlight a concentration in essential sectors (fabrics and medical devices) during the shock
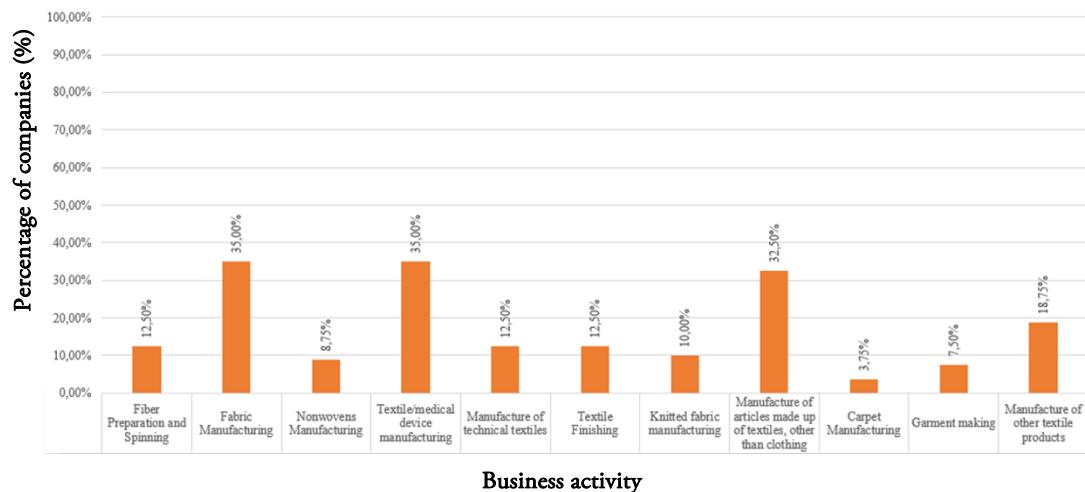

FIGURE 3.
Workforce distribution as of February 2021 confirming the SME-dominated structure of the cluster, which conditions firms' adaptive capacity.
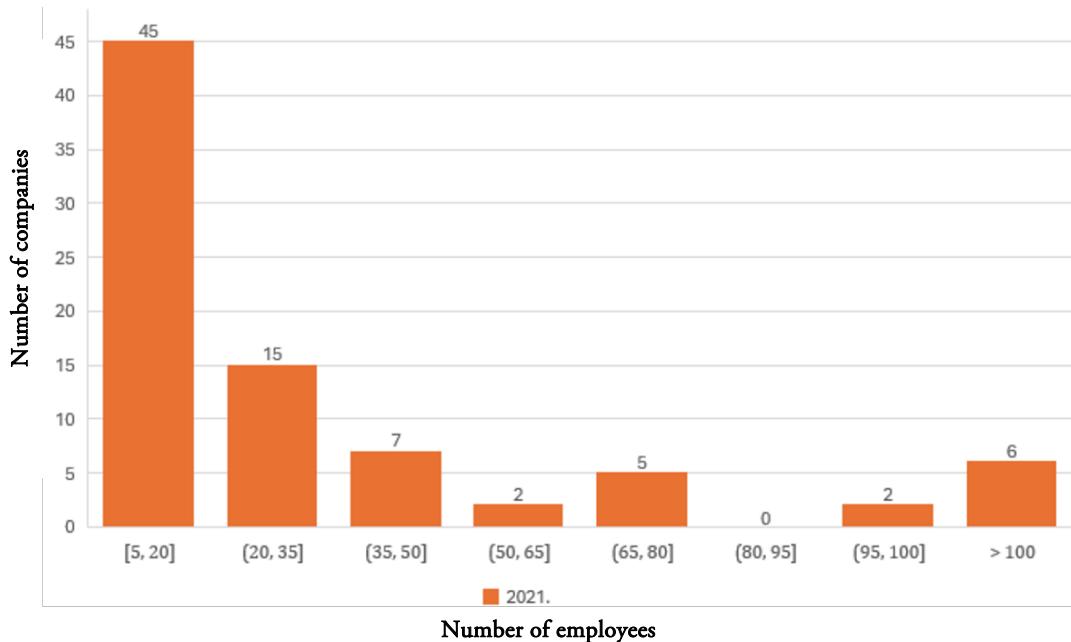
Firm size distribution showed that 56.25% of companies employed 20 or fewer workers as of February 2021. Only 7.5% had over 100 employees, confirming the cluster's SME-dominated structure (Figure 3).

Regarding firm age, 65% were established between 1968 and 2002, with some companies operating for over a century (Figure 4). The average age was around 36 years, highlighting tradition and renewal within the cluster.

FIGURE 4.
Distribution of company founding years in the sample highlighting the coexistence of long-established firms and younger entrants within the cluster
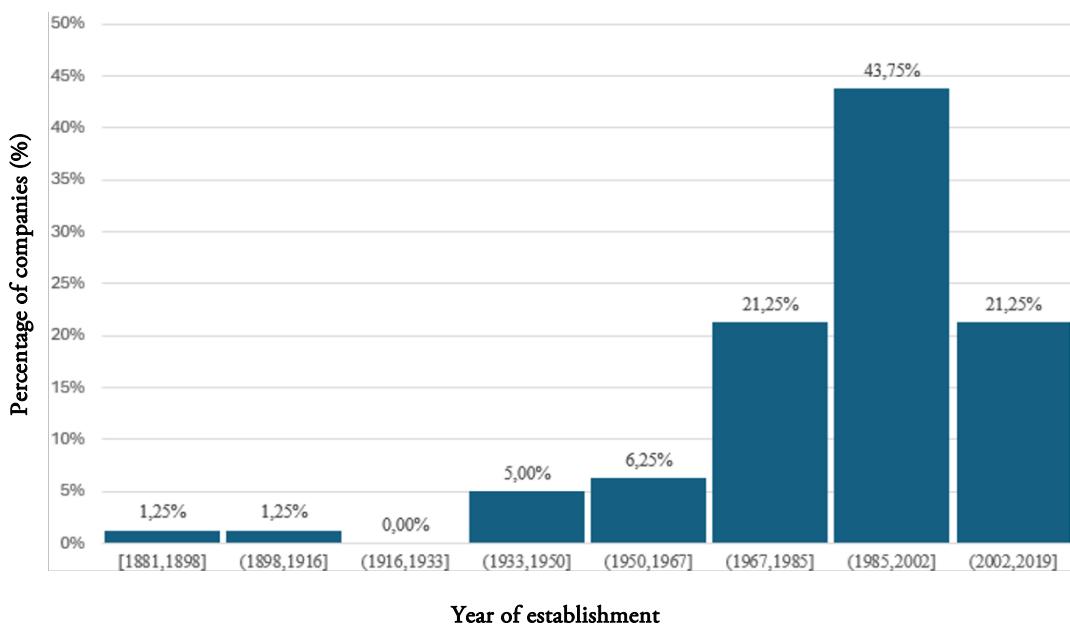
4.2. HYPOTHESIS TESTING

Building on the descriptive overview of the sample, this section presents the empirical findings regarding the study's hypotheses. The results are structured according to the theoretical constructs established in Section 2, providing empirical evidence on the determinants of SME resilience.

