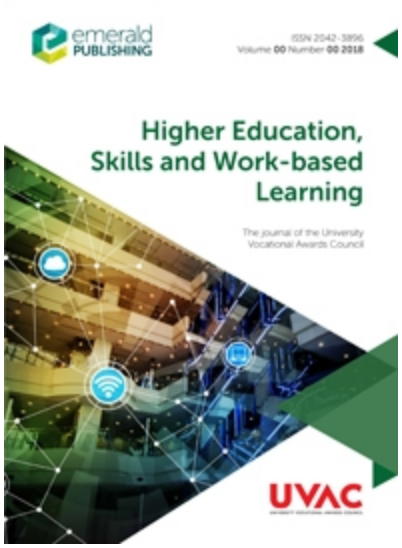

Co-Designing Doctoral Programs to Enhance Postgraduate Students' Employability: Insights from Industry Stakeholders

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Abstract

Purpose – Doctoral programs play a crucial role in promoting innovation and technology transfer in universities. To design these programs effectively and with a co-design perspective, it is essential to consider all stakeholders involved in the process, including teachers, students, and employers. The main objective of this study is to enhance postgraduate programs to improve students' employability.

Design/Methodology/Approach - This empirical study was conducted over a three-year period and employed semi-structured interviews as its primary research methodology. In the first phase, 21 in-depth semi-structured interviews were conducted with managers from various sectors. The second phase involved 20 interviews, and the final phase of the study included 18 interviews with the same managers from previous phases.

Findings - The study's main results revealed that international networks, language proficiency, and analytical skills of doctoral students were highly valued by employers. Main findings come from companies with doctoral students. Therefore, the skills were identified during the learning experience of the PhD graduates in the companies.

Originality - This research presents a novel approach to its findings. On the one hand, the study's conclusions may provide valuable insights for business agents, encouraging them to hire PhD students. On the other hand, it aims to drive necessary changes that promote more PhD students' focus on non-academic careers, creating significant value for research and innovation in the private sector.

Practical Implications - The study's results can guide improvements in postgraduate program curricula and design to enhance students' employability.

Keywords PhD students; competencies; curricula; PhD Education; employers; industry

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Introduction

Postgraduate education, particularly doctoral programs, plays a crucial role in today's education system. The European Union considers it a priority to increase the number of doctoral graduates and encourage their integration into the workforce, as this strengthens the scientific and technological framework of European society and enhances its competitiveness (European Commission, 2011). Therefore, incorporating the needs and demands of all stakeholders in postgraduate education is important in designing effective programs. The employability of doctoral graduates is also used as an indicator of the quality of doctoral programs (García Juanatey *et al*., 2019).

In this article, the demands of employers are analyzed to establish recommendations for improving postgraduate programs from a co-design perspective are analyzed (Pelta and López Peláez, 2021). Doctoral programs equip students with the skills and abilities necessary for knowledge generation, innovation, and result transfer. PhD graduates are employed in both public and private organizations, and during their third-cycle programs, they gain skills that enable them to continue innovating, integrating and strengthening scientific communities, and improving transfer activities (Sánchez Cañizares *et al*., 2015).

Even more, most of the skills can be learned at the workplace. Therefore, the discourse of employers is particularly relevant, given its practical knowledge and experience about their companies and sector of activity.

Three primary operational goals are considered to enhance postgraduate programs and enhance the employability of PhD graduates: these objectives encompass talent onboarding, strategic research areas, and the integration of PhD students into companies, fostering knowledge integration. These objectives serve to enhance the alignment between PhD programs and employment opportunities, as demonstrated by Escardíbul and Afcha (2017), thereby fostering the convergence of academia and industry, which constitutes the primary focus of our research.

In designing effective doctoral programs, it is important to involve all stakeholders from the beginning. The first step in co-design is to provide a voice to all stakeholders (Jahnke *et al*., 2022). Quality accreditation systems for university educational programs also evaluate the demands of future employers and the professional performance of graduates. However, the percentage of PhD graduates employed by companies in Spain is low compared to other countries. The main reason that justifies this situation is related to the limited understanding of the potential contributions that a doctoral degree can offer to an organization, or that companies

may undervalue the pertinence of the competencies acquired throughout the PhD program (Benito Bonito *et al*., 2014).

