International Journal of Innovation

e-ISSN: 2318-9975
https://doi.org/10.5585/2024.25143
Received: 31 Aug.. 2023 - **Approved:** 07 Aug. 2024

Evaluation Process: Double Blind Review
Editor-in-Chefe: Priscila Rezende da Costa
Co editor: Isabel Cristina Scafuto
Scientific Editor: Vânia Maria Jorge Nassif
Assistant Editor: Angelica Pigola
Special Issue: *Digital and Sustainable Academic Entrepreneurship*

Check for updates

Regional innovation ecosystem as a facilitator of digital transformation: evidence from Pacto Alegre (Brazil)

Leonardo Caliari[1] **Camila Coletto**[2] **Roberto dos Santos Donato**[3] **Fernanda Maciel Reichert**[4] **and Daniela Callegaro de Menezes**[5]

[1] Phd Candidate in Administration - leonardocaliari95@gmail.com

[2] Phd in Agribusiness - camila.coletto@iffarroupilha.edu.br

[3] Phd Candidate in Administration - donatodh@gmail.com

[4] Phd in Administration - fernanda.reichert@ufrgs.br

[5] Phd in Agribusiness - daniela.callegaro@ufrgs.br

Universidade Federal do Rio Grande do Sul – UFRGS. Porto Alegre, RS – Brazil

Author's Notes

Conflict of interest: I have no conflicts of interest to disclose and no funding was allocated to carry out this research

Correspondence regarding this article should be addressed: Leonardo Caliari

Cite as – American Psychological Association (APA)

Caliari, L., Coletto, C., Donato, R. S., Reichert, F. M., Menezes, D. C. (2024, Sept./Dec.). Regional innovation ecosystem as a facilitator of digital transformation: evidence from Pacto Alegre (Brazil). [Special issue]. *International Journal of Innovation - IJI*, São Paulo, *12*(4), Article e25143. https://doi.org/10.5585/2024.25143

Abstract

Purpose: The study aims to analyze the perception of quadruple helix actors in a regional innovation ecosystem regarding their contributions to the digital transformation of companies.
Methodology/approach: In-depth interviews were conducted with key actors from *Pacto Alegre* and with companies operating in the ecosystem, as well as document analysis of their projects focusing on the theme of digital transformation.
Originality/value: The study contributes by showing that regional ecosystems can function as facilitators in the process of the digital transformation of companies, corroborating the discussion that points to the need to integrate these two themes.
Findings: Traditional companies are at an early stage of digital transformation, considering the Covid-19 pandemic an accelerating factor in this process, forcing entrepreneurs to adopt digital technologies. To this end, the ecosystem provides a favorable environment for the exchange of knowledge, inter-organizational relationships, and learning by companies, enabling them to reduce the distance for digital transformation. From its projects, *Pacto Alegre* has generated direct and indirect impacts on the digital transformation of companies.
Theoretical/methodological contributions: The paper provides an analytical structure that links the themes of digital transformation and regional ecosystems and contains an empirical study of their application in the context of an emerging country and with a focus on low-tech companies.
Social/management contributions: The practical implications of the present study provide elements for organizing and improving *Pacto Alegre*'s actions as a facilitator of digital transformation, as well as a basis for different ecosystems.

Keywords: ecosystems, digital transformation, knowledge, Covid-19, quadruple helix.

Ecossistema regional de inovação como facilitador da transformação digital: evidências do Pacto Alegre (Brasil)

Resumo

Objetivo: O estudo tem como objetivo analisar a percepção dos atores da quádrupla hélice de um ecossistema regional de inovação quanto às suas contribuições para a transformação digital das empresas.
Metodologia/abordagem: Foram realizadas entrevistas em profundidade com atores-chave do *Pacto Alegre* e com empresas atuantes no ecossistema, bem como análise documental dos seus projetos com foco no tema transformação digital.
Originalidade/valor: O estudo contribui ao evidenciar que ecossistemas regionais podem atuar como facilitadores no processo de transformação digital das empresas, corroborando com a discussão que aponta a necessidade de integração dessas duas temáticas.
Resultados: As empresas tradicionais encontram-se em estágio inicial de transformação digital, sendo que a pandemia de Covid-19 foi considerada um fator acelerador nesse processo, obrigando os empresários a adotarem tecnologias digitais ao seu negócio. Para tanto, o ecossistema proporciona um ambiente propício às trocas de conhecimento, às relações interorganizacionais, e à aprendizagem por parte das empresas, possibilitando a estas reduzir a distância para a transformação digital. A partir de seus projetos, o *Pacto Alegre* tem gerado impactos diretos e indiretos para a transformação digital empresarial.

Contribuições teóricas/metodológicas: O artigo fornece uma estrutura analítica que vincula os temas de transformação digital e ecossistemas regionais, e contém um estudo empírico de sua aplicação no contexto de um país emergente e com foco em empresas de baixa tecnologia.
Contribuições sociais/gerenciais: As implicações práticas do presente estudo fornecem elementos para organizar e aprimorar as ações da *Pacto Alegre* como facilitadora da transformação digital, bem como uma base para diferentes ecossistemas.

Palavras-chave: ecossistemas, transformação digital, conhecimento, Covid-19, quádrupla hélice.

Ecosistema regional de innovación como facilitador de la transformación digital: evidencias de Pacto Alegre (Brasil)

Resumen

Objetivo: El estudio tiene como objetivo analizar la percepción de los actores de la cuádruple hélice de un ecosistema de innovación regional respecto de sus contribuciones a la transformación digital de las empresas.
Metodología/enfoque: Se realizaron entrevistas en profundidad con actores clave del *Pacto Alegre* y con empresas activas en el ecosistema, así como un análisis documental de sus proyectos centrados en el tema de la transformación digital.
Originalidad/valor: El estudio contribuye al mostrar que los ecosistemas regionales pueden actuar como facilitadores en el proceso de transformación digital de las empresas, corroborando la discusión que apunta a la necesidad de integrar estos dos temas.
Resultados: Las empresas tradicionales se encuentran en una fase inicial de transformación digital, y la pandemia del Covid-19 se consideró un factor acelerador de este proceso, obligando a los empresarios a adoptar tecnologías digitales en sus negocios. A tal fin, el ecosistema proporciona un entorno propicio para el intercambio de conocimientos, las relaciones interorganizacionales y el aprendizaje por parte de las empresas, permitiéndoles reducir la distancia que las separa de la transformación digital. A través de sus proyectos, *Pacto Alegre* ha generado impactos directos e indirectos para la transformación digital de las empresas.
Aportaciones teóricas/metodológicas: El artículo proporciona un marco analítico que vincula los temas de transformación digital y ecosistemas regionales, y contiene un estudio empírico de su aplicación en el contexto de un país emergente con enfoque en empresas de baja tecnología.
Aportaciones sociales/gerenciales: Las implicaciones prácticas de este estudio proporcionan elementos para organizar y mejorar las acciones de *Pacto Alegre* como facilitador de la transformación digital, así como una base para diferentes ecosistemas.

Palabras clave: ecosistemas, transformación digital, conocimiento, Covid-19, cuádruple hélice.

1 Introduction

Regional ecosystems, driven by digital transformation, have enabled business models with more dynamic organizational boundaries in response to the accelerated pace of information, knowledge, and innovation (Appio et al., 2021; Oliveira & Trento 2021; Cobben et al., 2022; Nascimento et al., 2022; Valkokari et al., 2022; Lara et al., 2023; Cai et al., 2024; Coletto et al., 2024; Haukipuro et al., 2024; Zen et al., 2024). The infrastructure of cities enables the development of a collaborative ecosystem in which the quadruple helix — government, universities, civil society, and companies — can and should develop, together, innovations in products, services, and solutions to everyday issues (Appio et al., 2019; Camboim et al., 2019; Thomas et al., 2021; Gonçalves et al., 2024; Majava & Rinkinen, 2024; Sorri et al., 2024).

One of these issues is the digital transformation of the companies, which involves changing the way digital technologies are employed in developing a new business model to create and capture value (Saarikko et al., 2020; Gong & Ribiere, 2021; Verhoef et al., 2021; Zahra et al., 2023; Xiong et al., 2024; Zhang & Chen, 2024). Although some companies have already entered the logic of digital transformation or are even "digital natives", the Covid-19 pandemic has accelerated the need for organizations to resort to these technologies to solve urgent problems and sustain their business (Oliveira & Trento 2021; Arias-Pérez & Vélez-Jaramillo, 2022; Reuschl et al., 2022; Skare et al., 2023; Haukipuro et al., 2024).

However, the digital transformation literature has mainly focused on the individual context of companies (Almeida et al., 2020; Saarikko et al., 2020; Stjepić et al., 2020; Kraus et al., 2021; Verhoef et al., 2021; Arias-Pérez & Vélez-Jaramillo, 2022; Gradillas & Thomas, 2023). Given this, Siachou et al. (2021) question whether all companies could develop the digital transformation process in their business model, emerging the theoretical proposition that not all companies are able to conduct this process individually. The digital transformation of companies requires the support of external stakeholders, highlighting the importance of alliances and inter-organizational arrangements that allow companies to access new markets, share knowledge, and develop capabilities, based on collaboration between actors (Bai et al., 2021; Oliveira & Trento 2021; Siachou, et al., 2021; Zahra et al., 2023; Haukipuro et al., 2024).