DYNAMIC CAPABILITIES AND INNOVATION INVESTMENT

We first analyse the role of dynamic capabilities and innovation investment in fostering SME resilience. Regarding the allocation of turnover to R&D activities (H1), results show that before the pandemic, most firms allocated less than 5% of turnover to R&D (Figure 5). Although some increased investment during 2020, no significant difference was found between resilient and non-resilient firms ($U = 853.0$, $p = .495$). Thus, R&D spending alone did not explain resilience outcomes in this context.

FIGURE 5.
R&D investment as % of turnover (N = 80). Comparison 2019–2020. Data show that formal
R&D spending did not significantly differ between resilient and non-resilient firms

	0-5%	6-10%	11-15%	16-20%
2019	85,00%	11,25%	2,50%	1,25%
2020	68,75%	23,75%	6,25%	1,25%

R&D investment (% of turnover)
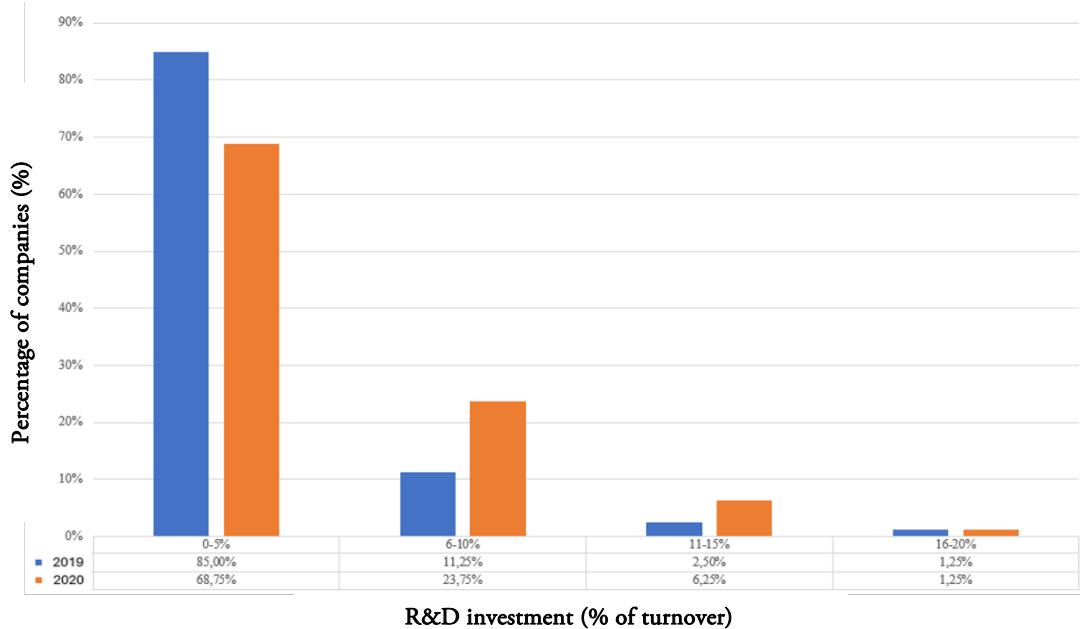
Similarly, when examining the number of R&D projects conducted during the crisis period (H2), participation increased notably from 2017–2019 to 2020–2021 (Figure 6). However, the Mann-Whitney U test did not detect significant differences between resilient and non-resilient firms (U = 915.5, p = .051), suggesting a possible trend but no decisive short-term effect. Interview evidence helps explain this: several managers reported that ongoing R&D projects primarily targeted long-term upgrading objectives and were difficult to translate into immediate revenue gains during the acute phase of the crisis. As a result, while R&D engagement supported firms' strategic orientation, it did not necessarily generate immediate resilience under conditions of abrupt demand disruption.

FIGURE 6.
Company participation in R&D projects during 2017-2019 and 2020-2021

	0	1	2	3	4	5	6	7	8
2017-2019	60,00%	22,50%	7,50%	2,50%	2,50%	2,50%	1,25%	0,00%	1,25%
2020-2021	50,00%	26,25%	15,00%	2,50%	5,00%	0,00%	0,00%	0,00%	1,25%

Percentage of companies (%)
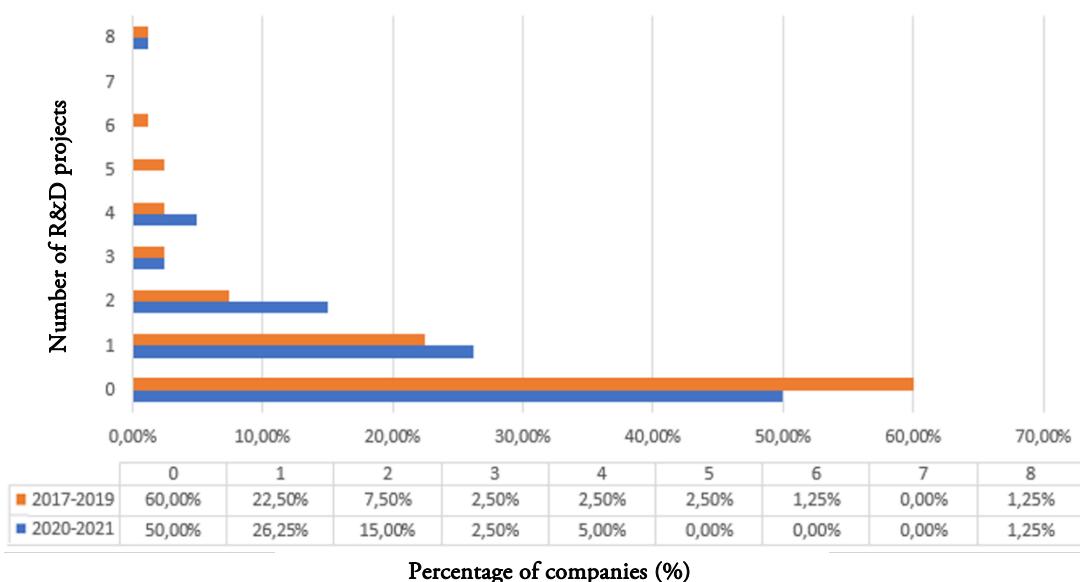
STRATEGIC INNOVATION AND PRODUCT-MARKET BEHAVIOURS

Concerning strategic behaviours, we analyse the impact of strategic innovation and product-market development strategies on SME resilience. Firms employed various strategies in response to the pandemic, as summarized in Figure 7. A significant portion of companies opted for Product Development (50%), while Related Diversification (as technical textile manufacturing) was also a predominant choice (50%). To a lesser extent, strategies such as Market Penetration (32.50%) and Market Development (23.75%) were observed, with lower participation in unrelated diversification. These strategic choices form the basis for analysing hypotheses H3, H4, and H5, which examine the association between product development, market development, and the production of technical textiles with business resilience.

