CESAER

Models of engagement for PhDs with non-academic partners

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Executive summary

This report explores the evolving models of engagement between PhD candidates at universities of science and technology (S&T) and non-academic partners, such as industry and societal institutions. These partnerships aim to foster societal engagement, enhance innovation efforts, and promote disruptive innovation within Europe.

The initiative was set in motion following an interest of our association to explore collaborations beyond academia, with a particular focus on boosting disruptive innovation. CESAER's Task Force Innovation spearheaded this exploration, outlining a roadmap, conducting focus groups, and interviewing key stakeholders, including universities and industrial partners. The primary objective was to assess the role of industrial doctorates as drivers of innovation within European industry and as a mechanism for bridging academic research with practical applications inside and outside academia.

The report is grounded in findings from an online workshop organised by the Task Force Innovation in October 2023. Presentations from representatives of universities across Europe, including *Universitat Politècnica de Catalunya* (UPC), Ghent University, the University of Strathclyde, and the University of Stuttgart, provided insights into their models for integrating PhD research with industrial needs. The presentations highlighted the challenges and opportunities for PhD candidates, universities, and industrial partners, with an emphasis on how industrial doctorates can foster innovation and serve the needs of all stakeholders.

Throughout the workshop, various strategies were shared for overcoming challenges related to intellectual property rights, publication timelines, and aligning academic and industrial expectations. Additionally, the workshop facilitated discussions on the broader implications of these partnerships for enhancing innovation ecosystems across Europe.

This report includes key recommendations to universities, industry leaders, political decision-makers, and European Union institutions on how to further develop and support industrial doctorate programs. These recommendations stress the importance of fostering collaboration, developing clear intellectual property guidelines, and creating pathways to better align the career prospects of PhD candidates with industry needs. By leveraging the collective insights from these partnerships, the report suggests that industrial doctorates can significantly contribute to Europe's leadership in innovation.

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Rooted in advanced engineering education and research, CESAER is an international association of leading specialised and comprehensive universities with a strong science and technology profile that advocate, learn from each other and inspire debates. Our Members champion excellence in higher education, training, research, and innovation, contribute to knowledge societies for a sustainable future and deliver significant scientific, economic, social, and societal impact.

To support its advocacy efforts, CESAER Members produce many publications such as white papers and positions, to be found on cesaer.org.

Recommendations to

University leaders

- Foster stronger collaborations with industry partners to create more opportunities for industrial doctorates.
- Develop leadership and professional development programs for faculty to better prepare them for supporting industrial doctorate programs and guiding students into industry careers.
- Invest in infrastructure and resources that support interdisciplinary research and industry-relevant projects.
- Establish clear pathways for students to transition from academia to industry, including mentorship programs and career counselling services.
- Give the industrial PhD students a rich flourishing research environment by establishing thematic “centres” for career growth, avoiding stand-alone PhD projects

Industry partners

- Increase financial support for industrial doctorate programs to attract top talent from universities.
- Provide more opportunities for students to gain practical experience through internships, co-op programs, and collaborative research projects.
- Offer competitive salaries and benefits to attract graduates with advanced degrees, including those from industrial doctorate programs.
- Communicate industry needs and priorities to universities to ensure that academic research aligns with real-world challenges and opportunities.
- Collaborate with universities to develop customised training programs and curriculum that meet industry demand for specialised skills.
- Establish “add on” projects from industrial PhD research projects to ensure bridging knowledge to innovation and impact within the company

Political leaders and policymakers

- Invest in funding and incentives to support industrial doctorate programs and encourage collaboration between universities and industry.
- Create policies and regulations that promote knowledge transfer and technology commercialisation, while protecting the intellectual property rights of all stakeholders.
- Support initiatives to expand access to advanced education and training programs, particularly in STEM fields, to meet the growing demand for skilled professionals in industry.
- Foster a culture of innovation and entrepreneurship by providing resources and support for startups and small businesses, including those founded by graduates of industrial doctorate programs.

