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Facilitators and Barriers of Knowledge Transfer in Innovation Clusters: A Case Study Approach

Ahmed Benali[1]*, Karim Boudiaf[2], Samir Touati[1]

1. Department of Organizational Management and Leadership, Faculty of Economics and Management, University of Algiers, Algiers, Algeria.
2. Department of Corporate Communication and External Relations, Faculty of Business Administration, University of Tunis El Manar, Tunis, Tunisia.

Abstract

This study examines how knowledge transfer occurs within technological innovation clusters. It specifically examines how organizations operating in networked environments can improve learning outcomes and benefits, with an emphasis on knowledge management practices. A qualitative research design was adopted, using a case study approach with a cross-sectional perspective and multiple sources of evidence – including semistructured interviews, nonparticipant observation, and the review of documents alongside secondary institutional data. The empirical setting was the Technology Park of São José dos Campos, Brazil, comprising private enterprises, public institutions, universities, and research centers. The findings confirm that knowledge transfer is shaped by a range of elements that may either promote or hinder it, including cooperation, ties with institutions, labor mobility, and spatial proximity. These aspects directly influence both the competitiveness and overall performance of organizations within the cluster. The results point to mechanisms that extend knowledge beyond organizational and geographic boundaries through collaborative, dynamic arrangements. This supports the notion that clusters should be viewed as evolving systems in which interactions generate enhanced collective capabilities. This research advances knowledge management studies in networked contexts, particularly technological innovation clusters, by structuring and emphasizing both the enabling and constraining factors in knowledge transfer processes. The study offers relevant insights for managers and stakeholders responsible for governing such organizational systems, especially regarding how to enhance knowledge creation and its dissemination across firms, educational institutions, governmental bodies, and other organizations.

Keywords: Cluster, Technology park, Knowledge management, Cooperation

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Corresponding author: Ahmed Benali
E-mail ✉ ahmed.benali@gmail.com

Introduction

In a networked society, knowledge transfer has become a critical factor in organizational survival. Within this framework, cooperative networks enable the development of mechanisms for sharing information and knowledge through interaction with other organizations [1], and they stand out for their strong capacity to disseminate knowledge among participants [2].

From a conceptual standpoint, networks may be examined through multiple lenses, including cluster-based approaches and the spatial concentration of firms [3]. The understanding that such geographic concentration produces advantages associated with superior performance has been further explored by authors such as [4-6].

When considering knowledge transfer among organizations within clusters, several conditions can either facilitate or obstruct this process. Identifying these conditions can support more effective management practices and improve the circulation of

knowledge [7-9]. Within this perspective, the present study aims to examine knowledge transfer through a case study, focusing on the factors that shape this process.

The Technology Park of São José dos Campos was selected as the empirical context. It was established to bring together companies, educational and research institutions, and other organizations to promote regional technological and economic development by enabling shared infrastructure among entrepreneurs, firms, and scientific institutions [10, 11]. Given its composition—characterized by multiple interconnected organizations—the case was analyzed from an interorganizational network perspective, complemented by cluster-specific characteristics related to geographic proximity.

The central issue of this study is how organizations can operate within networks to maximize learning and outcomes, particularly in knowledge management. Within technology clusters such as technology parks, firms, entrepreneurs, and academic institutions seek to combine efforts to foster technological advancement. Based on this, the guiding research question is: how does the cluster context shape the knowledge transfer process among organizations?

Analyzing knowledge transfer within interorganizational networks in a cluster setting, along with the factors that influence it, introduces the challenge of defining a methodological approach capable of capturing this phenomenon. While acknowledging the importance of these dimensions, this study focuses on identifying the factors that affect knowledge transfer in interorganizational networks within a technological cluster, without establishing causal relationships.

Theoretical foundation

In current organizational environments, debates on knowledge have increasingly emphasized its strategic importance. Some researchers have focused on how knowledge is transferred across internal units of firms [2], while others have examined knowledge circulation between multinational corporations and their subsidiaries, as well as within broader national innovation systems [12, 13]. There are also contributions highlighting the role of knowledge transfer in strengthening innovation capacity and competitive advantage [14, 15].