Given the growing volume of studies on ecosystems (Foguesatto et al., 2021; Cobben et al., 2022; Klimas & Czakon, 2022; Coletto et al., 2024; Zen et al., 2024) and digital transformation

(Saarikko et al., 2020; Siachou et al., 2021; Kraus et al., 2021; Arias-Pérez & Vélez-Jaramillo, 2022; Gradillas & Thomas, 2023; Zhang & Chen, 2024), there are gaps in discussing the contributions of a city-level innovation ecosystem for business' digital transformation.

First, the increasing digitization has become a centerpiece in inter-organizational settings (Valkokari et al., 2022; Lara et al., 2023; Gradillas & Thomas, 2023; Zahra et al., 2023). This requires advances in empirical work and theoretical development to strengthen the effective contributions of the ecosystems, since the digital transformation is no longer just an organizational-level phenomenon, that is, it extrapolates to the relationships with the ecosystem in which they are inserted (Siachou et al., 2021; Oliveira & Trento, 2021; Cobben et al., 2022; Fischer et al., 2022; Font-Cot et al., 2023; Guimarães et al., 2023; Liao et al., 2024).

Second, ecosystem approaches are mainly applied in developed countries, with a focus on high-tech industries, so analysis with low-tech firms and developing countries is encouraged by the literature (Thomas et al., 2021; Coletto et al., 2024). Likewise, recent studies that relate the territorial approach of ecosystems to digital transformation tend to be theoretical or with empirical cases from developed countries (Appio et al., 2021; Oliveira & Trento, 2021; Fischer et al., 2022; Font-Cot et al., 2023; Guimarães et al., 2023; Zahra et al., 2023). The integration between these two areas of knowledge with a focus in emerging economies is relevant, as the digital transformation plays a substantial role in value creation for the business (Verhoef et al., 2021; Skare et al., 2023; Liao et al., 2024) and the quadruple helix actors integrate into a city-level ecosystem to promote innovative business models (Autio & Thomas, 2022; Carayannis et al., 2022; Coletto et al., 2024; Gonçalves et al., 2024; Majava & Rinkinen, 2024).

In this sense, the research question pursued in the paper is as follows: How do regional ecosystems facilitate the digital transformation of low-tech companies in emerging economies? To answer it, the study aims **to analyze the perception of quadruple helix actors in a regional innovation ecosystem regarding their contributions to the digital transformation of companies**. To this end, an in-depth case study was carried out, using Pacto Alegre as the unit of analysis, a joint initiative developed in 2018 by the ecosystem of the city of Porto Alegre, in southern Brazil, in which the actors of the quadruple helix work together to foster innovation, competitiveness, and regional development.

As a result, it was possible to advance the discussion on the research gap by proposing a multi-level structure for analyzing the integration between the "Ecosystems" and "Digital

Transformation" constructs. The empirical application in a recent ecosystem of an emerging economy — Pacto Alegre (Brazil) — made it possible to investigate the actions and projects of the ecosystem aimed at the digital transformation of companies, considering the focus on low-tech companies, local dynamics, and the particularities of this process. These efforts demonstrate the relevance and contributions of the research, benefiting original approaches that seek ways to identify the spatial and/or organizational scope of ecosystems, with a focus on digital transformation, contributing to the development of a solid theoretical basis.

The next chapter presents a literature review related to regional ecosystems and digital transformation. In the third chapter, there is a presentation of the methodological procedures that outlined the study. In the fourth, there is the discussion of the description, analysis, and interpretation of the results obtained in the empirical study. Finally, there is the conclusion, followed by the references.

2 Regional ecosystems and digital transformation

Research focused on innovation ecosystems has advanced in recent decades, with the purpose of understanding the interdependent relationships among different actors in favor of the co-creation of value and development of innovations (Scaringella & Radziwon, 2018; Suominen et al., 2019; Cobben et al., 2022; Sorri et al., 2024). There are two different approaches adopted by researchers to analyze and conceptualize innovation ecosystems: structure and territory. The structure approach deals with the existence of a set of interconnected actors around a focal product, company, or platform. The territorial approach, adopted in the present study, has its roots in economic geography, and emphasizes ecosystems such as a region, city, neighborhood, or even a university campus (Fischer et al., 2022; Nascimento et al., 2022; Santos & Zen, 2022; Zen et al., 2024).

The territorial delimitation of a city makes it possible to better understand the functions performed by different agents and the geographic limits of their interactions, in addition to the local impacts resulting from entrepreneurial action, and the generation of value and innovation provided by ecosystems (Cohen et al., 2016; Fischer et al., 2022; Gonçalves et al., 2024; Majava & Rinkinen, 2024). These ecosystems include the environment and infrastructure in which energy

flows, capital, information, and people occur, seeking urban and social convenience, just as the sustainable production of goods and services (Autio & Thomas, 2022; Sorri et al., 2024).

It is worth emphasizing that empirical studies on city-level ecosystems differ regarding the terminology adopted. On the one hand, some studies emphasize the term "urban innovation ecosystem" or just "urban ecosystems" (e.g., Autio & Thomas, 2022; Sorri et al., 2024). On the other hand, there is the perspective of "regional innovation ecosystems" or just "regional ecosystems" (e.g., Thomas et al., 2021; Faccin et al., 2022; Mignoni et al., 2023; Coletto et al., 2024; Majava & Rinkinen, 2024). In this research, we have adopted the second perspective, as it is wider than an overly specific approach, while simultaneously encompassing the elements of urban ecosystems. This perspective emphasizes regional ecosystems as synonymous with the territorial approach, presenting different levels of analysis (city, region, or country), but which share a body of theory with similar characteristics, i.e. the territorial approach to ecosystems (Santos et al., 2021; Thomas et al., 2021; Faccin et al., 2022; Fischer et al., 2022; Mignoni et al., 2023; Coletto et al., 2024; Zen et al. 2024).

Regarding the actors, the territorial/regional approach uses the logic of the quadruple helix as a basis: academia, business, government, and civil society (Malik et al., 2021; Santos et al., 2021; Thomas et al., 2021; Carayannis et al., 2022; Coletto et al., 2024; Zen et al., 2024). The agglomeration of actors in a delimited region can provide advantages to all involved, such as: local infrastructure, knowledge spillovers, ease of accessing resources to innovate, and recombination of ideas, practices, and technologies between sectors (Cohen et al., 2016; Scaringella & Radziwon, 2018; Ardito et al., 2019; Fischer et al., 2022; Coletto et al., 2024), in addition to mitigating possible negative effects of external shocks (Roundy et al., 2018). Specifically, regarding the acquisition and application of technological knowledge, the engagement of different actors in inter-organizational alliances, such as regional ecosystems, can bring positive results for them to succeed in their digital transformation process (Appio et al., 2021; Siachou et al., 2021; Font-Cot et al., 2023).

Digital transformation, which goes beyond converting physical processes into digital, is one of the main challenges of the business context in the 21st century (Stjepić et al., 2020; Almeida et al., 2020; Reuschl et al., 2022; Gradillas & Thomas, 2023; Zhang & Chen, 2024). Considered a multidimensional phenomenon that influences organizations at distinct levels, forms, and intensities (Appio et al., 2021; Skare et al., 2023), digital transformation refers to a sociocultural

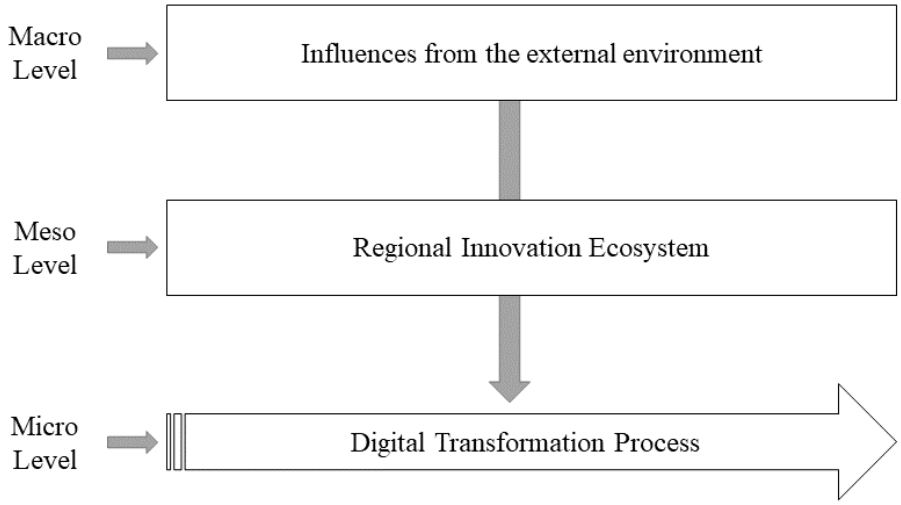
process in which companies seek to adapt to organizational forms and skill sets essential to remain viable in a digital and dynamic landscape. Digital transformation leads to changing the business model, value creation processes, organizational tasks, and how the business is run (Saarikko et al., 2020; Verhoef et al., 2021; Xiong et al., 2024). It is a learning process that requires integrating technology, business, and strategies in an organization focused on entrepreneurship (North et al., 2019; Font-Cot et al., 2023; Liao et al., 2024).