- Advocate for regional and national strategies that prioritise research and development, technology transfer, and industry-academic partnerships to drive economic growth and competitiveness.

EU institutions

- Support industrial doctorate programs through Horizon Europe and other EU research and innovation initiatives, including by boosting funding for the Marie Skłodowska-Curie Actions, including its Industrial Doctorates. Such funding supports collaborative research projects and mobility of PhDs between universities and industry partners, as well as provide stipends and scholarships for doctoral students.
- Simplify administrative procedures and regulations to make it easier for universities and companies to collaborate on industrial doctorate programs. This includes harmonising intellectual property rights policies, facilitating technology transfer, and reducing bureaucratic barriers to industry-academic partnerships.
- Disseminate best practices and success stories of industrial doctorate programs across EU member states to encourage more partners to participate, and to encourage more member states to offer suitable funding programs at national and regional levels. This could involve organising workshops, conferences, and networking events to share knowledge and experiences among stakeholders.
- Create platforms and online portals to facilitate matchmaking between universities, companies, and doctoral students interested in industrial research projects. This could include databases of research opportunities, funding sources, and potential collaborators to help stakeholders identify and connect with each other more effectively.
- Encourage interdisciplinary research collaborations between universities and industry partners by providing funding and resources for projects that address complex challenges at the intersection of multiple disciplines. This could involve establishing thematic research clusters or centres of excellence focused on priority areas such as clean energy, digitalisation, and healthcare innovation. Foster international collaboration and knowledge exchange between EU institutions and their counterparts in other regions of the world. This could involve partnering with international organisations, funding agencies, and universities to co-fund joint research projects, exchange programs, and mobility initiatives for doctoral students and researchers.

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Background

Over the past years, there have been ongoing discussions to advance the topic of engagement between PhD candidates and non-academic partners. However, further research is needed to fully understand the role of industrial doctorates and their impact on driving innovation in Europe.

Industrial doctorate vs "normal" doctorate: benefits and challenges

One key aspect under examination is how industrial doctorates differ from traditional doctoral programs and the associated benefits and challenges for all involved parties: doctoral students, industry partners, and academics. This comparison seeks to shed light on the unique features of industrial doctorates and the opportunities and obstacles they present in fostering collaboration between academia and industry.

In our undertaking to explore the diverse models of engagement of PhD candidates with non-academic partners, it is crucial to first define what we mean by such engagement, also called, in some universities, industrial doctorates, in the context of our work. Essentially, we are referring to PhD programs that are substantially conducted in close collaboration with an industrial partner. This collaborative aspect is the key criterion of an industrial doctorate, distinguishing it from many traditional PhD programs.

Within this overarching definition, a myriad of variations exist in how industrial doctorates are structured and supported. In this report we are particularly interested in understanding the different forms of industrial PhDs, how they are funded by government and industry, and the distinctions they hold compared to more conventional doctorates.

For doctoral students, engaging in an industrial doctorate offers a distinct experience that may shape their future career paths, potentially better aligning them with industry needs. However, this pathway also presents challenges, both for the students themselves and for the academics tasked with managing the relationship between academia and industry.

Context

Universities of S&T play a crucial role in leading collaborations with various societal partners, including industrial partners, SMEs, innovation organisations, and thenot-for-profit sector. They serve as hubs for developing future research talent, contributing uniquely to the innovation ecosystem. With research funders increasingly emphasising the quality of the PhD experience alongside research quality, it becomes imperative to explore and enhance the PhD journey, especially in collaboration with external partners who often contribute to funding doctoral research.

The landscape includes various types of doctorates (professional, industrial, and conventional PhDs) each with its distinct characteristics and implications. Managing expectations and ensuring the quality of the PhD experience for all stakeholders is particularly crucial. Factors such as the knowledge base and research environment of the partner institution, the inclusion of mid to late-career students, considerations of open research versus client confidentiality,

and the establishment of cohorts or industrial centres for doctoral training further shape the context.

