

From academia to industry: How PhDs contribute to knowledge and innovation in low-technology industrial districts

De la academia a la industria: cómo los doctores contribuyen al conocimiento y a la innovación en distritos industriales de baja intensidad tecnológica

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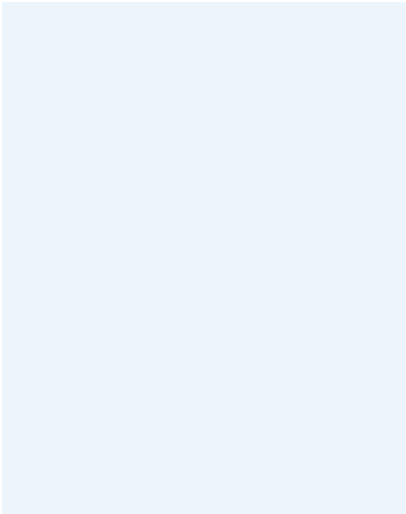
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Abstract: This study examines how PhD holders contribute to knowledge creation, innovation processes, and territorial development within low-tech industrial districts. While prior research has predominantly focused on high-tech and research-intensive environments, this paper investigates a Valencian traditional textile district characterised by low- and medium-technology firms. Drawing on 24 semi-structured interviews with PhD holders and business managers, the study adopts an interpretive qualitative approach to analyse how both groups perceive doctoral expertise in non-academic settings. The findings reveal contrasting narratives. Some PhD holders experience persistent research–practice gap and difficulties translating academic skills into firm-level impact, while others act as embedded change agents who leverage local networks to foster collaboration and problem-solving. Similarly, employers' perceptions range from scepticism regarding the relevance of doctoral training to recognition of its transformative potential in innovation and sustainability challenges. The study demonstrates that PhD holders can enhance the innovation capacity of low-tech territories when mutual trust, contextual adaptation, and institutional support mechanisms are strengthened. These findings contribute to debates on doctoral employability, knowledge transfer, and regional development by extending the analysis of PhD impact beyond high-technology contexts.

Keywords: PhD holders · Low-tech industries · Knowledge transfer · Industrial districts · Qualitative research · Spain.

Resumen: Este estudio analiza cómo los doctores contribuyen a la creación de conocimiento, a los procesos de innovación y al desarrollo territorial en distritos industriales especializados en sectores de baja intensidad tecnológica. Mientras que la investigación previa se ha centrado predominantemente en entornos de alta tecnología e intensivos en I+D, este trabajo analiza un distrito textil tradicional en la Comunidad Valenciana (España), caracterizado por la presencia mayoritaria de empresas pertenecientes a sectores de baja y media intensidad tecnológica. A partir de 24 entrevistas semiestructuradas realizadas a doctores y directivos empresariales,



el estudio adopta un enfoque cualitativo interpretativo para analizar cómo ambos colectivos perciben la aportación de los doctores en contextos no académicos. Los resultados revelan narrativas contrapuestas. Algunos doctores experimentan una persistente brecha entre investigación y práctica y dificultades para traducir sus competencias académicas en impacto a nivel empresarial, mientras que otros actúan como agentes de cambio integrados que aprovechan las redes locales para fomentar la colaboración y la resolución de problemas. Del mismo modo, las percepciones de los empleadores oscilan entre el escepticismo respecto a la relevancia de la formación doctoral y el reconocimiento de su potencial transformador ante los retos de innovación y sostenibilidad. El estudio demuestra que los doctores pueden reforzar la capacidad innovadora de los territorios de baja intensidad tecnológica cuando se fortalecen la confianza mutua, la adaptación contextual y los mecanismos de apoyo institucional. Estos hallazgos contribuyen a los debates sobre empleabilidad doctoral, transferencia de conocimiento y desarrollo regional al ampliar el análisis del impacto de los doctores más allá de los contextos de alta tecnología.

Palabras clave: doctores · Industrias de baja tecnología · Transferencia de conocimiento · Distritos industriales · Investigación cualitativa · España.

1. Introduction

For PhD holders, the academic job market has grown more competitive (Larson et al., 2014). Increasingly, they are not working formally as academics at higher education institutions (Cyranoski et al., 2011), but rather at other organisations (Pablo-Hernando, 2022). While policies on educating PhD holders often emphasise their role for national prosperity, the majority of PhD holders find their positions in those new research-based (but non-academic) organisations (Powell, 2015), which do not have policies or a tradition of employing PhD holders.

Several factors help explain why not all PhD holders enter academia. Structural issues as limitations in public spending may be a significant issue (Martin & Etzkowitz, 2001), but individual expectations and career aspirations also play an important role (Kuoppakangas et al., 2021). Some authors argue that the oversupply of PhD graduates exceeds the demand for faculty positions, leading to fierce competition for limited academic openings (Cyranoski et al., 2011). Additionally, the restructuring of higher education, with an emphasis on cost-cutting measures and the prioritisation of research funding over faculty salaries, further diminishes the opportunities for PhD holders seeking stable academic employment (Enders, 2004). Consequently, instead of working formally as academics at higher education institutions, they are increasingly finding jobs at other knowledge organisations, such as consultancy firms, technology institutes, among others, which presents more challenges in tracking their career paths (Herrera & Nieto, 2016). The role of PhD holders outside of academia is easily lost, despite their growing presence in the workforce (Aanerud et al., 2007; Pedersen, 2015). Recent research confirms that these non-academic career challenges persist into 2025, particularly regarding skill adaptation and employability tracking (Boman et al., 2025). Moreover, the contribution of PhD holders to non-academic environments has been mainly studied in contexts with a prevalence of high-tech firms, as in the studies by Germain-Alamartine et al. (2021) on Norway, Sweden and the United Kingdom, by Hoshino (2023) on Japan, or by Sekuler et al. (2013) on Canada. In terms of geographical scope, examples of such research focusing on high-tech environments have used several levels of analysis, from a local perspective as found in Canolle (2021) in Lyon, to a national perspective as seen in the studies by Aarnikoivu et al. (2019) and Haapakorpi (2017) in Finland.

