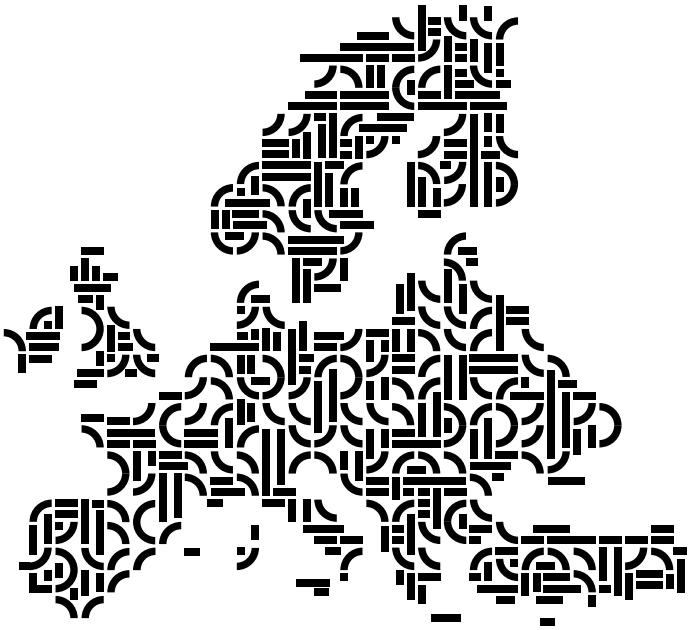

EELISA
European University

EELISA INNOCORE PLAN FOR COLLABORATIVE RDI, TECHNOLOGY TRANSFER AND INNOVATION ECOSYSTEMS

Deliverable 6.2

Date: 31 May 2022

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101035811

Technical references

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Task:	Task 6.1 Strengthening resources for technology transfer within the EELISA network Task 6.2 Developing PhD thesis financed by industry and co-advised Task 6.6 Novel education programs for flexible RDI – a path towards entrepreneurial university
Lead beneficiary:	BME
Due date of deliverable:	May 31, 2022
Actual submission date:	
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Document history

V	Date	WP Leader	Reviewed by:
1	May 6, 2022	BME	Review of 1st version of document with EELISA partners during online meeting.
2	May 20, 2022	BME	Review by SSSA (1st quality control)
3	May 26, 2022	BME	Review by EELISA InnoCORE quality assurance coordinator (2nd quality control)
4	May 28, 2022	BME	Updated version based on the quality control feedback

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EELISA InnoCORE Partners

Number	Role	Name in original language	Name in English	Short name	Country
1	COO	Universidad Politécnica de Madrid	Technical University of Madrid	UPM	Spain
2	BEN	École Nationale des Ponts et Chaussées	National School of Civil Engineering	ENPC	France
3	BEN	Friedrich-Alexander-Universität Erlangen-Nürnberg	Friedrich-Alexander University Erlangen-Nürnberg	FAU	Germany
4	BEN	İstanbul Teknik Üniversitesi	Istanbul Technical University	ITU	Turkey
5	BEN	Scuola Normale Superiore	Higher Normal School	SNS	Italy
6	BEN	Scuola Superiore di Studi Universitari e di Perfezionamento Sant'Anna	Sant'Anna School of Advanced Studies	SSSA	Italy
7	BEN	Universitatea Politehnica din Bucuresti	Politehnica University of Bucharest	UPB	Romania
8	BEN	Budapesti Műszaki és Gazdaságtudományi Egyetem	Budapest University of Technology and Economics	BME	Hungary
9	BEN	Université Paris Sciences et Lettres	Université PSL	PSL	France

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Executive summary

Universities have a distinctive role in the society by disposing over a wide range of scientific knowledge which is to be efficiently funnelled into societal use. Thus, they have to move from a reactive mode to a proactive mode of operation. As a result, new frameworks must be created in which universities can participate in developing products and offer services to their partners. This is especially true for universities of technology, which makes EELISA alliance focused on this task.

This document is the first deliverable of work package 6 (WP6) of EELISA InnoCORE project. The title of WP6 is “Reinforcing cooperation in R&I with other sectors, especially academia-business cooperation” and its implementation is based on six tasks

- Task 6.1 Strengthening resources for technology transfer within the EELISA network
- Task 6.2 Developing PhD thesis financed by industry and co-advised
- Task 6.3 Creation of Science Park development model – Structural development model
- Task 6.4 Models for collaboration with business and industry
- Task 6.5 RDI collaboration and answering the societal challenges
- Task 6.6 Novel education programs for flexible RDI – a path towards entrepreneurial university

The main objectives of WP6 are:

- to reinforce Research and Innovation Dimension of universities via the concept of Science Parks,
- to meet the transformative challenge of reshaping university operations to provide services for industrial, economical and societal development,
- to construct a dynamic university innovation ecosystem among the consortium members.

Science Parks – conceived as networked smart spaces where industrial, governmental, academic, and research stakeholders come together in close proximity and offer new services - may prove to be vital instruments of transformation for the universities. They can multiply the innovation potential and contribute to creating New Technology Based Firms to streamline innovation. WP6 is concerned with fully exploring the Science Park concept and its application as a networked RDI among the consortium members. As a part of this, Deliverable 6.2 is focusing on the “Plan for collaborative RDI, technology transfer and innovation ecosystems”, addressing the following items:

- **How to handle industrial PhD programs**, what are the working practices, financing scheme of the industrial PhD programs among the stakeholders, IP rights between the company and university, practices and requirements about industrial utilization in the PhD programme, working scheme of industrial PhD programs for companies.

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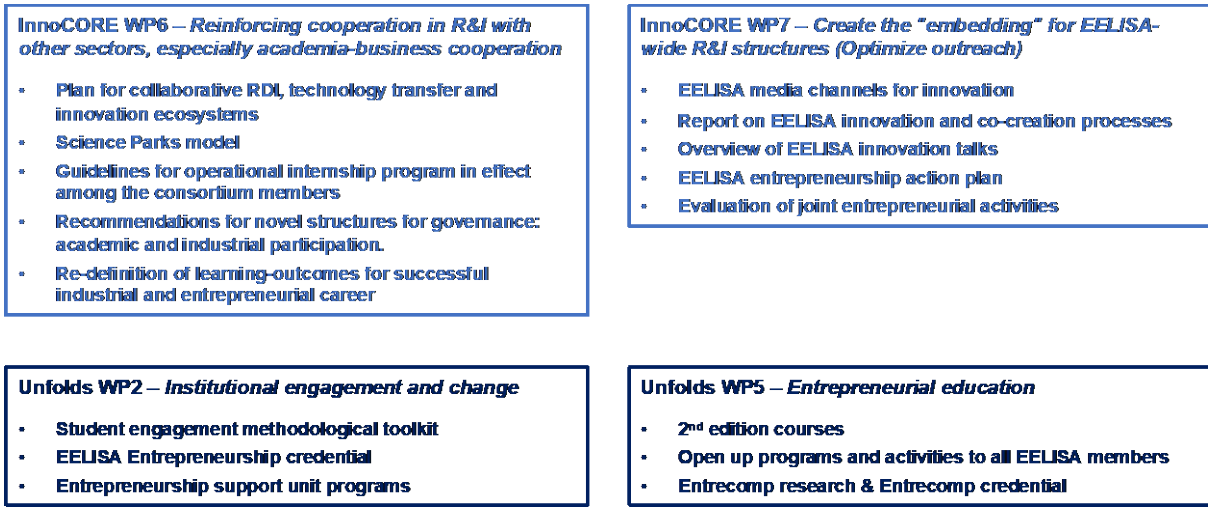
- **How to strengthen resources for technology** transfer within the EELISA network, research areas of mutual interest, possible knowledge sharing methods, and methods for joint ecosystem exploitation.
- **How the partner institutions are implementing the concept of "entrepreneurial university"** (goals, policies and practices), entrepreneurial courses the partner institutions offer, what are the needs of the entrepreneurial world?

Relationship with other project elements

The objective of this report is partly related to EELISA Unfolds project "Distributed I&E Education" (Deliverable No. D5.1.) and "Guidelines on how universities can scale-up institutional strategies and practices addressing student engagement" (Deliverable No. D2.1.). However, here we focus on an in-depth analysis of the institutional practices. The aim of this analysis is to develop common strategies which can be adopted by the members of the alliance and to create an "extended space" for the different elements university-industry relationship. The elements of this "extended space" are given by the next figure:



The roadmap of joint actions is depicted by the next table:

Date	Action
2022 December	Discussion of joint curriculum
2023 March	Devising course thematic
2023 July	Announcing the program
2023 October	Launch of the program (attendance is offered electronically)

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The aforementioned plan and proposals should be taken as a preliminary proposal or preliminary roadmap by InnoCORE WP6 leader, to be further analysed and decided upon among EELISA partners in coordination with EELISA InnoCORE WP7 and Unfolds project. The depicted roadmaps had not yet been agreed upon by partners.

Methodology of the report

The deliverable was drafted and processed according to the following methodology:

- Discussion sessions addressing the points of
    - "Developing PhD thesis financed by industry and co-advised" (meeting no. 1; December 1, 2021)
    - "Strengthening resources for technology transfer within the EELISA network" (meeting no. 2; January 18, 2022)
    - "Novel education programs for flexible RDI – a path towards entrepreneurial university" (meeting no. 3; March 18, 2022)
- Requesting institutional documents addressing the points raised in the discussion
- Processing the institutional replies and focusing
- Draft version of the whole deliverable sent back to the alliance members for revision
- Discussion session on the whole text of the deliverable (meeting no. 4; May 6, 2022)
- Sending the document to the two-step quality control procedure

Throughout the preparation of the deliverable, we focused on the mechanisms of raising the treated elements from the status of institutional practices to the "Alliance Level" where member institutions can adopt the new practices.

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Responsibles for WP6

Partner	Acronym	Contact person for
Universidad Politecnica De Madrid	UPM	Juan M. Munoz-Guijosa Isabel Salgueiro
Ecole Nationale Des Ponts Et Chaussees	ENPC	Gustavo Boriolo Emmanuel Girard Laura Molinari
Friedrich-Alexander-Universität Erlangen-Nuernberg	FAU	David Schkade Markus Schhober Ann-Kathrin Wenzel
Istanbul Teknik Universitesi	ITÜ	Nazım Kemal Üre
Scuola Normale Superiore	SNS	Chiara Cappelli
Scuola Superiore Di Studi Universitari E Di Perfezionamento S Anna	SSSA	Cristiana Neri
Universitatea Politehnica Din Bucuresti	UPB	Radu-Ioan Ciobanu
Budapesti Muszaki Es Gazdasagtudomanyi Egyetem	BME	János Levendovszky László Lengyel
Universite Paris Sciences et Lettres	PSL	Antoine Mercier

Review and quality check by EELISA

To guarantee coordination and complementarity and avoid overlapping between the two projects, the EELISA office has been consulted for the production of this deliverable.