Approach

To address these issues comprehensively, a research approach was elaborated which included focus groups and survey interviews with students, conducted at each university within the workstream. Additionally, interviews with industry partners provided valuable insights into their perspectives and experiences. These efforts culminated in a workshop on 'Models of engagement for PhDs with non-academic partners' as part of the CESAER Annual Meetings in October 2023.

Throughout our study, we delved into several key topics to better understand the dynamics of industrial doctorates. These include:

- Motivations and expectations: Why do students opt for an industrial doctorate, and what are their expectations?
- Supervision and training: How is supervision managed to provide effective training while offering a broader experience?
- Benefits and challenges: What are the advantages and obstacles inherent in industrial doctorates?
- Intellectual Property (IP) and dissemination: How is intellectual property managed and disseminated, especially when it holds commercial value?
- Future career plans: What are the immediate and long-term career ambitions of industrial PhD graduates, and how does the doctorate support these aspirations?

Case study analysis

Ghent University

Background and context

Ghent University administers an industrial PhD program supported by the Flemish government's agency for Innovation and Research (VLAIO). This initiative, spanning already over more than a decade, underscores the Flemish universities' commitment to fostering collaboration between academia and industry in the Flemish region of Belgium. The program aims to marry basic research with clear economic objectives, ensuring both academic rigour and practical applicability. It operates under a personal mandate model, wherein candidates are selected based on their potential to contribute to long-term research goals with tangible economic impacts.

Key characteristics

Ghent University's industrial PhD program emphasises the importance of basic research while maintaining a focus on economic relevance.

The program's budgeting and financing mechanisms ensure that candidates receive adequate support, with the company financing the project and receiving government subsidies.