In particular, PhD graduates in Spain face temporary contracts and job insecurity (Waaijer *et al.,* 2017). Although Spain has established itself as a prominent destination for doctoral studies due to its rich academic tradition, world-class universities, and diverse research opportunities, PhD students often harbor concerns that the extended duration of their doctoral programs may potentially impede their ability to attain higher standing within the realm of research (Caparrós-Ruiz, 2019). On the whole, public policy initiatives should endeavor to enhance the industry's capacity to recruit PhD graduates, thereby facilitating the achievement of a more robust alignment between doctoral programs and the employment opportunities presented by enterprises. This strategic approach is intended to promote a more effective convergence between academia and industry (Escardíbul and Afcha, 2017).

Through the inclusion of PhD graduates, knowledge becomes seamlessly integrated within companies. Complementary skills can be acquired by attracting professionals, and PhD graduates can facilitate the introduction of analytical skills and specific and qualified knowledge.

Our research offers two primary contributions. Firstly, it furnishes recommendations to business entities for the recruitment of PhD graduates. Secondly, it advocates for structural shifts that encourage a higher proportion of PhD graduates to pursue non-academic career paths, thereby enhancing the contributions of research and innovation to the private sector in a substantial manner. Higher education and professional training will be crucial to solving the problem of the lack of certain profiles. Social and political interlocutors must reflect deeply and identify opportunities within the business sectors of essential careers. PhD training and research will be crucial in this context. The analysis carried out aims to identify and share the opinions and realities of different stakeholders and generate new ideas that respond to the real needs of companies and PhD graduates, thus improving doctoral programs.

Literature review

The 2011 report titled "Report of a mapping exercise on doctoral training in Europe" by the European Commission outlines several good practices, including the promotion of intersectoral mobility, technology transfer, and participation of the business community (European Commission, 2011). Involving the private sector, specifically businesses and industries, in PhD programs strengthens the relationship between universities and businesses and enables highly

qualified professionals to develop their careers outside of academia, thereby promoting the labor insertion of PhD graduates into the private sector.

Furthermore, it is crucial to recognize the multifaceted contributions of PhD graduates to the national innovation system. These highly educated individuals play a relevant role in bridging the gap between academia and industry, acting as conduits for the transfer of cutting-edge knowledge (Etzkowitz, 2017; Wenqin *et al*., 2018). Their ability to translate complex academic concepts into practical solutions positions them as valuable assets to organizations seeking innovation and competitiveness.

However, the extent to which PhD graduates are integrated into the industrial landscape varies depending on their areas of specialization. Research by Wenqin *et al.* (2018) and Choe and Borrego (2020) suggests that individuals majoring in science, engineering, and agricultural sciences are more likely to find employment within firms. This aligns with the increasing demand for expertise in these fields, as they are often at the forefront of technological advancements and innovation. Along with this line, Benito Bonito *et al.* (2014) also suggested the role of the demand on the employment of PhD graduates.

The impact of PhD research extends beyond intellectual contributions to specific inputs of companies, such as patents. Herrera and Nieto (2015) highlight the role of patents as a manifestation of innovation resulting from PhD studies. Not only do patents signify original contributions to a field, but they also serve as a means for companies to protect their intellectual property and gain a competitive edge. This emphasis on practical applications and intellectual property rights fosters the introduction of PhD graduates to corporations seeking to leverage technology and knowledge assets (Sauermann and Cohen, 2010).

Moreover, when PhD graduates move to corporate roles, they often experience a shift in their professional priorities. Freed from the immediate pressures of academic publishing, they can redirect their energies toward addressing real-world challenges faced by their organizations (Balsmeier and Pellens, 2014). This transition allows them to apply their expertise in innovative ways, collaborating with multidisciplinary teams to drive product development, process improvement, and strategic decision-making. Employability skills such as communication, problem-solving, team-working and networking, and business and management expertise are required to commit this transition (Molla and Cuthbert, 2019).

Therefore, PhD graduates play a multifaceted role in the innovation ecosystem, facilitating the transfer of knowledge from academia to industry (Perkmann and Walsh, 2009). Their impact is particularly pronounced in fields where scientific and technological advancements are in high demand. As they navigate the transition to corporate roles, these graduates bring with

them a wealth of expertise and a commitment to driving practical solutions, making them valuable assets to organizations seeking to thrive in today's knowledge-driven economy.