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Glossary- Abbreviations and definitions

(alphabetic order)

CA. Consortium Agreement. The consortium agreement is a private agreement between the beneficiaries, to set out the rights and obligations amongst themselves. (It does NOT involve the European Commission/Agency.)

Communication. Taking strategic and targeted measures for promoting the action itself and its research outputs to a multitude of audiences, including the media and the public, and possibly engaging in a two-way exchange.

Dissemination. The public disclosure of the research outputs by any appropriate means, including by scientific publications in any medium.

Exploitation. The utilisation of research outputs in further research activities other than those covered by the action concerned, or in developing, creating and marketing a product or process, or in creating and providing a service, or in standardisation activities.

EELISA Community. The EELISA communities are mission-driven working groups that bring together students, teachers, and researchers from all partner universities with prestigious professionals, grassroots organizations, citizens, private companies, and public institutions to find innovative solutions to real-world challenges.

EELISA Cluster. EELISA Clusters are science-based working groups that will work on the scientific and technological solutions that may contribute to solve the societal challenges identified by EELISA Communities.

GA. Grant Agreement. This is the grant contract concluded between the EU and the beneficiaries. It establishes the rights and obligations that govern the grant. It consists of a core text and annexes (for instance, fixing the project content and the project budget).

Industrial PhD. It is a doctoral programme in which research is carried out in strong collaboration with the industry (sometimes under a co-supervision scheme) where the research results are close to industrial utilization based on pre-drafted IP rights and financing agreements.

KER. Key Exploitable Results. We refer to the research outputs with major potential for being exploited within the project.

KPIs. Key Performance Indicators

Project Results/ Project Outputs. By project results we understand a unit of knowledge that has been generated out of a project. This includes any tangible or intangible output of the action, such as data, prototypes, demonstrators, knowledge and information whatever their form or nature, whether or not they can be protected. It is not limited to pioneering discoveries, but may also include new methodologies/processes, adaptations, insights, alternative applications of prior knowledge. Along this document, we use project results and project outputs indistinctively, with the same meaning.

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1 Introduction to EELISA InnoCORE

The European Engineering Learning Innovation and Science Alliance (EELISA) is a bottom-up alliance of European higher education institutions representing more than 180,000 students and 50,000 graduates each year, 16,000 faculty members and 11,000 administrative staff. EELISA is one of the 41 European Universities selected by the European Commission under the Erasmus+ call, focused on education. EELISA was selected during the second pilot call. With the formalization of this European University, partners are initiating an unprecedented level of institutionalised cooperation between our institutions to gradually achieve our long-term ambitious vision: the education of European Engineers.

A pillar of EELISA will be the setting-up of EELISA Communities: challenge-based working groups where citizens, private companies and academia will collaborate to face societal challenges. EELISA Communities will be the place where education, research, innovation and public debate coexist and connect, enhancing the connection of engineering with society.

Within this framework, **EELISA InnoCORE is conceived as an integral part of the Alliance**, being a tool supporting, strengthening and delving deeper into the cooperation set up by EELISA. Building on the ecosystem of EELISA Communities, **EELISA InnoCORE focuses on the R&I dimension of the Alliance in a three-step plan**: 1) make our researchers and innovators know each other, create spaces for dialogue with citizens and with non-academic actors and set up a portfolio of shared scientific infrastructures; 2) foster and support the development of joint R&I actions and the creation of new structures (research groups, clusters, joint labs, start-ups, scientific parks) and 3) optimize the outreach of these actions.

EELISA InnoCORE will be running for three years and it is structured around seven (7) work packages (WPs), focusing each on one of the key elements of the project. Under InnoCORE, EELISA partners will work on establishing a portfolio of joint research areas and defining a joint roadmap of research infrastructures (WP2). InnoCORE will map existing research infrastructures and facilities (WP4), with two aims: establishing the rules for opening their use and defining the main features of a booking system so that these resources can be used by all researchers of the Alliance, on the one hand; eventually, establishing a framework for jointly investing in new infrastructures.

EELISA InnoCORE will support the collaboration and the setting-up of joint research projects among the members of the Alliance through the development of a networking platform (WP5), the setting-up of clusters[1], the launching of seed funding for prospective young researchers (WP5) and the use of existing or new equipment and facilities in labs to foster collaborations (WP4). In addition to this, EELISA InnoCORE has two work packages dedicated to interlinking the incubation, start-up and entrepreneurship support services of the members of the alliance (WP7) and to foster the participation of society in science (WP7) and strengthening relations with the industry world (WP6). UPM will coordinate and lead the management of the project, being responsible for guiding the project in cross-cutting issues, such as gender balance (WP1). Lastly, the project has a dedicated work package on open science (WP3).

[1] Science-based working groups that will work on scientific and technological solutions than can help solve the societal challenges identified by EELISA Communities.

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WP	WP title	WP Leader
WP1	Coordination, evaluation, communication and dissemination	UPM
WP2	EELISA Research and Innovation Strategy	ITÜ
WP3	EELISA Strategic Framework for Open Science practices	UPB
WP4	EELISA Multi Labs (sharing facilities & equipment)	PSL
WP5	Set up initiatives for joint research projects (Enable joint research)	SNS
WP6	Reinforcing cooperation in R&I with other sectors, especially academia-business cooperation	BME
WP7	Create the "embedding" for EELISA-wide R&I structures (Optimize outreach)	FAU

Table 1: List of work packages and WP leaders

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2 EELISA InnoCORE outreach - Universities as flagships for innovation and economic acceleration

Innovation is the drive of the modern world. It can sustain economic growth and tackle fundamental challenges the societies are faced with. This gives universities a special role and responsibility as being the cornerstones of modern, knowledge-based societies. While they maintain their core mission of education, they also must come to grip with an ever-expanding role of driving innovation and catalysing economic development. Thus, universities must change at a rapid pace to adapt to new roles and they must live up to the expectations of the society in the following levels[2]:

- **Industrial collaborations.** Cooperation with industry to provide skills and know-how for knowledge intensive technologies (such as AI, industrial digitalization, nuclear technologies… etc.) and help technology transfer via open innovation, especially in the case of Small- and Medium size Enterprises (SMEs)
- **Student innovation.** Supporting student innovation which may draw its potential from non-conventional thinking and academic freedom the students enjoy, while conducting their studies at the university,
- **Promoting entrepreneurship.** Promoting entrepreneurship and entrepreneurial mindset to propel the society towards entrepreneurship which can provide a steady contribution to the economy even in dynamic and ever-changing environments and can act as economic accelerators
- **Encouraging collaboration with the private sector.** Enhancing collaboration with private sector to develop new partnerships with companies and research-intensive institutions as they can provide critical funding for research.

1. Industrial collaborations

As far as collaboration with the industry is concerned, there has always been a close and long-standing relationship between universities and industry[3] which is based on mutual interest and benefits. Companies have realized the high-value, high-return provided by these collaborations. For example, according to data compiled by the National Science Foundation for the US, industry funding for university research and development has grown by more than 5.5% per year on average over the past 10 years, from about $2.4 billion in 2006 to more than $4.2 billion in 2016, as demonstrated by the figure bellow.

[2] Disruptive technologies: Advances that will transform life, business, and the global economy, McKinsey Global Institute report
[3] Alok K. Chakrabartiand Michael D. Santoro "Building social capital and learning environment in university–industry relationships", International Journal of Learning and Intellectual Capital, May 12, 2004pp 19-36

Steven Lewis, Patricia Baird, Robert G. Evans, William A. Ghali, Charles J. Wright, Elaine Gibson and Françoise Baylis "Dancing with the porcupine: rules for governing the university–industry relationship**",** CMAJ September 18, 2001 165 (6) 783-785;

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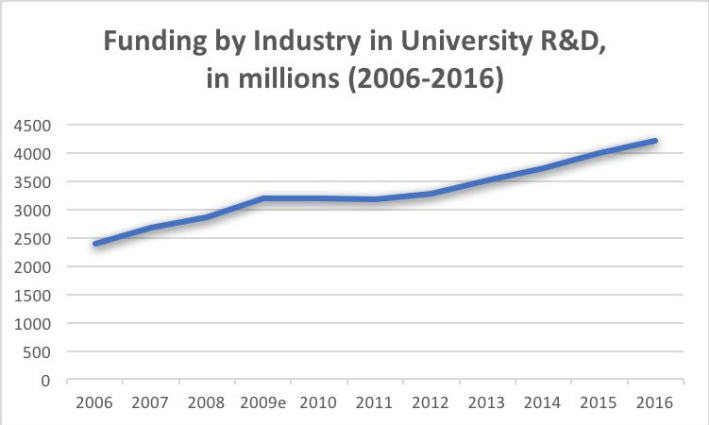

SOURCE: National Science Foundation, National Center for Science and Engineering Statistics, Higher Education Research and Development Survey.

Figure 1. Funding by industry in universities R&D

Unfortunately, in Europe there is large difference in university funding (see the figure bellow) which results in imbalanced performance.

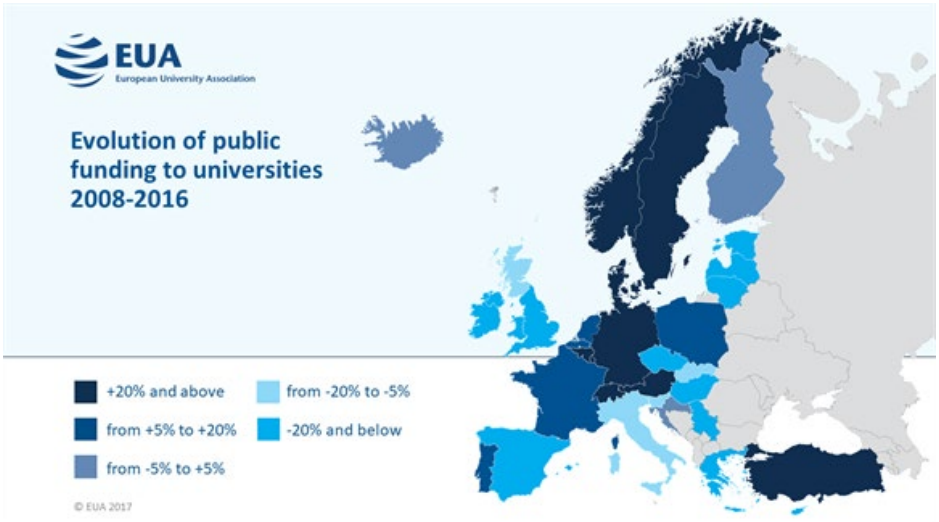

Figure 2. Public funding Gap (EUA study)

The average funding of the European universities is given in the figure bellow which suggests that industrial financing is not in match with public funding, which do not prompt closer relationships with industry.