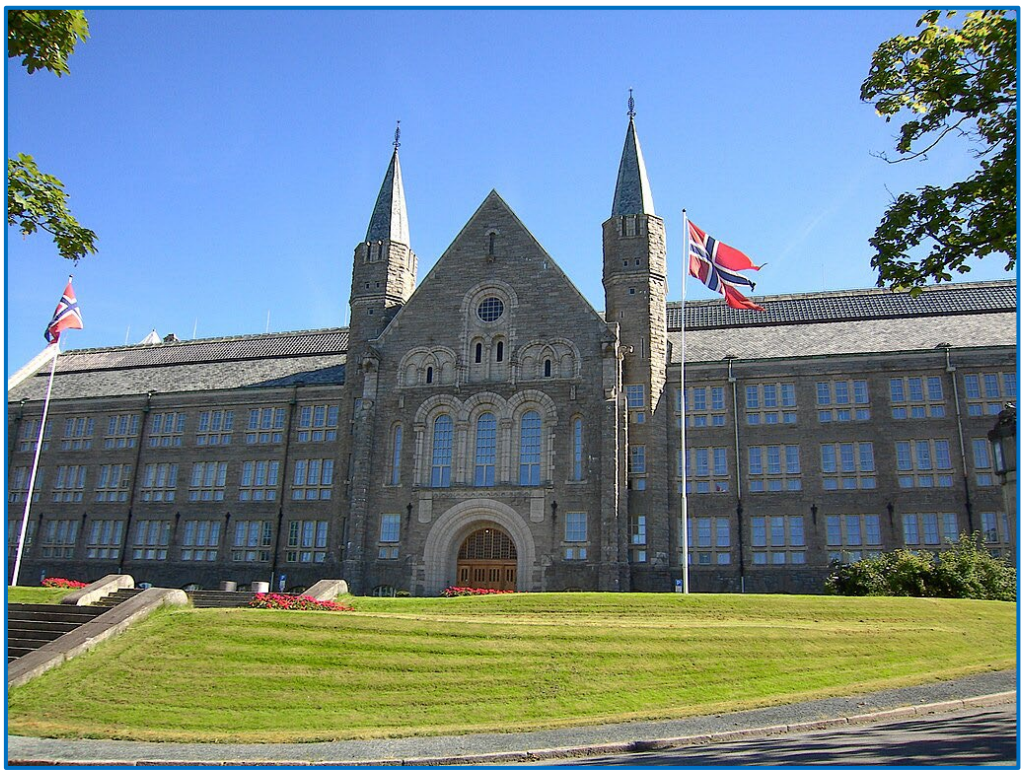
Funding and modalities

The program operates on a personal mandate basis, with funding calculated based on the candidate's employment costs. The company finances the entire project but receives a subsidy from the Flemish government, covering at least 50% of the costs. Clear agreements on IP rights are required before the candidate can defend their project. Model agreements are available, offering options for the allocation of IP rights between the company and the university. There are two calls per year, with oral defences conducted by a panel of academic and industrial experts. Success rates are around 50%, with selected candidates qualifying for government funding.

Key findings and outcomes

- The industrial PhD program at Ghent University facilitates collaboration between academia and industry, offering benefits for both parties.
- The program's success is evidenced by its high success rates and the positive feedback from candidates, companies, and academic supervisors
- Challenges such as IP rights and administrative complexities exist but can be managed through clear agreements and effective communication.
- Students are motivated by the opportunity to gain skills not available within the university and to work on real-world problems. However, they face challenges such as differing perceptions between academia and industry, administrative hurdles, and the balance between basic and commercial research.
- Ghent University's industrial PhD program serves as a model for fostering collaboration between academia and industry. By aligning basic research with economic objectives, the program cultivates a conducive environment for innovation and knowledge exchange. While challenges like intellectual property rights and administrative hurdles persist, they are manageable with clear agreements and effective communication. Overall, the program underscores the university's commitment to advancing research and driving economic growth in Flanders.

Norwegian University of Science and Technology (NTNU)



Background and context

NTNU has a broad range of PhD programmes covering various thematic areas. NTNU has approximately 3000 ongoing PhD students. In 2023, 429 graduates fulfilled their PhD at NTNU. A large amount of these students performed their PhD in collaboration with industry, especially within large scale academia-industry collaborative centres.

Funding and modalities

In general, a student undertaking a PhD at NTNU, is either employed by the university, a research institute, by a public organisation such as a hospital, or by an industry partner. Funding of the PhD is from various sources such as basic funding from NTNU, from public or industry partners or from the Research Council of Norway. One special mechanism in Norway, is the establishment of specific large-scale centres, specially designed for academia-industry collaboration and funded partly by the Research Council of Norway, industry, other partners and the university: 'Centre of research-based innovation' (SFI) or 'Centre of environmentally friendly energy' (FME). One such centre typically hold 20-40 PhDs employed by the university and a total budget of € 20-40 million over 8 years. NTNU is host/partner in 34 SFI and 26 FME since 2007. In these centres, NTNU has several hundred industrial partners.

Key findings and outcomes

Benefits

Benefits are typically that PhD students participating in centres have easy access to industry partners and their PhD project is well aligned with the overall centre goals and ambitions. The PhD is a part of an interdisciplinary research environment with different partners, both from academia and industry. Taking a PhD in a centre makes career planning easier, because a large amount of the PhD students from centres are employed by the industry after fulfilling their PhD. Mutual understanding of publication guidelines and intellectual property are handled in consortia agreement that is signed before starting the activities.