The pace of technologies and their impact on organizations have expanded in recent decades, and the Covid-19 pandemic has accelerated the integration of companies into this process, as a necessity rather than an opportunity for development (Almeida et al., 2020; Reuschl et al., 2022; Haukipuro et al., 2024). Traditional organizations, that is, those with low technological incorporation — also called low-tech companies — face difficulties in conducting the digital transformation of their business, being, in most cases, unsuccessful (Siachou et al., 2021; Verhoef et al., 2021; Skare et al., 2023; Onesi-Ozigagun et al., 2024).

Digital transformation is results-oriented at the strategic level, aimed at radical change (Gong & Ribiere, 2021; Gradillas & Thomas, 2023), and should be seen as a process of sociocultural change, not as a technical achievement in the company (Saarikko et al, 2020). This does not mean that technologies are unimportant, but that the drivers of digital transformation are represented by organizational culture and ideas, not just by technological capabilities (Verhoef et al., 2021). The role of the technology is noteworthy, yet it functions as a tool rather than an end in itself (North et al., 2019; Oliveira et al., 2023; Zahra et al., 2023).Most of the research on digital transformation has focused on how it affects individual companies (Almeida et al., 2020; Saarikko et al., 2020; Stjepić et al., 2020; Kraus et al., 2021; Verhoef et al., 2021). However, the study by Siachou et al. (2021) challenges this view by questioning whether all companies have the capability to implement digital transformation in their business model. In this way, the theoretical proposal of the present study is centered on the understanding that regional ecosystems can be considered an important means for the business digital transformation to occur, based on the dissemination of new knowledge, inter-organizational relationships, and of other actions and projects that help companies in the process. Figure 1 illustrates the theoretical model.

Figure 1

Theoretical Model



Source: Made by the authors, based in the literature review

Figure 1 considers a multi-level structure, with the levels of analysis often considered in organizational, regional, and innovation studies categorized as macro, meso, and micro (Roundy et al., 2018; Guimarães et al., 2023; O'Connor & Audretsch, 2023; Cai et al., 2024):

- The macro level includes the context and the cultural, institutional, and social environment of the ecosystem, including political guidelines and the influence of rules and regulations;
- The meso level consists of the actors who make up the ecosystem, i.e., the local economic agents who interact in the quadruple helix in favor of regional development. It includes those who provide support and resources for entrepreneurs — such as incubators, accelerators, and science and technology parks;
- The micro level refers to the set of personified individuals, including entrepreneurs and economic organizations that participate in the region's business activities. The characteristics of these individuals and organizations vary in terms of values, attitudes, behaviors, and intentions.

From the multilevel structure, the theoretical model emphasizes regional ecosystems as strategic mediators between the micro level of firms — where the need for digital transformation arises — and the macro level of the external environment, which exerts direct influence on this

transformative requirement. At the micro level, companies face the challenge of adapting and digitally reinventing themselves to remain competitive and relevant in an ever-evolving landscape (North et al., 2019; Stjepić et al., 2020; Reuschl et al., 2022; Zhang & Chen, 2024). On the other hand, factors such as technological development, changes in consumer behavior, regulatory demands, and the competitive dynamics of the macro-environment — including the Covid-19 pandemic — drive the urgency for the adoption of digital strategies (Almeida et al., 2020; Saariko et al., 2020; Reuschl et al., 2022; Font-Cot et al., 2023; Haukipuro et al., 2024).

In this context, ecosystems can play a crucial mediating role by providing relevant contributions to mitigate the risks of failure in the process of digital transformation for companies (Siachou et al., 2021). Thus, a relevant line of research that needs to be expanded refers to how ecosystems can boost digital transformation and the competitiveness of emerging economies. The growing prevalence of digitization has emerged as a pivotal aspect within inter-organizational environments, necessitating advancements in empirical research and theoretical frameworks to enhance the impactful contributions of the ecosystem (Oliveira & Trento, 2021; Cobben et al., 2022; Fischer et al., 2022; Haukipuro et al., 2024).

The issues discussed in digital transformation, such as changes in digital, culture, people's behaviors, leadership, and regulators, drive the development and implementation of innovation and the creation of value for customers, which are essential elements for ecosystems (Oliveira & Trento, 2021), and discuss the co-creation of value based on innovations (Scaringella & Radziwon, 2018; Cobben et al., 2022; Klimas & Czakon, 2022). In this context, it is worth considering that strategic interdependence is a condition for success in the relationship between knowledge from alliances and the company's digital transformation process (Siachou et al., 2021). From this perspective, it is possible to propose a discussion of the contributions of a regional ecosystem to business digital transformation, addressing theoretical gaps (Fischer et al. 2022; Cobben et al., 2022).

3 Methods

Regarding the need to meet the objective of the study, an in-depth case study was conducted concerning *Pacto Alegre* — an initiative encompassing the actors of the regional innovation ecosystem in the city of Porto Alegre, in southern Brazil. The choice for this case allowed investigating an emerging ecosystem in Latin America, relevant to link theory and practice. The Porto Alegre case follows the model of other successful cases, such as Barcelona and Medellín,

and is a promising ecosystem in which the city seeks to become a benchmark for innovation in Latin America (Thomas et al., 2021; Mignoni et al., 2023; Gonçalves et al., 2024). Therefore, it is a case study with two stages of data collection: one with secondary data (documents) and one with primary data (interviews).

The secondary source came from official documents and reports, such as information about the projects available on the official website of *Pacto Alegre* (*Projetos | Pacto Alegre*, n.d.) complemented by the YouTube channel, which features videos related to its actions (*Pacto Alegre Oficial*, 2021). The documentary analysis focused on understanding specific contributions to the digital transformation of the companies, directly or indirectly. The main source of documents was the list of *Pacto Alegre* projects, and the criteria for filtering the selected projects were: *i*) the value proposition is related to the digital transformation of organizations (public or private); and *ii*) the project was mentioned during the interview stage when questioning projects/actions aimed at digital transformation. Also, interviews were conducted with individuals who were part of the team that organized the *Pacto Alegre*, which resulted in the gathering of reports, news, and other documentary sources.

Regarding the primary source of data, the interviews took place online, and the search for interviewees initially focused on the *Pacto Alegre* orchestrators. Subsequently, the snowball technique was used to map relevant actors in the ecosystem, who have knowledge about the projects and actions developed with a focus on digital transformation.

This way, a semi-structured script was prepared, consisting of questions based on the literature on regional innovation ecosystems and digital transformation, which specifically address the following topics: *i*) stage in which companies in the region are in relation to digital transformation; *ii*) meaning of digital transformation for the ecosystem; and *iii*) role of the ecosystem for business digital transformation.

Each interview was recorded with the permission of the interviewees, allowing the transcription and analysis of the results obtained. Twelve interviews were conducted between March and July 2022 with different actors in the quadruple helix: Government (Gov), University (Uni), Company/Business (Bus), and Civil Society (Soc). Table I summarizes the actors interviewed, as well as the description of their relationship with ecosystem.

Table I

Profile of interviewees

Government	**Gov1 –** Orchestrator and founder of *Pacto Alegre;* currently has a coordination role in the ecosystem. **Gov2** – Actor of *Pacto Alegre*, representing the State Government, working with "innovation environments". **Gov3** – Actor of *Pacto Alegre*, representing the State Government, with activities focused on innovation and technology.
University	**Uni1 –** Orchestrator and creator of *Pacto Alegre;* currently superintendent of innovation and development of a technology park that is part of *Pacto Alegre*, and a university professor. **Uni2 –** Director of a scientific and technological park at a university that is part of *Pacto Alegre.* **Uni3 –** Coordinator of the entrepreneurship program at a local university with actions to connect the different players in the ecosystem.
Company/ Business	**Bus1 –** Company in the health sector participating in the "Digital Health" project. The company is in a technological park. **Bus2 –** Company in the technology sector with participation in meetings, workshops, and events of *Pacto Alegre*. The company is in a technological park. **Bus3 –** A technology hub that works at *Pacto Alegre* and is a member of the South Summit.
Civil Society	**Soc1 –** Actor of *Pacto Alegre*, member of *Sistema S*, with a focus on high-tech companies. **Soc2 –** Actor of *Pacto Alegre*, member of *Sistema S*, with a focus on low-tech companies. Participant in the "Hands-On 4D" project. **Soc3** – Non-profit companies association structured in the "*Caldeira*" project. It started from the union of forty-two companies.

Source: Research Data.

Three categories were defined for grouping the results, based on the structure of the themes proposed in the script. The categories of analysis, defined a priori, were: *i*) internships of companies in Porto Alegre regarding digital transformation; *ii*) *Pacto Alegre* projects aimed at the digital transformation; and *iii*) perception of interviewees regarding the role of *Pacto Alegre* in the digital business transformation. The analysis explored the logical connection between the data obtained, to identify the contributions of a regional innovation ecosystem in relation to the digital transformation of companies in its environment.