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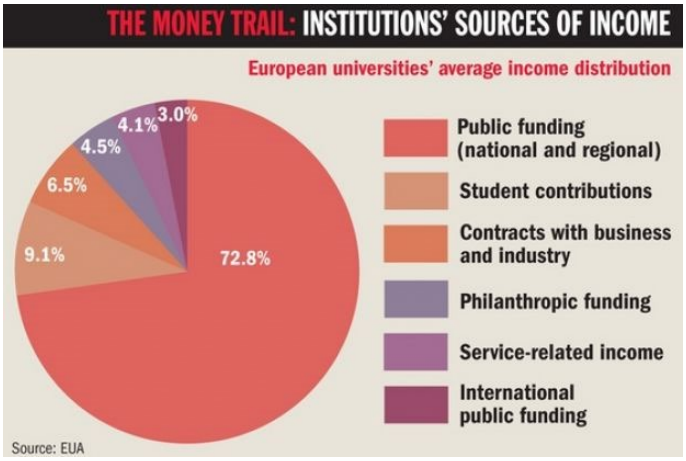

Figure 3. Institutions' sources of income

The estimated economic impact of disruptive technologies is given in the next figure by McKinsey.

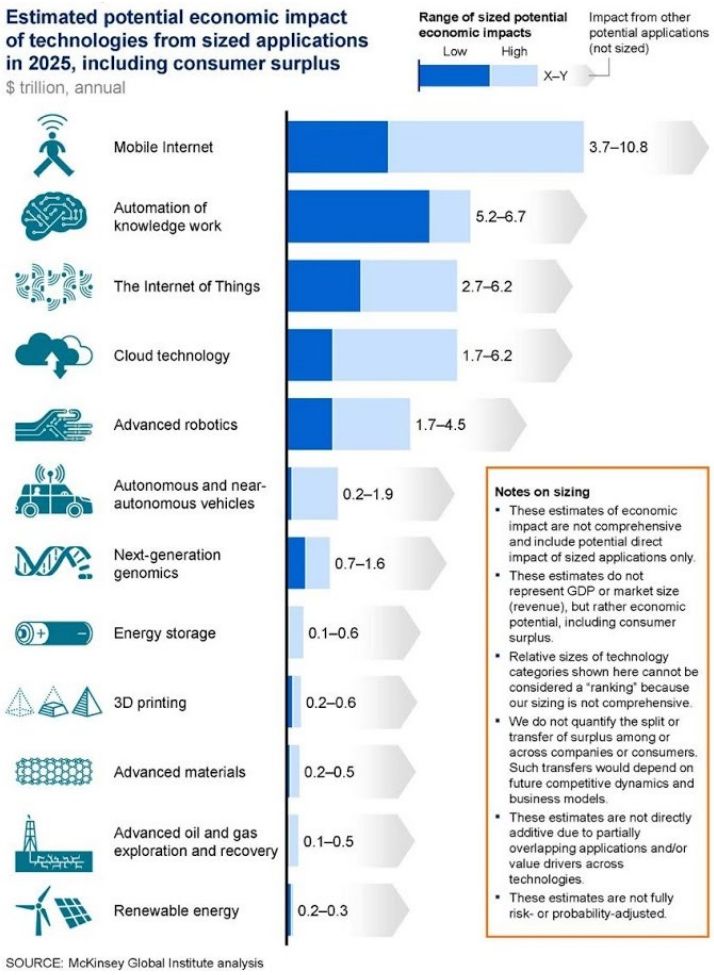

Figure 4. The estimated economic impact of disruptive technologies

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These technologies are knowledge intensive and require a scientific background, which are typically out of reach for SMEs. Thus, they must rely on outsourcing their RDI to the universities in the framework of open innovation. This puts a huge responsibility on the university as they have to universities that are expected to serve these needs.

Furthermore, industry always strives to employ graduates highly trained in cutting edge technologies and industrial practices. To achieve this, companies are bound to collaborate with universities to let their corporate challenges transpire in the curricula and channel RDI projects to the universities. Some selected students may be engaged to work on these projects, under the supervision of the professors and may later end up being employed by the company. As a result, the financing of university research projects by a company may not only serve the purpose of obtaining technological advantage but in addition the company can get the workforce who are already partly trained on their technology. Thus, after graduation, students can immediately become valuable "assets" to the company as far as labour force is concerned.

Therefore, the university must carefully calibrate its RDI portfolio to respond to corporate needs and increase its income but preserving its scientific edge.

2. Student innovation

There is one special factor which carves out the role of the universities as leaders of innovation even more predominantly. This factor is the presence of students. Students are the ones who are most likely to develop non-conventional ideas which are not rooted in traditional frameworks and conventional thinking, thus paving the way towards the emergence of new disruptive technologies which, in turn, may shape the future of humanity. In this way, innovation boils down to the capacity of developing and implementing non-conventional ideas. University policies must cultivate student innovation by providing the students with the necessary skills, as student innovation is the key to our future. In this regard, the related work packages of EELISA, InnoCORE and Unfolds should explore new ways and processes to support and streamline student driven innovation.

3. Promoting entrepreneurship

Universities should embrace promoting entrepreneurship as part of their mission. The Global Consortium of Entrepreneurship Centres counts more than 200 universities among its members. Universities should systematically add soft skills such as leadership, calculated risk taking etc… to their curricula, to perform their role as economic accelerators and to encourage students to take entrepreneurial paths.

4. Encouraging collaboration with the private sector

In today's competitive environment, universities must also develop new partnerships with leading companies, foundations, and other research-intensive institutions. These partnerships are not just about knowledge transfer but they yield critical funding for professors and students to carry out research, help students and faculty members exchange ideas with industry, and perhaps most importantly.

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In this document we investigate these factors along the following points:

- **Developing PhD thesis financed by industry and co-advised**
    - Industrial PhD program practices
    - Financing scheme of the industrial PhD programs among the stakeholders
    - IP rights between the company and university
    - Requirements about industrial utilization in the PhD programme
    - Best scheme of industrial PhD programs for companies
    - Sharing PhD students among each other

- **Strengthening resources for technology transfer within the EELISA network**
    - Research areas of mutual interest
    - Knowledge sharing methods
    - Methods for joint ecosystem exploitation

- **Novel education programs for flexible RDI – a path towards entrepreneurial university**
    - Implementation practices of the concept “entrepreneurial university”
    - Courses strengthening the entrepreneurial skills
    - What are the needs of the entrepreneurial world in a university?
    - Industrial chairs supporting university-industry cooperation and path towards entrepreneurial university
    - Contests and prizes

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3 Developing PhD thesis financed by industry and co-advised

The topic of this chapter is related to Task 6.2 *Developing PhD thesis financed by industry and co-advised*. One of the most efficient instruments of industry-university collaboration is joint RDI activities. Industrial PhD are the tool to allow PhD students to get deeper insights into practical problems a company may face. The solution is developed by the full rigor and armoury of scientific means relying on the co-supervision of a university and an industrial advisor. This process can make the bridge between theory and practice and smoothly channel strong scientific results into industrial utilization. Therefore, the potential of industrial PhD is to be explored among the universities of the alliance and best practices are worth being adopted to harvest all the advantage of industrial PhD.

Some EELISA InnoCORE partners offer programs, where industries are involved from the very beginning in the PhD research. Industrial partners may offer research topics and finance PhD positions and research.

To reveal the nature of these programs six aspects have been analysed, for each partner (where applicable). The results of this analysis are described in paragraphs 3.1-3.7, respectively:

3.1 Industrial PhD program practices
3.2 Financing scheme of the industrial PhD programs among the stakeholders
3.3 IP rights between the company and university
3.4 Requirements about industrial utilization in the PhD programme
3.5 What would be the best scheme of industrial PhD for companies
3.6 Possible sharing PhD students among each other

In the last paragraph (3.7) the key findings are summarized as basis for the proposal of possible joint actions.

3.1 Industrial PhD program practices

UPM practices

UPM has about 2,000 PhD students per year on average. In addition to the standard PhD degree, UPM awards the following PhD Modalities ("mention"):

- International Doctorate (mention, *mención "doctorado internacional"*), which requires:
    - Three months international secondment
    - PhD thesis reviewed by international experts
    - PhD thesis committee with international members
    - PhD thesis and dissertation: Spanish and other language

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- Industrial Doctorate (mention, mención "doctorado industrial")[4], which basically requires (a more detailed explanation is given below)
    - UPM-Industry collaboration agreement
    - Industrial research project
    - Industrial secondment

Furthermore, PhD degree can also be under co-tutelle scheme, leading to two PhD certificates, one from each tutelling university, which requires:

- Individual agreement for every PhD candidate
- At least 2 PhD advisors, one from each university
- Spend part of the PhD at each university (agreed by both universities)

UPM's Industrial Doctorate requirements. Doctoral studies are ruled by the Spanish law RD 99/2011[5], particularly article 15 bis. At UPM, there is an internal regulation, reflecting the requirements of the law[6].

In addition to the standard requirements for being awarded with the PhD degree, the following requirements apply to obtain the mention (i.e to be considered as) "Industrial Doctorate":

- The PhD student participates in an industrial research project, or an experimental development project directly linked to the topic of the PhD thesis, implemented within a private company or a public administration.
- There must be a **work contract or commercial contract between the PhD student and the private company or public administration.** The contract must have a duration of at least three years if the PhD programme is full-time and 5 years in case of part-time.
- The PhD student must inform the Academic Board of the relevant PhD programme (*Comisión Académica del Programa de Doctorado*, hereafter DPAC) about the name of the responsible person at the company or public administration. This person must be appointed during the first quarter of the thesis and will be the in charge of the communication between the DPAC and the company or public administration.
- The doctoral candidate shall be assigned a UPM TUTOR appointed by the DPAC; a SUPERVISOR appointed by the Company or the Public Administration; a **DIRECTOR**[7] or two CO-DIRECTORS of the Thesis, who might come from both the University or the Company/Public Administration. The co-directors might coincide with the TUTOR and the SUPERVISOR if they are doctors and comply with the requisites established by the doctorate regulations. These shall also be appointed by the DPAC.

[4] https://www.upm.es/Estudiantes/Estudios_Titulaciones/Estudios_Doctorado/Tesis/doctoradoIndustrial
[5] https://www.boe.es/buscar/pdf/2011/BOE-A-2011-2541-consolidado.pdf
[6] https://www.upm.es/sfs/Rectorado/Vicerrectorado%20de%20Doctorado%20y%20Postgrado/Negociados%20de%20Doctorado%20y%20Postgrado/Normativas/Doctorado_%20Industrial_Reglamento.pdf
[7] *DIRECTOR: the director in Spanish means what typically is called in English "supervisor", the official person guiding and monitoring the PhD student work.*

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- The research plan that the PhD student must submit during the first year must clearly reflect its industrial component. This plan must be approved by the DPAC. Likewise, when submitting the thesis, the PhD student must submit a report as well proving that the thesis is linked to an industrial research project, or an experimental development project developed within a company or public administration.
- **There must be a framework agreement, furthermore a specific agreement between the parties**. **UPM's framework agreement is available on UPM's website in ENGLISH**[8]**.** The agreement is provided by the relevant Vice rectorate of UPM.