FIGURE 7.
Distribution of companies by strategy type implemented in response to the pandemic
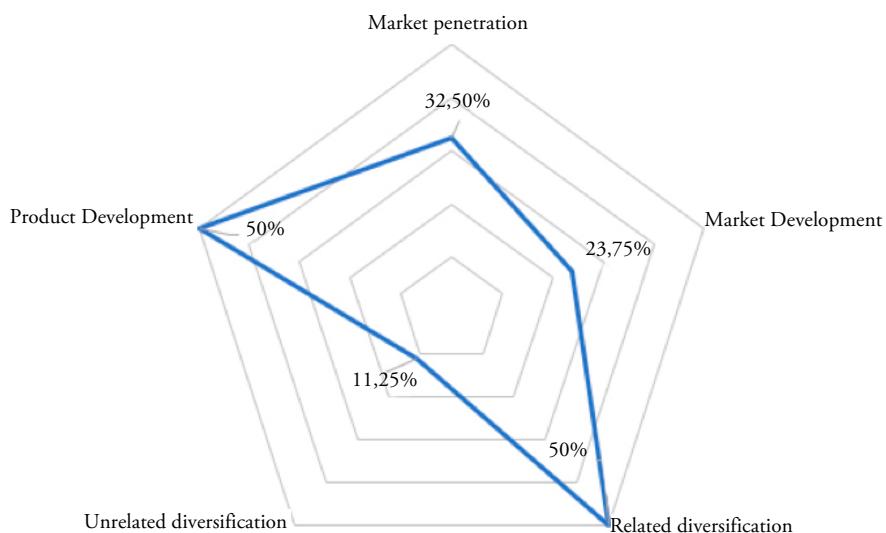
The evidence provides strong support for H3, as product development was found to be a key adaptive mechanism. A significant share of resilient firms developed new products (Figure 8), showing a strong statistical association with resilience (χ^2 = 9.968, p = .002). Among resilient firms, 70.3% diversified products compared to only 34.9% of non-resilient firms. Qualitative insights further illuminated this finding: managers of resilient firms frequently described how their pre-crisis capabilities in product design and agile manufacturing allowed them to rapidly reorient production lines. For instance, several firms mentioned leveraging existing machinery and textile expertise to quickly develop new hygiene products, protective gear, or specialized fabrics for medical applications, which, while distinct from their traditional output, drew upon their core competencies. This ability to quickly pivot and innovate within their product portfolio was consistently highlighted as a direct driver for maintaining or increasing turnover. Figure 8, by showing the shifts in business activities between 2020 and 2021, visually represents these product development efforts, particularly the significant increase in 'Textile/medical device manufacturing' and 'Manufacture of other textile products,' which includes new product lines developed in response to the crisis.

In contrast, market development strategies (H4) showed a non-significant relationship with resilience (χ^2 = 2.958, p = .085). Only 21.3% of firms entered new markets during the pandemic (Figure 9), and a Mann-Whitney test on the number of new markets also approached significance (U = 915.5, p = .051) without reaching the conventional threshold. Qualitative evidence suggests that high uncertainty and

logistical disruptions limited the short-term impact of market expansion compared to product-based adaptagions.

FIGURE 8.
Comparison of business activities in the sample across the analysed periods

	Fiber Preparation and Spinning	Fabric Manufacturing	Nonwovens Manufacturing	Textile/medical device manufacturing	Manufacture of technical textiles	Textile Finishing	Knitted fabric manufacturing	Manufacture of articles made up of textiles, other than clothing	Carpet Manufacturing	Garment making	Manufacture of other textile products
2020	13,75%	33,75%	8,75%	5,00%	12,50%	16,25%	7,50%	32,50%	2,50%	7,50%	18,75%
2021	12,50%	35,00%	8,75%	35,00%	12,50%	12,50%	10,00%	32,50%	3,75%	7,50%	18,75%

FIGURE 9.
Markets targeted by companies' products in February 2020 and February 2021

	Home textiles	Fashion	Technical clothing	Footwear	Feeding	Automotive & Transportation	Sanitary/ hygiene/ cosmetics	Geotextile	Agrotextile	Construction	Sports / leisure areas	Aeronautical	Other
2020	68,75%	30,00%	12,50%	10,00%	1,25%	2,50%	20,00%	2,50%	3,75%	3,75%	3,75%	2,50%	18,75%
2021	67,50%	30,00%	12,50%	10,00%	1,25%	3,75%	38,75%	2,50%	3,75%	3,75%	3,75%	2,50%	18,75%