Therefore, this paper addresses the gap in understanding of how (and why) PhD holders contribute to their (mostly low-tech) contexts, despite being indirect outputs of what universities offer in response to societal needs (Benneworth *et al.*, 2009). Our premise is that without understanding the types of contributions PhD holders make to society and the applicability of PhD education to societal and industrial needs, new initiatives of research and innovation policies aiming at strengthening the knowledge economies are harder to implement (Lundvall, 2023). This premise aligns with those authors who argue that doctoral studies serve as crucial benchmarks for both a knowledge-driven society and economy (Auriol, 2010; De Meyer, 2013; Gokhberg *et al.*, 2016; Plöger, 2020; Roy *et al.*, 2025). PhD holders, as the most proficient researchers, are exceptionally equipped to generate, utilise and disseminate knowledge (McAlpine & Amundsen, 2009).

This article therefore poses the following research question: How do PhD holders perceive their contributions to the territorial challenges in environments with less presence of high-tech firms? The paper is structured as follows: Section 2 examines the related literature on PhD holders' value outside academia and describes the research context. Section 3 explains how data was gathered and analysed. Section 4 presents the empirical analysis of the study. Finally, Section 5 discusses the final considerations and its implications for different audiences.

2. Background

While most advanced countries have been evolving towards knowledge-based economies (Vence-Deza & González-López, 2008), it has been increasingly crucial to put into practice for regions their competence to generate, use, diffuse and absorb new knowledge for economic success and societal development (Crespo & Vicente, 2016). Since conventional wisdom has assumed that the so-called high-tech industries, research-intensive and science-based industries were the key drivers of future economic prosperity (Coad & Rao, 2008), other authors have also recently shown a more critical view (Bagattolli & Brandão, 2021). Where those industries were seen as the main source of highly sophisticated and complex products, they received support and promotion easily by governments at policy circles (Bronzini & Piselli, 2016). Hence, high-cost industrialised countries were claimed to concentrate their efforts on promoting these industries (European Commission, 2006). However, It is essential not only to recognize that industries labelled as low- and medium-tech (LMT, hereafter) are the most prevalent among various sectors, for instance, in Europe (Kirner *et al.*, 2009), but also the interrelations between high- and low-tech firms for innovation processes (Hansen & Winther, 2011).

“According to OECD¹ categories, the industrial sectors can be classified as follows: High-technology sectors (*high-tech*) with a R&D intensity or more than 5% [of the turnover], sectors with complex technology (*medium-high-tech*) with a R&D intensity between 3% and 5%. Industries which are not research-intensive (*medium-low-tech* and *low-tech*) have a R&D intensity below 3 percent” (Hirsch-Kreinsen, 2008, p. 11).

This disputed perspective on the definition of innovation contrasts somewhat with the influential works in innovation studies from the 1980s onwards (Godin, 2006). Until very recently, the majority of research on innovation studies has concentrated on successful environments, such as Oxford (Lawton Smith, 2003), Cambridge (Cooke, 2018a), or Silicon Valley (Engel, 2015; Saxenian, 1991). However, a more critical stream of research has turned this hegemonic view towards an alternative perspective (Godin & Vinck, 2017), where innovation depends also on low-tech industries (Hirsch-Kreinsen, 2008). During the 2000s, a European research project on the innovativeness of industrial low-tech sectors (Hirsch-Kreinsen *et al.*, 2006, p. 4) concluded that

“The performance of LMT sectors is severely misrepresented by most current indicators and that they contribute very significantly to innovation and growth in advanced economies. LMT firms often face special problems, however, and their efficiency could be further improved through the implementation of appropriately targeted policies.”

¹ OECD stands for the Organisation for Economic Co-operation and Development.

Therefore, a re-examination of these LMT industries would further enhance their value in terms of employment, the role of integration in local and regional economies during an increasingly important period of globalisation, and the symbiotic relationships between LMT and high-tech sectors (Reguera-Alvarado & Bravo, 2018).

Contexts with a pre-eminence of high-tech firms are supposedly more likely to show better performances in terms of science-based innovative products (Hartog et al., 2012). Firms that operate in these contexts are commonly assumed to employ PhD holders, contributing to the culture and socio-economic performance of firms with their research skills (Marini, 2022). On the other hand, low-tech firms are characterised by using other sources for innovating rather than scientific knowledge: providers/clients exchange of information, machinery acquisition, marketing strategies, new raw materials, new markets, among others (Lundvall et al., 2002). Therefore, it seems plausible that the readiness to employ PhD holders is not as evident in firms that belong to low-tech environments as in those in high-tech environments (Pham, 2023). However, there are still few documented cases that encourage further study of low-tech context in greater detail (Pedersen, 2016). Therefore, the knowledge base of companies in low-tech contexts should be investigated taking into account their 'accumulated internal knowledge' (Hirsch-Kreinsen et al., 2006, p. 11), since they are more combiners of existing codified knowledge with practical knowledge, rather than merely basic innovators. This has implications for the organisational learning practices as they are more centred on benchmarking that in turn puts a stress on observing, obtaining information, analysing and transforming technologies from other contexts (Kyvik & Olsen, 2012). This is the case in the study conducted by Boschma and ter Wal (2007) where the authors emphasised the importance of building networks to facilitate knowledge transfer and highlighted the role of non-local ties in enhancing overall business performance (Schmierl & Köhler, 2005). In the present study we aim to empirically study the value of PhD holders within an industrial district where most of its industrial landscape is characterised by low-tech firms specialised in the textile industry. We choose this industry for three main reasons. First, the textile industry represents a traditional industry, with a prevalence of low-tech firms, which has undergone dramatic changes over the last thirty years (Lazzeretti & Capone, 2017). Second, the textile industry is located in industrial districts which can be also considered organisational models where competition and cooperation co-exist (Camarena-Gil et al., 2020). Third, the textile sector is the second most polluting industry in the world, which puts further pressure on stakeholders to address today's challenges, such as sustainability issues (de Oliveira Neto et al., 2021).