FAU practices

FAU's Industrial PhD programmes are mostly depending on the cooperation partners within and outside of the university. FAU has a high number of different programmes with different partners including global players like Siemens, Adidas, Schäffler, Audi and others. The cooperation is based on cooperation agreements and follow the standards of good supervision and good research practice as defined by the German Professors Association (DHV[9]) and the German Research Foundation (DFG[10,11]). FAUs own rules and regulations complement these principles[12,13].

ITU practices

At ITU there is a great number of MSc/PhD students ("Graduate Students") who are working full time at technology companies, while concurrently pursuing their degree at ITU. ITU does not distinguish these students from other students, and they go through the same curriculum and degree requirements as all standard graduate students at ITU. A significant number of faculty members who advise these students also engage in university-industry collaborations with the student's company, since there is a mutual benefit in working on a thesis that focuses on solving technological problems at the student's company. However, this is not a requirement and there is no protocol/agreement that enforces such cooperation.

In 2018, ITU has started a special graduate degree program with the defence company ASELSAN, which is one of the biggest technology companies in Turkey with more than 6500 employees and an annual revenue that exceeds 16 billion Turkish liras. The ITU-ASELSAN graduate programs are exclusive to students who are working full time at ASELSAN, and both the curriculum and the thesis work is tailored towards key technological areas of ASELSAN. Students who complete the program successfully receive the same degree as regular ITU graduate students.

Another important case for industrial PhD programs is the "TUBITAK 2244 Industrial PhD Program". This program/call is organized by TUBITAK (The Scientific and Technological Research Council of Turkey) and aims to strengthen the relations between industry and academia by joint funding of PhD students. Universities and companies apply to this call jointly

8 https://www.upm.es/sfs/Rectorado/Vicerrectorado%20de%20Investigacion/Doctorado/Normativa/Documentos/Modelo_Convenio_Doctorado_Industrial_ingles.pdf

9 https://www.hochschulverband.de/fileadmin/redaktion/download/pdf/resolutionen/Industriepromotion-english.pdf

10 https://www.dfg.de/en/research_funding/research_careers/career_support/index.html

11 https://wissenschaftliche-integritaet.de/en/code-of-conduct/

12 https://www.intern.fau.de/files/2020/03/Merkblatt_externe_Bachelor_Masterarbeiten_sowie_Dissertationen.pdf

13 https://www.doc.zuv.fau.de//KaB/Sonstige_Regelungen/Gute_wissenschaftliche_Praxis/Regulations_for_safeguarding_good_scientific_practice.pdf

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by submitting a proposal that outlines their collaboration structure (such as key research areas and thesis topics). If the proposal is funded, universities can fund the PhD students under this program, given that they agree to work on the key research areas that are provided by the industrial partner. Students admitted via this program are subject to the same conditions as regular PhD students in ITU. Currently, ITU hosts 10 TUBITAK 2244 projects with the top technology companies of Turkey, such as Arcelik and Turkish Aerospace Industries.

In addition to this specific partnership with ASELSAN and TUBITAK, ITU offers several graduate programmes which contribute indirectly to university-industry collaboration. Graduate programmes such as “Executive MBA”, “Management and Technology”, “Big Data and Analytics”, “Entrepreneurship and Innovation” are designed to respond to the increasing demand of qualified human resources in different sectors. These programmes directly target people from industry and enable them to follow scientific developments without interrupting their careers. It is essential to bring people with differentiating positions and from different sectors together to benefit from the synergy of their multidisciplinary backgrounds and present ways to gain knowledge, skills and proficiency to solve the problems they encounter in their profession and create added value for the institution they work for.

SNS practice

There is no active industrial PhD program at SNS (as the industrial PhD is defined by the Italian law), but there are forms for companies and external entities to fund PhD.

SSSA practices

PhD Programmes of Sant’Anna School aim to link basic and applied research with a strong focus on and demands for innovation by industry and public institutions. Sant’Anna’s PhD programmes are either three or four-year long: they are designed for young graduates, from Italy and abroad, who are admitted after a selective examination which takes into account the candidates’ educational background and their attitude to scientific research and interdisciplinary approach.

All positions are fully funded: the PhD student scholarship is renewed annually following a successful assessment. There are no tuition fees for the enrolment and all PhD students have free access to the School’s canteen for a meal a day.

The programmes entail – in different proportions according to the different disciplines – structured courses and supervised research. Periods of visiting fellowship in other Italian and foreign institutions are encouraged by the School which financially supports them with integrations to the basic grant.

Important features of the programmes offered by the School are the early introduction to research activities with intensive training at Sant’Anna research labs, and the constant interaction between students and the faculty members.

The completion of the programme requires the successful discussion of a dissertation presenting original results, publishable on the major international journals in the respective fields.

The number of positions is set each year in the call for admission. Positions may be increased if further funding becomes available, within special agreements, research projects or industrial partnerships.

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In addition to the scholarship, PhD students will be provided with personal research funds and specific funding for visiting periods abroad.

Companies may be interested in carrying out research or training activities together with the School for a multi-year period of time. A form of collaboration of this type is represented by joint laboratories, which involve both the sharing of research lines and the funding of PhD grants. These are agreements with a long duration and which focus on objectives of a more strategic and / or general nature, with the sharing of resources and purposes.

UPB practices

The main practices of an industrial PhD program at UPB are as follows: students can focus on a specific subject that is very close to an industrial product; in that case there is no coursework or academic work are required, offering the students more time to focus on their research. The research topics selection is supposed to be more focused on practical aspects and the incremental development and periodical testing of the final product in enterprise platforms. It also requires the immediate validation of the novel results.

The practices can be linked to the methodologies:

- Closed working in a team
- Following specific requirements, sometimes with high number of changes
- Using real-world testing environments
- Periodical discussions in the team
- Possibility to coordinate other persons working in your group.

BME practices

Since 2020 in Hungary, we have the “Cooperative Doctoral Program (CDP)” launched by the government. CDP aims 8i) to channel results into industrial utilization, and (ii) to further increase the number of employees with scientific qualifications in the field of research and development and innovation. This is primarily in the fields of mathematics, science, engineering and informatics, who wish to increase their professional knowledge with the latest scientific research results and committed to the social and economic exploitation of their knowledge.

The Program provides support to those who, in addition to their doctoral student status, carry out research work in a workplace other than a higher education institution, which facilitates the practical application of their scientific results.

Beside the Cooperative Doctoral Program, and before the program started in 2020, we have bilateral agreements with industrial partners. Several partners have research and development laboratories in the University with the gool to have a basis for continuous common RDI activities and to involve MSc and PhD students into the projects.

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PSL practices

PSL has some European funding to develop PhDs and expects that within EELISA similar funds will be available (like the Industrial Doctorate in Marie Curie[14]).

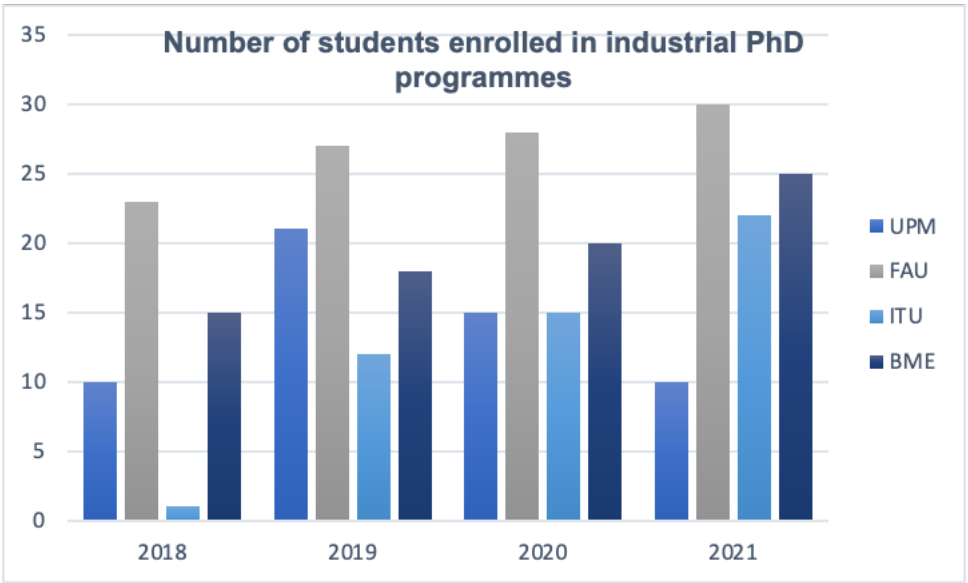

Figure 5. Number of students enrolled in industrial PhD programmes

3.2 Financing scheme of the industrial PhD programs among the stakeholders

UPM practices

- The Spanish Government has a specific National call for financing the industrial PhD programmes in the framework of the State Program for the Promotion of the Research, Development and Innovation Talent and its Employability[15]. The beneficiary of the grant is a company. The grant covers three concepts: 1) co-financing of the work contract; 2) expenses for going on secondments within R&D entities; 3) registration fee for the doctoral studies. The duration of the grant is maximum 4 years, the duration of the work contract must be minimum three years. The PhD student has a work contract with the company. The PhD student must be registered in a PhD programme.
- Madrid Regional Government has a specific regional call for the financing of industrial PhD programmes (2021 call[16]). The applicants (and future beneficiaries) must be both an entity from the academic sector to which the thesis director or co-director is affiliated, on the one side, and a company, on the other hand. Both entities must sign an agreement which is to be submitted together with the application. There must be one application per doctoral thesis project. The beneficiaries must have a PhD

[14] https://ec.europa.eu/research/mariecurieactions/actions/doctoral-networks
[15] https://www.aei.gob.es/convocatorias/buscador-convocatorias/ayudas-contratos-formacion-investigadores-empresas-14
[16] https://mcyt.educa.madrid.org/uploads/O.80CONVOCADOCTORADOSINDUST.pdf

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candidate for the thesis project. The duration of the grant is at most three years. The grant will be used to cover enrolment fees, hiring, equipment, consumables, travel and accommodation and other expenses. The maximum grant amount for the PhD thesis project for the academic partner is 30,000 €. In addition to this, the company receives a grant for the salary of the PhD candidate. The salary of the PhD student must be minimum 25,000 € per year (TOTAL COST including social costs) The grant will be used to partially cover the cost of the work contract, up to 20,000 € for small companies and to 15,000 € for big companies, the top-up must be provided by the company. The PhD student will be hired by the company and not by the academic partner. The contract must be a work contract, full-time, with exclusive dedication, with a minimum duration of three years. In the last call, UPM got 28 contracts awarded (results of the last call 2021)[17].

- UPM is also taking part of the SDGine project, a 60-month H2020 COFUND project funded by the European Union under a Marie Sklodowska-Curie grant. With an overall budget of 1,952,640.00 €, the action will run from 1st October 2020 to 31st September 2025. SDGine gives 12 Early-Stage Researchers the opportunity to complete International Industrial Doctorates at UPM. The researchers will enjoy a 36-month employment contract to complete a PhD degree co-supervised by a UPM professor and an industrial supervisor from one of the companies that are participating in this project. SDGine has special rules being different from the standard industrial doctorates, e.g. in this case the work contract is signed between the PhD student and the university instead of the company. In addition to this, the company can finance the industrial doctorate itself without having a grant.

