Unlocking the Dynamics of Innovation Clusters: Sectoral Impacts and Organisational Capabilities

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ABSTRACT

Purpose: This article explores innovation clusters, analysing their operation, the impact of sectoral factors, and their role in regional economic growth. It highlights the intersection of sectoral effects, organisational capabilities, and collaboration dynamics within clusters, providing insights for policymakers and businesses seeking development opportunities.

Methodology/Approach: The research methodology involves a literature review, quantitative survey, factor analysis, cluster analysis, and correlation analysis to explore the relationships between sectoral effects, organisational capabilities, and collaboration within innovation clusters.

Findings: The findings suggest that sector-specific effects influence cluster members' strategic and innovation capabilities. Technological complexity is predominant, impacting market orientation and product development capabilities. The article also identifies four distinct groups of organisations based on sectoral impacts and export activities within clusters.

Research Limitation/implication: While the methodology provides valuable insights, there is potential sampling bias as non-random sampling via cluster manager recommendations may introduce selection bias. The findings are specific to Hungarian innovation clusters and may not be generalised universally.

Originality/Value of paper: The uniqueness of this study lies in its holistic and data-driven exploration of innovation clusters, considering a wide range of factors and their practical implications for fostering collaboration and innovation in different industries.

Category: Research paper

Keywords: innovation; innovation clusters; strategic and innovation capabilities; industrial environment; collaboration

1 INTRODUCTION

Innovation clusters are collaboration hubs where creativity thrives, offering valuable insights into economic growth, job creation, and technological progress within specific regions or industries. By studying these clusters, we uncover dynamic forces that drive innovation, benefiting policymakers and businesses seeking strategic opportunities for growth and partnerships, ultimately boosting competitiveness and sustainable development.

DeBresson (1999) shifts the focus from internal organisational processes to inter-firm collaboration and infrastructure, aligning with innovation systems theories. Transaction cost theory, by Coase (1937) and Richardson's (1972) knowledge transfer emphasis on inter-firm cooperation, expands this perspective. Knudsen (1996) connects this to innovation network theory, highlighting continuous knowledge exchange.

Von Hippel's early research (1976, 1977) emphasises knowledge transfer between firms in innovation. Shenkar (2010) supports this by highlighting that follow-on innovators benefit the most. DeBresson's study (1999) shows that firm cooperation often involves coordination among units of horizontally diversified firms across sectors, with national variations. Buyer-supplier relationships contribute to only 16 percent of innovations. Most innovations involve cooperation among 3-5 independent firms, demonstrating their deep connections.

Studies exploring the link between innovation and regionality, as by Cooke (2008), challenge centralised regional innovation paradigms. Empirical studies show that SMEs can compete with large firms through flexible specialisation and cooperative networks (Altomonte et al., 2013; Fitjar and Rodrígez-Pose, 2015; Bracanti, Bracanti and Maresca, 2017). Regional innovation systems share conceptual similarities with national systems.

Recent research (Cooke and Leydesdorff, 2006; Frenken, van Oort and Verburg, 2007; Coenen, Benneworth and Truffer, 2012; Hansen and Coenen, 2015) highlights the effectiveness of regional innovation systems in managing complex clustering cases. Even in green technology, industries collaborate on shared goals, regardless of profile differences. The regional organisation remains prevalent in complex cluster collaborations, exemplified in California.

In conclusion, this research underscores inter-firm collaboration, knowledge sharing, and regional innovation systems as critical drivers of innovation and economic growth, emphasising the success of regional cooperation across diverse industries.

2 LITERATURE REVIEW

2.1 Defining Innovation Clusters

Innovation clusters are collaborative groups of organisations aiming to drive innovation, with three main definitions in the literature: a general approach, a research network approach, and a creative field approach.

Preissl and Solimene (2003) define innovation clusters as interdependent organisations contributing to innovations within an economic sector or industry. This definition emphasises innovation focus, allows competency integration without physical proximity, and highlights the collective benefits for the entire cluster.