To address the current regional challenges, it is necessary to give a voice to the managers of both higher education and scientific research, since every post-industrial society needs highly qualified personnel in line with what a knowledge-based economy requires (McAlpine et al., 2021). This requirement becomes particularly acute in localised industrial districts, where one of their main characteristics is precisely the presence of specialised workers in a particular industry (Molina-Morales, 2001), further enhanced by geographical proximity to knowledge institutions such as universities that facilitate knowledge spillovers and talent retention (Molina-Morales et al., 2022). The fact of obtaining a doctorate degree has become increasingly important, given the current highly complex challenges of society, such as climate change (Su & Moaniba, 2017), the scarcity of mineral resources (Li et al., 2024), or the social inequalities between regions (Lee, 2011). Those PhD holders who have been accumulating skills and human capital throughout their training appear to be one of the key actors behind the creation of economic growth based on knowledge (Auriol, 2010).

2.1. Research context

The Valencian textile district represents a paradigmatic case of low-tech industrial specialisation, where incremental innovation through client-provider networks predominates over formal R&D. According to the Spanish Statistics Institute (INE), the textile industry accounted for 8% of industrial companies, 4% of industrial employment and 6% of Spanish industrial exports in 2022. This production is concentrated in geographical areas such as the textile industrial district of Spain's Valencia Region. This sectoral agglomeration of companies ranks third in the list of Spanish textile agglomerations, just behind Barcelona and Madrid. According to the Association of textile firms of the Valencia Region

(ATEVAL), the Valencian district comprises 1,456 textile companies, mainly SMEs, which carry out different activities within a significantly fragmented value chain. District firms employ 22,270 workers with a total turnover of 2,275 million euros, which represented 21% of the Spanish textile industry in 2022. The industrial district has a long tradition, which is reinforced by the existence of strong inter-organisational links and the presence of several institutions, such as four public universities, the ATEVAL Association or the Textile research institute (AITEEX) that support the technical, commercial and administrative processes of the companies (Belso-Martínez *et al.*, 2020). In recent years, technical textiles have become one of the priorities of the Spanish textile industry. According to AITEEX, around 40% of these firms in Spain are located in the Valencian industrial district. This context aligns perfectly with recent analyses documenting the Spanish textile industry's adaptation through circular economy practices and sustainable supply chain strategies (De Felice *et al.*, 2025).

Since Alfred Marshall's time, one of the three primary externalities that defined agglomeration economies in the literature on industrial districts has been the significance of having a pool of highly skilled labour (Boix & Galletto, 2009). However, the manner in which those highly skilled individuals interact and contribute to their respective contexts remains unexplored, even in comprehensive studies about how productive activity is organised in the textile industry (Puig & Marques, 2010). Up to this point, the hegemonic quantitative approach in cluster literature has not allowed to show the actual interactions between PhD holders in their clusters (Ortega-Colomer *et al.*, 2016). For instance, this seems to still be reflected in official reports about clusters, where the approach adopted is 'deliberately based on the measurement of the revealed effects of clusters' (European Commission, 2008) and assumes that 'the interactions [in and between clusters] are meaningful' despite differences in type and intensity. The common limitation of the cluster approach is that it neglects the quality of relationships between many heterogeneous actors with different motivations or logics (mainly based on science and market rewards). As a result, approaches that consider additional information on the interactions between actors are required (Calvo Palomares *et al.*, 2020).

3. Methods

3.1. Research approach and Design

This article explores a micro reality where PhD holders act as catalysts for change in industrial districts. By examining their diverse roles in addressing territorial challenges, we shed light on their potential impact, which may not be extraordinary, but rather normal (Sivertsen & Meijer, 2020).

To achieve this, we first adopt an inductive approach to explore the various perceptions held by PhD holders working in non-academic organisations. Subsequently, we enrich this perspective incorporating insights from business managers through interviews.

Employing an interpretive approach (Sandberg, 2000), this article draws from narratives collected from both PhD holders and their employers, providing insights into how they perceive their contributions to the local setting (Baker, 1997). Therefore, it is crucial to recognise the challenges in attaining a comprehensive understanding of the socio-economic and cultural contributions of PhD holders. These difficulties arise from their diverse expertise level, specific research domains, individual and social characteristics, and workplace environments (Auriol, 2010). This article further acknowledges the varied cultural contexts and disciplinary realities of PhD holders (Haapakorpi, 2017).

Moreover, it emphasises the importance of contextualising results by considering factors such as work responsibilities, organisational structures or socio-economic influences like the labour market, as proposed by as proposed by McAlpine and Inouye (2022, p. 1648). The research orientation of PhD holders is also pertinent, distinguishing between basic and

applied researchers and exploring their inclination towards using generated knowledge or advancing knowledge within their epistemic communities (Stokes, 1997).

3.2. Sampling Strategy and Participants

Data were collected from two groups of informants. First, we selected 12 PhD holders through personal contacts and university administrators. The sample covers a diverse range of disciplines, including Textile Engineering (n=4), Business Administration (n=3), and Fine Arts, Biology, Sociology, Geography and Mechanical Engineering (n=1 each). Table 1 summarises the key features of these interviewees.

Second, we selected 12 business managers from firms within the industrial district under study (Table 2).

Table 1: Key features of the interviewees: PhD holders

	Date of interview	Gender	PhD Research Area	Duration of Interview (min)	Pages of Transcription
PhD1	03 Sep 2018	Male	Textile Engineering	58	28
PhD2	06 Nov 2018	Female	Business Administration	67	33
PhD3	25 Feb 2019	Female	Fine Arts	65	31
PhD4	05 Mar 2019	Male	Biology	55	26
PhD5	09 Apr 2019	Female	Sociology	62	30
PhD6	16 Apr 2019	Female	Business Administration	60	29
PhD7	19 Apr 2019	Male	Geography	70	34
PhD8	12 Feb 2020	Female	Textile Engineering	53	24
PhD9	21 Feb 2020	Male	Mechanical Engineering	64	32
PhD10	10 Sep 2020	Female	Business Administration	57	27
PhD11	24 Sep 2020	Male	Textile Engineering	50	22
PhD12	13 Oct 2020	Female	Textile Engineering	59	28