4 Results and Discussion

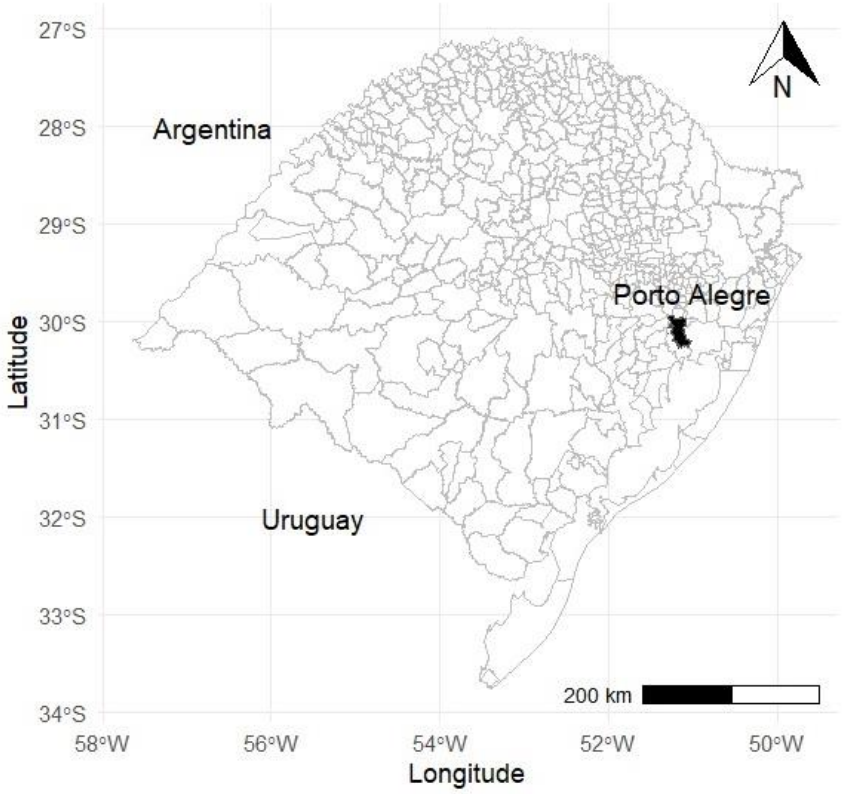
4.1 Case Presentation: *Pacto Alegre* (Brazil)

Pacto Alegre is a recent initiative among research institutions, public authorities, and companies in the city of Porto Alegre, in the state of *Rio Grande do Sul,* southern Brazil (Figure

2). This initiative aims to foster a collaborative ecosystem that promotes innovation and creativity across multiple sectors. The relevance of the ecosystem in Porto Alegre can be justified by a well-established environment focused on innovation that has been built at the state and municipal levels (Thomas et al., 2021; Balestrin, 2022; Gonçalves et al., 2024).

Figure 2

The location of Porto Alegre in Rio Grande do Sul State



Source: Research data.

Rio Grande do Sul was considered leader in the innovation pillar in Brazil in 2021, 2022, and 2024 (*Ranking de Competitividade CLP*, 2024), The state standing out in the five evaluated indicators: *i*) public investment in research and development (R&D); *ii*) scientific research; *iii*) filed patents; *iv*) master's and doctoral scholarships; and *v*) innovative ventures, highlighting the 16 technology parks and 43 incubators.

In the same ranking, the city of Porto Alegre is constantly among the 5 most innovative capitals in Brazil. It is one of the urban centers that invests the most in training human resources and is home to one of the most recognized and awarded structures and environments for promoting

innovation in Brazil (Faccin et al., 2022). In addition, the city hosted the first editions of the South Summit in Brazil — an innovation platform that brings together entrepreneurs, companies, startups, and investors to create business opportunities and discuss digitalization, technologies, and innovation (Balestrin, 2022).

Porto Alegre, despite its seemingly stable economic situation, has been facing ongoing challenges related to public safety, quality of life, talent retention, and the creation of start-ups. These issues highlight a unique context where the quadruple helix seeks to revitalize the ecosystem, through actions aimed at start-ups growth, talent retention, increased interactions between ecosystem members, creation of a new local identity, and promotion of an environment that fosters creative thinking (Faccin et al., 2022; Mignoni et al., 2023).

In this context, the *Pacto Alegre* officially emerged in 2018, as a joint initiative between the so-called "Alliance for Innovation" — formed by educational institutions and the local government. The main goal is to engage quadruple helix entities in favor of a more innovative city, internationally recognized as a model of high-impact innovation, and with quality of life for citizens (*Pacto Alegre*, 2021).

Pacto Alegre was inspired by successful innovation projects — such as Barcelona and Medellín (Gonçalves et al., 2024) — and has approximately 40 projects, divided into 4 cycles and at different stages of development. The projects aimed at digital transformation being present in the first and second cycles. Table II describes the first two cycles, dimensions, and projects specifically related to digital transformation, and each project presents its value proposition.

Table II
Pacto Alegre projects aimed at Digital Transformation

Cycle	Dimension	Projects related to digital transformation	Project Value Proposition
First Cycle (March 2019 – December 2019)	**Modernization of Public Management**	Transparent City	To facilitate access to data from the Municipality of Porto Alegre (POA) in an open and clear manner for citizens.
		Start Gov.	To modernize Public Administration by the dissemination of the Startup culture.
	Business environment	Innovation Blitz	To stimulate interaction between the community and the most advanced actors in the POA innovation ecosystem.
	Urban transformation	Hands On 4D	*Kick-off* about the creative revitalization of the 4th District with community engagement, entrepreneurs, and innovation agents in the region.
	Strategic	*Caldeira* Institute	To drive transformations and new businesses by connecting companies, startups, and innovation agents.
		Digital Health	To generate an integrated city-wide platform for sharing Health information.
Second Cycle (December 2019 - February 2021)	**Business environment**	Digital Transformation - Business POA 4.0	To articulate actions to support the development of the service sector or other business clusters operating in POA, seeking to encourage a better understanding and to facilitate the application of digital technologies to increase competitiveness, efficiency, and the level of services.

Source: Elaborated by the authors based on *Projetos | Pacto Alegre* (n.d.).

All listed projects, despite belonging to closed cycles, continue to be developed until nowadays and are available on the *Pacto Alegre* website. These elements highlight the relevance of Porto Alegre as a context to explore the themes of Regional Ecosystems and Digital Transformation. In this sense, the next topic addresses the stage of digital transformation of companies in Porto Alegre, to characterize the attributes that influence this process.

4.2 Stage of digital transformation of companies

Companies have turned their actions to strategies that improve their operational performance before the implications of digital transformation. However, each company has various levels of knowledge, technological maturity, capabilities, and business sizes, with different people and cultures, being at dissimilar stages of digital transformation. In this sense, respondents were asked about the stage at which companies in the region are in terms of digital transformation, that is, whether they still have their processes analogically or whether they have already adhered to the digital transformation process (Saarikko et al., 2020; Verhoef et al., 2021; Gradillas & Thomas, 2023; Skare et al., 2023).

The answers highlighted the Covid-19 pandemic, which forced many companies to accelerate or even adhere to the digitization of their processes (Uni1; Soc1; Soc3; Gov3). Many companies were forced to migrate from the analog, as the Covid-19 scenario made the digital medium the only means of subsistence during its peak period. Excerpts from Uni1 and Soc1 illustrate this point.

> Covid-19 accelerated digital transformation processes. Undoubtedly, many companies have had to reinvent customer relationships. [...] in that unplanned way, in desperation. 'I have to do something or I won't sell my product'. [...] And initiatives like 'save yourself if you can' [...] that's why it accelerated in things that probably would take many companies years to do, and they did it in a month because otherwise, they wouldn't have revenue (Uni1).

> The pandemic, I believe, has stimulated this. Companies did not innovate, by seeking this transformation, for love' in the pre-pandemic era, so they had to seek it in 'pain', they made this digital transformation for survival [...]. To a certain extent, Covid-19 woke them up to the minimum, to at least realize that they needed to change. If it's not for love, it's for pain, right? (Soc1).

The pandemic has brought challenges and uncertainties to companies, requiring greater adaptability from their insertion in the digital context and, therefore, accelerating the digitalization process (Arias-Pérez & Vélez-Jaramillo, 2022). Such efforts intensified because of the state of emergency, without rigorous planning, leaving organizations with no time to adapt their structure, processes, and culture (Almeida et al., 2020; Bai et al., 2021; Reuschl et al., 2022; Haukipuro et al., 2024). Companies were forced, at the very least, to incorporate digital work tools, and, despite all the negative impact on public health, the pandemic was a catalyst in the movement linked to innovation and digital transformation in companies (Soc3; Gov2).

However, such cases mainly refer to the first stages of the digital transformation process, in which analog processes become digital, but do not change strategies aimed at value generation (Saariko et al., 2020; Gong & Ribiere, 2021; Gradillas & Thomas, 2023; Xiong et al., 2024). In view of this, it is highlighted that there are companies with different characteristics in terms of technological contribution: i) technology-focused companies, with high technology incorporation; and ii) "traditional" companies, which commonly have low technological incorporation (Siachou et al., 2021; Verhoef et al., 2021; Onesi-Ozigagun et al., 2024). Companies with high technological incorporation tend to look for innovation and digitalization of processes as a natural aspect, as they already have a mindset of innovation, technologies, and new business models since their origin (Soc1; Gov3).