The key to unlocking more opportunities for PhD graduates lies in identifying how to increase their usefulness and fit within the company in coherence with the level of knowledge they have acquired. Collaborative endeavors between PhD students and enterprises during their academic journey have been demonstrated to substantially enhance their prospects of securing positions within the private sector (Mangematin, 2000; Wallgren and Dahlgren, 2005). These collaborations not only enrich their practical experience but also foster a deeper understanding of industry dynamics, thereby augmenting their appeal to prospective employers.

Nonetheless, it is noteworthy that the corporate landscape is not universally adept at recognizing the inherent value that PhD graduates bring to the table (Benito Bonito *et al*., 2014). Some companies may inadvertently underestimate the remarkable skill set of these graduates (De Grande *et al*., 2014). This oversight can result from a lack of awareness regarding the depth and breadth of expertise acquired during the rigors of doctoral research. Consequently, there is a compelling need for greater awareness and education within the corporate sector about the unique abilities and problem-solving aptitude that PhD graduates possess, thus facilitating a more seamless integration of their talent within organizations seeking innovation and intellectual capital.

In summary, PhD students should have greater access to employment opportunities after completing their highly qualified training. Additionally, the academic system should provide more information about the role of a PhD graduate to the general public, as it has a significant impact on students' decisions when choosing their career paths (Muscio and Ramaciotti, 2019). Finally, universities and companies should establish long-term alliances (Lutchen, 2018) to bridge the gap between academia and the private sector. It is important to note that the academic system should only allow a person to start a PhD if there is a demand for their profile, that is if there is a future project available.

Methodology

A qualitative research approach is considered particularly appropriate for studying the attraction of PhD students to companies as it allows for investigation, interpretation, and understanding of companies' experiences from the perspectives of those who were personally involved in the analyzed circumstances. Qualitative research is essential in addressing issues that cannot be adequately investigated by quantitative research methods alone, as they do not effectively

capture the opinions, motivations, viewpoints, beliefs, and attitudes of managers (Gartner and Birley, 2002; Yin, 2009).

This paper presents findings from a longitudinal study conducted between 2016 and 2018. The study's primary objective was to examine the progression and adjustments of the incorporation of PhD graduates in companies over this three-year timeframe, in order to gain a better understanding of PhD graduates concerning the workplace to re-design the programs.

Prior to the start of the study, we sought and obtained ethical approval from the University where the study took place. Furthermore, we ensured that participants were fully informed about the study and obtained their consent, explicitly stating that their data would be utilised for research purposes.

The first phase of the study was conducted from November 2015 to February 2016, involving twenty-one in-depth semi-structured interviews with managers from different sectors. The second phase was carried out from April to June 2017, through 20 semi-structured personal interviews. In this phase, 18 of the managers interviewed were the same as in the first phase, and two new companies joined the study, replacing two others. The third and final phase of the study was conducted from April to September 2018, involving 18 semi-structured personal interviews. In this phase, the 18 managers interviewed were the same as in the previous phases, and two companies did not participate due to the departure of one manager and the declining of the last manager to participate.

During the first phase, the study's design and planning were developed, including the design of the phases for data collection and the planning of contents and schedules. In this phase, the research team analyzed information of interest from published secondary sources (e.g., companies´websites and reports, the practitioner press and academic articles), and reviewed similar studies carried out by other universities over the past few years. In the second phase, personal interviews were conducted with a sample of representative companies from each sector.

This research was primarily exploratory in nature, and our goal was not to identify a statistically representative group. Nonetheless, there is no compelling reason to assume that the organizations we interviewed displayed any consistent patterns of uniqueness. Our interviews with experts were aimed at understanding the diverse strategies that businesses were contemplating, rather than quantifying the prevalence of any particular planning. During the research, we did manage to gather insights from a broad spectrum of sectors, recognizing that different industries may adopt distinct approaches.

Semi-structured interviews were conducted in three rounds: 2016, 2017, and 2018. The interviews were recorded and analyzed using Interpretative Phenomenological Analysis (Larkin *et al*., 2019; Miller *et al*., 2018) to prioritize the depth of the interviews over the number of participants. This methodology was used to identify the main themes and subthemes in the conducted interviews. A categorization of results was developed to facilitate the analysis of the responses. From the quantitative questions of the interview, concordance indexes were estimated to analyze data reliability.