ENPC practices

Today, the Ecole des Ponts has 185 PhD candidates registered in our doctoral programs. Among those candidates:

- 96 are directly financed by the Ponts, via national public funding.
- 29 are financed via industrial partnerships. In France, the most common program for industrial funded thesis is called CIFRE. The candidate is hired by the company, but fully dedicated to his/her PhD thesis under the advisory of a Professor of Ecole des Ponts. The company receives a financial consideration from the national research agence (ANRT).
- 23 are financed via industrial partnerships with public organisms. In this case, the candidate is an employee of one of these institutions, but the CIFRE disposit is not applicable (since they are not private companies).
- 11 international candidates, financed via international fellowships programs (such as China, Colombia, Brazil).
- 12 government officials, paid by the national administration.
- 14 without funding, usually working in a private company but without any relation with their PhD project.

[17] https://mcyt.educa.madrid.org/uploads/documents/resol._definitiva_admitidos_exc._ddii_2020_20324287.pdf

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FAU practices

The funding schemes are coordinated among the cooperation partners within and outside our university and tailored to the specific needs of the respective project. A whole range of different variants are implemented at FAU, ranging from non-material cooperation and mixed funding to fully industry-financed projects.

ITU practices

For the ITU-ASELSAN program, students do not receive any extra funding since they already receive compensation for working full time at ASELSAN. Professors who are willing to propose and teach specific courses for the ITU-ASELSAN program receive extra payments based on the hours they spend on the program. The same applies to thesis advisors who are willing to advise students in the work on addressing technological challenges that are critical to ASELSAN. Although the program does not involve any extra funding for research, faculty members who participate in the program usually sign additional contracts with ASELSAN to conduct larger-scale research (with additional funding) which involves cooperation of ASELSAN engineers and ITU researchers. Hence the program can be seen as a gateway for large-scale scientific collaboration between ITU faculty/research centres and ASELSAN.

For the TUBITAK 2244 program, 75% of the scholarship fund is provided by TUBITAK and the remaining 25% is provided by the industrial partner, for the entirety of the student's PhD studies.

SNS practices

Companies can fund a PhD student under the specific University's regulation for PhD financed by private entities, which rules companies' obligations, amount to be transferred, taxes to be paid, IPR regulations.

SSSA practices

The Scuola Superiore Sant'Anna collaborates with organizations and companies interested in developing joint training and research activities on topics of common interest through the funding of one or more PhD scholarships. Institutions or companies can finance scholarships related to PhD courses activated by the School. Relations between the School and the company are regulated by a specific agreement. The grants financed by the companies will be awarded competitively and regulated according to the current provisions of the law.

The amounts of the scholarships are defined by the bodies of the School in accordance with current legislation.

The course also includes a period of training at the company that financed the grant and periods of study abroad; for these periods, which cannot exceed half the duration of the doctoral course, the amount of the scholarship is increased by up to 50%, also subject to the INPS contribution.

The external lender, both public and private, is required to cover the following costs: scholarship for the duration of the PhD Course (3 or 4 years); 50% of the annual amount of the scholarship for the stay abroad; 10% of the annual amount of the scholarship, for two years, intended for the student for the research budget; cafeteria; overheads; other variable costs.

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UPB practices

In an industrial PhD at UPB, the student usually works on an applied research topic in a specific domain that benefits the funding company and contributes to its industrial development in a direct (working in companies) or indirect way. This is a real advantage in which the PhD student is involved in real industrial problems, which expose the student to the real challenges in design, development, manufacturing, even marketing. The financing scheme can follow several models: (1) directly to the students from companies as a scholarship; (2) through a cooperation agreement between companies and doctoral schools; (3) as material support for PhD studies (equipment, licenses, publication and travel costs, different costs); (4) as institutional support (sponsorship) from companies to universities, direct or by support to specific laboratories or to research activities.

BME practices

The Cooperative Doctoral Program is financed by the state, by the Ministry of Innovation and Technology (Managing Authority) and handled by the National Research, Development and Innovation Fund through the National Office for Research, Development and Innovation (Managing Authority).

Within the framework of the application, the student with a cooperative scholarship will receive a net monthly grant of HUF 400,000 (~1120 EUR). The supervisor and expert who assists the scholarship holder and contributes to the implementation of the application will also receive a prize. Its gross value is HUF 240,000 / month (~670 EUR). Since PhD students belong to accredited Doctoral Schools, the school will also receive a grant of HUF 1,300,000 / semester (~3640 EUR). The latter can be used primarily for supporting research, development and innovation (RDI) activities by infrastructure development, international relations, knowledge transfer and related services.

Industrial partners finance projects and support the infrastructure development.

PSL practices

- National public scheme: CIFRE (Industrial Agreement for Training through Research).
- European funding COFUND awarded to the University: Ex. Artificial Intelligence for the Sciences (AI4theSciences) doctoral program | PSL[18]
- European and regional funding : Ex. Paris Region PhD 2021 | Région Île-de-France (iledefrance.fr) (in French)[19]

3.3 IP rights between the company and university

UPM practices

For industrial doctorate, there must be a framework agreement between the company and the academic partner plus a specific agreement (normally an annex of the framework agreement in which the IP rights are specified, as follows:

[18] https://psl.eu/en/research/major-research-projects/european-programs/ai4thesciences-doctoral-program

[19] https://www.iledefrance.fr/paris-region-phd-2021

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- Intellectual and industrial property: If results might be granted patent protection, software registration or other industrial property titles, the candidate will be named as the inventor. Likewise, co-directors of the thesis and other participant researchers that have actively participated in the outcome of the results will also be named as co-inventors. Distribution of authorship among them will be granted in the proportion they determine themselves.

  Intellectual property rights entitlement will be analysed on a case-by-case basis according to the nature of the works, percentage of funding between the parts, previous subscribed contracts and the participation of the researchers. In case researchers are UPM's teachers, they correspond to the university. In any case, authors/inventors of the work will be acknowledged authorship in any giving dissemination or registration of the results while actions will be taken according to current legislation as well as UPM'S Intellectual Property regulations.

- Confidentiality: In case the parts agree to sign confidentiality agreements or the possibility to generate patents from the content of the thesis, the Doctorate Program Academic Commission will request the confidentiality of the thesis to the UPM's doctorate commission.

- Dissemination of results: According to the UPM doctoral regulations, for a thesis to be processed for admission either its results should be published in prestigious scientific journals or existing patents on exploitation should be demonstrated through contract of sale or license. For the dissemination of these results, the candidate's identity should figure with his/her affiliation with the company or Public Administration and the UPM, regardless the industrial property. The Centre responsible for the doctorate program should validate the progress in the results before the doctoral thesis is handed while being the UPM doctorate commission properly informed.

  If doctoral candidates subject to this agreement are willing to use partially or fully the results of their performance to publish them in the form of an article, conference, memoir, or any other way, they must ask for written consent of the parts, who are compelled to respond giving their consent, reservations or disconformity within two-month time. If the parts do not take a decision within this period, this will be interpreted as a tacit acceptance for its dissemination.

ENPC practices

IP rights are defined case-by-case. In case of private funding, IP is shared between the Ecole and the industrial partner, including patents and royalties.

FAU practices

The IP agreements with our partners vary form case to case. In these FAU follows – and has to follow – the principles and regulations of superior law restricting the scope of a German public university.

ITU practices

For the ASELSAN-ITU and TUBITAK 2244 programs, there are no specific agreements on the IP that is related to thesis work done by the students. If there is a viable IP, every thesis/research output is investigated separately on a case-by-case basis.

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ITU technology transfer office (TTO) has a significant experience for handling IP rights between companies and ITU. There are different models that were executed successfully in the past. The most restrictive model is transferring all IP rights to the company while ensuring that the company will be the sole user of the IP and will not license the IP out to other entities. An alternative model lets the company license the IP to other entities, while making sure that ITU benefits from the revenue generated by the IP. The usual agreement is a fixed payment + % of the revenue generated by the IP. This income is later distributed between the TTO, ITU and the ITU researchers that are credited as the inventors of the IP.

SNS practices

The agreement between SNS and the private investor stipulates that

- The school has the ownership of the intellectual property - exclusive or at least joint - of the research results, with the possibility of granting economic exploitation to the Funder against the expenses for the protection of industrial property (and reimbursement to the school of those already incurred for deposits, maintenance, etc.) and any royalties and guaranteed minimums (onerous license).
- In the event of transfer of its share of intellectual property rights to the Funder, the School is always entitled to a free and exclusive license for the sole purpose of research and/or study of the results of the project.
- The regulation of intellectual property considers the inventive contribution of the parties.
- The SNS supervisor and the corporate supervisor of the Funder define a shared research activity program, to prevent any possible doubt about the traceability of the research results.
- The PhD student that has materially contributed to the achievement of an invention has always the moral right to be included among the inventors in the patent application or to deposit other industrial property rights.

SSSA practices

Generally, the student's PhD thesis, as well as any other work proposed for printing and deriving from the funded research activity, must be sent to each of the parties in advance of the date of publication, to allow the school and the industry to verify that these documents do not contain confidential information that the parties do not intend to disclose, or results susceptible to protection through intellectual property rights.

All scientific publications produced by the PhD student who benefits from a grant funded by an external body must indicate their affiliation with the school and the funding body.

The intellectual property of the research results deriving from the activities carried out by the PhD student is shared between the parties based on the inventive contribution and the economic and instrumental contribution of each party.

Regarding confidentiality, the school requires the PhD student to sign a commitment of secrecy and respect for the discipline of intellectual property referred to in the Internal Regulations of the School.

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UPB practices

Intellectual property (IP) refers to both the research and teaching aspects in universities and usually are negotiated in industrial collaborations. UPB's university IP policy is a formal document which deals with:

- ownership of and right to use the IP, that usually is split between a company and a university (the final products can be used by the company and the artefact as theoretical result is used by university in other research projects),
- procedures for identification, evaluation, protection and management of IP (like software, hardware, platforms, publications, pattens, press releases, web sites, social media presence),
- procedures for cooperation with third parties in the case the final product can be used or extended in other collaborations,
- guidelines on the sharing of profits from successful exploitation (usually the profit obtained by companies can be used to support new PhD students),
- mechanisms to ensure respect for third-party IP rights.

The framework agreement between business and academia can be established directly in several scenarios: general terms, specific terms related to specific projects, institutional agreement, personal agreement, etc. IPR is especially relevant for the student's publications in connection with the PhD education.

BME practices

The Cooperative Doctoral Program handles IP questions in the contracts: contract between the Company and the student (employee), and also the legal relationship of the PhD student to the Doctoral School (i.e. the University). In company-university contracts we follow the IP regulations of the company, the IP related law and the Intellectual Property Management Policy of the Budapest University of Technology and Economics[20].

PSL practices

IP rights management are dealt on a case-by-case basis. PhD recruitment is usually part of a bigger contract with the industrial partner (to include research costs, overheads, other aspects).