Nooteboom (2005) adopts a social/cognitive approach, emphasising embeddedness and cycles of research and exploitation within innovation clusters. Hamdouch (2007, 2010) distinguishes clusters from innovation clusters based on their research-oriented logic, while Scott's creative fields theory (2006) focuses on social relationships driving creativity and innovation.

Clusters play a vital role in the economy, offering several benefits:

- Resilience: Specialisation within clusters enhances resilience, allowing efficient knowledge and expertise exchange (Porter, 1990). The sectoral landscape of clusters in Hungary reflects this as well. The prevalence of the IT and health sectors notably characterises it. Information and Communications Technology (ICT)-oriented innovation clusters are the most prominent among these. This dominance can be attributed to the IT industry's inherently "trendy" nature, the rapid dissemination of innovations, and the dynamic and diverse nature of the market.
- Information Exchange: Clusters facilitate sharing of best practices and expertise among firms (Porter, 1998). The communication dynamics within and emanating from cluster relations exhibit a multifaceted and multidirectional nature in Hungary. This trait is rooted, firstly, in the diverse composition of the membership, which encompasses various types of organisations and institutions. Secondly, the "actors" represent a broad spectrum of professional knowledge, competencies, and job positions during collaborative endeavours, whether within joint projects or beyond. This spectrum includes individuals ranging from small entrepreneurs and managers of large companies to university professors, researchers, developers, marketers, coordinators, consultants, and more. This diversity in membership and expertise contributes to the rich and intricate flow of information and communication within the cluster ecosystem.
- Innovation: Clusters promote innovation through knowledge transfer, trust-based relationships, and social capital (Szanyi, 2008; Szanyi et al., 2010; Szabo, Ferencz and Pucihar, 2013). In Hungary, the overarching objective

of innovation clusters is evident: fostering successful market entry for innovative solutions through collaborative efforts and well-managed relationships. The core strategy involves partners integrating their competencies and technical resources. This cooperative approach aims to facilitate mutual support, enabling each member to contribute to and benefit from the collective pursuit of successfully bringing innovative solutions to the market.

- Efficiency: Clusters spread economic activity efficiently, impacting employment, productivity, and competitiveness on various scales (Muro and Katz, 2010). In Hungary, particularly in the health sector, clustering is a pivotal strategy to expand market opportunities for domestic companies within an industry steeped in tradition. The dissolution of large companies in the sector has transformed development groups into smaller, compelled enterprises. The influx of multinational competitors and an increasing prevalence of imports have nearly marginalised these domestic micro, small, and medium-sized enterprises within the local market.

  This situation is unfortunate because a product structure grounded in professional expertise could comprehensively address the demand spectrum. Clustering thus emerges as an avenue for these domestic firms to collaborate. The primary anticipated benefit for members is gaining market share through collective action. This involves pursuing export market objectives and identifying niche domestic markets and supplier opportunities where the flexibility advantages inherent in smaller company sizes can be effectively leveraged.

The definition of innovation clusters and the concepts mentioned above were also adopted in Hungary. However, the inception of clusters in Hungary dates back to the early 2000s, and a distinctive characteristic, especially in comparison with other European counterparts, is the top-down formation. Notably, these clusters often originate in the more developed regions of the country, deviating from the typical bottom-up process driven by SMEs.

The conceptualisation of long-term cluster development took shape in 2007 by introducing a multi-stage cluster development model, aligning with the European Cluster Memorandum (MAG Zrt, 2012). The sequential levels in this model are as follows:

- Innovation Clusters of Local Relevance: These clusters emerge from new initiatives, signifying the initiation of networking and collaboration in support activities.
- Evolving Clusters: This stage involves the development of relationships between members, collaboration in value-adding activities, and joint investments, marking a progression in cluster maturity.

- Accredited Innovation Clusters: At this level, clusters deepen trust, engage in cooperative investments and mutual investment endeavours, and emphasise innovation, gaining accreditation.
- Collaborative Clusters with International Competitiveness: The pinnacle of cluster development, where clusters collaborate extensively and ensure international competitiveness.