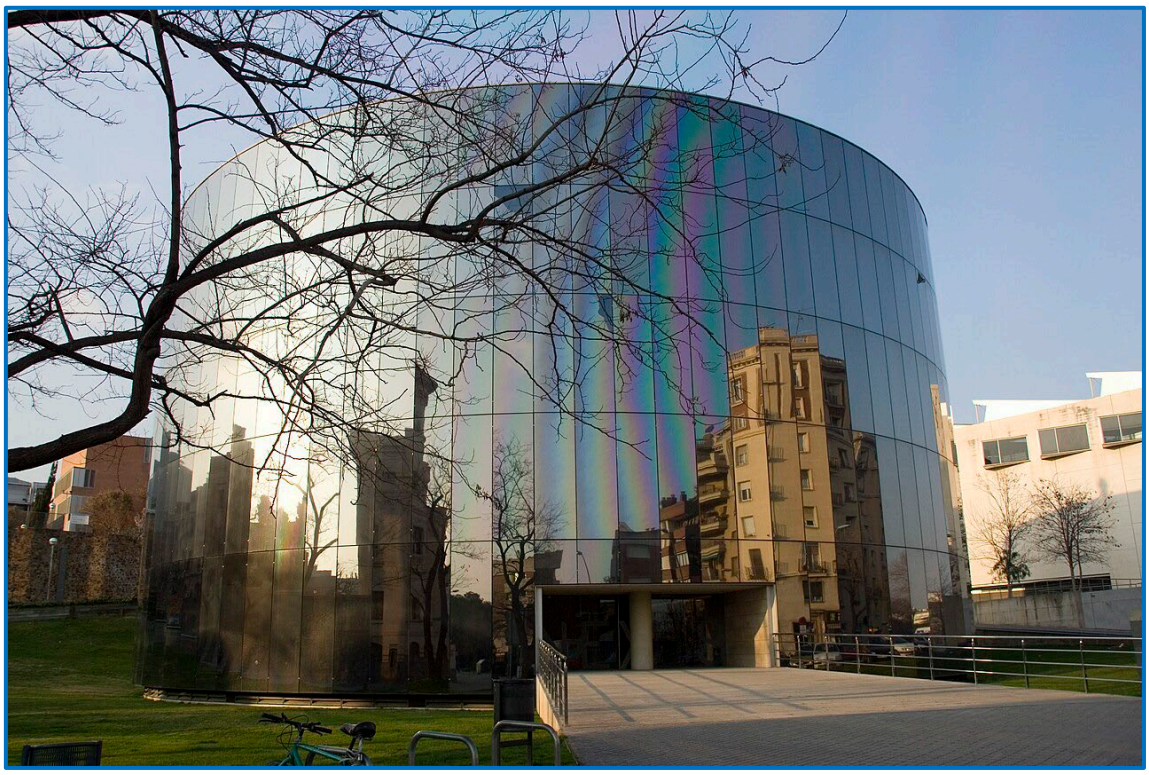
Challenges and solutions

Challenges might be to agree upon topics of PhD research that can be relevant for several industrial partners while simultaneously ensuring academic freedom and pursuing what is most interesting scientifically. Another challenge is to ensure further funding for development of 'add on' innovation project fostering innovation by the industrial partners from PhD results. One IP-related challenge is to ensure possibilities to develop startup companies from centres with many industrial partners in case no industrial partners intend to explore the results from a PhD in a centre. Challenges might also include delayed publication of results due to protection of intellectual property.

Overall implications

Organising PhDs in centres with industry and university is beneficial from both a PhD student perspective and for an industry and academia perspective. Engagement from industrial partners in academic projects makes bridging of knowledge and demands both ways easier, hence increasing innovation potential and further impact and usage of PhD results. Career planning for PhDs in university-industry centres is easier, and industrial partners in centres have easy access to top talents and candidates for further employment.

Universitat Politècnica de Catalunya (UPC)



Background and context

The industrial doctorate program in Catalonia, Spain, was established in response to the growing number of PhD graduates in the region and aims to increase the percentage of workers in research and development employed in industries.

The program draws inspiration from international models such as the CIFRA program in France and innovations funded in Denmark.

Key characteristics

- An industrial doctorate is perceived as a strategic research project with a significant impact on the company or institution, aligned with core business objectives.
- The program involves collaboration between private companies, public administration, universities, and the PhD candidate.
- Academic supervisors must belong to accredited research groups or receive funding from the European Research Council.
- Companies must designate an overseer for the project and offer a minimum gross annual salary of €22,000 for the PhD candidate.