It is necessary to observe that high-tech companies represent a small portion of the region in which the ecosystem is located. According to Soc1, "*they have a great added value, but they represent little*". In this sense, it is worth highlighting low-tech companies, that is, companies from non-technological sectors and which undertake it out of necessity. Interviewee Gov2 highlights the representativeness of small businesses, and the importance of orienting them towards the digital.

> [...] in the meetings of *Pacto Alegre*, the entrepreneurs are already included in this process, they are always the same [...] But if you take the division between the size of companies in the region, the majority are micro companies, not being active in *Pacto Alegre*. And then *Sistema S* has been working hard to bring digital transformation to them, which I think is the focus, which has to work in this perspective (Gov2).

Companies that have already participated since the beginning of their actions still focus of the targeting of the ecosystem, and it is necessary to develop actions for the integration of other companies. The digital transformation of small businesses requires the support of external stakeholders, such as supply chain partners, government, and educational institutions (Bai et al., 2021; Font-Cot et al., 2023; Guimarães et al., 2024; Haukipuro et al., 2024). Therefore, focusing on companies considered "traditional" and reaching a larger number of companies is relevant, as many become unsuccessful when trying to digitally transform (Onesi-Ozigagun et al., 2024). As highlighted in the literature, not all companies are able to conduct this process individually (Siachou et al., 2021) and suffer the consequences of not adapting the business to digital transformation (Verhoef et al., 2021; Arias-Pérez & Vélez-Jaramillo, 2022).

In this sense, it is possible to understand that the regional innovation ecosystem, based on its projects and actions, can contribute as a facilitator in the digital transformation of companies in

the city of Porto Alegre. The next topic highlights *Pacto Alegre*'s actions aimed at digital transformation based on the documental analysis of the projects (*Pacto Alegre*, 2021), and on the evidence from the interviews.

4.3 Projects focused on digital transformation

Although it is not the main goal of the regional ecosystem, digital transformation is aligned with the strategic areas and projects developed, meaning a change in culture and a challenge for the city (Uni1; Uni2). *Pacto Alegre* "s*timulates projects to help this digital transformation, but it is not the flagship of the ecosystem* (Uni2)". In this perspective, Gov2 points out that *Pacto Alegre* considers digital transformation "*as one of the strategic areas, and the importance of the theme will continue for a long time, as long as there is an alliance and pact for innovation in the city, which society has now understood and embraced the idea*".

In the literature, digital transformation is considered a sociocultural change that requires systemic integration of digital technologies into operations, to reshape the business model (Saarikko et al., 2020; Siachou et al., 2021; Arias-Pérez & Vélez-Jaramillo, 2022; Zhang & Chen, 2023). This aspect emphasizes that the engines of digital transformation are in organizational culture and ideas, and not just in technological capabilities (Verhoef et al., 2021), but also perceived by respondents as a change in strategy that may or may not involve technology (Gov1; Gov2; Uni2; Bus3). The importance of technology's role is pertinent, although it serves as a means rather than an end in itself (Oliveira et al., 2023). In this way, the need arises for a change in the technological base, which will support the newly established strategy. When the process is the other way around, the technologies used in business change (mobile devices, social media, intelligent systems, etc.), except for the company's processes, without using the potential of digital transformation itself (Uni1; Bus3). Bus3's statement illustrates this perception.

> Technology is a condition that is almost "*si ne qua non*", [...] it is an enabler. There is no digital transformation without technology, but companies do not make the transformation because of this technology. [...] Technology turns out to be an important driver for any business, for some a little more and for others a little less (Bus3).

The interviewees' perception highlights the need to plan business strategies that best define the technologies that the company will need. In this way, the support that *Pacto Alegre* provides to companies, especially the traditional ones, directly or indirectly contributes as a digital

transformation facilitator (Uni2; Gov2). In addition, the projects developed involve different sectors and goals for companies and society, legitimizing the search for life quality with the purpose of making the city smarter (Camboim et al., 2019; Sorri et al., 2024). There are actions to encourage the companies' digitization in the region, and this is being corroborated in the interviews conducted in the present research. Projects such as “Innovation Blitz” and “Digital Transformation - Business POA 4.0” have contributed directly to facilitating the process of digital transformation.

The project most mentioned by the interviewees was *Caldeira* Institute, the first *Pacto Alegre* project led by the private sector, which is considered an innovation hub. *Caldeira* is a non-profit association, established based on the union of companies that seek to connect the region to themes associated with the new economy, such as technologies, innovation, the connection between companies, and digital transformation (Soc3; Gov1; Gov2).

In general, the project provides inter-organizational alliances and knowledge exchange; these elements, according to the literature, are relevant to the companies' digital transformation process (Siachou et al., 2021). However, the alignment of the project with large companies and startups is perceived, this is aimed at companies with a high technological incorporation, which reiterates the need to establish more specific actions for traditional companies, as already highlighted, represent a large part of the companies in the city (Gov2; Gov3).

From this perspective, another project mentioned was *Hands On 4D*, aimed at revitalizing the region called 4th District (4D). The 4D is located in the northern part of Porto Alegre and is known for having been the city's former industrial district, which until the 1960s represented the main local economic hub. However, from the 1980s onwards, the suburbanization and metropolization of industrial activities led to the deindustrialization of the 4D, which came to be considered a territory "in abandonment" (Silva et al., 2023). After decades of deindustrialization, the 4D has once again reclaimed its relevance in the city, with investments from the government and the private sector to become a space for innovation and creativity (Soc2; Gov2).

In this sense, the *Hands On 4D* project has actions aimed at supporting local entrepreneurs, city infrastructure, and new rules for setting up companies in partnership with the Municipal Secretariat for Economic Development, among others (*Projetos | Pacto Alegre*, n.d.). Specifically for traditional companies, diagnostic actions were developed in the region, considered by *Pacto Alegre* orchestrators a need to understand the business profile of the 4D (Soc2). These actions

aimed to obtain an overview of local businesses that would enable the planning of actions to support digitization.

> We joined Hands-on from the moment they (the orchestrators) understood the need to diagnose the traditional businesses of the 4th District. [...] And we made the diagnosis in 2019. At first, we had a huge difficulty being received by the entrepreneurs, because they are really traditional there, where we heard "I've been doing it like this for 40 years and it works" [...]. But the pandemic has made clear the need for digital transformation. It was a moment when they really realized the need to adapt (Soc2).

In the first stage of the actions, a resistance was identified by the companies regarding the participation in the project, with the Covid-19 pandemic mentioned again as a factor that accelerated the process. Although the project *Hands-on 4D* is considered a completed project, the actions carried out specifically affecting the business digitalization are considered as an initial step, following its development by the different actors in the ecosystem.

In the health field, the *Digital Health* project was mentioned, aiming to integrate health information, based on data transparency. The project interconnects hospitals in the city, sharing patient records between hospitals and transmitting data to improve public health management (Bus1). From this perspective, Gov1 points out that projects like this one can influence the behavior of entrepreneurs in the region, as presented in the following excerpt.

> Entrepreneurs will be "provoked" by the digital actions of *Pacto Alegre* projects [...]. Services, such as *Digital Health*, are migrating. [...] When users realize that their personal experience is also being digital, they begin to think that it can also happen in the company. There is a cultural change, which forces companies to say "if everyone speaks digital, I have to speak too" (Gov1).

The excerpt from Gov1's interview connected the digital transformation of companies, emphasizing that digitized services that are offered to the society can provide a change in the behavior of entrepreneurs, resulting in externality. So, upon receiving the services, entrepreneurs may identify the benefits that digitization can bring, if applied to their company's processes.

In addition to the projects structured by *Pacto Alegre*, it is important to mention the *South Summit*, an event held in 2022, for the first time in Brazil, which involved actors from the ecosystem, as well as national and international speakers. The *South Summit Brazil* was held two years after the pandemic and, along with it, the beginning of an intense process of urban transformation in Porto Alegre (Gov2; Bus3). As highlighted by Bus3, an event of this magnitude "*offers companies in the ecosystem options that can help them on the digitalization journey,*

whether through the provision of services, partnership, product collaboration, there are many ways". In addition, the event enabled the definitive inclusion of the city in the global scenario of innovation.