At the organizational level, knowledge transfer can be understood as a process in which one unit (an individual, department, or firm) is influenced by the experience accumulated by another unit [16]. Although networked organizations tend to exchange knowledge more rapidly than isolated firms, analyzing such processes is inherently more complex [1]. Some scholars suggest that knowledge transfer may be evaluated through observable changes in organizational knowledge bases or performance, as firms improve their results by leveraging knowledge accessed through the networks to which they belong [2, 6, 16].

More recent studies have examined the multiple dimensions involved in knowledge transfer. [8], for example, identified key components such as: (1) the reasons driving participation in collaborative arrangements, (2) the activities through which transfer occurs during interactions, (3) mediating elements within the transfer process, (4) factors that either enable or hinder knowledge transfer, and (5) innovation outcomes associated with these processes.

In this research, the presence of knowledge transfer is assessed using observable indicators derived from [17], selected for their practical measurability and alignment with the instrumental perspective reflected in the dimensions proposed by [8]. These authors indicate that knowledge transfer may manifest through various pathways, including: (1) the introduction of new technologies, (2) changes in work structures, (3) improvements in workforce qualifications, (4) processes of organizational learning, (5) managerial practices, (6) strategic business decisions, (7) entrepreneurial capabilities at both firm and regional levels, (8) structuring of work activities, and (9) both tacit and codified knowledge forms.

Knowledge transfer in clusters

The study of networks can be approached through a variety of theoretical perspectives [18]. Among these, cluster-based approaches are particularly relevant, where clusters are typically defined as geographically concentrated groups of firms. In the literature, clusters and networks are closely related, with clusters often viewed as specific configurations of networks characterized by sectoral specialization and spatial proximity [19]. In this study, the concept of a cluster follows [20], who define it as a collection of firms producing similar outputs and operating as an evolving system, in which interactions generate collective capabilities that exceed those achievable individually. This definition is adopted because it allows empirical application by incorporating multiple observable elements.

A substantial body of literature has examined knowledge management within networks and clusters, addressing its role in enhancing competitiveness [14, 21], its effects on regional economic development [9, 22, 23], its contribution to scientific and technological progress [24, 25], its importance for innovation processes [2, 10, 15, 26], and its relevance in university–industry collaborations [27, 28]. In this framework, knowledge spillover is interpreted as the diffusion and expansion of knowledge across individuals, organizations, and the broader local environment.

When principles from network theory are combined with the effects of geographic proximity, they provide a strong basis for explaining why certain sectors accumulate knowledge and capabilities more rapidly than others—an effect commonly observed in clusters. As firms increasingly share experiences and conditions, their absorptive capacity is strengthened, enabling them to engage more effectively in knowledge transfer processes [29, 30]

Accordingly, clusters foster the emergence of knowledge networks formed by interconnections among actors, which, in turn, support both learning and knowledge exchange [29]. These networks can take multiple forms, including subcontracting arrangements, supply chain relationships, formal and informal collaborations, interpersonal ties among employees and family members, involvement in trade associations, strategic partnerships, and workforce mobility across organizations at different hierarchical levels [31, 32]. Thus, a knowledge network can be described as an interconnected system of actors that facilitates learning across firms and institutions.

In this study, knowledge transfer is defined as the process through which both tacit and explicit knowledge is shared, disseminated, and transmitted via formal and informal mechanisms within an existing knowledge network. This network is understood as a structure of relationships among actors that enables learning processes across organizations and firms [29].

Factors in the knowledge transfer process

Instead of limiting the discussion to definitions and components of knowledge transfer, it is essential to examine the conditions that shape how the process actually occurs. [33] identified several elements that may restrict knowledge transfer, organizing them into motivational aspects and barriers related to knowledge itself. Within this framework, three central issues stand out: (1) low absorptive capacity, (2) causal ambiguity, and (3) the quality of the relationship between the knowledge source and the recipient.

[34] approached knowledge transfer as a phenomenon shaped by both positive and negative influences, drawing on research concerning organizational learning strategies. They organized the elements affecting this process into three groups: facilitators, inhibitors, and barriers. Their analytical model is structured around six dimensions—actor, activity, source, receiver, context, and environment—and is summarized in **Table 1**.

Table 1. Classification of factors that influence knowledge transfer.