Table 2: Key features of the interviewees: Business managers

Business managers	Date	Gender	Industry (NACE Rev.2)	Size (Employees in 2018)	Experience in the Sector (years)	Duration (minutes)
BM1	04 Sep 2018	Male	C13. Manufacture of textiles	98	>20	39
BM2	07 Nov 2018	Male	C13.3. Finishing of textiles	72	>20	35
BM3	19 Feb 2019	Male	C13. Manufacture of textiles	67	>20	126
BM4	07 Mar 2019	Male	C14. Manufacture of wearing apparel	44	>10	84
BM5	15 Apr 2019	Male	C13.9. Other textiles	154	>20	86
BM6	16 Apr 2019	Male	C13. Manufacture of textiles	36	>10	75
BM7	18 Apr 2019	Male	C13 & C14 (Textiles & Apparel)	42	>20	36
BM8	13 Feb 2020	Male	C13. Manufacture of textiles	152	>20	57
BM9	03 Mar 2020	Male	C13 & C14 (Textiles & Apparel)	16	>10	54
BM10	13 Oct 2020	Male	M71. Architecture & Engineering	253	>10	101
BM11	21 Oct 2020	Female	C13.9 & M72 (Textiles & R&D)	123	>20	38
BM12	1 Nov 2020	Female	C13.9. Other textiles	32	>10	47

3.3. Data Collection Procedures

All interviews were semi-structured. Questions for PhD holders were divided into three sections: before, during, and after obtaining the PhD. For business managers, questions were divided into four sections: context, innovative sources for firms, internal analysis, and perceptions of PhD holders (see [Appendix 1](#)). The interview guide was developed based on a review of the literature, focusing on gaps relevant to low-tech environments, and adapted for each participant's context. Appointments were arranged via phone or email, with interviews lasting 30 minutes to 2.5 hours, conducted either face-to-face or via video conference.

3.4. Data Analysis Procedures

All transcripts were imported into Excel and analysed using an iterative coding process. Open coding identified meaningful segments related to PhD holders' roles, skills, contributions, and territorial challenges. Codes were then grouped into categories (e.g., perceived impact, skill mismatch vs. untapped potential, business priorities and practical constraints...) and integrated into higher-order themes. [Table 3](#) presents the data structure linking quotes to codes, categories, and themes, and thereby making explicit how empirical evidence informed the analytical interpretations reported in Section 4.

Table 3: Data structure: From empirical evidence to themes

Theme	Category	Code	Example of illustrative quote
Contrasting narratives on PhD contribution	Perceived impact	Optimistic orientation	"As an engaged scholar, I have dedicated significant efforts to disseminate my scientific findings in various non-academic forums... This proactive approach allowed me to bridge the gap between research and industry." (PhD10)
		Sceptical orientation	"While I was hired to improve their circular economy system, I soon realised that achieving such goals was an illusion in this context." (PhD3)
Research–practice gap	Skill mismatch	Research–practice gap	"My research results were sufficient to obtain a doctoral degree but insufficient to secure employment within academic institutions." (PhD1)
	Untapped potential	Underutilisation of scientific skills	"I haven't had the chance to showcase my scientific findings outside of university forums." (PhD1)
Organisational constraints in low-tech firms	Business priorities	Limited relevance of PhD profiles	"Since our goal is to grow our business rather than explain phenomena, a PhD has limited room to manoeuvre here." (BM6)
	Practical constraints	Hands-on expertise over analytical skills	"Our industry operates under specific constraints and demands practical, hands-on expertise rather than academic qualifications." (BM1)
Embeddedness and networks	Local embeddedness	Network-embedded research	"My supervisor's connections with non-academic organisations helped align my PhD topic with local needs." (PhD10)
Agency and implementation barriers	Structural constraints	Agency constraints	"While we proposed environmentally friendly solutions, political and industrial interests prevented their implementation." (PhD5)
Collaboration potential	Industry–academia interaction	Collaborative learning	"Participating in research programs with universities fuels a culture of innovation within our firm." (BM12)

In the coding process, we followed three systematic phases: (1) open coding, where all transcripts were examined line-by-line to identify meaningful segments; (2) axial coding, in which initial codes were compared, refined, and grouped into higher-order categories based on conceptual similarity; and (3) selective coding, where categories were integrated into the core interpretive themes presented in Section 4. As coding was carried out by a single researcher, no intercoder disagreements occurred. Consistency was ensured through reflexive analytical memos written during the coding process, in which emerging interpretations, coding decisions, and potential biases were systematically documented. After transcription and coding, we interpreted the narratives around PhD holders' roles in low-tech, non-academic organisations, describing their contributions in a largely understudied context (Heidenreich, 2009).

The analytical conclusions reported in Sections 4 and 5 derive directly from the data structure presented in Table 3. This table makes explicit the progression from illustrative quotations to first-order codes, second-order categories and overarching themes, ensuring a transparent and traceable link between the empirical material and the interpretive claims developed later in the manuscript.

3.5. Ensuring Trustworthiness

Our analysis follows an interpretivist approach (Porta & Keating, 2008; Sandberg, 2000), focusing on meanings rather than decontextualising events (Cooke, 2018b). Given limited prior evidence, we adopted an inductive case-study method (Hayter & Parker, 2019), interviewing 24 key informants: 12 PhD holders and 12 business managers, to explore both perspectives. This allowed us to explore both perspectives: PhD holders' perceptions of their role in addressing territorial challenges, and business managers' assessments of their contributions.

In line with the procedures of other interpretive studies (Bonache & Zárraga-Oberty, 2020), our analysis is divided into three different phases, following the recommendations by Sandberg (2000): (1) comprehensive review of transcripts to understand participants' experiences; (2) immersion in the data, comparing initial literature-based insights with participants' perspectives; (3) synthesis of findings, distinguishing optimistic and pessimistic perceptions and identifying key themes not found in the literature.

To ensure rigor, we followed widely accepted criteria for trustworthiness: credibility, transferability, and dependability. Credibility was enhanced through prolonged engagement, triangulation of informants, iterative coding, and constant comparison. Transferability was addressed by providing detailed descriptions of the industrial district and organisational contexts, while dependability was supported through reflexive memoing.