Internally, the accreditation process serves as a significant milestone for innovation processes. It establishes criteria for high innovation performance, export capacity, and the implementation of substantial development projects through efficient cooperation.

Accreditation in Hungary, which involves gauging the success of a cluster and evaluating its potential for development in both national and international markets, is based on five key criteria (:

- Degree of Cooperation Between Members: This criterion assesses the extent of collaboration and synergy among the cluster's members.
- Composition of the Cluster's Membership: It considers the diversity and makeup of the members within the cluster.
- Business Performance of SME Sector Members: The performance and contributions of members belonging to the SME sector are evaluated.
- Cluster's R&D Performance: This criterion focuses on the cluster's research and development achievements and capabilities.
- Cluster's Strategic and Operational Plans: The strategic and operational plans of the cluster are scrutinised to understand its direction and approach.

In our study, we specifically concentrate on accredited innovation clusters. These clusters have demonstrated a commendable level of innovation and cooperation, meeting the essential conditions and characteristics for reliable investigation of our research questions.

In summary, innovation clusters have diverse interpretations but commonly involve interactions among member companies, shared resources, geographical proximity, institutional links, and economic specialisation. This research views innovation clusters as networks fostering open innovation, translating R&D into market success, and promoting market-oriented innovation based on a broad knowledge base.

2.2 Industrial Environment of Innovation Clusters

As mentioned in the previous chapter, innovation clusters are heavily influenced by their industrial surroundings (Alarcón-Martínez, Güemes-Castorena and Flegl, 2023). To understand successful innovation collaborations driven by market needs, we examine external factors: political, legal, economic, social, and technological

influences. Our research focuses on market-oriented innovation in these clusters and explores the impact of the external environment.

Two primary innovation models are "pull" and "technology push." The "pull" model is demand-driven, aiming to meet existing needs through R&D and technology transfer, influenced by buyers (Kiss, 2006). In contrast, the "technology push" model relies on scientific discoveries to drive R&D, with less customer influence (Szakály, 2013).

Uncertainty is a crucial factor in innovation. Predictable environments require less new knowledge acquisition while increasing uncertainty demands robust development efforts to adapt to rapidly evolving markets, competitors, and technologies (Petruska, 2005; Teece and Leih, 2016).

In conclusion, the industrial environment significantly affects innovation clusters, especially market-driven innovation. The choice between a "pull" or "technology push" approach and the level of uncertainty greatly influence these clusters' innovation activities.

2.3 Strategic and Innovation Capabilities

Organisational capabilities significantly impact an organisation's goals and strategies (Birchall and Tovstiga, 2005; Löfsten, 2016). These capabilities operate at three levels: within departments, in the value-creation process, and among market actors (Gelei and Nagy, 2004).

Effective collaboration across functional departments involving specific competencies is crucial in market-oriented innovation. Assessing market orientation means evaluating how well departments cooperate and share knowledge (Kohli and Jaworski, 1990; Narver and Slater, 1990). Smaller organisations often integrate R&D and marketing activities, while larger ones tend to separate them.

Size often influences these capabilities, leading to specialisation and physical separation of R&D and marketing, sometimes causing conflicts due to different professional cultures.

Coordination challenges can arise in technology-focused companies prioritising technology over customer needs (Atuahene and Evangelista, 2000). Collaborations within clusters rely on trust and past projects, but inter-organisational skills are also vital (Håkansson and Snehota, 2017).

Individual member organisations' strategic and innovation capabilities significantly impact cluster market orientation. The lack of such capabilities hinders communication, synergy, and innovation potential. Enhancing capacity, especially communication, is vital, with cluster management playing a crucial role (Dobronyi, Halmos and Somosi, 2012).

3 METHODOLOGY

Our research comprised three primary phases. Initially, we undertook a qualitative survey through face-to-face professional interviews. During the data collection phase, we reached 20 of Hungary's 21 accredited innovation clusters (cluster management companies), achieving a robust 95% coverage rate.