Type of influence	Factor	Component
Facilitator	Frequency and intensity of activities	Activity
Facilitator	Capacity to share knowledge	Actor/source
Facilitator	Ability to absorb knowledge	Actor/receiver
Facilitator	Motivation, willingness, and leadership	Actors
Facilitator	Strength of relationships, organizational size, and social capital	Context
Facilitator	Availability of time	Context
Facilitator	Information technology systems	Means
Facilitator	Organizational learning culture	Actor/receiver
Facilitator	Physical workspace and shared culture	Context
Inhibitor	Lack of clarity or ambiguity	Actor/source
Inhibitor	Knowledge distance (how far apart knowledge bases are)	Actors
Inhibitor	Physical separation, organizational separation, and environmental uncertainty	Context
Inhibitor	Differences in language	Means
Inhibitor	Protectionist behavior	Actor/source
Inhibitor	Differences in age and gender	Actors
Obstacle	Technology and skill limitations	Actor/receiver
Obstacle	Confidence level	Actors
Obstacle	Infrastructure limitations	Means
Inhibitor / Facilitator	Communication channels	Means
Inhibitor / Facilitator	Nature/type of knowledge	Context

Source(s): Adapted from [34]

This framework is grounded in the assumption that knowledge transfer may be influenced in different directions: strengthened by facilitating elements, weakened by inhibiting elements, or entirely blocked by obstacles.

Within clusters, knowledge transfer does not occur uniformly; instead, it varies depending on the level and type of interaction, such as relationships between suppliers and manufacturers or between large firms and smaller enterprises [35]. Furthermore, the nature of relationships within the cluster—whether cooperative or not—tends to intensify knowledge circulation among participants. Empirical findings indicate that knowledge exchange may still take place even when explicit cooperation is not formally recognized among cluster members [36]. As a result, knowledge transfer in clusters should be understood as a multidimensional phenomenon, encompassing dimensions such as cooperation, interaction with support institutions, workforce mobility, and geographic proximity, as highlighted by [25, 28, 31, 37-40]

In this setting, cooperation refers to processes involving the exchange of techniques, the sharing of information, and complementarities among firms within the cluster [31, 38]. Studies also emphasize the relevance of informal social connections—such as family ties—in supporting knowledge transfer within cluster environments [37, 39]. Additionally,

factors such as the willingness of firms to participate in knowledge and technology transfer activities [2, 41], as well as partnerships structured within the triple helix model (industry, government, and universities), play an important role [42].

At the same time, participation in clusters may raise concerns about opportunistic behavior and the potential erosion of competitive advantage, which can discourage knowledge sharing [14, 43]. This creates a situation in which collaboration and competition coexist simultaneously [36]. From the perspective of knowledge transfer, this duality is reflected in both the reluctance to share knowledge due to perceived risks and the increased willingness to share when trust and credibility are established among actors [2, 14, 43].

Clusters may also include support institutions that provide resources and assistance to participating organizations [44]. These institutions can be public—such as universities and research centers—or private entities that coordinate the cluster. Their role is significant in enabling knowledge transfer through mechanisms such as access to technical expertise, interaction with specialists, availability of skilled labor, training initiatives, and knowledge dissemination events [28, 36, 38]

However, such relationships may also present difficulties, as firms often struggle to interpret and absorb knowledge originating from universities [41, 44]. This limitation is likely linked to insufficient absorptive capacity, supporting the arguments of [26].

Regarding workforce mobility, clusters concentrate a large number of skilled individuals within a defined geographic area. The movement of these individuals between firms and universities, as well as between companies, combined with spatial proximity, plays a crucial role in enabling knowledge transfer [38, 40]

In such environments, collective learning emerges through informal interactions, face-to-face communication, and unstructured flows of information [2]. These interactions foster shared norms and behavioral patterns that influence both professional and social conduct [20]. Within this context, informal social ties—including family relationships—have been identified as particularly significant in supporting knowledge transfer in clusters [5, 37, 39].

Based on these considerations, this study formulates and examines five propositions regarding the dimensions of knowledge transfer processes in clusters, as outlined in **Table 2**. These propositions provide the basis for structuring the research and guiding the analysis of the selected case, ultimately addressing the central question of how cluster characteristics (and their dimensions) influence knowledge transfer among participating organizations.

Table 2. Proposals for knowledge transfer in clusters.