[20] https://bridge.bme.hu/wp-content/uploads/2020/10/8-2020-RKKU-BME-IP-Policy-EN2_clean26.pdf

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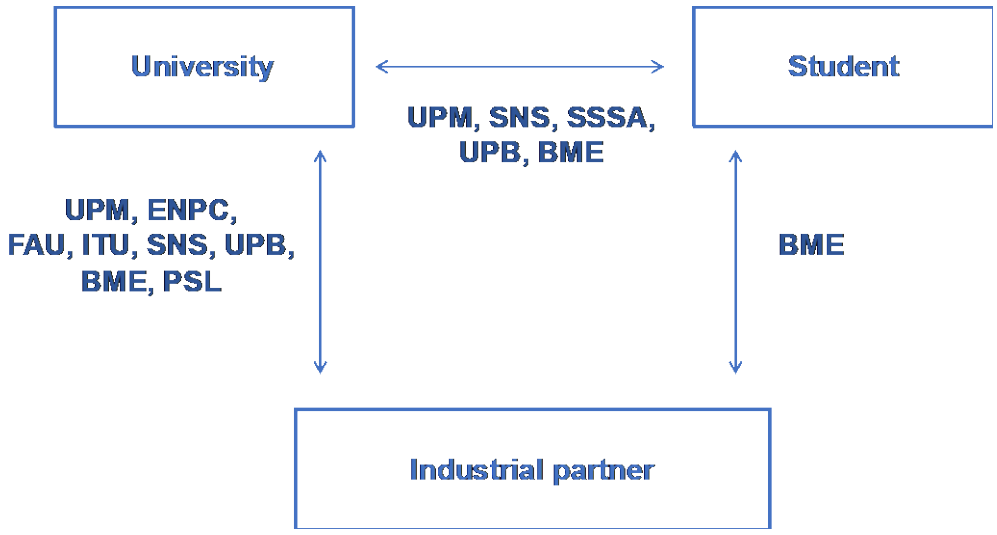

Figure 6. Contracts between the University, Student and Industrial partner

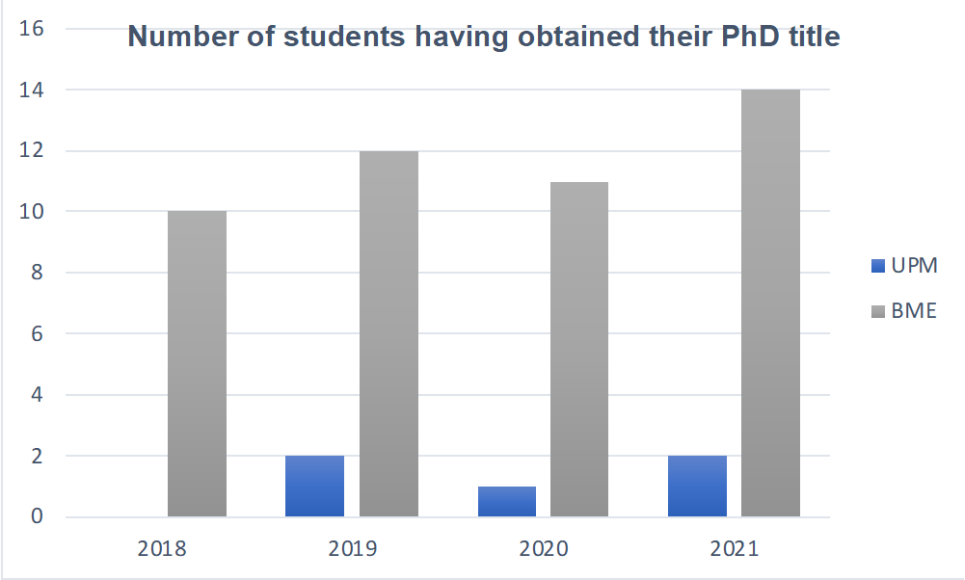

Figure 7. Number of students having obtained their PhD title

3.4 Requirements about industrial utilization in the PhD programme

UPM practices

In UPM, there is no specific utilization requirement, however, the completion of a doctoral thesis happens within the framework of a research project at the Company or Public Administration.

For being granted a PhD, as a general requirement, the results of the project must be either published in a prestigious scientific journal or existing patents on exploitation should be demonstrated through contract of sale or license. The same requirement applies for the industrial doctorate: prestigious publication or patent/licence.

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In addition to this, the time spent by the doctoral candidate on preparing the thesis must be distributed between the Company or Public Administration and the University, so that completing the doctorate program on time will be feasible. However, there is no fixed/specific distribution of the time, but this is agreed upon in the agreement.

The doctoral candidate shall be assigned a UPM TUTOR appointed by the Doctoral Project Academic Commission (hereafter DPAC); a SUPERVISOR appointed by the Company or the Public Administration; a DIRECTOR or two CO-DIRECTORS of the Thesis, who might come from both the University or the Company/Public Administration. The co-directors might coincide with the TUTOR and the SUPERVISOR if they are doctors and comply with the requisites established by the doctorate regulations.

FAU practices

Generally spoken, exploitation rights are typically subdivided between parties. While the doctoral candidate holds exploitation rights for his or her thesis, exploitation of the specific project result is given to the industrial partner and the university is authorized for the use in Research and teaching.

ITU practices

There are no explicit requirements for the ITU-ASELSAN program, however, in practice since the outputs of these target key technological problems of the company, they become utilized in the company in various capacities.

For the TUBITAK 2244 program, the industrial partner agrees to employ the PhD student after their graduation for at least a period of 36 months.

SNS practices

The regulation industrial utilization and economic exploitation of IPR has to take into account the inventive contribution of the parties.

UPB practices

Industrial utilization in the PhD programs usually considers the use of industrial products in academia, so the corresponding practices refer to: free using of products (hardware or software) only for the research projects where the PhD students are involved; participation in specific events organized by companies. The main scope is to support research, development, and innovation in the public sector through focused and application-oriented research projects proposed by companies by offering support. The finality of these practices is focused on building excellence networks (public-private) and supporting an exchange of knowledge between public sector organizations and university and research institutions. Usefulness for the doctoral schools and universities can be seen by improving efficiency, knowledge consolidation that directly improves the universities competences, systematic knowledge and results dissemination, strengthening the quality of the product/service/research results provided by both companies and universities.

BME practices

Typically, exploitation rights are divided between the parties. The PhD student and his research group (supervisor and group members) hold exploitation rights for his or her scientific

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results. The exploitation of the specific project results is given to the industrial partner and the university is authorized for its use in further research and teaching.

3.5 What would be the best scheme of industrial PhD for companies

UPM view

We consider industrial PhD degrees as one of the instruments supporting and fostering collaboration between academia and the non-academic sector. There are not different "schemes" for industrial PhDs, at least for UPM/Spain, where industrial PhDs are regulated by law and must comply with the regulation (Spanish law RD 99/2011[21], particularly article 15 bis) and requirements as explained above.

Considering industrial PhD programmes as part of the range of instruments supporting the collaboration between academia and the non-academic sector. The number of industrial PhDs is linked to the functioning of the rest of instruments supporting industry-academia collaboration. The stronger the collaboration under the other instruments, the more possibilities of having industrial PhDs. Industry-Academia Collaboration Instruments/ Schemes:

Private funding:

- *Private agreements and contracts* with the business sector: contracts where universities provide a scientific, technical, or consulting service to a company against payment (Consulting and Technical Assistance, Technological Support, R&I projects).
- *Industry-University Chairs* (I-U Chairs) are strategic and long-term partnership between companies/institutions and the University to carry out education, research or knowledge transfer activities in an area of common interest.
- *Joint Research Units.* A Joint Research Unit is a structure, which is set up by different higher education and research institutions (both public and private) by pooling human resources and equipment based on a joint strategy and common scientific project.
- *UPM communities.* Research communities are new research structures promoted by UPM. Research communities are meant to be interdisciplinary cross-cutting research spaces linking the traditional research structures of UPM (groups, institutes, and centres) with external stakeholders around transversal challenges.

Public funding: Public-Private Partnership instruments deployed by means of European and National projects.

ENPC view

ENPC sees 2 options to create an industrial collaboration model in EELISA:

- Option 1: Central agreement between the industrial company and one EELISA member (usually the one in the same country of the company's head office) + cooperation agreement between EELISA institutions including students' mobility and financial flows between institutions.

[21] https://www.boe.es/buscar/pdf/2011/BOE-A-2011-2541-consolidado.pdf

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- Option 2: Local agreements in each country between each EELISA member and the local subsidiary + mobility agreement between EELISA institutions.

FAU view

Schemes have to be flexible to allow different individual settings depending on the industrial sector, company size (SME vs. global player), specific objective and individual capabilities and resources.

ITU view

Based on our experience, ITU believes that the best practice is a combination of specialized programs (such as the ITU-ASELSAN program) and large-scale university-industry research collaborations that involve full-time ITU researchers, as well as engineers/researchers from the industry. Developing collaborative educational programs helps companies to improve the quality and productivity of their personnel, but long-term research problems cannot be solved by only educating the company engineers. For that reason, complementing these educational programs with research grants that enable ITU faculty and other students to work together with the company engineers is of critical importance.

UPB view

The best scheme for companies requires strong collaboration with people from universities (PhD coordinators), having signed institutional collaboration agreements. Having these, the selection process of students, the coordination and final examination can involve both companies and universities. The company may be involved in admission phase, can select proper students that have requirements needed by the company. Then, a mentor from the company must be in contact with the PhD advisor. The goal is to have a research program on the industrial PhD that is assessed by its broader use to society that considers the dissemination to other similar organizations of specific results and improving the conditions for the business sector. A specific company should be oriented to obtain dependable products, to patent the products, by using the academic knowledge. Some problems that appear in the industrial sector have no immediate in-house solution, so the collaboration with academia must be part of this collaboration scheme.

BME view

Extension of the Cooperative Doctoral Program would provide a useful program for the industry. Only companies with strong research development departments are allowed to be part of the program. The industrial advisor should also have a PhD to keep the program at scientific track. A strong review process must be in place to involve only those projects in the program which have both scientific and industrial relevance.

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3.6 Possible sharing PhD students among each other

UPM view

For the time being, the only way is the co-tutelle, which implies the corresponding agreements, which in turn must be aligned with the applicable local laws and regulations.

FAU view

Different models for cooperation and "sharing" doctoral researchers may be put into practice. This ranges from guest researcher visits and sandwich doctorates to European Doctoral Networks (MSCA) and Binational joint doctorates ("Cotutelle de these").

SNS view

The most suitable instrument for sharing PhD students among EELISA partners is to make Institutional agreements within EELISA Consortium.

SSSA view

At SSSA it is not the industry that selects its students, but the PhD candidates are assigned to the funding Industry based on their research project. PhD candidates, in fact, are requested to present a research project and once they win a position, they are assigned by the School to one the Industry which has provided the funding but it is not allowed to choose among the PhD students which one to host.