Funding and modalities

- Two funding modalities exist: co-funding (for companies with a COR Centre in Catalonia) and specific funding (open to international companies).
- The program is flexible and compatible with various grants and credits for both academia and companies.
- Calls for applications are held multiple times a year, with funding decisions made within two to three months.

Key findings and outcomes

- Over the past decade, 900 projects have been funded, amounting to nearly €120 million.
- The majority of projects are in life sciences and health, followed by ICT and engineering.
- Feedback from companies indicates a positive influence on the company and benefits such as incentives for research and development.
- Academics consider industrial doctorate theses to be on par with conventional theses, both in quality and quantity of publications.
- Feedback from industrial doctorate students:
  - Motivations for pursuing an industrial doctorate include higher salary, real-world application of research, and higher impact of work.
  - Students report challenges such as sometimes conflicting interests between academia and industry, but also value opportunities for technical and soft skill development and networking.
  - Preference for continuing in the private sector is common among industrial doctorate graduates.
- The industrial doctorate program at UPC has been successful in fostering collaboration between academia and industry, leading to impactful research outcomes and benefits for both parties.
- The positive feedback from companies and academics underscores the effectiveness of the program in meeting its objectives and delivering value to stakeholders.
- Despite challenges, such as conflicting interests and the balance between confidentiality and open access, the program continues to attract motivated students and produce high-quality research.
- Moving forward, continued investment in and support for industrial doctorate programs will be essential for driving innovation, economic growth, and the development of research talent in Catalonia and beyond.

The University of Strathclyde

Background and context

The University of Strathclyde has a broad range of industrial doctorate programs. These programs, supported by various funding sources, aim to bridge the gap between academia and industry, providing students with opportunities for applied research and practical experience.

They focus on collaboration with companies in sectors like engineering, automation, and production.

Key characteristics

The University of Strathclyde offers several industrial doctorate programs, catering to different needs and preferences. These programs include industry-funded initiatives for large companies with cohorts of PhD students, as well as university-based programs with smaller cohorts sponsored by individual companies. Additionally, Strathclyde hosts industry centres where companies and academics collaborate on-site, providing students with valuable industry contacts and research opportunities.

Funding and modalities

Funding for industrial doctorate programs at Strathclyde comes from various sources, including government support and direct industry sponsorship. The university collaborates with companies to develop joint proposals, securing funding for research projects that address real-world challenges. Intellectual property rights and publication guidelines are crucial aspects of these collaborations, often defined in pre-approved research contracts to ensure clarity and fairness for all parties involved. Students typically split their time between academic and industry settings, receiving guidance from both academic supervisors and industry mentors.

Strathclyde's industrial doctorate programs include industry-funded programs for large companies with cohorts of PhD students, as well as university-based programs with smaller cohorts sponsored by individual companies.

The university hosts large industry centres where companies and academics collaborate on research projects, providing opportunities for a significant number of PhD students.

Key findings and outcomes

- Students are motivated to undertake industrial doctorates for access to industry contacts, applied research, and better funding opportunities.
- They perceive a difference between academic and industrial PhDs, with a stronger emphasis on practical applications and industry-relevant research in the latter.
- Reported challenges included standalone projects, difficulty in translating industry-based projects for academic writing, and tensions between practical applications and academic publishing.

Benefits

- Benefits include access to industry contacts, a more holistic approach to research, and the development of a unique skill set through interdisciplinary projects.
- Students felt prepared for careers in both industry and academia, with opportunities for postdoc positions and exposure to academic expertise enhancing their employability.
- Industrial doctorate programs provided a unique blend of academic quality and industry experience, contributing to students' future success.