Dimension	Propositions	Base authors
Cluster participation	Proposition 1 – Engagement in the cluster strengthens knowledge transfer among organizations within the cluster	[4, 5, 27, 29, 36]
Cooperation	Proposition 2 – Collaborative relationships enhance the exchange of knowledge among organizations within the cluster	[33, 35, 36, 41]
Relationship with institutions (support, teaching, research)	Proposition 3 – Interactions with educational, research, and support institutions strengthen knowledge transfer among cluster organizations	[2, 20, 36, 41, 45]
Workforce mobility	Proposition 4 – Labor mobility enhances knowledge transfer among organizations within the cluster	[36, 38, 40, 41]
Proximity	Proposition 5 – Geographic and relational proximity increase knowledge transfer among organizations within the cluster	[2, 5, 20, 27]

Materials and Methods

The case selected for analysis is the São José dos Campos Technology Park, which brings together firms, entrepreneurs, and educational and research institutions. Nonparticipant observation was conducted during events held at the site, along with visits undertaken for interview purposes. Within network research, the unit of analysis may encompass the entire network (all participants), the dyadic relationship, or the individual actors involved [46].

The selection of the Technology Park was motivated by its suitability for observing the phenomenon under investigation, as it is explicitly designed to foster the creation and transfer of technological knowledge. At the same time, it exhibits characteristics that allow it to be classified as a cluster, and it offers the researcher access to the educational and research institutions that form part of the study context.

Source and data collection

Multiple sources of evidence were employed, including primary data (semistructured interviews and nonparticipant observation) and secondary data (documents and institutional information available on company and Technology Park websites). To strengthen research validity, procedures recommended by [47] were followed, such as the use of a case study protocol, pretesting, reliance on multiple evidence sources, data triangulation, and subsequent validation of collected data and interpretations with interviewees.

The initial phase of data collection involved semistructured interviews with organizations participating in the network, conducted between November 1, 2016, and January 31, 2017. Respondents were selected based on their qualifications and managerial roles within their organizations, enabling a comprehensive understanding of organizational processes. A total of 09 in-depth interviews were carried out, comprising: 01 manager from an educational institution, 02 university researchers, 03 managers from companies within the cluster, 01 representative from a governmental organization, and 01 representative from the support association responsible for managing the technology park. The number of interviews was determined using the concept of theoretical saturation [48], understood as the point at which additional interviews yield minimal new insights, meaning that subsequent data contribute less than earlier findings.

The second phase consisted of observational data collection, focusing on the knowledge transfer phenomenon within the cluster context, specifically the São José dos Campos Technology Park. Evidence was gathered in the field using an observation protocol as suggested by [47]. Observations took place between October 17, 2016, and January 31, 2017, as detailed in **Table 3**. Activities such as courses, lectures, and events within the unit of analysis were monitored to identify factors that facilitate or hinder knowledge transfer in the context in which the phenomenon occurs, and to examine relevant physical artifacts in the environment.

Table 3. Collection of observational data

Order	Place and date	Description
01	Unifesp – São José dos Campos campus / Technology Park of São José dos CamposDate: 10/17/2016 – 1:00 p.m. to 5:00 p.m.	Lecture on intellectual property organized by Clark and Moet in partnership with Unifesp, aimed at organizations located in the São José dos Campos technology park
02	Convention Center – Technology Park of São José dos Campos 10/19–20/2016 – 10:00 a.m. to 4:00 p.m.	3rd RM Vale TI event – a fair and congress focused on technology and innovation
03	Nucleus – São José dos Campos Technology Park Association10/27/2016 – 9:00 a.m. to 2:00 p.m.	"Paths to Importation" training course delivered by Sebrae for companies based in the SJC technology park
04	Business Center II – Technology Park of SJCDate: 11/16/2016 – 3:00 p.m. to 6:00 p.m.	Official opening of CAD I – Center for Development and Innovation Support

In addition, secondary data were gathered from materials produced by organizations and external sources, including news reports, bylaws, meeting minutes, institutional website content related to the unit of analysis and participating organizations, and documents provided by interviewees. These materials were used to identify patterns and explore potential relationships among organizations, based on categories emerging from the interviews and observations.

For the data analysis, the following procedures were applied: (1) transcription of interviews and collected materials; (2) identification of nonequivalent dependent variables through pattern matching; (3) content analysis using defined units of analysis; and (4) data interpretation through pattern matching techniques [49]. For observational data, an analytical system adapted from the theoretical coding approach proposed by [50] was utilized.