Description of the sample

The selection of companies was based on the following criteria: a) presence of the sector in the region; b) economic significance in the selected industry; and c) accessibility of the contact person for the interview.

Companies surveyed represent various sectors, including law, technology centers, construction, home appliances, chemistry, vending, agro-industry, and more.

Each interview took approximately one hour and was conducted with the owner or, if unavailable, the manager or primary manager of the company. In 2016, 55% of the interviewed companies had fewer than 100 employees. In the second phase, this percentage increased to 60%, and in the final phase, it was 56%. Table I presents the classification of companies in the sample based on their size.

Insert Table I here

The semi-structured interviews comprised a total of 44 questions, including 17 open-ended and the remaining closed-ended questions pertaining to the general state of the sector, company, potential for hiring highly qualified candidates, demanded competencies, PhD students' training and vision, and future recruitment trends. Specifically, three qualitative questions (with binary yes/no answers) from the interview enabled us to analyze the concordance indexes and confirm the data's validity. Moreover, the qualitative data provided insights into the interviewees' perceptions and interpretations.

Data reliability

To ensure the reliability of the data, Fleiss' Kappa statistics were estimated for the quantitative responses to the survey (Fleiss, 1981). The coefficients for the Fleiss' Kappa statistic were k=0.466, k=0.661, and k=0.688 for the years 2016, 2017, and 2018, respectively. These results indicate moderate to substantial agreement. Furthermore, the agreement percentage was higher than 0.80 in every round, as shown in Table II.

Insert Table II here

Results

The main results of the study are organized into three categories: talent onboarding, strategic research areas, and the role of PhD students in companies and knowledge integration. To maintain transparency, we have organized the responses chronologically by year. Nevertheless, it is worth noting that in the majority of statistical analyses, there is no substantial shift in trends over time.

On boarding talent

The majority of companies have expressed their intention to hire highly qualified specialized professionals. Respondent #5 suggested that specializations should be determined by the specific needs of the company, rather than vice versa: "The PhD should respond to the company specialization needs and not the reverse. Firstly, you must have a need in the company that can be solved with a PhD student. The process must start from a need and then the specialization occurs".

Respondent #9 also noted that small and medium-sized enterprises (SMEs) may face challenges in attracting PhD students: "SMEs do not have access to the doctoral students they would like to have, where do they have to go to hire a doctor? Where are the PhD students? Do PhD students desire to work for an SME?".

Respondents also identified a range of academic backgrounds that could address the needs of these companies: "A lawyer with a master's degree (tax specialists, economics with language skills), double degrees in business administration and economics, language skills or an engineer with legal knowledge would be a highly demanded profile (engineering from the point of view of venture capital)". Balsmeier and Pellens (2014) have identified differences in the priorities of the private sector and academia. Respondents' preferred academic backgrounds aligned with previous research, with engineering and architecture being the most highly valued, followed by

experimental sciences and economics and business management. Biology, food science and technology, veterinary medicine, and nutrition experts were also frequently mentioned. Wenqin *et al*. (2018) found that PhDs in science, engineering, and agricultural sciences were most relevant for companies.

Additionally, companies identified the importance of acquiring social skills. They specifically stated the need for creative individuals who are highly attuned to the needs of society at large.

Respondent #3 noted the importance of crosscutting knowledge: "Crosscutting knowledge will be required. Philosophers and sociologists will also be needed; there has to be a new paradigm of work. Universities also have to think about horizontal rather than vertical profiles. For example, in Germany minijobs and quick formations are highly demanded. The horizontality of knowledge is important. Specialization, but with a very broad base in horizontal knowledge". Statistics and mathematics are currently in high demand, especially for big data projects.

Furthermore, the interviewees emphasized that the advancement of artificial intelligence is subject to contributions from philosophy. Artificial intelligence is capable of imitating human reasoning processes, such as analysis, learning, understanding, communication, and decision-making. Therefore, its development requires professionals who understand the functioning of the human mind and can replicate it. As the father of mathematical logic and analytical philosophy, Frege stated, "Every good mathematician is at least half a philosopher, and every good philosopher is at least half a mathematician" (Hale and Wright, 2001).