3.6. Ethical Considerations

All participants provided informed consent, were briefed on the study's aims and voluntary nature, and anonymised data were used for reporting, with pseudonyms (PhD1–12, BM1–12). To strengthen confirmability, we engaged in reflexive practice, explicitly interrogating our assumptions about PhD employability and territorial dynamics, and revisiting these notes at key analytical milestones to minimise interpretive bias.

4. Findings

The presence of PhD holders in the industrial district under study has been relatively recent. Until 1991, the higher education institution located in the area of influence, the Alcoy Campus of the Universitat Politècnica de València, did not offer doctoral courses. After 1991, the campus of Alcoy added a PhD course to its doctoral programme offered by the Textile

and Paper Engineering Department. Since then, a process of training PhD holders began uninterruptedly and increasingly (Ortega-Colomer, 2013).

Our analysis starts by paying attention to how PhD holders perceive their function as a worker in a non-academic organisation within the industrial district. The perceptions of employers are therefore also looked at to complement the other side of the coin. Our discussion of the intricate interaction between the two figures—PhD holders and employers—considers the industrial district conditions at the local level as well as the potential effects of global events once we have separately analysed both viewpoints. Finally, we explore varied perspectives on the significance of PhD holders within the context of an industrial district, considering not only their viewpoint but also that of their employers.

4.1. Emergence of contrasting narratives

During the second and third phases of analysis, we identified systematic differences in how PhD holders evaluated their potential contribution to low-tech firms and territorial challenges. These differences emerged across multiple codes related to ‘local embeddedness’, ‘perceived impact’, ‘structural constraints’, and ‘career satisfaction’.

Based on the dominant orientation of their narratives across these codes, we classified the 12 PhD holders into two interpretive groups:

- Optimistic group (7 PhD holders, ~60%): those articulating predominantly positive views of their current or potential contribution
- Sceptical group (5 PhD holders, ~40%): those emphasizing structural limitations and questioning impact feasibility.

Participants were assigned to one group when at least two-thirds of their coded segments across the “perceived impact”, “local embeddedness”, “research–practice gap”, and “agency constraints” codes consistently reflected either an optimistic or a sceptical orientation. Borderline cases were revisited to ensure that classification captured a stable narrative pattern rather than isolated statements.

This classification was data-driven rather than imposed a priori, reflecting the convergence of coded segments from individual interviews rather than quantitative counting.

4.2. How do PhD holders perceive their own role?

Through interviews with PhD graduates, it has become apparent that not all individuals with doctorates employed in low-tech companies possess a comprehensive understanding of how to apply their skills in non-academic settings. Consequently, the interviews placed particular emphasis on discerning their perceptions regarding the recognition and assimilation of their experiences (Carregal-Castro *et al.*, 2018).

Additionally, from the managerial perspective, our observations indicate that some managers frequently overlook the potential value that employees with doctorates could bring, potentially perpetuating a detrimental cycle. While this viewpoint was not expressed by all interviewees, we consider it a noteworthy barrier to the effective integration of PhDs into non-academic organisations within this industrial context. Moreover, it has been observed that the prevailing political and social context does not consistently value scientific knowledge. This occasional lack of recognition may lead PhD holders to perceive themselves as outsiders and pioneers in this unconventional situation. Consequently, a paradox persists, defined by the presence of “contradictory yet interrelated elements that exist simultaneously and persist over time” (Smith & Lewis, 2011, p. 382).

This is exemplified by the widely recognized advocacy for a circular economy in both political and industrial spheres. The provided quote exemplifies the viewpoint of individuals who experienced the specific scenario in question during the interviews:

Code realism vs expectations: “I was purportedly brought on board to enhance their circular economy system. Right from the outset, I cautioned them that achieving this goal was an illusion. I emphasized that by delving into more accurate information, they would recognize that their best achievable outcome is more akin to a spiral economy. In this approach, they strive to progress toward the envisioned ideal of a circular economy. Nevertheless, I often find myself holding back my reservations, participating in industrial events, and feigning expertise in circular economy.” (PhD3)

Among the interviewed PhD holders, 40% held a sceptical view of their potential contribution to the industrial district's community, whereas the remaining 60% expressed a more optimistic attitude towards the transformation of their socioeconomic context based on their capabilities. For this reason, we find it convenient to present the two opposing views provided by the PhD holders through the interviews separately.

4.2.1. Group 1: The sceptical PhD holders

Considering the themes included in the interview script (see [Appendix 1](#)) and our analysis of the first group's responses, we can state that the sceptical PhD holders can be distinguished, in the first place, by having lived abroad and having encountered a wide range of living and working circumstances. More than half of the interviewed PhD holders were supervised by relevant academics in their field which allowed them to become autonomous in terms of several crucial decisions, such as the choice of the topic for their PhD thesis, the exploration of new research methods, and the connection of their findings with the ongoing academic debates in their field. It is noticeable their perception on the research-practice gap, which they remarked as huge. While the results of their research were sufficient to obtain a doctoral degree, they were insufficient to obtain employment in an academic organisation. They were not highly valued by employers in their immediate area, but this was outweighed by their advanced problem-solving abilities or even just the fact that their PhD was the primary factor for being hired. An example of this is provided by PhD1:

Code research-practice gap: “I characterize myself as an individual who, with the guidance of pertinent academics, achieved independence in crucial decision-making for my research, encompassing the selection of my PhD thesis topic, exploration of innovative research methods, and active participation in ongoing academic debates within my field. I recognize a substantial gap between research and practice, where my research results met the criteria for obtaining a doctoral degree but fell short in securing employment within academic institutions.” (PhD1)

They had great expectations of obtaining a position at the university or in some organisation at an R&D department. Hence, their efforts to communicate their scientific findings in non-academic forums were virtually symbolic.