Market type
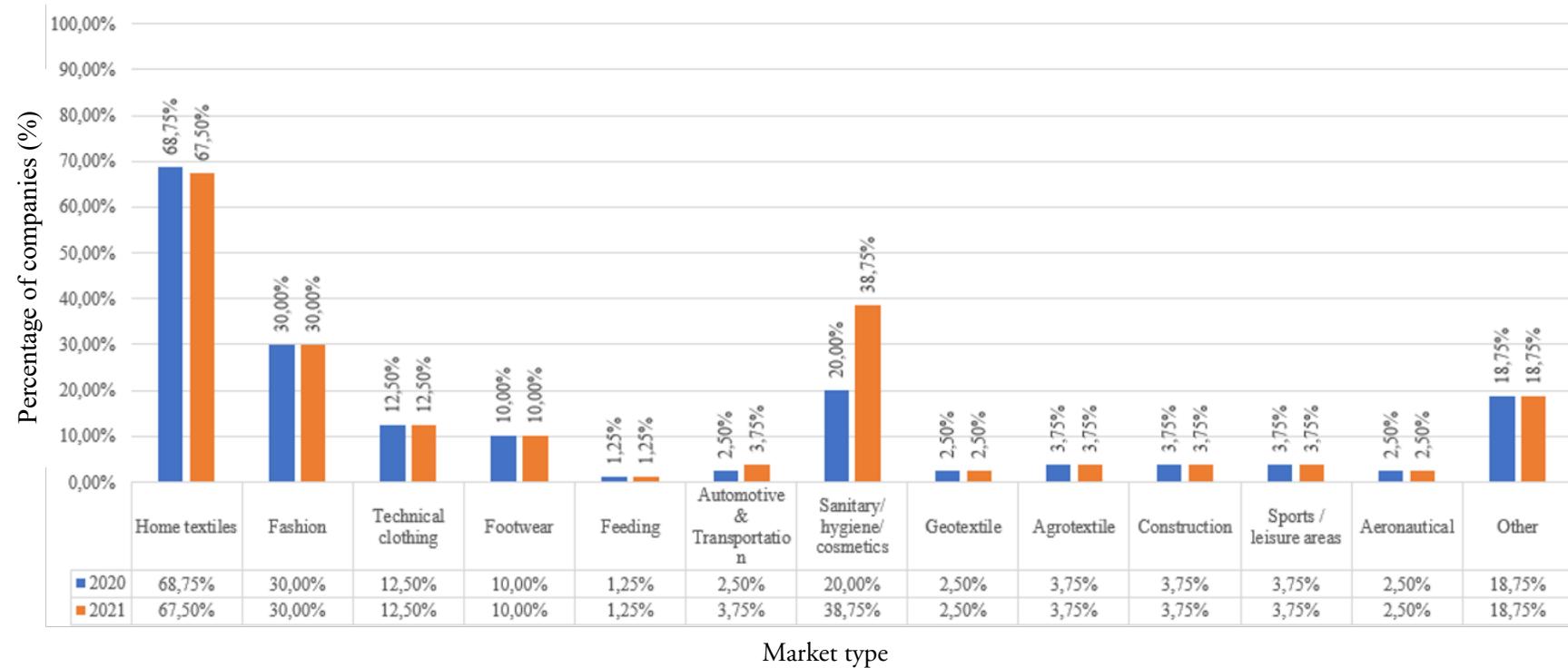
Finally, results supported H5 regarding diversification strategies. Resilient firms showed significantly higher technical textile shares (U = 1026.5, p = .009), indicating that specialisation contributed to resilience (Figure 10). Interviews revealed that this shift into technical textiles was often a strategic choice, driven not just by immediate crisis demand for medical textiles, but by a longer-term vision for higher-value-added production. Firms that had already initiated some degree of technical textile production prior to the pandemic were able to rapidly scale up and leverage this specialisation. They reported that the move allowed them to access new supply chains and markets that were less affected by traditional textile demand fluctuations, proving a crucial buffer against the crisis. Figure 10 clearly illustrates this strategic shift, showing an increased percentage of companies dedicating a higher proportion of their output to technical textiles in 2021 compared to 2020, underlining its role as a key diversification strategy.

FIGURE 10.

Proportion of technical textile manufacturing (N = 80). Higher concentration in the 80–100% range among resilient firms suggests that high specialisation in technical applications acted as a resilience buffer
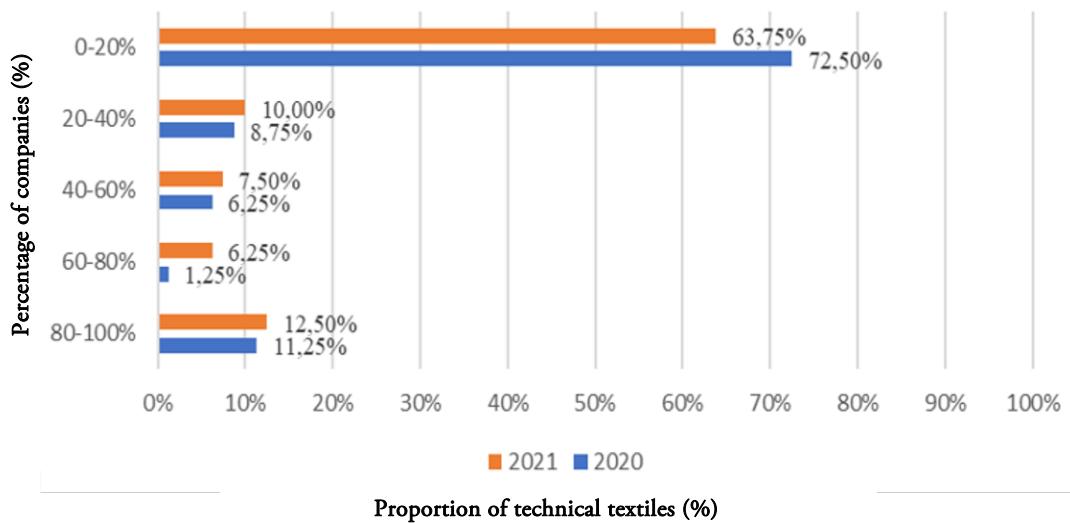
ORGANISATIONAL CHARACTERISTICS AND HUMAN CAPITAL

Regarding organisational structure, we investigated the influence of firm age and gender diversity. Analysis suggests marginal support for H6, as resilient firms tended to be younger (U = 594.5, p = .052), implying that lower structural inertia may facilitate adaptation. More decisively, analysis showed significant support for H7, with resilient firms displaying a higher percentage of female employees (U = 1043.0, p = .015). This suggests that a gender-diverse workforce contributes to resilience through broader problem-solving perspectives (Figure 11).

Lastly, the percentage of women in management (H8) showed a trend towards significance (U = 624.0, p = .085). While not a decisive effect with p < 0.05, this marginal support indicates a potential role for gender diversity at leadership levels in fostering resilience (Figure 12). Interview material provides additional context for these patterns. Managers in younger firms and in firms with more diverse management teams often described faster decision-making processes, fewer hierarchical constraints, and greater openness to experimentation, factors that may facilitate adaptive responses but are difficult to capture fully through quantitative indicators. Other human capital characteristics, such as the percentage of employees with university education or employees with more than five years' experience, did not significantly correlate with resilience outcomes).

FIGURE 11.

Workforce composition in the sampled firms illustrating differences between resilient and non-resilient firms