When examining mini-jobs, the interviewees stressed that the next generation of jobs has little to do with professions but more to do with the search for challenges and problem-solving. This concept is referred to as "micro-jobs" (Bonanno, 2016). The interviewees stated the need for a change in the way we conceive of professions, as specific areas of specialization develop over time. Professional careers will be a more or less continuous succession of long-term projects related to certain technical knowledge, but in which we will adapt to the needs of the assignment rather than the other way around.

Strategic areas for future research activities

Various interviewees have identified strategic areas of interest, including agri-food, agroindustry, big data, biotechnology, data science, digital skills, distributed generation, e-commerce, expert lawyers, food safety, green product development, personalized health, Industry 4.0, internalization, IT developments, logistics 4.0, new architecture and construction

technologies, renewable energies, renewable grid integration, market science, social networks, and training technology, among others. The mentioned strategic research areas should be considered in PhD programs to enhance PhD graduates employability.

According to companies interviewed, in particular, engineers and information technology professionals are among the most in-demand profiles in a paradoxical job market. Despite high unemployment rates, talent remains scarce in many jobs, such as those related to biosciences.

Profiles linked to international business development must also be considered. The interviewees claim that experts in e-commerce, e-health, etc. are linked to international mobility of PhD students and their language skills, which facilitate their incorporation into these positions. Other profiles related to high qualifications and PhD students are included in the industrial area, such as quality and process engineers in the chemical industry, the automotive sector, or the gas and oil sectors.

All profiles related to the internet, mobile technology, radio, video, television, and computer networks induce new needs in companies and clients. In addition, solutions in the R&D area are necessary, in line with the previous findings of Nieto (2015) and Sauermann and Cohen (2010). Cybersecurity experts, big data experts, and data analytics specialists are also newly demanded profiles with a low level of competition due to the scarcity of trained candidates, making them good job opportunities for those who want to pursue a profession of the future or reorient their current path.

The health science and pharmacy sector is one of the most in-demand sectors. In medicine and health sciences, the areas of health economics and socio-sanitary, among others, are examples of future positions for PhD students. Customer-oriented health or personalized health are also concepts that are being introduced in this sector. In the scientific area, the openness towards biotechnology means that profiles of analysts, technicians, and scientists in areas of the energy sector and in the pharmaceutical industry are in-demand, as well as the figures responsible for the research and development department, together with access profiles to the market and those related to business intelligence.

In the agrifood sector, in addition to specific positions, others related to the areas of quality, laboratory, export, and the development of organic products are incorporated. Delicatessen products or select products are indicated in the last phase of this study as a sector of great development and trajectory. In the case of construction, new professional profiles related to energy efficiency, construction management, and new technologies applied to construction are also included.

In the industrial sector, the need for qualified operators (mechanical, electrical, electronic, robotics, etc.), as well as engineers of all specialities, is evident. Companies are already developing research projects in these strategic areas that ensure the future need for talent in these projects. Customers demand advanced technology solutions focused on increasing production, which implies the need to investigate further.

Respondent #2 indicates their interest in developing research projects related to secondary products (waste treatment). Another company in the study acknowledged that they lack the necessary critical mass to initiate research projects from scratch, but they focus on innovation and development in the most applicable research areas. This respondent (#7) highlighted that their company is engaged in incremental innovation and development (i and d) rather than radical innovation (I).

The role of PhD students

Demonstrating the role of PhD students in companies is crucial for emphasizing their value, especially in countries like Spain, where these profiles tend to be undervalued (Benito Bonito *et al*., 2014).

Approximately more than half of the interviewed companies were aware of the employment of doctoral degree holders within their organization, while fewer than half were not aware. The responses to this question are presented in Table III.

Insert Table III here

Benefits of having PhD students in companies include their ability to think creatively, their strong interpersonal skills, their forward-looking perspective and expertise in technology surveillance, their experience in managing knowledge and searching for information, their proven experience in working effectively as part of a team, their individuality, and of course, their highly specialized knowledge in specific areas, among others (Table IV).

Insert Table IV Here

Respondent #8 mentioned that PhD profiles have skills and attitudes that are beneficial to the organization, and their peers view them positively. In particular, analytical skills and entrepreneurship were also important to companies, as well as the ability to focus on problem-

solving. However, some respondents mentioned negative characteristics related to PhD students, such as the lack of attitudes and the inability to provide mature technology. Moreover, PhD students could be considered expensive employees, but salaries should be linked to their contribution to the company.