Moving to the second phase, we continued with qualitative face-to-face professional interviews, targeting the cluster membership within the clusters. At this stage, 40 member companies linked to these clusters were interviewed.

Based on the results of the first two phases, we moved on to our survey's third and final phase; we conducted quantitative and descriptive research targeting both cluster management organisations and member companies. The emphasis was on obtaining quantitative data aligned with our research questions. While the survey was primarily administered online, we recognised the complexity of the research topic and provided the option for in-person (face-to-face and on phone too) completion, facilitating engagement with key stakeholders. The ensuing paper presents the outcomes of this third phase, organised by the research questions outlined below, focusing on the answers of the member companies:

- Do external sectoral factors connect to the internal capabilities of member companies, and do they influence cooperation within the cluster?
- In each industry under examination, which effect is more commonly observed?
- Are intra-cluster collaborations influenced by environmental factors that affect member firms, and which influences tend to be more significant?
- What is the relationship between external factors and the internal capabilities of member firms?

Hungary had 27 accredited innovation clusters during the quantitative, descriptive research phase. However, due to the unavailability of a centralised database for the member companies within these clusters, we took the initiative to construct our database. This involved collating information provided by cluster managers and extracting details from the lists of member companies available on the accredited innovation clusters' websites. Our resulting database encompassed contact details for 984 member companies.

In this survey stage, we distributed our questionnaire to each member company. Ultimately, we received and evaluated 120 completed responses, achieving a commendable response rate of 12%. This rate is particularly noteworthy in the context of the Hungarian B2B market. Sampling was a blend of non-random (using snowball sampling through cluster manager recommendations) and partly random (exhaustive) sampling, with all companies in the database gaining online questionnaire access.

The respondent's characteristics were the following: 50 managers, 18 owners, directors, cluster coordinators, 12 employees, and four R&D directors. They came from various industries, including 30 from the food sector, 29 from machinery, 26 from information technology, and 14 from healthcare. The sample mostly comprised organisations with functional structures (46) and divisional-product-based facilities (38). Regarding export activity, 50 indicated medium-level, and 34 had low export activity. The sample was predominantly medium-sized companies (54), with smaller enterprises (34) and large corporations (32). Most respondents were from the services and community services sector (46). The ownership structure mainly focused on domestic (non-governmental) entities (94), reflecting the goal of promoting local collaboration.

The sample's representation of cluster membership highlights the importance of the responses, as all participants are involved in some way in projects and partnerships initiated within the cluster. As previously noted, the accreditation of an innovation cluster involves meeting specific predefined conditions. This accreditation process ensures that each member company within the cluster adheres to predetermined criteria related to cooperation and innovation. This stringent evaluation framework enhances the reliability and relevance of the responses obtained in our survey. However, it is essential to acknowledge that the non-random sampling method can introduce potential biases in the results.

3.1 Clarification of Assessment Criteria: Industrial Environment

We gathered cluster members' perceptions of technological effects through a Likert scale to assess the industry's environmental impact. We confirmed variable correlations through the KMO-Bartlett test, which exceeded the threshold at 0.783, making our variables suitable for factor analysis.

Applying the principal component method, we identified three factors explaining 74.72% of the total variance, surpassing the accepted threshold. Varimax rotation further pinpointed variables associated with each factor, as outlined in Table 1

Table 1 – Key Components of the Principal Factors - Effects of the Industry's Environmental Conditions

Factors	Statements	Factor weight value
F1 – Environment Dynamic Change	Consumer habits in our industry are constantly changing.	0.857
	Our competitors' strategies/actions are constantly changing.	0.761
	In our main markets, products/services are rapidly becoming obsolete.	0.731
	Our consumers have very different product expectations.	0.687
	Technological developments in our industry represent an excellent opportunity for us.	0.916

Factors	Statements	Factor weight value
F2 – Technological Environment	Many new product ideas in our industry are the result of technological breakthroughs.	0.799
	The pace of technological change in our industry is rapid.	0.748
F3 – Competitor Threat	The quality/novelty of our competitors' products threatens our company.	0.824
	Tough price competition is a threat to our company.	0.815