	% in ERE / ERTE	% of women	% with a university education	% with 5 years or less of industry experience	% with more than 5 years of industry experience
0-15%	88,75%	13,75%	62,50%	57,50%	2,50%
15-30%	3,75%	17,50%	21,25%	21,25%	0,00%
30-45%	2,50%	17,50%	7,50%	3,75%	3,75%
45-60%	2,50%	30,00%	6,25%	10,00%	12,50%
60-75%	0,00%	8,75%	2,50%	3,75%	6,25%
75-90%	1,25%	8,75%	0,00%	2,50%	23,75%
90-100%	1,25%	3,75%	0,00%	1,25%	51,25%
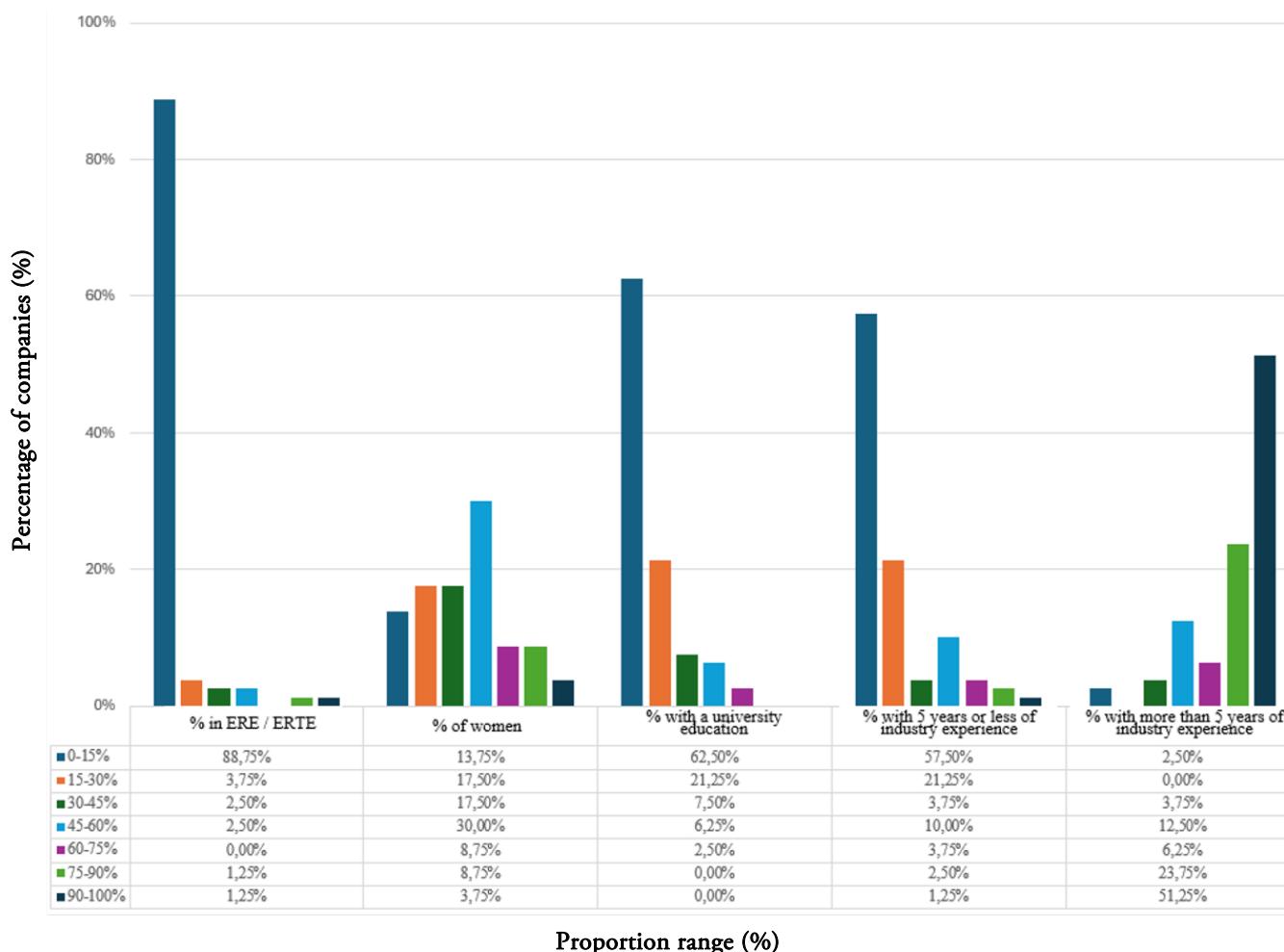
FIGURE 12.

The composition of management teams in the sampled companies illustrating differences between resilient and non-resilient firms

|	% of women	% with a university education	% with 5 years or less of industry experience	% with more than 5 years of industry experience
■ 0-15%	40,00%	37,50%	90,00%	5,00%
■ 15-30%	10,00%	10,00%	1,25%	0,00%
■ 30-45%	13,75%	7,50%	1,25%	1,25%
■ 45-60%	17,50%	13,75%	3,75%	2,50%
■ 60-75%	6,25%	7,50%	0,00%	2,50%
■ 75-90%	2,50%	2,50%	0,00%	5,00%
■ 90-100%	10,00%	21,25%	3,75%	83,75%

Proportion range (%)
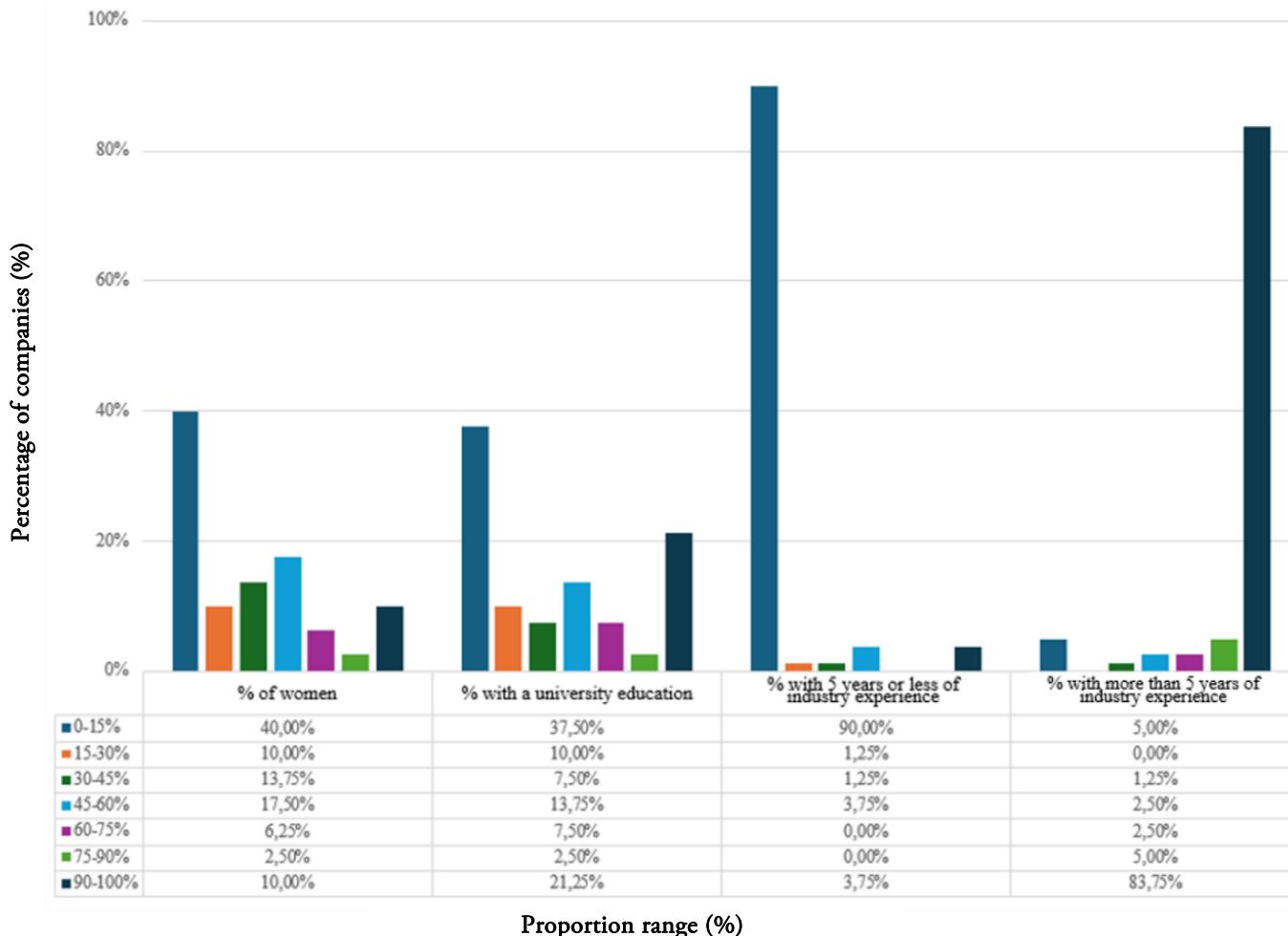
Table 1 provides a comprehensive overview of each hypothesis, including the statistical tests performed, their values, p-values, and the final support status. This summary facilitates a quick understanding of the key associations identified in the study.