The public and private sectors have differences, with doctorates historically considered a step before the academic structure, followed by the technological center, and finally the company. However, companies cannot afford to have unemployed PhDs.

Finally, management positions and the role of PhDs in coordinating resources were analyzed (Table V).

Insert Table V here

As Table VI shows, most respondents believe PhD students can have managerial responsibilities. Along this line, the majority also respond that they could increase their time spent on other tasks related to the responsibility of the project or the project management (Table VI).

Insert Table VI here

Respondent #3 suggests, “it is even something inherent since when you make a career in a company you acquire management responsibilities”. In addition, according to Respondent #11: “This is the usual. They acquire responsibility for projects and if it is a project with a certain specificity, it would be interesting for that person to be complemented with project management”. Finally, another respondent affirms that: “For a person with a doctorate to have professional development, it has to be assigning responsibility”.

Incorporation of knowledge

Companies were asked for their recommendations to increase the incorporation of PhD students in companies. Fostering collaboration between the university and the private sector was the main action suggested. Table VII includes other proposals.

Insert Table VII here

In response to the question, the participants were able to select multiple measures, with "Collaboration between university-enterprise" emerging as the most frequently cited option by companies. This was followed by "Take action so that the company understands PhD profiles" and "Value R+D+i as a factor of competitiveness". The interviewees conveyed the view that

doctoral programs should have a more practical application to businesses and that the PhD should be linked to the company from the stage of writing the doctoral thesis. Several observations made by the participants highlighted the importance of the university serving society and addressing the needs of companies, rather than merely filling in gaps in the teaching staff.

Additionally, the study examined the relationship between the university and the private sector, with the findings indicating a lack of collaboration between the two. The participants suggested that it would be beneficial for both the university and the private sector to work together more closely. Prior research has also highlighted the significance of collaboration in increasing employment opportunities for PhD students in the private sector, as well as the importance of forming long-term alliances.

In terms of the PhD profile, Respondent #5 emphasized that the PhD is still viewed as an unusual qualification and that technology centers should seek to increase the number of PhDs they employ. The respondent suggested that technology centers could lose competitiveness due to their critical mass not being specialized enough and that the incorporation of PhD students could address this issue.

Discussion and conclusions

When considering the debate surrounding the design of graduate programs, our research draws attention to the demands of a significant stakeholder group: employers. As such, our study aims to identify the competencies and skills sought after by employers of PhD students, with the objective of incorporating these skills into postgraduate programs. Our findings demonstrate the close link between business and innovation, both of which require a high level of academic training.

The results of the study indicate that companies are seeking highly qualified professionals to fill various roles in their organizations. These roles are largely concentrated in fields such as engineering, experimental sciences, economics, and business management. However, cross-cutting knowledge in fields such as philosophy and sociology will also be essential. It is clear that the next generation of jobs will be characterized by micro-jobs and a continuous succession of long-term projects that require technical expertise, problem-solving skills, and the ability to adapt to the needs of the assignment. Therefore, universities must adapt their academic programs to meet the demands of the future workforce.

In terms of the competencies, most sought after by companies for high-responsibility positions, Table VIII presents a breakdown of the skills required. The group of skills most highly valued by employers during the initial phase of hiring highly qualified individuals pertains to self-management and time management skills (averaging at 8.85), followed by leadership and change management skills (8.7). In the subsequent phases, leadership and change management skills give way to relational skills and abilities, remaining unchanged in the final phase. Overall, our interviewees exhibit a high degree of selectivity when it comes to the skills and abilities required for a highly qualified profile. Notably, research skills are the least in-demand competency group in all phases of our study.

Insert Table VIII here

In general, the interviewees consider that the competencies of group 3, 4 and 5 are more difficult to be taught at Universities and point out the importance of professionals possessing these competencies, since knowledge and technical competence is taken for granted, but they give more value to other groups. Specifically, the most important competencies indicated are presented in Table IX (they do not respond to an order of preference, they are arranged in alphabetical order, showing the competencies indicated in all the phases of this study).