4.4 The role of the regional innovation ecosystem in digital transformation

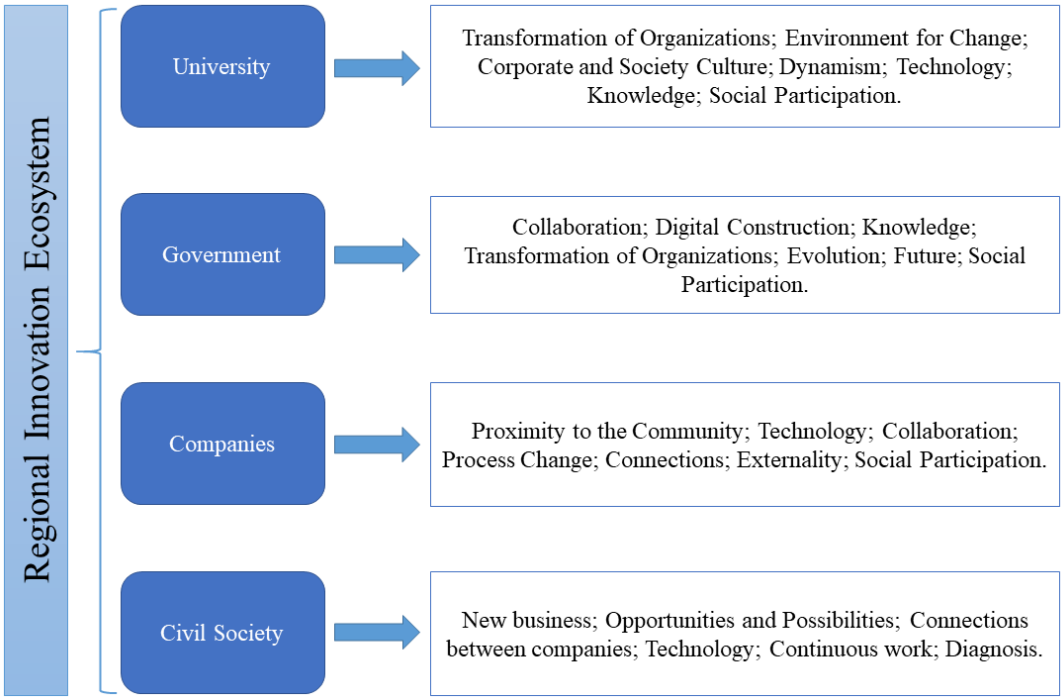
Concerning the projects' identification that directly or indirectly involves digital transformation, it was found that, although it is not the priority of the ecosystem, it is integrated with its objectives and actions. Considering *Pacto Alegre* as recent, and with many projects paralyzed or in the preliminary stages of development, digital transformation stands out as a long-term effect for the ecosystem.

According to Gov1, the businesses are in a transition phase, initiating a process that will be evident in the upcoming years. In the words of the interviewee, "*there will be a great wave of digital transformation, which is inevitable, but we are in a moment where it is not yet understood exactly where it will start, the strategy is not very clear on how to do this*". In this way, the ecosystem assumes a facilitating role so that knowledge reaches all citizens of Porto Alegre, and this has been done through different projects (Gov2).

Based on this finding and trying to understand the perception of the different actors, Figure 3 summarizes the responses regarding the contributions of *Pacto Alegre* to the digital transformation of companies in the region. Considering the idea of the quadruple helix, the answers were grouped for each axis: university, government, companies/business, and civil society.

Figure 3

Contributions of Pacto Alegre to Digital Transformation



Source: Research Data.

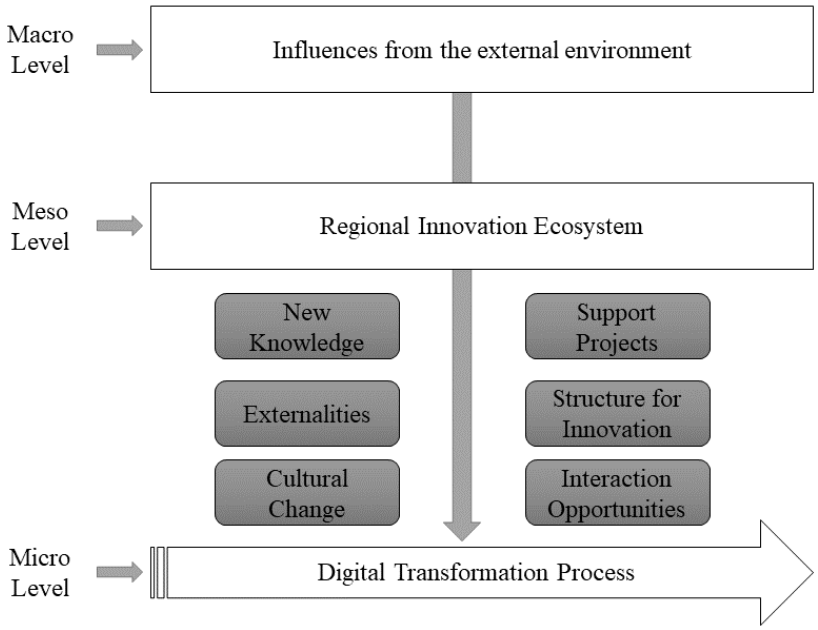
For the actors categorized as universities, the **culture** element stands out when compared with the responses of the other interviewees. According to these actors, the ecosystem provides a change of culture in companies and society, in addition to a favorable environment for changes and social participation. The elements are not limited to the digital transformation topic, as they involve cross-cutting issues relevant to the development of society. This perception is corroborated by the actors characterized as the government, who show concern with long-term planning, in which issues of **collaboration, knowledge, evolution,** and **collective construction** synthesize this thought.

Civil society and **companies/business** axes focus on more specific points in the contributions of *Pacto Alegre* projects. Respondents representing **civil society** highlight **new businesses, opportunities, and possibilities** that emerge from the ecosystem, with a clear focus on entrepreneurship. Participants categorized as **companies/business** highlight the **connections** provided by *Pacto Alegre*, as well as the **externalities** of the process, that is, the indirect contributions that the ecosystem's activities can provide to companies.

Based on the established discussions regarding the contributions of the regional innovation ecosystem to the digital transformation of companies, Figure 4 summarizes the theoretical model proposed at the second chapter of this paper, complementing it with the main findings of the empirical stage.

Figure 4

Theoretical proposition and empirical results



Source: By the authors.

The theoretical model, complemented by the empirical findings, argues that regional ecosystems function as a strategic mediator between firms and the external environment, facilitating access to resources, partnerships, funding, and market opportunities, which are fundamental in driving digital transformation. Appio et al. (2021) also proposed a multi-level model for analyzing companies' digital transformation, delineating the ecosystem as the macro level, organizations as the meso level and individuals as the micro level. However, our study goes further by considering the importance of the institutional environment — positioned at the macro level — in the process of companies' digital transformation. This is in line with the levels of analysis normally considered in organizational, regional and innovation studies (Roundy et al., 2018; Guimarães et al., 2023; O'Connor & Audretsch, 2023; Cai et al., 2024).

Among the macro-level influences, the Covid-19 pandemic was a catalyst for the digital transformation of Porto Alegre companies, corroborating the literature that points to a global acceleration of digitization driven by the pandemic (Arias-Pérez & Vélez-Jaramillo, 2022; Zhang & Chen, 2023; Haukipuro et al., 2024). The abrupt change — motivated by the need of the moment — is in line with the perception that digital transformation is a response to crises that challenge traditional business models (Bai et al., 2021). This corroborates the proposed model, which considers the macro level as something higher than the ecosystem, exerting an influence on it, which integrates the different actors of the quadruple helix.

Thus, the interconnectedness of actors provides advantages for the low-tech companies, and participating in regional innovation ecosystems can provide the engaging in collaborative projects that drive digitalization. The ecosystem provides a conducive environment for collective learning, experimentation, and joint innovation through the establishment of collaborative networks, knowledge exchange, and resource sharing, offering relevant contributions to prevent failure in the digital transformation process for companies.

The literature connecting regional ecosystems and digital transformation emphasizes that inter-organizational collaboration and access to resources are important for overcoming economic, social and knowledge barriers that many companies encounter when adopting new technologies (Oliveira & Trento, 2021; Cobben et al., 2022; Fischer et al., 2022; Font-Cot et al., 2023; Majava & Rinkinen, 2024). Our results corroborate this perspective, especially in the context of low-tech companies, which traditionally lack the tangible and intangible necessary resources to adopt recent technologies. In this sense, although it is still necessary to expand actions to low-tech companies, *Pacto Alegre* projects assist companies in overcoming practical and financial challenges associated with digital transformation by providing technical support, mentoring, training, and access to financing.

The results allow us to state that city-level ecosystems are enablers of digital transformation. The ecosystem, with its role as an orchestrator and promoter, is relevant for the business digital transformation to occur, based on the dissemination of new knowledge, the articulation of networks between actors, and other actions that contribute directly or indirectly to companies. Such results corroborate with the studies that requested the integration between the themes of regional ecosystems and digital transformation (Oliveira & Trento, 2021; Siachou et al.,

2021; Cobben et al., 2022; Fischer et al., 2022; Guimarães et al., 2023), and go further by emphasizing low-tech companies in emerging economies, which have peculiar characteristics.

5 Conclusions

Considering the purpose of the present research — to analyze the perception of quadruple helix actors in a regional innovation ecosystem regarding their contributions to the digital transformation of companies — an in-depth case study was conducted in *Pacto Alegre*. In the results found, the digital transformation is clearly aligned with the value proposition of the ecosystem. The role of *Pacto Alegre* is to be responsible for orchestrating an environment conducive to knowledge exchange, inter-organizational relationships, and learning by companies in the region, being a facilitator for companies in the digital transformation process. This contribution ranges from projects that perform diagnostics in traditional companies, through actions and events involving technology, and reaching the orchestration of relationships between different actors.

From a theoretical point of view, the article contributes to the advancement of knowledge by proposing a multi-level structure, which positions the ecosystem between the institutional macro-environment and the micro-level of companies in the digital transformation process. On the one hand, many companies do not develop digital transformation in isolation and need the support of the ecosystem as a source of knowledge and infrastructure. On the other hand, the regional innovation ecosystem cannot neglect one of the main needs of local companies — digitalization. In this context, the actors in the innovation ecosystem must understand the environment in which they operate (macro level) and find ways to enable digital transformation in different segments of society. Therefore, the empirical results confirmed the theoretical proposition that regional ecosystems function as strategic facilitators for the digital transformation of companies, especially in emerging countries and for low-tech companies.