Results and Discussion

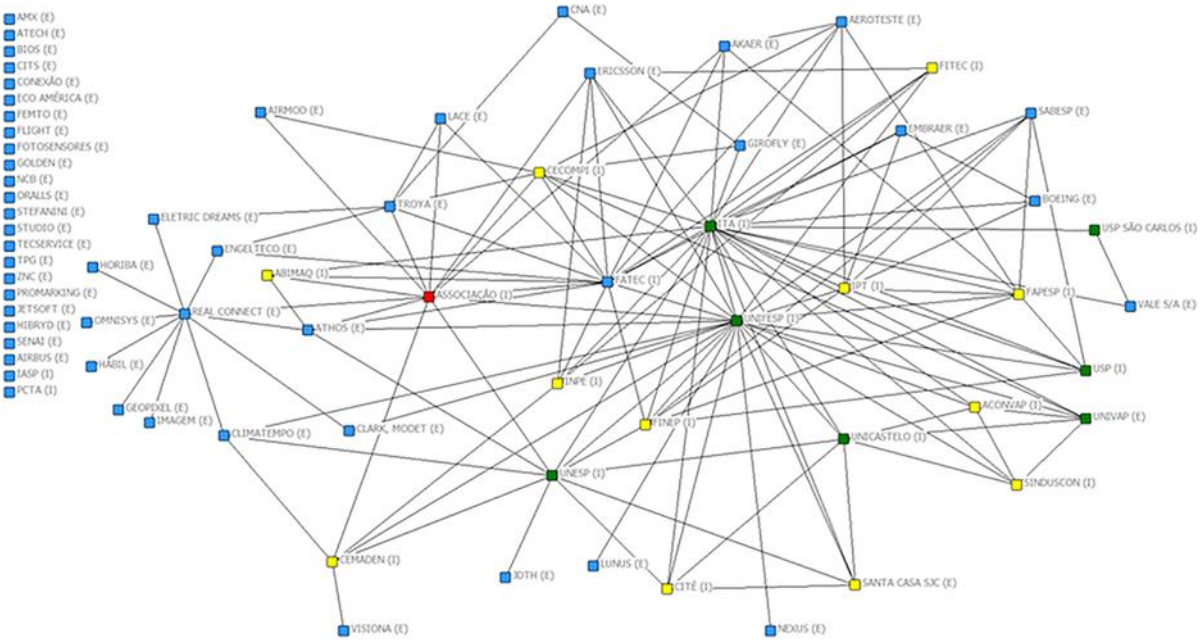
Presentation of the case

The São José dos Campos Technology Park is designed to foster technological research, development, and innovation, benefiting the local community while addressing the demands of the São José dos Campos region (São Paulo, Brazil). Its operational structure is organized into the following components:

1. Technology development centers (TDCs): collaborative arrangements involving anchor firms, universities, and research organizations, dedicated to advancing specific technological areas. Anchor firms are leading organizations within their sectors, maintaining their own Research and Development (R&D) activities. Beyond enhancing the Park's visibility and credibility, they also attract small and medium-sized enterprises.
2. Universities and educational institutions: entities responsible for generating knowledge and supplying skilled labor within the Park. Their scientific and technical expertise, along with access to laboratories, represents a significant resource.
3. Business centers (CEs): facilities intended to accommodate technology-oriented small and medium-sized enterprises (SMEs), operating within a highly interactive environment that encourages entrepreneurship, connectivity, and competitiveness.

The network comprises 72 actors, including firms, educational and research institutions (both public and private), governmental bodies, other types of organizations, and the managing association. Based on this configuration, a network map **(Figure 1)** was developed using UCINET software. To construct the graph, all actors were identified, and their connections were mapped. These ties represent relationships such as joint projects, research collaborations, shared technological

development, collective initiatives, commercial interactions, and shared resources (e.g., laboratories and physical infrastructure).



Caption: (E)- Companies / (I) - Institutions (support, teaching, research)

Companies | Management Association | Teaching and Research Institutions | Other Nature Organizations

Source(s): Prepared by the authors, using UCINET 6.62 software

Figure 1. Graph of the São José dos Campos Technology Park Network – São Paulo, Brazil.

Analysis of proposition 1–Participation in the cluster intensifies the transfer of knowledge between organizations

To integrate perspectives from business networks, cluster theory, and knowledge transfer, the first proposition of this study was formulated as follows: Proposition 1: Participation in a cluster intensifies knowledge transfer between organizations within the cluster.