Insert Table IX Here

In most cases, companies seek a combination of technical and personal skills in their professionals. Technical skills such as language proficiency or the handling of new technologies are highly valued, as are personal skills such as proactivity, adaptability to change, geographic mobility, teamwork, and results orientation. PhD programs must respond to these requirements. The interviewees conveyed different profiles in training and specificities with a common denominator: the need to be strategic for the sectors that demand them. Moreover, it is increasingly important that new professionals possess a multidisciplinary profile, with great versatility, analytical capacity, and a focus on results, as well as a strategic vision, proactivity, and adaptability to change - all of which are needs that are more present than ever in companies. Proficiency in other languages is a requirement that can no longer be ignored when selecting qualified positions and significantly increases the demand for people with experience and international networking for certain positions.

It could be concluded that in the near future, work will be characterized by the demand for more qualified and sophisticated profiles, not only in engineering or technology positions but

also in professions that traditionally required fewer qualifications. Numerous interviewees have also reported seeing many opportunities in profiles that relate to business development and the expansion of the market, but they have also pointed out the need for continuous reinvention. We must stop thinking about "careers and jobs" and move on to "challenges and problems," as the discontinuity of the latter makes it difficult to establish long-term personal projects.

As a result of our research, we present three recommendations that allow doctoral programs to be strengthened by incorporating the demands of employers. Firstly, to enhance the employability of PhD graduates, it is crucial to not only focus on their academic research but also integrate practical skills and employer-driven considerations into doctoral programs. Thus, PhD programs should go beyond academic knowledge and provide comprehensive training in professional development. PhD programs should incorporate general and specific skills for knowledge generation, innovation, and result transfer. This includes skills such as project management, communication, teamwork, leadership, and entrepreneurship. By equipping PhD candidates with these skills, they become better prepared for diverse career paths, both within and outside academia.

Secondly, collaboration between universities and employers is essential to bridge the gap between academic research and industry needs. PhD programs should facilitate partnerships with businesses, government agencies, and nonprofit organizations, particularly in countries where the value of incorporating PhD graduates is not enough recognized. These partnerships can take various forms, such as joint research projects, internships, or mentorship programs. By involving employers directly in the research and development process, the specific contributions of PhD theses can become more visible and aligned with industry demands.

Thirdly, to ensure the sustainable research careers of PhD students and their seamless transition into the workforce, it's essential to explore mixed financing strategies. These strategies may include a combination of traditional research grants, industry-sponsored research projects, and income-generating activities within academia (e.g., teaching assistantships). By diversifying funding sources, PhD students can gain experience working on projects with real-world implications while also securing financial stability. This recommendation has already been implemented through industrial theses in Spanish regulations, which require a specific agreement with the corresponding company or institution for the thesis's development and that it has been opened to all areas of knowledge (Real Decreto 534/2013, de 12 de julio).

However, the development of high-quality doctoral programs necessitates adequate and sustainable funding. For many candidates, sufficient financial support during their doctoral studies is a prerequisite for finding the initial motivation to undertake the challenging and

demanding goals that research and innovation demand. Therefore, it is essential that the necessary resources are available to support the development of such programs.

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Table I. Sample description

Size	2016	%	2017	%	2018	%
0 to 100	11	55%	12	60%	10	56%
101 to 300	4	20%	4	20%	4	22%
301 to 500	2	10%	1	5%	1	6%
> 500	3	15%	3	15%	3	17%
Total	**20**	**100%**	**20**	**100%**	**18**	**100%**

Table II. Data reliability

	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
2016						
Percent Agreement	0.8167	0.0650	12.56	0.000	0.6806	0.9527
Brennan and Prediger	0.6333	0.1300	4.87	0.000	0.3612	0.9054
Cohen/Conger's Kappa	0.4993	0.1386	3.60	0.002	0.2091	0.7894
Scott/Fleiss' Kappa	0.5111	0.1546	3.31	0.004	0.1876	0.8347
Gwet's AC	0.7067	0.1258	5.62	0.000	0.4434	0.9699
Krippendorff's Alpha	0.4772	0.1513	3.15	0.005	0.1604	0.7939
2017	**Coef.**	**Std. Err.**	**t**	**P>|t|**	**[95% Conf.**	**Interval]**
Percent Agreement	0.8611	0.0853	10.10	0.000	0.6827	10.000
Brennan and Prediger	0.7222	0.1216	5.94	0.000	0.4677	0.977
Cohen/Conger's Kappa	0.6127	0.1177	5.21	0.000	0.3665	0.859
Scott/Fleiss' Kappa	0.6610	0.1081	6.11	0.000	0.4347	0.887
Gwet's AC	0.7647	0.1335	5.73	0.000	0.4853	10.000
Krippendorff's Alpha	0.5848	0.1290	4.53	0.000	0.3127	0.857
2018	**Coef.**	**Std. Err.**	**t**	**P>|t|**	**[95% Conf.**	**Interval]**
Percent Agreement	0.8750	0.0934	9.36	0.000	0.6779	10.000
Brennan and Prediger	0.7500	0.1286	5.83	0.000	0.4786	10.000
Cohen/Conger's Kappa	0.6113	0.1327	4.61	0.000	0.3314	0.891
Scott/Fleiss' Kappa	0.6885	0.1194	5.77	0.000	0.4366	0.940
Gwet's AC	0.7912	0.1383	5.72	0.000	0.4994	10.000
Krippendorff's Alpha	0.5664	0.1495	3.79	0.002	0.2478	0.885