For the performance and development of research training activities the industries host the PhD students and provide the advanced equipment and the technical-scientific assistance of the staff present in their structures and laboratories. The students will be taken in charge by an external tutor and will be affiliated to the industry.

The School, in particular the research Institute that manages the doctoral course, as the administrative headquarters of the course, is in charge of all the administrative and managing aspects concerning the admission competition, the PhD Course, the obligations to which the doctoral students are subject up to the title and provides the facilities and staff for the development of the training activity, in particular the educational courses and related training events (Seminars, Workshops, etc.).

The Institute notifies to Industry the fundamental steps of the PhD curricular process and in particular: admission to the course, indicating the name of the student; admission to the second and third year; admission to the final exam and its outcome, indicating the title of the thesis.

The Institute provides the insurance coverage for accidents and third-party liability.

UPB view

Open Science makes science and research more efficient, reliable, and responsive to different challenges (coming from the academic sector, the industry, the society, the cultural sector, etc.). The transition to Open Science is a multidimensional and multistage process, so the involvement of companies is very important to support it. Open Science helps PhD students to always be connected to existing achievements and to efficiently use results that already have been implemented. Furthermore, Open Data allows the sharing of research result to reproduce scenarios and testing environments, to be utilised for formulating new research premises.

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Companies can have issues with the IP side, but opening it can be done partially, based on what the current legislation allows. Moreover, the existence of portfolios of results and good practices is part of the knowledge and result sharing scheme towards other PhD students.

BME view

Dual PhD degree programs between two universities can be the way to share PhD students. E.g. BME currently has 9 dual degree PhD program. Similar programs can be set up by EELISA member universities.

3.7 Summary and synopsis of possible joint actions

The joint elements of the industrial PhD programs are summarized as follows:

Studies and requirements

- The PhD students participate in an industrial research project, or an experimental development project directly linked to the topic of the PhD thesis and the project is implemented in a private company or a public administration office.
- The main goal of the industrial PhD programs is to increase the workforce of the companies in the field of research and development and innovation, primarily in the fields of mathematics, science, engineering and informatics, who wish to increase their professional knowledge with the latest scientific research results and committed to the social and economic exploitation of their knowledge. In this way, industrial PhD can contribute to and expand the skills of deep tech companies.
- There is a work contract or commercial contract between the PhD student and the private company or public administration.
- The industrial PhD students have double supervision, i.e. both university supervisor and a company supervisor.
- There must be an agreement or framework agreement between the institutions (university and company)
- Universities are not supposed to distinguish industrial PhD students from other students, i.e. the industrial PhD students must go study according to the same curriculum and the same degree requirements are to be met which er required from the standard PhD students. The conferred PhD degree is identical with the one issued for the standard PhD students.
- Industrial PhD programs and participants of these programs (doctoral candidate, supervisors, company, university) are usually financially supported by eighter the industrial partner or by various grants provided by the government or other agencies.

IP rights between the company and university

- For industrial PhD students, there is an agreement between the company and the academic partner that handles IP related questions: e.g. (i) intellectual and industrial property, (ii) confidentiality, and (iii) rules related to dissemination of results.

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- In these agreements, universities follow the principles and regulations of the national law restricting the scope of a (public) university.

Utilization of results

In general, there is no specific utilization requirement posed to the results of the PhD program, however, the completion of a doctoral thesis happens within the framework of a research project at the company. Exploitation rights are typically subdivided between parties. While the doctoral candidate holds exploitation rights for his or her thesis, exploitation of the specific project result is given to the industrial partner and the university is authorized for the use in research and teaching.

Proposed joint actions

- Partners in the alliance without industrial PhD program can use the building blocks listed above when deciding about launching a similar program.
- Cross-supervision of industrial PhD students participating in a company in one of the countries of the alliance and providing academic supervision by a university form another country of the alliance. In. this way EELISA InnoCORE can better provide for the companies' needs in the case locally missing expertise.

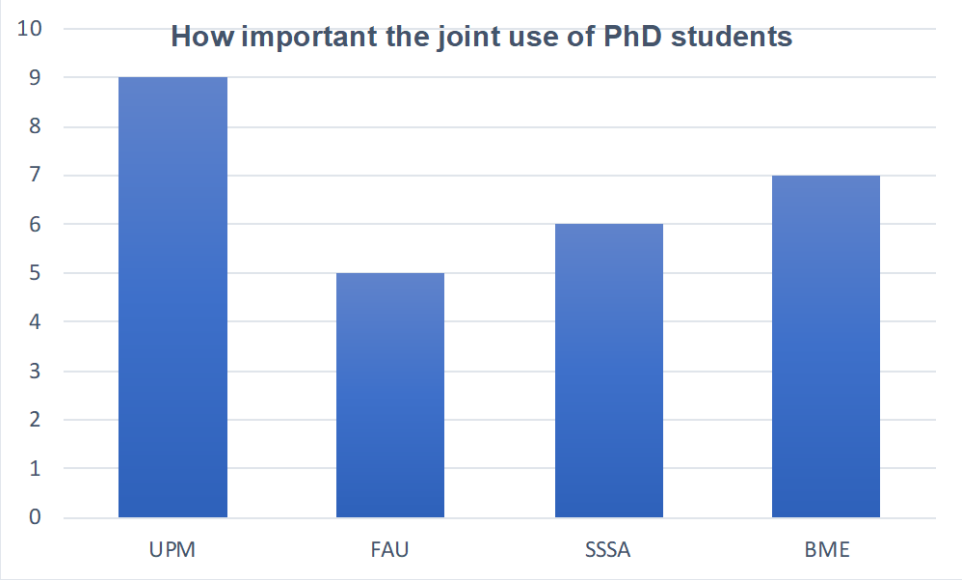

Figure 8. A scale from 0 to 10 how important the joint use of PhD students, e.g. in dual degree programs, possible project involvement

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4 Strengthening resources for technology transfer within the EELISA network

The topic of the chapter is related to Task 6.1 *Strengthening resources for technology transfer within the EELISA network*. The main function is to create a relevant service-portfolio to support utilization of the intellectual products, coordinate the management of intellectual property rights and their protection. These two types of university functions and activities - improving research potential and management of intellectual products - will be integrated and will support each other in the future.

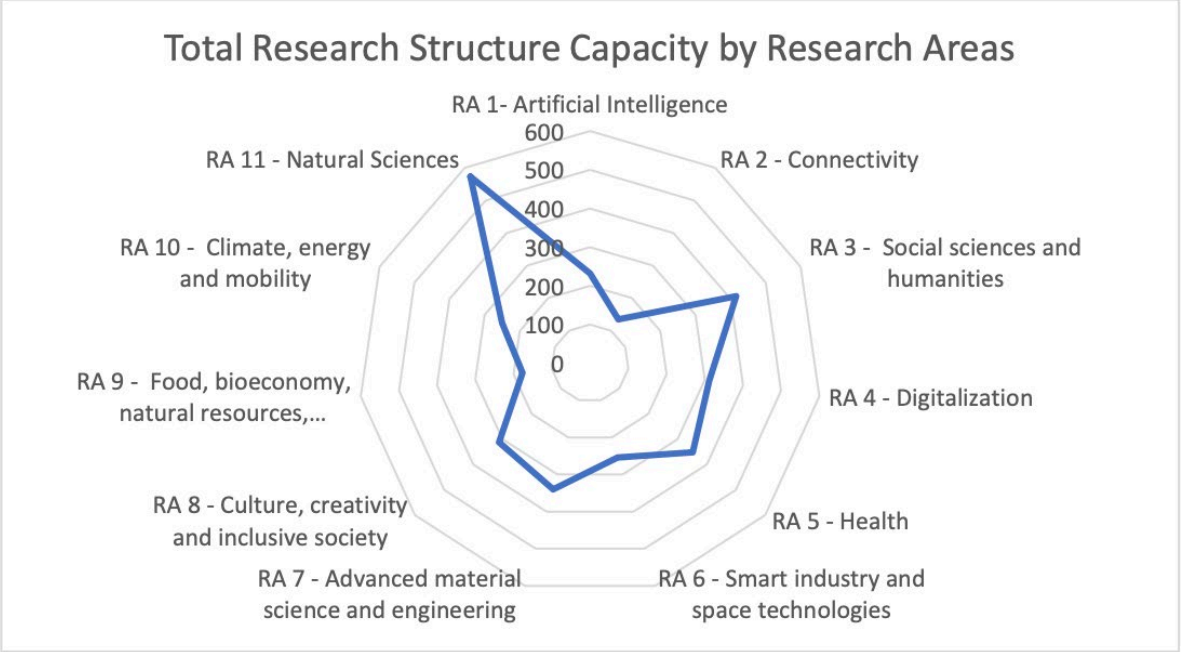
This chapter focuses on three topics, processed in separate sections:

4.1 Research areas of mutual interest
4.2 Knowledge sharing methods
4.3 Methods for joint ecosystem exploitation

Finally, we summarize the key messages and suggest some actions.

4.1 Research areas of mutual interest

During the kick-off meeting and according to the work of WP2, using a bottom-up approach, EELISA partners identified a series or key research lines and topics that were grouped in **11 EELISA Strategic Research Areas**[22]: 1) Artificial intelligence, 2) Connectivity, 3) Social sciences and humanities, 4) Digitalization, 5) Health, 6) Smart industry and space technologies, 7) Advanced material science and engineering, 8) Culture, creativity and inclusive society, 9) Food, bioeconomy, natural resources, agriculture and environment, 10) Climate, energy and mobility, and 11) Natural sciences, according to the following figure (EELISA InnoCORE strategy document, InnoCORE project deliverable 2.1):



[22] EELISA InnoCORE strategy document, InnoCORE project deliverable 2.1 (28 February 2022)