Based on these findings, we have identified the following environmental impacts to be explored further:

- F1 - Environment Dynamic Change Factor: This factor encompasses the rapid industry changes, shifts in consumer behaviour, competitive strategies, and the shortened product and service lifecycles, which can challenge the organisations within the study.
- F2 - Technological Environment Factor: This factor aligns with the complexity of the environment and highlights the accelerating pace of technological advancements, impacting product lifecycles. Respondents generally view technological change as an opportunity.
- F3 - Competitor Threat Factor: This factor emphasises competitors' tactical actions, such as product quality and innovation, and the threat of price competition. It can be seen as a positive and negative influence within the sample.

Through this analysis, we have consolidated the survey statements, facilitating a clearer understanding of the environmental impacts on cluster members.

3.2 Clarification of Assessment Criteria: Strategic and Innovation Capabilities

Our study analysed member firms' capabilities, categorising them into key competencies for sectoral impact. The KMO index value for these competencies was 0.812, and we identified 5+2 factors explaining 82.37% of the variance. Table 2 displays statements and their weights for each factor obtained through Varimax rotation.

Table 2 – Key Components of the Principal Factors - Strategic and Innovation Capabilities

	Factors	Statements	Factor weight value
	F1 – Informa-	Information about our competitors' activities often reaches the right employee after it is ready for use.	0.924

	Factors	Statements	Factor weight value
Internal Competencies	*tion Dissemination*	The information that affects our relationships with our consumers takes an eternity to reach the right employee.	0.921
		Important information about our consumers is often "lost in the system."	0.909
		Information about our target market (regulation, technology, etc.) is often lost in the company's communication chain.	0.835
	F2 - Product Development	We develop and market (export) our products quickly.	0.920
		We develop new products (exports) to capitalise on our R&D investments.	0.811
		We can also apply rapid development systems to new products for the market (export).	0.784
	F3 - Internal Innovation	We successfully launched our new products (export).	0.681
		Developing an innovation strategy also enhances employee skills.	0.887
		Part of monitoring our innovation strategy is to improve employee engagement, morale, or both.	0.848
		Internal cooperation is an integral part of the implementation of our innovation strategy.	0.839
	F4 – Responsiveness	We react quickly to competitive activities that threaten our target markets.	0.851
		We react quickly to changes in our business environment (e.g., regulation, technology).	0.833
		We react quickly to the price changes of our competitors in our target markets.	0.829
	F5 – Technological Capabilities	The success of our R&D activities is based on long-term know-how.	0.884
		We have invested quite a lot in specific R&D projects.	0.620
		Our technological capabilities are first-class.	0.493
Sectoral Competencies	*F6 – Innovativeness*	In our industry, our company is known as an innovator.	0.888
		Our company is a leader in developing new products/services.	0.882
		Our company is at the forefront of new methods and technologies in the industry.	0.878
		Our company often tests new ideas.	0.838
		Our company often tests new solutions with new activities.	0.726
		Our company tries to be creative.	0.598
	F7 – Proactiveness	We take every opportunity to seize opportunities in our target market operations.	0.882
		We are looking for opportunities in our target market before our competitors.	0.733
		We act opportunistically to shape the business environment in which we operate.	0.344

The organisational capabilities we identified are as follows:

- F1 – Information Dissemination Capability: This factor relates to an organisation's ability to efficiently share information internally. The scale values in our research were reversed for statements associated with this factor, highlighting that organisations characterised by this factor can quickly share information about their customers, competitors, and target markets within the organisation.
- F2 – Product Development Capability: This factor encompasses an organisation's competencies in swiftly developing new products. Organisations with this capability excel at creating and launching products rapidly, viewing product development as a means to leverage their R&D activities. Such organisations typically have efficient systems for rapid development.
- F3 – Internal Innovation Capability: This factor delves into the firm's planning and design of innovation activities.
- F4 – Responsiveness: This factor centres around an organisation's capacity to react swiftly to market changes, including competitor activities, price fluctuations, and regulatory adjustments.
- F5 – Technological Capability: This factor pertains to the technological knowledge and expertise available within the organisation. Firms characterised by this capability possess the necessary know-how for development and collaboration.
- F6 – Innovativeness Capability: This one contains the most statements among the factors. It gauges an organisation's innovation capabilities based on its perceived role in the industry. If other actors regard an organisation as an innovator, it typically demonstrates strong R&D and innovation competencies.
- F7 - Proactiveness: Organisations with this factor are more inclined to proactively shape the business and market environment. They seize opportunities from market changes, such as capitalising on emerging product development trends.