Code untapped potential: “While I haven't had the chance to showcase my scientific findings outside of university forums, I believe it would present a valuable opportunity to enhance the legitimacy of my work.” (PhD1)

4.2.2. Group 2: The optimistic PhD holders

The second group of PhD holders is characterised by having mostly resided in their hometown within the industrial district, while also having had brief stays abroad. All of them were supervised by academics affiliated with Valencian universities who had connections with non-academic organisations. This allowed them to have an overall view of the social, cultural, and economic needs of the employers. Hence, the choice of their PhD topic was very closely aligned with the local needs and debates, which somewhat reduced the research-practice gap. They found this gap to be less significant than the former group of PhD holders (who were *sceptical*). The results of their research were sufficient to obtain a doctoral degree, and they were unable to secure employment in an academic organisation. However, they easily found a job through their already established connections (via their supervisor or collaborators during their PhD studies). PhD10 offers an illustration of this:

Code network-embedded research: “As someone who holds a PhD guided by academics associated with Valencian universities, I benefited from their networks in non-academic sectors, providing me with a thorough grasp of employers’ social, cultural, and economic needs. This led to a closely aligned choice of my PhD topic with local needs and debates, resulting in a reduced research-practice gap compared to the more sceptical PhD holders. While my research outcomes met the requirements for a doctoral degree, obtaining academic employment posed challenges. Fortunately, tapping into the connections forged with my supervisor and collaborators during my PhD studies facilitated a seamless transition into a non-academic career.” (PhD10)

They demonstrate excellent problem-solving abilities and were highly motivated to apply their knowledge to the local context. Consequently, they relinquished their initial ambition to become academics and sought recognition within the organisation, often within departments with significant responsibilities (primarily in R&D or quality departments). By dedicating considerable efforts to communicating their scientific findings in non-academic forums such as newspapers, talks or conferences, they were able to establish valuable connections with key actors in the main industrial district. PhD10 exemplifies this:

Code science communication: “As an engaged scholar, I have dedicated significant efforts to disseminate my scientific findings in various non-academic forums, including newspapers, talks, and conferences. This proactive approach not only enhanced the visibility of my research but also forged valuable connections with key actors in the main industrial district. Through effective communication beyond traditional academic channels, I have been able to bridge the gap between research and industry, fostering collaboration and mutual understanding.” (PhD10)

4.3. How do employers perceive the role of PhD holders?

After presenting the perceptions of PhD holders in low-tech sectors, in this subsection we will illustrate the perceptions expressed by managers or employers to gain a better understanding of the value of PhD holders in industrial districts. In this regard, we identified two main groups of managers: firstly, those who were sceptical about the potential role of PhD holders in the industrial district context (more than 80% of them); and secondly, only two managers showed a more optimistic view, representing less than 20% of the total business managers interviewed.

4.3.1. Group 3: The sceptical employers

At the industry level, textile companies typically import machinery as a means of innovation rather than incorporating highly skilled workers. Such workers could develop solutions better suited to the firm. However, in many companies, scientific knowledge, often with an analytical knowledge base, cannot be absorbed by low-skilled workers. This implies that the dependence on this imported machinery has been restricting other alternative ways for an endogenous-like development of the industrial district to compete in the global marketplace. This was brought up in almost every interview, and it appears to be the main issue found within these territorial contexts. An instance of this is demonstrated not only by BM3 and BM6 but also by PhD2:

Code skill mismatch: “In my industry (textile), the integration of doctors into the work teams is challenging. Since these are industries where technical skills are highly appreciated and not as much analytical ones, there is a limited acceptance of highly qualified profiles.” (BM3)

Code business priorities: “Since our goal is to grow our business rather than find explanations for phenomena, a doctor has limited leeway to manoeuvre in this environment.” (BM6)

Code PhD irrelevance: “I think this is a problem that affects a lot of people in Spain since, in the world of private companies, having a PhD is irrelevant because it doesn’t add much to the abilities that the company needs in its administrators.” (PhD2)

In this regard, it can be quite challenging to convince managers of small- to medium-sized family firms of the importance of internally generated, truly innovative products or processes. As a result, managers of those SMEs continue to have a sceptical perspective on the value that a PhD holder can bring to those companies. These organisations have moreover historically contracted out R&D activities to the AITEX, which has been in operation since 1985 offering cutting-edge services to its customers.

Code practical constraints: “While the academic prowess of PhD holders is undeniable, our industry operates under specific constraints and demands practical, hands-on expertise. Hiring a PhD holder comes with its own set of challenges, including adapting to the fast-paced environment and the established routines within our organisation. We need solutions that align with our industry realities and constraints, not just academic qualifications.” (BM1)

4.3.2. Group 4: The optimistic employers

Among the interviewed employers, we found only two informants whose perspective on hiring PhD holders was slightly optimistic. Both were women, with international academic backgrounds and life experiences in foreign countries. Despite their firm being part of LMT industries (textile), they displayed a strong drive to promote innovation processes within their respective organisations. For instance, both expressed a desire to actively participate in research programmes in collaboration with universities and other innovation supporting agents, like ATEVAL or AITEX. In this context, we present their assertion as follows:

Code industry-academia collaboration: “As a business manager, I firmly believe in the transformative power of collaboration between industries and academia. Actively participating in research programs with universities and knowledge organisations not only propels our company forward but also fuels a culture of innovation.” (BM11)

Code collaborative learning: “In my role as a manager in the business realm, my commitment to actively engaging in research programs with universities and knowledge organisations stems from the recognition of the invaluable learning processes that arise from such collaborations within the textile industry. These partnerships not only drive our company’s progress but also foster additional avenues of learning, contributing to the continuous evolution and advancement of our industry.” (BM12)

In this context, we have identified two instances where individuals, despite holding managerial positions in small or medium-sized family enterprises, exhibit a positive attitude towards incorporating individuals with doctoral qualifications into their workforce. Consequently, they are actively seeking opportunities to enhance their product portfolio by engaging with other local stakeholders within the innovation system.

4.4. An analysis of matches or mismatches between PhD holders and their employers

All the issues raised above need to be considered from both the employers’ and PhD holders’ points of view. In that regard, a conciliation is necessary when there is a stark contrast in the perception of the two collectives.