The practical implications of the present study provide elements for organizing and improving *Pacto Alegre*'s actions as a facilitator of digital transformation, as well as a basis for different ecosystems. Among the actions, we can mention: *i*) Projects directed not only to high technology companies, but also to low-tech companies; *ii*) The promotion of an environment that encourages subjective issues, such as cultural change, and practical issues, such as having permanent or temporary arenas that promote digitization, such as *Caldeira Institute* and *South*

Summit Brazil; and *iii*) Joint actions between actors (orchestrators) with complementary purposes and aimed at innovation purposes in the region. Therefore, the actions developed by actors in a recent ecosystem in an emerging country make it possible to encourage and facilitate the digital transformation process of companies, especially for those with greater difficulty in conducting this process.

Finally, it should be noted that *Pacto Alegre* is a medium to a long-term project that considers all aspects of the city, in which business digital transformation is directly or indirectly included in its projects and actions. By enabling the creation of environments conducive to innovation in the most diverse areas of knowledge, focused on meeting social demands, and on building intelligent products and services, the regional innovation ecosystem contributes to this process.

A limitation of this article is that the focus of the interviews was directed to the ecosystem orchestrators and companies that actively participate in their projects. Although interviews were conducted with representatives of the Civil Society that work directly for support with companies in the region, it is relevant to suggest a deeper search for the contributions of the *Pacto Alegre* to digital transformation from the perspective of traditional companies, with low technological support. Therefore, it is suggested to increase research from this perspective, to complement the results about the contributions of the *Pacto Alegre* projects, and their externalities for the digital transformation of companies in the region. Furthermore, the proposed multilevel framework can be applied and explored in future studies on different ecosystem cases at the city level.

CRediT Authorship Contribution Statement

Contribution	Caliari, L.	Coletto, C.	Donato, R.S.	Reichert. F.M	Menezes, D.C
Contextualization	X	X	X	X	-----
Methodology	X	X	-----	X	-----
Software	-----	-----	-----	-----	-----
Validation	X	X	X	X	X
Formal Analysis	X	X	X	-----	-----
Investigation	X	X	X	-----	-----
Resources	-----	-----	X	-----	-----
Data Curation	X	X	X	X	X
Original	X	X	X	-----	-----
Revision and Editing	X	X	-----	X	X

Contribution	Caliari, L.	Coletto, C.	Donato, R.S.	Reichert. F.M	Menezes, D.C
Viewing	X	X	X	X	X
Supervision	-----	-----	-----	X	X
Project Management	-----	-----	-----	X	X
Obtaining Funding	-----	-----	-----	-----	-----

References

Almeida, F., Santos, J.D. & Monteiro, J.A. (2020). The challenges and opportunities in the digitalization of companies in a post COVID-19 world. *IEEE Engineering Management Review, 48*(3), 97–103. https://doi.org/10.1109/EMR.2020.3013206

Appio, F.P., Lima, M. & Paroutis, S. (2019). Understanding Smart Cities: Innovation ecosystems, technological advancements, and societal challenges. *Technological Forecasting and Social Change*, *142*, 1–14. https://doi.org/10.1016/j.techfore.2018.12.018

Appio, F.P., Frattini, F., Petruzzelli, A.M. & Neirotti, P. (2021). Digital Transformation and Innovation Management: A Synthesis of Existing Research and an Agenda for Future Studies. *Journal of Product Innovation Management*, *38*(1), 4–20. https://doi.org/10.1111/jpim.12562

Ardito, L., Ferraris, A., Petruzzelli, A.M., Bresciani, S. & Del Giudice, M. (2019). The role of universities in the knowledge management of smart city projects. *Technological Forecasting and Social Change*, *142*,.312-321. https://doi.org/10.1016/j.techfore.2018.07.030

Arias-Pérez, J. & Vélez-Jaramillo, J. (2022). Ignoring the three-way interaction of digital orientation, Not-invented-here syndrome and employee's artificial intelligence awareness in digital innovation performance: A recipe for failure. *Technological Forecasting and Social Change*, 174, 121305. https://doi.org/10.1016/j.techfore.2021.121305

Autio, E. & Thomas, L.D. (2022). Researching ecosystems in innovation contexts, *Innovation & Management Review*, *19*(1), 12-25. https://doi.org/10.1108/INMR-08-2021-0151

Bai, C., Quayson, M. & Sarkis, J. (2021). COVID-19 pandemic digitization lessons for sustainable development of micro-and small-enterprises. *Sustainable production and consumption*, *27*, 1989-2001. https://doi.org/10.1016/j.spc.2021.04.035

Balestrin, A. (2022). *RS, primeiro em inovação no Brasil*. Portal do Estado do Rio Grande do Sul. https://estado.rs.gov.br/rs-primeiro-em-inovacao-no-brasil

Cai, L., Sheng, N., Bruton, G. D., & Yu, H. (2024). Redefining the entrepreneurial ecosystem in China from a network-based view: A review and proposal for future research. *Small Business Economics*, 1-29. http://dx.doi.org/10.1007/s11187-024-00905-3

Camboim, G.F., Zawislak, P.A. & Pufal, N.A. (2019). Driving elements to make cities smarter: Evidences from European projects. *Technological Forecasting and Social Change*, *142*, 154-167. https://doi.org/10.1016/j.techfore.2018.09.014

Carayannis, E. G., Campbell, D. F. & Grigoroudis, E. (2022). Helix trilogy: The triple, quadruple, and quintuple innovation helices from a theory, policy, and practice set of perspectives, *Journal of the Knowledge Economy*, *13*(3), 2272-2301. https://doi.org/10.1007/s13132-021-00813-x

Cobben, D., Ooms, W., Roijakkers, N. & Radziwon, A. (2022). Ecosystem types: A systematic review on boundaries and goals. *Journal of Business Research*, *142*, 138-164. https://doi.org/10.1016/j.jbusres.2021.12.046

Cohen, B., Almirall, E. & Chesbrough, H. (2016). The city as a lab: Open innovation meets the collaborative economy, *California Management Review*, 59(1), 5-13. https://doi.org/10.1177/0008125616683951

Coletto, C., Caliari, L., Bernardes-de-Souza, D., & Callegaro-de-Menezes, D. (2024). Knowledge flows for rural producers: evidence from the Medellín ecosystem, Colombia. *International Food and Agribusiness Management Review* (published online ahead of print 2024). https://doi.org/10.22434/ifamr1068

Faccin, K., Thomas, E., & Kretschmer, C. (2022). University dynamic capabilities to boost innovation ecosystems: The case of a university alliance in Brazil. In *Universities and Regional Engagement* (pp. 41-57). Routledge. http://dx.doi.org/10.4324/9781003150299-4

Fischer, B., Gomes, L., Bernardes, R. C. & Facin, K. (2022). Guest editorial Innovation ecosystems: new perspectives and the way forward. *Innovation & Management Review*. *19*(1), 2-11. https://doi.org/10.1108/INMR-02-2022-180

Foguesatto, C. R., Santini, M. A. F., Martins, B. V., Faccin, K., De Mello, S. F. & Balestrin, A. (2021). What is going on recently in the innovation ecosystem field? A bibliometric and content-based analysis, *International Journal of Innovation Management*, 25(07), 2130001. https://doi.org/10.1142/S1363919621300014

Font-Cot, F., Lara-Navarra, P., & Serradell-Lopez, E. (2023). Digital transformation policies to develop an effective startup ecosystem: the case of Barcelona. *Transforming Government: People, Process and Policy*. https://doi.org/10.1108/TG-01-2023-0006

Gonçalves, L., Faccin, K., Garay, J., Zarpelon, F., & Balestrin, A. (2024). The development of Innovation and entrepreneurial ecosystems in cities: An institutional work approach. *Cities*, *146*, 104747. https://doi.org/10.1016/j.cities.2023.104747

Gong, C. & Ribiere, V. (2021). Developing a unified definition of digital transformation. *Technovation*, *102*, 102217. https://doi.org/10.1016/j.technovation.2020.102217

Gradillas, M., & Thomas, L. D. (2023). Distinguishing digitization and digitalization: A systematic review and conceptual framework. *Journal of Product Innovation Management*. https://doi.org/10.1111/jpim.12690

Guimarães, J. D. S., Fernandes, C., Veiga, P. M., & Ramadani, V. (2023). The relationship between entrepreneurial ecosystems and digital transformation. *FIIB Business Review*, 23197145231173850. https://doi.org/10.1177/2319714523117385

Haukipuro, L., Väinämö, S., Virta, V., & Perälä-Heape, M. (2024). Key aspects of establishing research, knowledge, and innovation-based hubs as part of the local innovation ecosystem. *R&D Management, 54*(2), 283-299. https://doi.org/10.1111/radm.12584

Klimas, P. & Czakon, W. (2022). Species in the wild: a typology of innovation ecosystems. *Review of Managerial Science*, *16*(1), 249-282. https://doi.org/10.1007/s11846-020-00439-4

Kraus, S., Jones, P., Kailer, N., Weinmann, A., Chaparro-Banegas, N., & Roig-Tierno, N. (2021). Digital transformation: An overview of the current state of the art of research. *Sage Open*, *11*(3), 21582440211047576. https://doi.org/10.1177/21582440211047576