Table III. Are you aware of the existence of doctors in your company with highly qualified profiles?

Answer	2016	%	2017	%	2018	%
Yes	12	60%	12	60%	11	61%
No	8	40%	8	40%	7	39%

Table IV. Do you think that a person with doctoral training could add differential value to your company in highly qualified profiles?

Answer	2016	%	2017	%	2018	%
Yes	17	85%	14	70%	13	72%
No	3	15%	4	20%	3	17%
Do not know, no answer	0	0%	2	10%	2	11%

Table V. Do you think that a doctor could have a directive / managerial professional career in your company regardless of the branch of knowledge beyond their specialisation?

Answer	2016	%	2017	%	2018	%
Yes	13	65%	14	70%	13	72%
No	6	30%	4	20%	3	17%
Do not know, no answer	1	5%	2	10%	2	11%

Table VI. Would you be willing to increase the time dedicated by doctors to other tasks related to responsibility or project management?

	2016	%	2017	%	2018	%
Yes	18	90%	17	85%	15	83%
No	1	5%	1	5%	0	0%
Do not know, no answer	1	5%	2	10%	3	17%

Table VII. What measures do you consider more appropriate or better to favour the incorporation of doctors in the company?

Alternatives	2016	2017	2018
Adapt the number of PhD graduates to the absorption capacity by the public or private system	1	2	3
Collaboration between university-enterprise	16	15	16
Career guidance for doctoral students or doctors	9	10	11
Value R+D+i as a factor of competitiveness	11	10	11
Promote science and technology parks	3	4	5
Take action so that the company understands PhD profiles	11	13	14

Table VIII. Competences demanded by companies for high responsibility positions

Competencies (*)		2016	2017	2018
1.Knowledge and intellectual abilities	Understanding this group of competencies as theoretical knowledge, the ability to learn and interest, adaptation and innovation, mastery of the research area and language management.	8.62	8.32	8.25
2. Capacities and skills for research	Understanding this group of skills as the ability to plan research, control the search and interpretation of data information, as well as the writing of reports, publications and articles. Know how to attract funds and resources for research and transmit its relevance.	7.4	7	7.5
3. Leadership and change management skills	Understanding this group of skills as the capacity for leadership and motivation, creativity and innovation, vision of the future and flexibility, as well as a clear international focus.	8.7	8	8.27
4. Relational skills and abilities	Understanding this group of skills as the ability to work in a team, develop collaborations, international networks and oral communication.	8.6	8.7	8.7
5. Self-management and time management capabilities	Understanding this group of skills as the capacity for autonomy, planning and organization, problem solving and perseverance.	8.85	8.5	8.5

(*) "What level of competency skills do you believe PhD students truly possess from the perspective of your experience or belief?" On a scale of 0 to 10, where 0 represents none and 10 represents a high level

Table IX. Competences demanded by companies

1. Adaptation to change
2. Autonomy and time management
3. Learning capacity
4. Ability to identify with the company
5. Capacity and relational skills
6. Technical competence
7. Ability to raise funds
8. Knowledge and intellectual abilities
9. Creativity and innovation
10. Availability
11. International focus
12. Flexibility
13. relational skills
14. Humility, loyalty, optimism
15. Initiative
16. Leadership
17. language management
18. Planning
19. Proactivity
20. International networks
21. Conflict resolution
22. Feel the company as yours. Commitment
23. Teamwork
24. Future vision
25. Business vision, knowing how to impact a line of research on the business
26. Vocation for applied research