TABLE 1.
Summary of Hypotheses and Empirical Results

Hypothesis	Test Applied	Statistical Value	p-value	Support Status
H1 - turnover allocated to R&D	Mann-Whitney U	853	.495	Not Supported (No significant difference found between resilient and non-resilient firms regarding R&D spending). The hypothesis is rejected.
H2 - R&D project participation	Mann-Whitney U	915.5	.051	Marginally Supported (p < 0.10). The hypothesis is accepted with caution.
H3 - product development	Chi-square	9.968	.002	Supported (Strong association between product development and resilience). The hypothesis is accepted.
H4 - market development	Chi-square Mann-Whitney U	2.958 915.5	.085 .051	Marginally Supported (p < 0.10). The hypothesis is accepted with caution.
H5 - diversification	Mann-Whitney U	1026.5	.009	Supported (Significantly higher technical textile shares in resilient firms, indicating that specialisation contributed to resilience). The hypothesis is accepted.
H6 - year of establishment	Mann-Whitney U	594.5	.052	Marginally Supported (p < 0.10). The hypothesis is accepted with caution.
H7 - % female employees	Mann-Whitney U	1043.0	.015	Supported (Significantly higher in resilient firms; p = .015). The hypothesis is accepted.
H8 - % of women in management	Mann-Whitney U	624.0	.085	Marginally Supported (p < 0.10). The hypothesis is cautiously accepted.

Hypotheses marked as "marginally supported" showed trends (p < 0.1) but did not meet the conventional significance threshold of p < 0.05.

Hypotheses H2, H4, H6 and H8 receive exploratory or indicative support in bivariate analyses, but do not emerge as robust predictors once controls are introduced. Accordingly, these hypotheses should be interpreted as exploratory indications rather than confirmed short-term determinants of resilience. For H2 (R&D project participation) and H4 (market development), the p-values (p=.051 and p=.085 respectively) suggest trends that approach conventional significance. This could indicate a potential, albeit weaker or more indirect, role for these factors, or might be influenced by the specific characteristics of the crisis. For instance, while R&D projects (H2) might foster long-term resilience, their impact on immediate turnover during an acute, demand-driven shock like COVID-19 might be less direct than rapid product development (H3, H5). Similarly, market development (H4) often requires longer lead times and higher investment, making its short-term impact on resilience during an abrupt crisis less pronounced than more agile product pivots. For H6 (firm age) and H8 (% of women in management), the marginal support (p=.052 and p=.085 respectively) suggests that while younger firms and greater gender diversity in management may confer flexibility and broader perspectives, other factors or specific contextual elements within the Valencian cluster might have attenuated their statistical significance in this particular dataset.

These trends, however, still provide valuable avenues for future research to explore under different crisis conditions or over longer timeframes.

A binary logistic regression model was estimated to assess the joint effect of all predictors on SME resilience. The model was statistically significant ($\chi^2(8) = 24.69$, p = 0.0018) and explained 22% of the variance in resilience (Nagelkerke $R^2 = 0.22$), correctly classifying 75% of firms.

As shown in Table 2, product development emerged as the most powerful and robust predictor of resilience. Specifically, the Odds Ratio (Exp(B) = 4.73; p = 0.012) indicates that firms implementing product development strategies were nearly five times more likely to be resilient than those that did not. This substantial effect size underscores that agile product reconfiguration was a decisive survival mechanism, providing strong empirical support for the theoretical model's emphasis on strategic agility over formal assets. The increase in the share of technical textiles (diversification) exhibited a positive but marginal effect (B = 0.74, p = 0.064), while firm age (years since establishment) exhibited a negative association with resilience (B = -0.034, p = 0.050), suggesting greater adaptability among younger firms.

TABLE 2.
Binary logistic regression results for SME resilience (N = 80)

Predictor	B (Coef.)	SE	Wald	p-value	Odds Ratio (Exp(B))	95% CI OR (Lower – Upper)
Constant	1.12	1.08	1.07	0.301	3.06	,
Turnover allocated to R&D	-0.10	0.67	0.02	0.880	0.91	0.26 – 3.20
R&D project participation	0.20	0.30	0.44	0.510	1.22	0.67 – 2.24
Product development	**1.55**	**0.62**	**6.29**	**0.012***	**4.73**	**1.40 – 15.95**
Market development	-0.68	0.80	0.72	0.400	0.51	0.11 – 2.42
Diversification	0.74	0.40	3.43	**0.064†**	2.10	0.96 – 4.62
Years of establishment	**-0.034**	0.017	**3.84**	**0.050**	**0.97**	**0.93 – 1.00**
% female employees	1.63	1.85	0.78	0.380	5.10	0.13 – 193.94
% of women in management	-2.49	1.29	3.73	**0.054†**	0.08	0.01 – 1.04

Notes: *p < 0.05; † p < 0.10 (marginal significance). Dependent variable: Resilience (1 = turnover maintained/increased; 0 = turnover decreased). B: Unstandardized coefficient; SE: Standard Error; Wald: Chi-square statistic; OR: Odds Ratio (Exp(B)); 95% CI: Confidence Interval. OR > 1 indicates increased likelihood of resilience. Product development emerges as the only robust predictor (p < 0.05), with an OR of 4.735.

In contrast, neither changes in R&D investment nor the number of R&D projects were significant when controlling for the other variables. Workforce and management gender composition did not retain significance in the multivariate context. Similarly, results for firm age (p = 0.050) and women in management (p = 0.054) must be interpreted with appropriate caution; while they show values at or near the significance threshold, they represent suggestive trends rather than conclusive effects. Theoretically, this implies that while younger firms and inclusive leadership may facilitate an environment prone to adaptability (reducing structural inertia), their impact during an acute systemic shock was less immediate than direct strategic pivots. The bivariate associations previously observed for gender may thus be partially mediated by the specific strategic actions, such as product diversification, that these diverse teams were able to implement.