Another theme discussed in the fieldwork conducted was referred to the creation of more sustainable regions. After several decades of widespread criticism of industrialisation’s shortcomings, we are still waiting for political decisions that limit the action of several industrial sectors. These sectors are, in fact, the biggest contributors to atmospheric pollution. Thus, the role of the PhD holder, as a reflexive agent and an evidence-based decision-maker, can get feasible answers

to the main problems of society, though they are not always popular. Those problems are, indeed, reflected within the European Programme “Horizon 2020” as six axes to be tackled, and recently within the European Green Deal (European Commission, 2019). Here, the conflict may again seem to be the existing vested interests among hegemonic actors that were created by the former generations.

Code transformative potential: “I believe that hiring PhD holders could be a transformative step for us. Their fresh perspectives and research-based insights may just be the catalyst we need to navigate the conflicts rooted in existing vested interests among hegemonic actors, which were established by former generations. Embracing the knowledge and innovative thinking of PhD holders can pave the way for a more inclusive and forward-thinking workplace.” (BM8)

From PhD holders’ side, the main insight and lesson to put into practice, according to the interviews, is to encourage them to be more active in the public life of the industrial district, instead of remaining confined within academic boundaries, that their status of scientist is providing. The more a consensus can be reached and the more a joint plan can be drawn, the better regional political landscape we will witness in the coming years.

The main problem found was that such an infrastructure, the Technology Park, was planned to be built on a reservoir of an aquifer. While PhD holders were searching for environmental-friendly solutions, politicians and some industrialists were focusing only on other vested economic interests. So, the public interest was out of place. Meanwhile, the promise of creating jobs and bring prosperity to the region was spread with a misguiding message to the population of that textile area. Hence, this is an example where PhD holders can contribute with their rigorous knowledge to tackle sensitive regional problems. However, the barriers to implement and use this scientific knowledge come from a problem of agency, as PhD5 affirmed:

Code agency constraints: “In the midst of it all, we stumbled upon a major concern: the idea of building the Technology Park right on top of a vital aquifer reservoir. It was disheartening to see us, PhD holders, passionately striving for eco-friendly solutions, only to discover that some politicians and industrial bigwigs were more focused on their own financial gains, overlooking the well-being of the public. They spun a narrative of job creation and prosperity for our region, but it was clear that the message was misleading our fellow residents in the textile area. This situation vividly showcases how our knowledge as PhD holders can be a game-changer in tackling crucial local issues. Yet, the real hurdle lies in putting that scientific wisdom into action – a challenge rooted in matters of agency.” (PhD5)

The role of higher education institutions has been crucial since the inception of the Industrial Revolution (Ortega-Colomer, 2013). In the textile area studied, four public higher education institutions are providing their services (*Universitat Politècnica de València, Universitat de València, Universidad de Alicante* and *Universidad Miguel Hernández de Elche*). Despite this, the problem discussed with the interviewees at this stage was the lack of capacity of higher education institutions to hire the increasingly highly skilled personnel. An example of this perception was captured by PhD2:

Code perceived overqualification: “As a PhD holder, I resonate strongly with the concern about the insufficient capacity of higher education institutions to bring on board the growing number of highly skilled personnel. It’s disheartening to see talented individuals facing barriers in finding suitable roles within academia. Strengthening the capacity of our educational institutions is not just a necessity; it’s a crucial investment in the future of knowledge and innovation. We, as PhD holders, should advocate for policies and initiatives that empower these institutions to harness the wealth of expertise among highly skilled professionals and create an environment conducive to academic growth and collaboration.” (PhD2)

Consequently, other kinds of organisations are called to play a role while the university is not functional in that regard. The new employers of PhD holders are, for instance, technology institutes, industrial firms with (or without) R&D projects and consultancy firms. PhD5 informed us about this:

Code diversified career paths: “As a fellow PhD holder, I fully endorse the idea that entities beyond traditional higher education institutions must step up to play a vital role. The reality is that universities may not have the capacity to absorb all the PhD graduates each year. It’s heartening to witness the emergence of alternative opportunities in various sectors. Technology institutes, industrial firms involved in research and development projects, and consultancy firms are becoming crucial players in providing meaningful avenues for PhD holders. Embracing this diversification of employment avenues not only addresses the challenge of absorption but also enriches the professional landscape for individuals with advanced academic qualifications.” (PhD5)

Here, we found another mismatching between the employer profile and the PhD holders’ responses. While PhD holders who worked in non-university sector felt that they were not using the analytical skills that characterise a researcher, the employers argued that the lack of contextual knowledge, from the PhD holders’ side impeded finding joint solutions that solve the industrial problems. In other words, the employer was seeking adaptation from PhD holders to the context of the sector in terms of habits and routines embedded in the firm and their immediate network of collaborators.

Code adaptation challenges: “As a PhD holder transitioning into this sector, I understand the challenges the employer faces in adapting us to the context. It’s not just about our academic qualifications but also about integrating our habits and routines with the established practices within the firm and its network of collaborators.” (PhD10)

As black or white-like solutions do not work here, a tentative answer to this issue lies in planning more open spaces for debating a more sustainable future for all. This space of discussion should be located outside the comfort zone of employers (their factory) to avoid certain conflicting interests as stated by PhD8:

Code nuance sustainability: “Acknowledging the constraints of simplistic solutions, we understand the importance of adopting a more nuanced approach. The strategic planning of open forums for discussions on sustainable futures becomes imperative. It is crucial to place these platforms beyond our familiar territory, like the factory, to facilitate authentic idea exploration and mitigate the risk of conflicting interests.” (PhD 8)

In parallel with this, from PhD holders’ side, one can suggest them to strive to incorporate more entrepreneurial spirit in their routines, to anticipate to the abovementioned problems of incoordination, in terms of employability and the purpose and sense of each task. That means, they should adopt a more project-based attitude to better offer their value-added solutions to employers. Thus, a possible understanding between them could consider as a win-win strategy: The employer wins a highly skilled worker, who is a change agent, and provides more scientific mindset within the firm culture, as well as to the rest of local actors, while the PhD holders can start to avoid statements like the following one:

Code deprofessionalisation: “The employer is the adversary who did not hire me, or if they did, it makes me feel like not as a scientist, but rather like any other low-skilled worker who does not engage in critical thinking.” (PhD12)

5. Discussion

This article has focused on examining the perspectives of both PhD holders and their employers regarding the role of PhD holders in low-tech industrial districts, as identified through the contrasting narratives in Section 4. Three core tensions emerge directly from the coded data that explain both challenges and opportunities: knowledge-transfer barriers; agency and implementation; collaboration potential. Each tension is directly grounded in the higher-order themes reported in Table 3: *knowledge-transfer barriers* synthesise evidence from *research–practice gap*, *skill mismatch*, and *underutilisation of scientific skills*; *agency constraints* integrate *structural constraints*, *political vested interests*, and *deprofessionalisation*;

and *collaboration potential* builds on *network-embedded research* and *collaborative learning*. This mapping guided the structure of Section 5 and prevents interpretive leaps beyond the empirical material.