Evidence supporting this proposition emerged from the respondents' statements, such as:

"[…] we end up becoming aware of many things, because there are numerous opportunities and announcements; it is impossible to track everything online. So, they help, and knowing someone personally makes a difference" (Respondent 1).

"[…] even if someone does not directly interact and only moves around, that alone is already a distinguishing factor. Being present is a major advantage. There is no need to go elsewhere—they are already here. For students, especially, there is direct knowledge exchange in practice. It is not only theoretical; I can observe it happening" (Respondent 3).

These observations align with the arguments of [51] and [25], who suggest that knowledge creation and transfer arise from interactions between tacit and explicit knowledge through social processes among actors, extending beyond the individual level as the two forms interact continuously.

The presence of shared goals was also identified, including joint technological development initiatives and resource-sharing arrangements, which generate outcomes that would not be achievable independently. This indicates that participation in the cluster strengthens knowledge transfer among organizations by enabling access to collectively produced knowledge.

"I met several companies here; one of them works with virtual reality, a startup incubated in this space. We have started collaborating—I had an idea for a service using virtual reality, and now we are developing the project together" (Respondent 8).

"There are critical systems laboratories with a supercomputer that we frequently use. (…) We could be located elsewhere, even in downtown São José, where costs are lower. However, especially in the early stages, being here is clearly more advantageous" (Respondent 9).

Observational data further revealed recurring interactions during formal and informal events held within the Park. These included exchanges of information related to corporate strategies (such as the development and commercialization of technological products), as well as the sharing of tacit and explicit knowledge—for instance, information on patents, legal aspects of intellectual property, business models, and emerging technologies (e.g., smart cities and energy trends).

The findings suggest that organizations benefit from greater knowledge acquisition when embedded in the cluster compared to operating independently. Interview data consistently indicated that being part of the Technology Park provides access to

an environment that encourages knowledge exchange, innovation, and technological advancement through interorganizational relationships. In this sense, the cluster not only supports economic development but also serves as a mechanism that enhances knowledge creation and transfer among its members.

Accordingly, the results reinforce the notion that a knowledge network emerges within the cluster through interconnected relationships among actors, facilitating both learning and knowledge exchange. Participation in such a network enables organizations to acquire technological capabilities from firms, partners, and research and development institutions. Therefore, Proposition 01—that participation in the cluster intensifies knowledge transfer among organizations—can be considered supported.

Analysis of proposition 2 – cooperation intensifies the transfer of knowledge between organizations within the cluster

The second proposition of this study is revisited and stated as follows: Proposition 2: Cooperation intensifies the transfer of knowledge between the organizations inserted in the cluster.

Field evidence indicates that cooperative dynamics significantly shape knowledge transfer within the São José dos Campos Technology Park. Supporting statements include:

"Being located in the same environment changes everything. There is no strict formality; instead, informality plays a positive role. Since people already know each other and interact daily, trust and mutual support naturally emerge. This is the key advantage" (Respondent 1).

"When I identify that a company is developing something relevant, or I notice a client need that could be solved by combining our solutions, ideas emerge. I approach the company and suggest, "Let's build something together" (Respondent 9).

A notable motivational element was also identified in interactions with the institution responsible for managing the Park. This organization facilitates and disseminates visits from external entities, including representatives of the European Aerospace Cluster Partnership (EACP) and international delegations, thereby enabling knowledge exchange and serving as a gateway for external innovation entering the cluster.

Document-based secondary data further reinforces the idea that cooperation contributes to knowledge transfer among organizations through established relational ties. These relationships are mainly expressed through collaborative technological development initiatives between Park members, as well as training activities aligned with cluster interests, typically carried out on a voluntary partnership basis.

These findings align with the perspectives of [11, 31, 35, 36, 38, 41], and [8], which emphasize that cooperation in knowledge transfer contexts involves exchanging technical know-how, sharing information, and combining complementary capabilities among cluster participants.

Analysis of proposition 3 – the relationship with educational, research, and support institutions intensifies the transfer of knowledge between organizations within the cluster

The third proposition of this study is restated as follows: Proposition 3: The relationships with educational, research, and support institutions intensify the transfer of knowledge among organizations within the cluster.