Our analysis has enabled us to define each factor using the statements from the survey, making it easier to pinpoint the organisational capabilities of cluster members. The impacts of these capabilities are elaborated upon in the subsequent sections.

3.3 Clarification of Assessment Criteria: Collaboration Among Cluster Members

In our study, we sought to gain a deeper understanding of how cluster members engage in collaboration. To achieve this, we scrutinised members' perceptions of

collaboration, prior collaborative experiences, and how to categorise these various forms of cooperation based on our previous qualitative research results.

The notably high KMO value of 0.864 signifies that the variables utilised in our analysis are well-suited for factor analysis. Employing the principal component method, we identified three distinct factors representing the diverse facets of collaboration. These factors were chosen based on their significant explained variance, 76.22%. Subsequently, we identified the variables associated with each primary factor through Varimax rotation, as outlined in Table 3.

Table 3 – Key Components of the Principal Factors – Cooperation

Factors	Statements	Factor weight value
F1 – Exploring sales opportunities	Investigate potential sales prospects within the domestic market (outside cluster members).	0.876
	Investigate potential sales prospects in export markets.	0.866
	Explore sales opportunities among cluster members.	0.835
	Share information related to the internal market.	0.610
	Share information about the external market.	0.607
	Investigate opportunities for logistical cooperation.	0.576
	Explore possibilities for joint procurement.	0.495
F2 – R&D activities	Exchange R&D concepts.	0.921
	Engage in collaborative R&D endeavours.	0.915
	Test R&D concepts collectively.	0.809
F3 – Other joint activities	Participate in exhibitions together.	0.908
	Collaborate on tender submissions.	0.895
	Undertake joint projects.	0.876
	Share experiential knowledge.	0.727

Our analysis led to the classification of cooperation levels into the following factors:

- Sales Opportunity Exploration (F1): This factor encompasses efforts to explore sales prospects, which member organisations regard as vital in collaborative endeavours.
- R&D Activities (F2): This factor revolves around exchanging ideas and benefits related to research and development. Member companies within the cluster possessing this characteristic strive for fruitful R&D collaboration.
- Other Collaborative Activities (F3): This factor involves additional benefits derived from collaboration, with participation in exhibitions emerging as

the most crucial aspect. The exchange of experiences follows it, favouring cooperative ventures less.

4 RESULTS

We have explored the issues raised in the research based on the factors outlined earlier. We calculated the individual aspects of industry characteristics by taking simple averages of the values of the 4-3-2 variables on a seven-point scale for each factor. The total industry impact was determined by calculating a simple average for all nine statements, as detailed in Table 4.

Table 4 – The Influence of Specific Aspects Related to Industry Traits on Member Companies

	Descriptive statistics			t-test values		
Environmental Conditions	**N**	**Average**	**Standard Deviaton**	**Environment Dynamic Change**	**Technological Environment**	**Competitor Threat**
Environment Dynamic Change	120	4.12	1.28376	-		
Technological Environment	120	4.77	1.43493	-5.549031***	-	
Competitor Threat	120	4.23	1.19672	-0.906733642	3.8085712***	-
Environmental Conditions Average	120	4.36	1.06964			

*** p<0.01; ** p<0.05; * p<0.1

The results indicate that the technological environment received the highest score among the three dimensions. The difference between the average value of this dimension (4.77) and the competitor environment (4.23) is statistically significant, as indicated by a t-test performed at a 1% significance level. Conversely, the lowest score was attributed to the dynamic change of the environment (4.12), which is also significantly lower than the technological environment dimension.