Lara, J. E., Batista, A. S., Ribeiro, R. M., & Tissot-Lara, T. A. (2023). Corporate digital transformation: companies towards Industry 4.0. *International Journal of Innovation - IJI*, *11*(3), 1-32, e24194. https://doi.org/10.5585/2023.24194

Liao, A. T., Pan, C. L., & Wu, Z. (2024). Digital Transformation and Innovation and Business

Ecosystems: A Bibliometric Analysis for Conceptual Insights and Collaborative Practices for Ecosystem Innovation. *International Journal of Innovation Studies*. https://doi.org/10.1016/j.ijis.2024.04.003

Majava, J., & Rinkinen, S. (2024). Twenty years, twenty studies: what can we learn from San Diego's innovation ecosystem?. *Technology Analysis & Strategic Management*, 1-16. https://doi.org/10.1080/09537325.2024.2372781

Malik, A., Sharma, P., Pereira, V. & Temouri, Y. (2021). From regional innovation systems to global innovation hubs: Evidence of a Quadruple Helix from an emerging economy. *Journal of Business Research, 128*, 587-598. https://doi.org/10.1016/j.jbusres.2020.12.009

Mignoni, J., Bittencourt, B. A., da Silva, S. B., & Zen, A. C. (2023). Orchestrators of innovation networks in the city level: the case of Pacto Alegre. *Innovation & Management Review*, 20 (3), 194-210. https://doi.org/10.1108/INMR-01-2021-0002

Nascimento, S. F., Lima, M. C., & Gondim, I. J. C. (2022). Level of collaboration and knowledge transfer among actors of the innovation ecosystem: the proposition of an analytical model. *International Journal of Innovation - IJI*, São Paulo, *10*(Special issue), 434-460. https://doi.org/10.5585/iji.v10i3.21057

North, K., Aramburu, N., & Lorenzo, O.J. (2019). Promoting digitally enabled growth in SMEs:

a framework proposal. *Journal of Enterprise Information Management*. 33(1). 238-262. https://doi.org/10.1108/JEIM-04-2019-0103

O'Connor, A., & Audretsch, D. (2023). Regional entrepreneurial ecosystems: learning from forest ecosystems. *Small Business Economics*, *60*(3), 1051-1079. https://doi.org/10.1007/s11187-022-00623-8

Oliveira, S. R. M. & Trento, S. (2021). Innovation Ecosystem and Digital Transformation: Linking Two Emerging Agendas through Knowledge. In: *2021 IEEE 15th International Conference on Application of Information and Communication Technologies (AICT)* (1-6). IEEE. https://doi.org/10.1109/AICT52784.2021.9620240

Oliveira, B. X., Pereira, F. C. M., & Fialho, W. A. (2023). Digital transformation: proposed theoretical-analytical model for value generation. *International Journal of Innovation - IJI*, *11*(2), e23451. https://doi.org/10.5585/2023.23451

Onesi-Ozigagun, O., Ololade, Y. J., Eyo-Udo, N. L., & Ogundipe, D. O. (2024). Leading digital transformation in non-digital sectors: a strategic review. *International Journal of Management & Entrepreneurship Research*, 6(4), 1157-1175.

Pacto Alegre Oficial, (2021). "*O poder das parcerias e o papel da coreografia em ecossistemas"* [Vídeo]. Youtube. https://youtu.be/P7b0eKFX9l8

Projetos | Pacto Alegre. (n.d). Página inicial - Pacto Alegre. https://pactoalegre.poa.br/projetos

Ranking de Competitividade dos Estados. (2024). Ranking de Competitividade dos Estados. https://www.rankingdecompetitividade.org.br/sul/rs/ranking-geral/nota-do-pilar?year=2024

Reuschl, A.J., Deist, M.K. & Maalaoui, A. (2022). Digital transformation during a pandemic: Stretching the organizational elasticity. *Journal of Business Research*, 144, pp.1320-1332. https://doi.org/10.1016/j.jbusres.2022.01.088

Roundy, P.T., Bradshaw, M. & Brockman, B.K. (2018). The emergence of entrepreneurial ecosystems: A complex adaptive systems approach. *Journal of Business Research*, *86*, 1-10. https://doi.org/10.1016/j.jbusres.2018.01.032

Saarikko, T., Westergren, U.H. & Blomquist, T. (2020). Digital transformation: Five recommendations for the digitally conscious firm. *Business Horizons*, *63*(6), 825-839. https://doi.org/10.1016/j.bushor.2020.07.005

Santos, D. A. G., Zen, A. & Bittencourt, B.A. (2021). From governance to choreography: coordination of innovation ecosystems. *Innovation & Management Review*, 19(1), 26-38. https://doi.org/10.1108/INMR-08-2020-0117

Santos, C. A. F., & Zen, A. C. (2022). Value creation and capture in innovation ecosystems.

International Journal of Innovation - IJI, São Paulo, *10*(Special issue), 483-503. https://doi.org/10.5585/iji.v10i3.21470

Scaringella, L. & Radziwon, A. (2018). Innovation, entrepreneurial, knowledge, and business ecosystems: Old wine in new bottles?, *Technological Forecasting and Social Change*, 136, 59-87. https://doi.org/10.1016/j.techfore.2017.09.023

Siachou, E., Vrontis, D., & Trichina, E. (2021). Can traditional organizations be digitally transformed by themselves? The moderating role of absorptive capacity and strategic interdependence. *Journal of Business Research*, *124*, 408-421. https://doi.org/10.1016/j.jbusres.2020.11.011

Silva, L. H. A., Júnior, J. L. A., & de Oliveira Winckler, J. (2023). Criando e Inovando no 4º Distrito: contribuição das subjetividades empreendedoras em Porto Alegre. In Soares, M. L. (Org.). *Teias Urbanas: Estratégias de Sobrevivência, Transformação e Inovação*. Campina Grande: Editora Licuri, 57-83.

Skare, M., de Obesso, M. D. L. M., & Ribeiro-Navarrete, S. (2023). Digital transformation and European small and medium enterprises (SMEs): A comparative study using digital economy and society index data. *International Journal of Information Management*, *68*, 102594. https://doi.org/10.1016/j.ijinfomgt.2022.102594

Sorri, K., Yrjönkoski, K., & Seppänen, M. (2024). Smart cities, smarter values: Unpacking the

ecosystem of urban innovation. *Technology in Society*, *77*, 102499. https://doi.org/10.1016/j.techsoc.2024.102499

Stjepić, A. M., Ivančić, L., & Vugec, D. S. (2020). Mastering digital transformation through business process management: Investigating alignments, goals, orchestration, and roles. *Journal of entrepreneurship, management and innovation*, *16*(1), 41-74. https://doi.org/10.7341/20201612

Suominen, A., Seppänen, M., & Dedehayir, O. (2019). A bibliometric review on innovation systems and ecosystems: a research agenda. *European Journal of Innovation Management*. 22(2), 335-360. https://doi.org/10.1108/EJIM-12-2017-0188

Thomas, E., Faccin, K., & Asheim, B. T. (2021). Universities as orchestrators of the development of regional innovation ecosystems in emerging economies. *Growth and change*, *52*(2), 770-789. https://doi.org/10.1111/grow.12442

Valkokari, K., Hemilä, J., & Kääriäinen, J. (2022). Digital transformation- Cocreating a platform-based business within an innovation ecosystem. *International Journal of Innovation Management*, *26*(03), 2240016. https://doi.org/10.1142/S1363919622400163

Verhoef, P. C., Broekhuizen, T., Bart, Y., Bhattacharya, A., Dong, J. Q., Fabian, N., & Haenlein, M. (2021). Digital transformation: A multidisciplinary reflection and research agenda. *Journal of Business Research*, *122*, 889-901.

https://doi.org/10.1016/j.jbusres.2019.09.022

Xiong, D., Khaddage-Soboh, N., Umar, M., Safi, A., & Norena-Chavez, D. (2024). Redefining entrepreneurship in the digital age: exploring the impact of technology and collaboration on ventures. *International Entrepreneurship and Management Journal*, 1-27. https://doi.org/10.1007/s11365-024-00996-0

Yang, W., Liu, J., Li, L., Zhou, Q., & Ji, L. (2021). How could policies facilitate digital transformation of innovation ecosystem: A multiagent model. *Complexity*, 2021. https://doi.org/10.1155/2021/8835067

Zahra, S. A., Liu, W., & Si, S. (2023). How digital technology promotes entrepreneurship in ecosystems. *Technovation*, *119*, 102457. https://doi.org/10.1016/j.technovation.2022.102457

Zen, A. C., Santos, C. A. F. D., Santos, D. A. G. D., da Rosa, J. R., & Spindler, E. D. S. (2024). Exploring the theoretical foundations of innovation ecosystems between 2006 and 2020: an analysis at the different approaches. *International Journal of Innovation Science.* *16*(3), 550-571. https://doi.org/10.1108/IJIS-11-2022-0223

Zhang, J., & Chen, Z. (2024). Exploring human resource management digital transformation in the digital age. *Journal of the Knowledge Economy*, *15*(1), 1482-1498. https://doi.org/10.1007/s13132-023-01214-y