Evidence supporting this proposition includes:

"Every six months, the Park organizes a research and development meeting where firms present ongoing projects and universities showcase their areas of expertise. After these presentations, discussion tables are formed to connect actors and explore possible collaborations" (Respondent 1).

"The Technology Park does not hold all the necessary expertise; it has part of it, but not everything required. (…) For this reason, universities act as partners. There are specialists in CFD, CAD, market analysis, and management. Depending on project needs, we seek this expertise to work jointly with companies" (Respondent 4).

The empirical findings highlight the strong influence of educational institutions within the network structure. In the São José dos Campos Technology Park, these institutions occupy a central position in knowledge transfer processes, acting as connectors among different actor groups and participating in multiple flows of knowledge dissemination across the cluster. The analysis also suggests that, without universities and research institutions, the network would tend to fragment into isolated clusters of actors.

Technology parks and clusters, in this sense, enhance the integration of knowledge between firms and universities [20], enabling access to shared resources that would otherwise involve higher costs or complexity [2, 45]. Firms also acknowledge the importance of these institutions in facilitating knowledge transfer through technical expertise, access to specialists, the provision of a qualified workforce, training activities, knowledge dissemination events, and resource-sharing mechanisms.

However, certain barriers may still emerge in these interactions, as companies often report difficulties in interpreting and assimilating academic knowledge from universities [41], which is likely associated with insufficient absorptive capacity [26].

Observational findings further support the idea that relationships with educational, research, and support institutions strengthen knowledge transfer among organizations in the cluster. Events involving the exchange and dissemination of tacit knowledge were observed, particularly those related to patent exploitation and emerging technological trends.

Analysis of proposition 4 – workforce mobility intensifies knowledge transfer between organizations within the cluster

Researchers such as [38, 40, 41], and 36 emphasize that clusters can concentrate a substantial pool of individuals with specialized competencies. In this context, the circulation of employees across firms within the cluster, combined with spatial proximity, plays an important role in shaping knowledge transfer processes.

This understanding aligns with the fourth proposition of this study: Proposition 4: The mobility of the workforce intensifies the transfer of knowledge between organizations within the cluster.

Supporting evidence for this proposition includes:

"At the start of the year, we created a pool of consultants from professors who were interested in providing consultancy services within the Park (...). We connected companies with these professors, identified potential contributors, and this led to the development of several projects" (Respondent 1).

"So we maintain a very updated understanding of the productive sector; we experience it directly and absorb emerging trends. Often, the same individual also teaches here and in other institutions, which allows them to observe ongoing developments and identify new tendencies" (Respondent 2).

The most prominent evidence related to workforce mobility in the São José dos Campos Technology Park concerns the role of consultants operating across multiple organizations, particularly professors from educational and research institutions collaborating with firms. Companies recognize that these academics and researchers possess specialized expertise relevant to cluster activities, and that their joint engagement significantly enhances firms' technological knowledge and innovation capacity [15].

Regarding employee circulation between firms, combined with geographic proximity and its influence on knowledge exchange, this dynamic is reflected in professors' participation as consultants and in the training of professionals within cluster-based educational institutions. These factors are reinforced by both the perceived quality of such training and the interpersonal networks established among professionals.

Workforce mobility within the cluster may occur through employees with prior experience in other firms. These suppliers have worked across different organizations and have received academic training from institutions within the cluster. Among these, consulting activities and academic formation appear to have a stronger influence, supporting Proposition 4, which states that workforce mobility intensifies knowledge transfer among organizations in the cluster.

Analysis of proposition 5 – proximity intensifies the transfer of knowledge between organizations within the cluster

Scholars such as 27 and 5 argue that spatial proximity facilitates knowledge flows among organizations located in Technology Parks. It is important to note that proximity is not limited to geographic distance; it also encompasses technological and organizational dimensions, such as structure, culture, and communication patterns. This understanding aligns with the fifth and final proposition of this study: Proposition 5: Proximity intensifies the transfer of knowledge between organizations within the cluster.

Evidence supporting this proposition is presented below:

"I believe it is this closeness to other companies that enables it; it is the ease of addressing needs—you simply go and talk. For companies as well, this happens when they attend a lecture and then decide to come here" (Respondent 7).

"It feels as if we are part of the same organization. They are distinct entities, but they operate together within a shared environment" (Respondent 2).