Taken together, these results highlight the need to distinguish between statistical significance and practical relevance. Predictors with marginal support (H2, H4, H6, H8) suggest potential behavioural tendencies in the cluster, but their interpretation should remain tentative and cannot be viewed as robust

short-term determinants of resilience. By contrast, the variables with stronger statistical support, particularly product development and diversification into technical textiles, provide clearer practical insights. These findings indicate that SMEs in traditional clusters are more likely to sustain performance during systemic shocks when they prioritise agile product renewal and selective diversification rather than increases in formal R&D spending. For cluster policy, this underscores the value of supporting flexible manufacturing capabilities and facilitating rapid product adaptation across firms.

5. Discussion and conclusions

5.1. Discussion

This study examined SME resilience in the Valencian textile cluster in Spain during the COVID-19 crisis through an integrated model combining dynamic capabilities, strategic innovation, and organisational characteristics, explicitly situated within a mature industrial context characterised by strong path dependencies. The findings show that strategic innovation behaviours, particularly product development and selective diversification into technical textiles, were the most robust predictors of short-term resilience, measured as turnover maintenance or growth during the crisis. By contrast, formal R&D indicators displayed limited explanatory power in distinguishing resilient from non-resilient firms.

These results contribute to and qualify a dominant strand of the resilience literature that emphasises formal R&D investment and technological capabilities as central drivers of adaptive performance, especially in high-technology sectors or contexts characterised by incremental environmental change (e.g., Teece, 2007; Wenzel et al., 2021; Gianiodis et al., 2022). While this literature has generated important insights, it is largely grounded in settings where innovation processes are structured, cumulative, and oriented towards medium- to long-term competitiveness. The evidence presented here suggests that these mechanisms do not translate straightforwardly to mature manufacturing clusters facing abrupt, demand-driven systemic shocks. In such contexts, market-oriented strategic innovation appears to play a more decisive role than formal R&D investment in explaining short-term resilience outcomes, a pattern that is consistent with dynamic capabilities arguments and recent empirical evidence from traditional manufacturing contexts (e.g., Teece, 2007; Pallás-Rocafull et al., 2024).

This pattern can be explained by the nature of the shock, the temporal horizon of resilience, and the structural characteristics of the sector under analysis. The COVID-19 crisis required rapid operational and strategic responses oriented toward immediate survival rather than longer-term capability accumulation. Strategic innovation, understood as the rapid reconfiguration of products, markets, and production priorities, offered firms a direct mechanism to stabilise performance under extreme uncertainty. By contrast, formal R&D typically operates through longer gestation periods and uncertain payoffs, making it less effective as a direct driver of short-term resilience. In mature manufacturing sectors such as textiles, where innovation is often incremental and embedded in established routines, R&D primarily plays an enabling role by supporting absorptive capacity and technical flexibility rather than generating immediate performance effects (Muneeb et al., 2023; Kyrdoda et al., 2023). As a result, firms' ability to redeploy existing capabilities and pivot strategically toward emergent demand proved more consequential for resilience than increases in formal R&D inputs.

Beyond strategic behaviour, organisational characteristics also shaped resilience outcomes, in particular, the so-called "diversity advantage" (Glass et al., 2016; Gianiodis et al., 2022). Gender diversity in the workforce, and to a lesser extent in management positions, was positively associated with resilience, lending support to arguments that diverse teams enhance problem-solving capacity, adaptability, and decision-making quality under turbulent conditions (Glass et al., 2016; Piscopo, 2020). Although the effect of women in management did not reach conventional significance thresholds, its consistent direction suggests a potentially meaningful organisational mechanism that warrants further investigation. Firm age exhibited a negative association with resilience, indicating that younger firms may benefit from greater structural flexibility and fewer path dependencies, reducing inertia in crisis response (Hannan & Freeman, 1984).

Overall, the findings indicate that resilience within industrial clusters is not homogeneous but shaped by firm-level heterogeneity in strategies, capabilities, and organisational configurations. Even within a shared territorial and institutional environment, SMEs differ markedly in their capacity to reconfigure activities and respond to systemic disruption. This underscores the importance of firm-level agency within clustered settings and cautions against treating clustered SMEs as uniform actors when analysing resilience dynamics.

5.2. THEORETICAL, MANAGERIAL, AND POLICY IMPLICATIONS

The study offers significant implications at theoretical, managerial, and policy levels. From a theoretical perspective, it validates an integrated resilience framework that moves beyond technology-intensive contexts to explain adaptation in mature manufacturing ecosystems. By combining strategic innovation behaviours with organisational characteristics, the analysis contributes to a more nuanced understanding of resilience as a dynamic, heterogeneous and context-dependent process embedded within specific territorial contexts.

From a managerial perspective, the results suggest that SME leaders in traditional industrial clusters should prioritise strategic agility over static resource accumulation when facing abrupt demand-driven crises. Rather than treating increased R&D expenditure as a primary short-term resilience lever, managers are likely to achieve more immediate performance stabilisation by focusing on rapid product adaptation, short-cycle experimentation, and the redeployment of existing production capabilities toward emergent market needs. Formal R&D remains relevant, but mainly as an enabling background condition that supports flexibility and absorptive capacity, rather than as a direct driver of short-term resilience under systemic shock conditions.

From a policy perspective, the findings indicate that regional innovation and industrial policies, particularly those embedded in RIS3 agendas, may be poorly aligned with the needs of SMEs confronting sudden systemic disruptions, particularly in mature industrial clusters. More effective resilience-oriented policy instruments include rapid-response funding schemes, support for short-cycle prototyping and pilot production, and mechanisms that facilitate temporary production reorientation through technological intermediaries and cluster organisations. Such instruments reduce coordination and experimentation costs and allow firms to respond within compressed timeframes that traditional R&D programmes are not designed to accommodate.

At the territorial level, although this study focused primarily on firm-level dynamics, the results also underscore the relevance of the cluster's support infrastructure. Institutions such as ATEVAL, AITEX, and regional universities contribute to what can be described as a "collective adaptive cushion", facilitating access to technical knowledge, experimentation capabilities, and coordination mechanisms. Beyond their enabling role, these intermediaries can actively accelerate firm-level experimentation, coordinate temporary production reorientation, and act as rapid translators between emergent market demand and existing industrial capabilities during systemic shocks. These observations are in line with prior evidence on the role of universities and intermediary institutions in supporting adaptation processes within industrial clusters (e.g. Molina-Morales et al., 2022; Capó-Vicedo et al., 2025). While this institutional role is not modelled directly, it constitutes an enabling territorial condition that shapes the opportunity space within which resilient firms were able to enact strategic shifts during the crisis.