First, *knowledge transfer barriers* are evident across multiple codes from Section 4. The *research-practice gap* expressed by sceptical PhD holders (PhD1, 4.2.1.) aligns with employers' perceptions of *skill mismatch* in textile firms (BM3, 4.3.1.) and the broader sense of *PhD irrelevance* in Spanish private companies (PhD2, 4.3.1.). These findings confirm that low-tech industries face structural challenges absorbing analytical expertise (Hirsch-Kreinsen, 2008, p. 11) and resonate with recent evidence on the difficulties PhD holders encounter in translating their research skills into non-academic employment context (Compagnucci *et al.*, 2025).

Second, *agency and implementation* constraints limit impact despite available knowledge. The *agency constraints* faced by PhD5 when advocating environmental solutions (4.4) and the *deprofessionalisation* felt by PhD12 (4.4) echo employers' *practical constraints* related to organisational pace and routines (BM1, 4.3.1.) This reveals a cultural disconnect beyond individual capabilities.

Third, *collaboration potential* emerges among optimistic actors. PhD10's *network-embedded research* leveraging Valencian academic connections (4.2.) finds complementarity in employers' recognition of *collaborative learning* (BM12, 4.3.2) and *transformative* potential against entrenched interests (BM8, 4.4). PhD8's call for *nuanced sustainability* through open forums (4.4) further illustrates actionable pathways.

These tensions identified in Section 4 suggest PhD holders contribute to low-tech districts through mechanisms already present in the data. The *adaptation challenges* (PhD10, 4.4) and mutual trust gap between PhD holders and employers require clearly defining firm needs during recruitment, as suggested by Plöger (2020). This addresses the *research-practice gap* and *skill mismatch* tensions while leveraging *network-embedded research* and *collaborative learning* strengths. However, employers must accept non-conventional talent while PhD holders embrace non-academic careers differing from initial expectations. Public support could facilitate this alignment, enabling the contributions identified across Section 4 findings.

5.1. Limitations

Given the exploratory approach, this article possesses several limitations. Even though the generalizability is not our goal, we acknowledge that we have focused on a specific context, analysing only partially the phenomenon with a small number of interviews. In further studies, we can make use of multiple cases, with more interviewees, to improve external validity of the findings. However, the presented case study has helped us to induce further research on these debates, such as the comparative between the role of PhD holders coming from STEM areas or coming from social sciences, arts and humanities. In further studies, it would be also advisable to replicate our approach through case studies in different settings or with different populations, which would allow us to assess whether similar patterns emerge (or not) across different contexts.

As coding was conducted by a single researcher, we mitigated the absence of inter-coder reliability through reflexive memoing focused on challenging early interpretations, an appropriate quality practice in interpretive qualitative research.

5.2. Conclusions

In conclusion, the match between PhD holders and their employers can vary widely. While challenges exist, such as potential overqualification or mismatched expectations, there are also significant benefits, including transferable skills, adaptability, and the potential for innovation and expertise in niche areas. The key lies in fostering understanding between

employers and PhD holders, recognizing the value each actor contributes to territorial innovation dynamics, as evidenced by the contrasting narratives in Section 4.

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Appendix 1

Semi-structured questionnaire template for individuals with a PhD

1st list of questions: "Before getting the PhD degree".

Topic

Main motivations: (i.e. family-driven, problem-focused, institutionally driven)

Expectations and future perspectives

Interview guiding questions

What were the primary reasons that led you to pursue a PhD program?

What were your expectations regarding future employment?

Did you consider the possibility of being employed by non-academic organisations?

2nd list of questions: "During the PhD studies"

Topic

The nature of knowledge production mode

Interview guiding questions

Do your research themes draw inspiration from already established scientific problems?

Are your research themes influenced by potential applications in the social world?

What weight would you assign to each of these dimensions?

Disciplinary specificities

What intrinsic features do you believe your discipline possesses?

Supervisor's role

How would you describe your supervisor's role during your studies?

Performance

How would you describe your main achievements as a PhD student?

3rd list of questions: "post-doc positions"

Topic

Evident and imperceptible contributions at different geographical levels—local, regional, national, supranational

Outcomes in the realm of science compared to those beyond scientific domains

Interview guiding questions

How would you describe your primary achievements from a geographical perspective after obtaining your PhD?

How would you describe your main achievements in scientific terms after getting your PhD?

What non-scientific outcomes would you describe after getting your PhD?

Activities for disseminating impact: Industry-oriented or location-oriented? Voluntary or mandatory?

Can you describe the efforts you had to make to enhance the diffusion or impact of your contributions?

Identification of gaps or potential tools/mechanisms that could enhance your societal impact

Were there any specific instruments or mechanisms, such as public policies or institutional support, that you felt were missing to make your contributions more accessible to society?

Semi-structured questionnaire template for business managers

Topic	Interview guiding questions
Context (institutions, industries)	How would you describe your region/industry/markets/competitors?
Firm's sources of innovation	How do you perceive the role of STI institutions in your region? What are the sources for innovating, according to your strategy/industry/identified demand?
Competition/cooperation	How do you perceive the role of science in your business?
Internal analysis	How does your business compete in the global economy? How do you perceive the role of your business' staff to compete globally?
PhD holders' roles	How do you usually recruit your personnel? And more particularly, how do you usually recruit these high-skilled workers (i.e. PhD holder)? Have you ever hired a worker with a PhD degree at your organisation? If yes, how do you perceive his/her roles?