The main recurring idea is that the proximity among organizations within the São José dos Campos Technology Park, when combined with cooperation, creates a favorable environment for knowledge sharing, innovation, and technological advancement. This suggests that spatial and organizational proximity facilitates knowledge flows within Technology Parks by improving interaction quality, reducing information search costs, and fostering long-term relationships that support more meaningful knowledge exchange.

Social interaction is also seen as a key enabler of access to and exchange of knowledge among Park organizations, occurring through informal discussions and visits between entities. This aligns with the view that knowledge creation and transfer arise from the interaction between tacit and explicit knowledge through social processes among actors, rather than being confined to individuals, with both forms of knowledge interacting dynamically in this process [51]. These findings demonstrate that proximity among cluster organizations, together with formal and informal linkages among academia, industry, and other institutional actors, enhances knowledge transfer, consistent with 5 and this study's results.

Final considerations

It is anticipated that organizations operating within networks—particularly in cluster configurations—will experience a more intensive exchange of knowledge among themselves due to their interconnected structure, compared to when they function independently. In the context of interorganizational knowledge transfer, several elements may either hinder or promote this process, and understanding these determinants can improve managerial practices and enhance the circulation of knowledge among participating entities.

Conclusion

This study was grounded in concepts of knowledge transfer, integrated with theoretical perspectives on interorganizational networks and clusters. The findings indicate that multiple influencing elements, including cooperation, institutional relationships, workforce mobility, and geographical proximity, shape knowledge transfer within clusters. Some of these factors operate as facilitators, while others function as barriers, either preventing the emergence of knowledge transfer or limiting its outcomes. In certain situations, the same factor may act in dual ways—supporting knowledge transfer when present or intensified, or restricting it when absent or excessively dominant within the cluster context.

Contributions and implications

This research advances the knowledge management literature in networked environments. The findings reveal that knowledge extends beyond organizational boundaries through dynamic and collaborative arrangements, reinforcing the idea that clusters should be understood as evolving systems whose collective performance surpasses what individual actors could achieve independently [20], and that may exhibit highly similar activity patterns [4], thereby supporting the arguments of these authors. The study also aligns with the work of [52], emphasizing that the network society is structured around interconnected systems that generate, process, and distribute information and accumulated knowledge across network nodes. Furthermore, this research complements studies by [27, 29-31, 36, 41], particularly in relation to knowledge transfer within network environments, with emphasis on technology-based clusters.

The case of the São José dos Campos Technology Park may serve as a reference for managers of similar organizational arrangements, such as industrial districts, business incubators, and technology parks in other regions, particularly in efforts to enhance regional innovation and development capacity. This study may also support managers and governance actors of such structures by providing insights into improving knowledge creation and dissemination across organizations, encouraging factors that promote these processes while limiting those that inhibit them.

Another practical contribution lies in highlighting the importance of collaboration in knowledge transfer processes, which represents a central challenge for both organizational and societal development. In this sense, greater impact is expected through the adoption of diverse mechanisms for cooperation and knowledge sharing involving academia, industry, and government—aligned with the triple-helix framework—as well as other stakeholders, serving as a reference for the development of more collaborative ecosystems with stronger innovation potential.

Limitations and future studies

The first limitation of this study relates to its cross-sectional design, which captures the phenomenon at a single point in time within the network. Given the dynamic nature of networks, longitudinal studies tracking their evolution could provide deeper insights into knowledge transfer processes within organizational networks, particularly in Technology Parks. The second limitation concerns the use of convenience sampling for interview selection, with data complemented by nonparticipant observation and document analysis. Finally, since the empirical context is restricted to the São José dos Campos Technology Park, the findings, although relevant, cannot be generalized to other sectors or types of clusters.

Future research is encouraged to replicate the analysis of factors influencing knowledge transfer in clusters across different organizational contexts, such as business incubators, industrial districts, and networks in other industries and regions. Expanding research across diverse settings may enable broader generalizations regarding knowledge transfer processes in networks. Accordingly, the following future research agenda is proposed: (1) longitudinal studies tracking knowledge transfer in clusters and Technology Parks over time; (2) comparative analyses between clusters and Technology Parks in different regions focusing on knowledge creation and transfer processes; (3) quantitative investigations into factors influencing knowledge transfer in clusters, aimed at strengthening the validity of the conceptual model and measurement instrument used in this study, as well as exploring correlations between influencing factors and organizational performance outcomes.

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