5.3. CONCLUSIONS, NOVELTY, AND FUTURE RESEARCH

The primary novelty of this research lies in its empirical demonstration of how gender composition, strategic agility, and technical diversification interact to explain SME resilience within a mature Southern European industrial cluster, a context that remains under-represented in the resilience literature. By providing granular firm-level evidence from the Valencian textile district, the study shows that resilience in traditional manufacturing sectors is driven less by formal R&D intensity and more by intentional strategic decisions, incremental upgrading paths, and organisational configurations.

While this study does not explicitly model institutional actors or territorial governance mechanisms, it contributes indirectly to the literature on local institutions and regional resilience by clarifying the context within which firm-level adaptive strategies emerged. The evidence suggests that strategic agility and diversification were enacted within an institutional environment that lowered coordination costs, facilitated rapid access to technical knowledge, and supported experimentation during the crisis. The mixed-methods design adopted in the study reinforces this interpretation by linking observable performance outcomes with managerial accounts of how firms interpreted the shock, justified strategic choices, and mobilised organisational resources. In this sense, institutions and qualitative insights are not treated as independent explanatory factors, but as complementary elements that help illuminate the mechanisms through which resilience unfolded in a mature, territorially embedded cluster.

At the same time, the study acknowledges several limitations that open promising avenues for future research. The cross-sectional design and the pragmatic focus on turnover maintenance capture short-term adaptive outcomes but do not fully reflect the multidimensional nature of resilience, including longer-term transformational learning, workforce stability, or organisational well-being. Future research could therefore build on this work by adopting longitudinal designs that track firms beyond the immediate crisis period, allowing assessment of whether observed strategic adaptations consolidate into sustained post-crisis transformation. In addition, comparative analyses across different industrial clusters and sectors would help clarify the extent to which the mechanisms identified here are context-specific or generalisable across mature manufacturing districts. Finally, further work could develop multidimensional resilience indicators that integrate financial performance with strategic, organisational, and human capital dimensions, providing a richer measurement framework for resilience in regional industrial systems.

In closing, this study reinforces the view that SME resilience in mature clusters is neither accidental nor uniform, but emerges from the interaction between strategic agility, organisational diversity, and territorially embedded capabilities. As systemic shocks become an increasingly structural feature of the global economy, understanding and supporting these mechanisms will be essential not only for firm survival, but also for the long-term competitiveness and resilience of industrial regions.

ACKNOWLEDGEMENTS

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APPENDIX A. DATA COLLECTION INSTRUMENT

This appendix summarises the mixed-methods interview protocol used in the study, including the main quantitative items, their measurement scales, and the qualitative prompts employed to contextualise firms' adaptive responses during the COVID-19 crisis.

A1. STRUCTURED QUESTIONNAIRE (QUANTITATIVE COMPONENT)

The structured questionnaire was jointly developed by researchers from the Universitat Politècnica de València and ATEVAL and administered to SME owners or general managers in the Valencian textile cluster. Items were organised into the following thematic blocks:

FIRM PROFILE AND STRUCTURAL CHARACTERISTICS

- Core activity and position in the textile value chain
  Measurement: Multiple-choice categories (e.g. fabric manufacturing, technical textiles, medical textiles, apparel)
- Year of establishment
  Measurement: Continuous (year)
- Firm size
  Measurement: Number of employees before COVID-19 (Feb 2020) and during COVID-19 (Feb 2021)

- Manufacturing vs commercial orientation
  Measurement: Categorical (manufacturer, commercial, mixed)

PRODUCTION AND MARKET ORIENTATION

- Product portfolio before and during COVID-19
  Measurement: Multiple-response categorical items
- Share of technical textiles in total production
  Measurement: Ordinal categories (0–20%, 21–40%, 41–60%, 61–80%, 81–100%)
- Client profile
  Measurement: Categorical (B2B, B2C, mixed)
- Markets served before and during COVID-19
  Measurement: Multiple-response categorical items (domestic and international markets)

HUMAN CAPITAL AND ORGANISATIONAL COMPOSITION

- Workforce composition by gender
  Measurement: Percentage categories (ordinal ranges)
- Educational level of employees
  Measurement: Percentage categories
- Workforce experience in the sector
  Measurement: Percentage categories
- Gender composition of the management team
  Measurement: Percentage categories

INNOVATION AND DYNAMIC CAPABILITIES

- Number of active R&D projects
  Measurement: Count variable (Number of projects), reported for pre- and post-COVID periods
- R&D intensity
  Measurement: Percentage of turnover allocated to R&D (ordinal ranges)
- Engagement in technical textile development
  Measurement: Binary (Yes/No)
- Product and market innovation initiatives during COVID-19
  Measurement: Binary indicators for each strategic action

INTER-FIRM AND INSTITUTIONAL RELATIONSHIPS

- Commercial exchanges with suppliers, customers and competitors
  Measurement: Count variable (number of partner firms), pre- and post-COVID
- Knowledge exchanges within and outside the cluster
  Measurement: Count variable (number of partner firms)
- Institutional support received (e.g. AITEX, ATEVAL, universities)
  Measurement: Ordinal scale (None, 1, 2, 3, 4, 5 or more institutions)

RESILIENCE OUTCOME

- Turnover variation between 2019 and 2020
  Measurement: Ordinal categories ranging from losses greater than 50% to turnover maintenance or increase
  Operationalisation: Recoded as a binary variable (1 = maintained/increased turnover; 0 = decreased turnover)

A2. SEMI-STRUCTURED INTERVIEW GUIDE (QUALITATIVE COMPONENT)

To complement the quantitative data, the interview protocol incorporated a set of open-ended prompts aimed at capturing managers' perceptions, strategic reasoning, and contextual constraints. These prompts were used flexibly during the interviews and focused on the following areas:

PERCEIVED IMPACT OF THE COVID-19 CRISIS

- Main operational, commercial and organisational challenges faced
- Timing and intensity of the shock experienced by the firm

STRATEGIC RESPONSES AND ADAPTATION MECHANISMS

- Rationale behind product, market or diversification decisions
- Drivers of rapid product reorientation or technical textile adoption
- Role of experimentation and improvisation during the crisis

ROLE OF INTERNAL RESOURCES AND CAPABILITIES

- Importance of existing technological, human and organisational resources
- Changes in internal decision-making processes during the crisis

TERRITORIAL EMBEDDEDNESS AND EXTERNAL SUPPORT

- Role of relationships with suppliers, customers and competitors
- Support received from cluster institutions and public bodies
- Perceived advantages and limitations of being located in the textile cluster during the crisis

REFLECTIONS ON RESILIENCE AND FUTURE OUTLOOK

- Lessons learned from the crisis
- Perceived long-term implications for strategy, innovation and organisation

Qualitative information derived from these prompts was not analysed as an independent qualitative dataset but was used to contextualise and interpret the quantitative findings, particularly in relation to statistically significant and marginal effects.