Challenges and solutions

- Challenges include issues with IP, publication timelines, and confidentiality agreements, but companies are generally supportive of dissemination and publication of results.
- Successful programs require strong senior sponsorship, active management, and collaboration between academic and industry supervisors.
- The model's success led to its expansion into multiple research fields and international participation, demonstrating its value to both the university and industry partners.

Overall implications

- Strong industry partnerships facilitated the initiation and growth of industrial doctorate programs.

- Co-design and collaboration between academia and industry were key to program success.
- Encouraging publications while navigating IP and confidentiality issues required careful management and support.
- The model's success in one area of business led to its replication in other areas, demonstrating its effectiveness as a recruitment tool for attracting high-calibre staff.

University of Stuttgart

Background and context

The University of Stuttgart is located in one of Europe's most active regions economically, with strong ties to industries like automotive, automation, and production.

Industrial doctorate programs have been an integral part of the university for a long time, fostering collaborations with companies in the Stuttgart region and beyond.

Funding and modalities

- Multiple funding schemes exist, including public funding from the European Union and the federal government, as well as industry partnerships and bilateral research contracts.
- Funding aims to stimulate technology development, support research in key areas like digitalisation of production, simulation and energy, and to promote collaboration between academia and industry.
- Industrial doctorate programs typically involve joint proposals between the university and industry partners in public funding schemes, with PhD students working on industry-relevant research topics.
- PhD candidates may be employed by both the university and the industry, with responsibilities divided based on the joint proposal.
- IP rights are typically defined in cooperation contracts, with ownership often belonging to the individual employee or the employing institution.

Key findings and outcomes

Benefits

- PhD candidates are attracted to industrial doctorate programs for their focus on applied research, practical experience in industry, and often shorter duration compared to more academically focused PhDs.
- Career outcomes for graduates often involve research and development roles in the industry where they completed their doctorate.
- Benefits include building industrial contacts, receiving academic and technical support, and gaining insights into both academic and industrial work environments.

Challenges and solutions

- Coordination between the university and industry partners is crucial, requiring clear communication, defined roles, and support for PhD candidates over the three-year program.
- Establishing a memorandum of understanding beforehand helps define key aspects such as division of work, supervision team, talent recruitment, publication guidelines, IP, and compensation.

Warsaw University of Technology

Background and context

The "Implementation Doctorate" program was introduced in Poland in 2017 by the then Ministry of Science and Higher Education. It aims to support the preparation of doctoral dissertations by doctoral students conducting scientific research, the results of which can be applied to the activities of a given company. In six editions of the program (2017-2023), 2772 projects have been funded, accounting for about 7% of all doctoral students in Poland. Implementation doctorates are carried out in the private sector in almost 70% of the cases and the public sector in the remaining 30%, which includes state-owned companies, scientific institutions, local government-controlled entities, and state institutions. In the case of private entities, the dominant participants are enterprises (97%).

The program aims to create conditions for the development of cooperation between higher education and science entities with the socio-economic environment conducted within doctoral schools, involving the education of postgraduate students in collaboration with their employing entrepreneurs or other entities, the effect of which will be the implementation of the results of scientific activities conducted by doctoral students in these entities.

Key characteristics

The "Implementation Doctorate" program was established by the Minister of Science and Higher Education on 29 May 2019. The program aims to create conditions for the development of cooperation between higher education and science entities with the socio-economic environment conducted within doctoral schools, involving the education of postgraduate students in collaboration with their employing entrepreneurs or other entities, the effect of which will be the implementation of the results of scientific activities conducted by doctoral students in three entities:

1. "Implementation Doctorate I" supports the preparation of doctoral dissertations by doctoral students conducting scientific activities in areas other than those specified in points 2 and 3, the results of which may be applied in the activities of the entities.
2. "Implementation Doctorate II—artificial intelligence and quantum technologies" supports the preparation of doctoral dissertations by doctoral students conducting scientific activities on the use of artificial intelligence and quantum technologies in technological or social processes, including those related to cybersecurity, the results of which may be applied in the activities of the entities employing the doctoral students.
3. "Implementation Doctorate III—metrology" supports the preparation of doctoral dissertations by doctoral students conducting scientific activities on the use of metrology in technological and social processes, including the development of digital technologies and the latest technologies in health, environment, energy, and advanced measurement techniques.