Next, we analysed how member firms could be categorised based on sectoral effects. A cluster analysis was conducted, grouping organisations into four distinct groups using the three main factors. All 120 respondents were included in the study. The results, obtained using the WARD method, considering standardised variables and cluster characterisation, were based on the cluster centroids representing each cluster's average variables. Table 5 displays the characteristics of the four clusters created based on each primary factor.

Table 5 – Characteristics of Clusters Based on Sectoral Impacts

	1. cluster	2. cluster	3. cluster	4. cluster
N (%)	36	32	22	30

		1. cluster	2. cluster	3. cluster	4. cluster
		30%	27%	18%	25%
F1 – **Environment Dynamic Change**		*0.541*	*-1.285*	*0.935*	0.035
F2 – **Technological Environment**		*-0.615*	0.001	*0.926*	0.050
F3 – **Competitor Threat**		0.287	0.457	*0.681*	*-1.332*
Other Variables					
Company size	*Small*	27.80%	18.80%	*45.50%*	26.70%
	Medium	*38.90%*	*56.30%*	*45.50%*	*40.00%*
	Large	*33.30%*	25.00%	9.10%	*33.30%*
Export activity	*No activity*	11.10%	18.80%	9.10%	*33.30%*
	Low activity	*33.30%*	*31.30%*	36.40%	13.30%
	Medium activity	*44.40%*	*37.50%*	*54.50%*	*33.30%*
	Significant activity	11.10%	6.3%	0.00%	20.00%
Four sectors highlighted in the sample*	*IT*	*11.10%*	*18.80%*	*54.50%*	*13.30%*
	Health	0.00%	0.00%	0.00%	*40.00%*
	Environment	0.00%	6.30%	*9.10%*	6.70%
	Energy	0.00%	0.00%	0.00%	6.70%

*Percentages do not add up to 100% as several industries are represented in the sample, but only the four higher item numbered industries are included.

Four distinct clusters emerged from our analysis:

- Complexity-Driven IT Medium-Sized Firms: This cluster comprises medium-sized enterprises in the IT industry facing substantial challenges from environmental complexity, including rapidly changing consumer trends, competitive strategies, and product lifecycles. Their export activity is generally low to medium.
- Competitive-Aware Medium-Sized Firms in Dynamic Environments: Medium-sized companies operate in highly dynamic environments in this cluster but may not perceive these changes as significant. Limited resources for analysing sectoral effects may contribute to this perception. However, they are acutely aware of competitive threats. The cluster includes companies from both the IT and environmental industries.
- Medium IT-Driven Exporters with Sectoral Impact: The third cluster encompasses organisations where all three sectoral factors exert a substantial influence, significantly affecting managers. These organisations primarily engage in medium-level export activities, with a notable presence in the IT sector.
- Medium-large firms with Minimal Competition Impact, Health & Energy Export Focus: The fourth cluster, representing a quarter of the respondents, includes medium-sized and large companies. They experience relatively

low impacts from competitors' tactical moves. Export activity falls mainly within the medium and large categories, with significant involvement in the health and energy sectors.

Cluster analysis sheds light on the diverse effects of industry-specific factors on business activities among our sample members. Notably, the predominant sectors in the sample, including IT, health, environment, and energy, shaped these outcomes.

We examined the relationship between sectoral characteristics and cooperation levels to address our research question, presented in Table 6. The table shows moderate correlations between dynamic environmental changes, technological complexity, and R&D cooperation activities. A separate β test revealed a moderately strong relationship between the total value of cooperation activities and the total value of sectoral effects, confirming their association.

Table 6 – Connections Between Industry Traits and Levels of Cooperation

	Environment Dynamic Change		**Technological Environment**		**Competitor Threat**		**Overall Sectoral Impacts**		
	Correlation	Signifi-cance	Correla-tion	Signifi-cance	Correla-tion	Signifi-cance	t-value	Signifi-cance	Correla-tion
Exploring Sales Opportunities	0.035	0.708	-0.017	0.856	0.122	0.183	-	-	-
R&D Activities	***.328******	0.000	***.250******	0.006	***-0.221****	0.015	-	-	-
Other Joint Activities	-0.139	0.130	0.139	0.129	-0.007	0.941	-	-	-
Overall Value of Cooperation	-	-	-	-	-	-	***-3.038****	***0.003***	***0.204***

*** p<0.001; ** p<0.05; * p<0.1

This suggests that, among the environmental effects, dynamic changes in the environment and technological complexity are significant determinants of collaborative R&D activities within the cluster.

Since sectoral characteristics influence organisational capabilities, we investigated their interrelationships with strategic and innovation capabilities in the sample. The results in Table 7 indicate that environmental effects are moderately correlated with external innovation and technological capabilities. A stronger relationship is observed between technological sector complexity and product development capabilities, which aligns with the idea that organisations leverage technological changes for product development.

Table 7 – Correlation Between Sectoral Characteristics and the Strategic and Innovation Capabilities of Member Companies

	Environment Dynamic Change		**Technological Environment**		**Competitor Threat**		**Overall Sectoral Impacts**		
	Correlation	Signifi-cance	Correla-tion	Signifi-cance	Correla-tion	Signifi-cance	t-value	Signifi-cance	Correla-tion
Information Dissemination	-0.062	0.498	0.067	0.467	-0.077	0.402	-	-	-
Product Development	***0.434****	0,000	***0.641****	0,000	0.119	0.196	-	-	-
Internal Innovation	***0.297****	0.001	***0.206***	0.024	0.08	0.386	-	-	-
Responsiveness	***0.235****	0.01	0.034	0.712	0.014	0.875	-	-	-
Technological	***0.443****	0,000	***0.521****	0,000	-0.031	0.74	-	-	-
Innovativeness	***0.379****	0,000	***0.302****	0.001	-0.08	0.387	-	-	-
Proactiveness	***0.408****	0,000	***0.375****	0,000	0.037	0.686	-	-	-
Overall Internal Competencies	-	-	-	-	-	-	-3.937	0,000	***0.411****
Overall Sectoral Competencies	-	-	-	-	-	-	-1.233	0.22	***0.375****
Overall Competencies	-	-	-	-	-	-	1.687	0.094	***0.461****

*** p<0.01; ** p<0.05; * p<0.1

No significant relationship is found between the two total values, but correlations emerge regarding individual factors. In summary, while no stronger-than-average correlation exists between the examined factors, a slightly stronger relationship is observed between technological effects and product development capabilities. Additionally, companies with better innovation skills tend to be less concerned about competitors.

Based on this analysis, it can be concluded that external sector factors are related to the internal capabilities of member companies. Organisations adapt their strategic and innovation skills accordingly, influencing the quality of cooperation within the cluster.

5 CONCLUSION

This study strongly connects cluster members' innovation characteristics, market goals, and sector-specific features. Sector-specific effects significantly influence member companies' strategic and innovation capabilities, affecting collaborative activities within the cluster.

Three key dimensions impact innovation clusters: technological complexity, dynamic environmental changes, and competitive factors shaping how organisations adapt. Technological pressure stands out, but market orientation is equally vital, particularly in industries like IT and food, where the technological environment plays a significant role.

Cluster analysis identifies four distinct groups of organisations, suggesting tailored strategies for collaboration and innovation within these clusters. Furthermore, the

research underscores the vital role of organisational capabilities in shaping market orientation and collaboration within clusters. Factors such as information dissemination capability, product development capability, and internal innovation capability profoundly impact how organisations engage in collaborative activities.

In conclusion, the findings of this study emphasise the importance of recognising the dynamic nature of innovation clusters for policymakers and businesses. Strategies should be tailored to align with sectoral impacts and the unique organisational capabilities of cluster members. By fostering collaboration, knowledge sharing, and innovation, clusters can continue to serve as hubs of creativity and economic development, driving sustainable growth in specific regions and industries.

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CONFLICTS OF INTEREST

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