Funding and modalities

Interested individuals apply for participation to the program coordinator at the faculty (17 Faculties), where they plan to conduct scientific research. Warsaw University of Technology then conduct a competition for recruitment of program laureates to the Warsaw University of Technology Doctoral School. The Ministry approves the list of persons admitted. Each participant of the Doctoral School receives a scholarship and receives payment for up to 4 years.

Key findings and outcomes

Benefits

To meet the needs of the program participants, conditions for the implementation of mandatory didactic practices for doctoral students have been established, which consider the possibility of completing teaching hours at the doctoral student's place of work. Recommended forms of didactic practice for doctoral students include:

- Independently or co-conducting didactic classes;
- Support for the academic teacher conducting didactic classes in their preparation:
    - preparation of lecture materials,
    - preparation of measurement positions,
    - development of exercises in remote version,
    - development of laboratory instructions,
    - co-conducting fragments of classes;

- Supervision of interns at the workplace of the implementation doctoral student (certified by a person authorised to represent the entity and containing information about the doctoral student's time burden);
- Supervision of graduates (assistance in research, preparation of publications, etc.);
- Conducting training/courses at the workplaces of implementation doctoral students (certified by a person authorised to represent the entity and containing information about the doctoral student's time burden);
- Coordinate study visits for students at the workplaces of implementation doctoral students (certified by a person authorised to represent the entity and contain information about the doctoral student's time burden).

Challenges and solutions

Challenges in cooperation with non-academic partners

- Maintaining employment for the doctoral student throughout the project duration (significant for implementing doctorates in state-owned companies).
- Rotation in the position of supervisor from the workplace.
- Burdening the doctoral student with tasks that do not consider the hours necessary to prepare the doctoral dissertation.
- Lack of institutional and substantive patterns of regular cooperation between program partners and supervisors.
- Lack of benefits and aspirations for the visibility of the supervisor's role in the workplace.
- Lack of negative consequences for the workplace in the event of dismissal of the doctoral student and project closure.

Challenges for the university

- Lack of clear substantive expectations between a regular and implementation doctorate.
- Bearing all financial risk in case of project failure.
- Lack of a systemic education of academic supervisors to cooperate with non-academic partners.

Overall key findings

Variability in industrial doctorate schemes

Different countries have different approaches to industrial doctorate schemes. For example, the United Kingdom relies largely on industry co-funding PhDs sponsored through research councils, while other European regions, like Flanders and Catalonia, have more elaborate government-funded schemes to support collaboration between universities and industry.

Importance of industry experience

Industrial doctorates provide valuable industry experience for PhD students, helping them understand how industry works, its challenges, and how to translate academic skills into industry settings. This experience reduces the gap between academia and industry and makes cooperation more attractive.

Role of intellectual property

IP arrangements vary across schemes and countries. Some schemes require students to assign their IP to the university, while others allow students to retain ownership. Clear IP regulations set by government, funding agencies, or a specific consortia agreement, can reduce friction between partners.

Impact of funding and career prospects

Funding agencies and schemes may influence the focus of research (e.g., basic research versus applied research, academic freedom versus alignment with industry interest) and the duration of the PhD program. Additionally, the availability of well-paying jobs in industry may influence students' decisions to pursue industrial doctorates.

Building bridges and networking

Industrial doctorate programs aim to bridge the gap between academia and industry, facilitating collaboration and networking between researchers, companies, and universities. Programs often include internships, secondees, or joint projects to facilitate this interaction.

Leadership and career development

Industrial doctorate programs should also focus on developing leadership skills and providing career guidance for PhD students. This includes preparing them for both academic and industry career paths and helping them navigate the transition between sectors.