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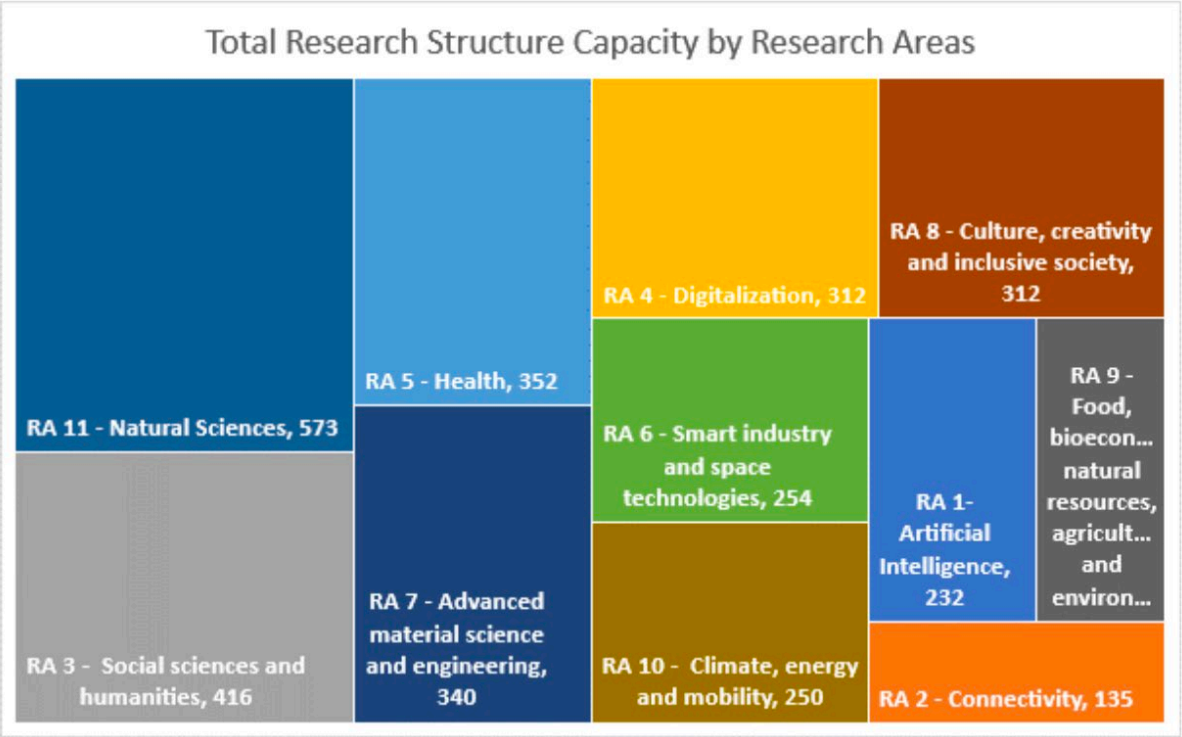

Figure 9. EELISA Strategic Research Areas

Universities in EELISA alliance cover a wide range of R&D areas, therefore, there is a more detailed list of possible cooperation fields:

1. *Artificial intelligence, High Performance Computing:* Intelligent environment and e-technologies; Smart cities; Autonomous systems/vehicles; Robotics; Digital manufacturing; Big Data; Data science; High Performance Computing.
2. *Connectivity:* 5G, beyond 5G communication; Telecommunications; Next-generation wireless communications; Security, defence and disaster resilience.
3. *Social sciences and humanities:* Digital humanities; Urban economics (city as a system); Social and economic transformations; Innovation management; Human-centered urban design; Security; Economics and management; Governance and organization of cities; The World of Work; Political sciences.
4. *Digitalization:* Digital technologies, quantum technologies; Digitalization; Information & Library Science; Modelling, optimization; Digital transformation.
5. *Health:* Health and wellbeing; Bio based innovation systems in the EU Bioeconomy; Biotechnology, health and environment protection, Medicine and life sciences; Medical engineering.
6. *Smart industry and space technologies (Engineering Sciences):* Electrical engineering; Power engineering; Systems engineering; Computers and information technology; Electronic engineering, telecommunications and information technology; Mechanical engineering; Industrial engineering; Transport engineering; Aerospace engineering; Engineering and management; Materials engineering; Environmental engineering; Chemical engineering.

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7. *Advanced material science and engineering:* New construction approach (eco materials, recyclability, innovative structures); Advanced materials; Biomaterials science; Nanophysics, nanotechnology and materials science; Safety engineering; Materials, industry and circular economy; Disaster prevention: engineering methods; Engineering, Multidisciplinary; Space technology; Optics and optical technologies.
8. *Culture, creativity and inclusive society:* Social innovation, open science, governance.
9. *Food, Bioeconomy, natural resources, agriculture and environment:* Bioengineering and bio-based innovation systems for bioeconomy; Food Science & Technology; Plant biotechnology and agricultural sciences; Biotechnology, health and environment protection; Natural resources; Bioeconomy, biotechnology and food systems.
10. *Climate, energy and mobility:* Climate change and its impact; Energy supply & storage; Sustainability, sustainable energy; Transportation & Smart mobility; Energy and New Generation Rail Systems; Energy systems and grids; Technical design of sustainable cities; Mobility; Data science for lowering CO2 emission from high performance computing.
11. *Natural Sciences:* Physics; Chemistry; Mathematics; Archeology.

These lists are important as joint RDI action can be born out of the items indicated above.

4.2 Knowledge sharing methods

The key to concentrated actions is proper knowledge sharing. The suggested knowledge sharing methods are meetings, workshops, electronic forums held in the cyberspace. Since Technology Transfer Offices or the rectors' offices of the universities handle the RDI portfolio of the given university, often they maintain the detailed competence maps and database. Therefore, it is suggested to involve these offices into the organization of the knowledge sharing events.

Methods for knowledge sharing:

- EELISA, EELISA InnoCORE meetings and symposiums, for example "EELISA innovation and entrepreneurship initiative" workshop,
- Joint research seminars related to common RDI topics. Ideally presenters are from several universities,
- Thematic RDI workshops,
- Workshops on technology transfer and knowledge management,
- Mobility of the researchers,
- Utilization of already working network services where one or more EELISA partners are active with an appropriate experience,
- Up to date online platform available within the alliance: websites, intranet, knowledge sharing platform, partner/researcher finding,
- Strengthening foreign language curricula,

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- Permanent collaboration with the economic and social environment, involvement in the implementation of policies and strategies at regional and national level, through university specialists.

The participating institutions must develop a plan and schedule how to implement these elements in the year 2023.

4.3 Methods for joint ecosystem exploitation

The goal of EELISA alliance is to benefit from the common work of universities. There are several well working methods and practices already applied by member universities. However, the key question remains how to benefit from the alliance, how to share best practices in a way that not only to learn from each other but establish common processes and achieve more via the common efforts. The identified methods towards the joint ecosystem exploitation:

- Understanding and mapping of ecosystem at each partner institution (EELISA main project, other WPs of InnoCORE project and Unfolds project already work on it),
- Thematic workshops to identify synergies and common opportunities,
- Cooperation of Technology Transfer Offices within the EELISA alliance: discussing and sharing methods and practices related to IP protection, startup (accelerator and incubation programs/services) and spinoff companies, furthermore, move to market activities (competencies and laboratory capabilities/capacities). This point is strongly related to Unfold activities.

4.4 Summary and synopsis of joint action

EELISA partners identified a series or key research lines and topics that were grouped in **11 EELISA Strategic Research Areas.** Universities in EELISA alliance cover a wide range of R&D areas, therefore, here we introduced a detailed version of possible cooperation fields.

Knowledge sharing methods apply meetings, workshops, various forums. Technology Transfer Offices or the rector's office of the universities handle the RDI portfolio of the given university, often they maintain the detailed competence maps and database. Therefore, it is suggested to involve these offices into the organization of the knowledge sharing events.

The goal of EELISA alliance is to benefit from the common work of universities. There are several well working methos and practices at member universities. One of the key questions is how to benefit from the alliance, how to share best practices in a way that not only to learn from each other but establish common processes and achieve more via the common efforts.

Proposed joint actions

A subcommittee can embark on organizing joint research seminars based on the 10 key topics of mutual interests:

1. *Artificial intelligence, High Performance Computing*
2. *Connectivity*
3. *Social sciences and humanities*

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4. *Digitalization*
5. *Health*
6. *Smart industry and space technologies (Engineering Sciences)*
7. *Advanced material science and engineering*
8. *Culture, creativity and inclusive society*
9. *Climate, energy and mobility*
10. *Natural Sciences*

It is important that PhD students should participate of these seminars. This may lay the groundwork for developing joint PhD courses which can then be taken for credits and attended via electronic means.

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5 Novel education programs for flexible RDI – a path towards entrepreneurial university

The topic of the chapter covers the Task 6.6 *Novel education programs for flexible RDI – a path towards entrepreneurial university*. Since the concept of entrepreneurial university can embrace student driven innovation, we must seek to implement the elements of this concept. In this regard, we analysed five topics: Implementation practices of the concept "entrepreneurial university" (5.1); Courses strengthening the entrepreneurial skills (5.2); What are the needs of the entrepreneurial world in a university (5.3); Industrial chairs supporting university-industry cooperation and path towards entrepreneurial university (5.4); Supporting contests and prizes (5.5). Finally, we summaries the key messages and suggested action points (5.6).

5.1 Implementation practices of the concept "entrepreneurial university"

Current practices cover start-up and incubation programs, methods to support spinoff companies, innovation platforms and networks, various services for inventors and IP management.

UPM practices

ActúaUPM[23] is the leading Entrepreneurship Programme among Spanish universities whose main goal is to detect innovative and/or differentiating business ideas and contribute to the formation of entrepreneurial teams, to support some of the most innovative ideas with a specific business training and to build and validate business models with social and economic impact.

ActúaUPM is a nine-month competition program for entrepreneurs – mostly students, but also academic staff, researchers, non-academic staff and alumni – who want to develop their ideas and projects from very early stages until developing an MVP, a sound business model, a comprehensive deck for different type of pitches and, eventually, incorporate them into a start-up company.

The Competition is divided into three phases:

1. Phase 1. Business ideas competition (detection, selection and promotion of the best ideas).
2. Phase 2. Development of the business model of the selected ideas.
3. Phase 3. Start-up Competition and awards.

Best practices to be learnt:

- Continuous monitoring and feedback during the nine months in which the entrepreneurs develop their business model
- 50,000 euros in prizes

[23] https://www.upm.es/Investigacion/innovacion/CreacionEmpresas/Servicios/Competicion_Creacion_Empresas

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- Training in entrepreneurship (#1 in the ranking of the European Institute of Innovation and Technology EIT Master DS and HCID)
- Network of contacts and access to the Alumni Club
- Expert mentorship

Aspects to be improved: once the process of idea validation and start-up creation is over, we need to provide them with an acceleration service and commitment to the institution.

Impact of the program:

- 309 start-ups launched so far
- More than 120 million euros of investment raised by start-ups from actúaupm
- 70% of start-ups are still active in the third year

UPM2T[24] is a 10-week on-line programme that aims to support researchers and high-tech entrepreneurs on their way to validate a successful business based on technology and get ready for launching a tech venture.

The participants tackle the key challenges you must face when validating your innovative project in terms of business value. By acquiring advanced skills, knowing new tools and approaches or getting access to our ecosystem, you will be challenged to structure your market validation while testing your value proposition. Get in touch with industry experts, investors, and entrepreneurs for a direct access to market know-how and stay connected from now on (institutional program/extracurricular). Sessions:

- Kick-off & Introduction
- Technology & Market Fit
- Customer Development
- Business Modelling
- Business Communication
- Corporates & Investors Lab
- Entrepreneurs Lab
- Demo-Day
- Workshop WIT Tech & Venture

ENPC practices

ENPC runs the structuration of a pre-incubation and mentorship internal program. Researchers and PhD candidates can apply for pre-incubation and pre-maturation services.

[24] http://upminnovatech.blogspot.com/p/upm-innovatech-2t-challenge.html

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FAU practices

The following components of the entrepreneurial university concept can be found at FAU:

1. FAU consulting services for start-up businesses:[25] The FAU Start-up Service provides aspiring entrepreneurs and young companies with sound advice. Students, staff or professors at FAU are supported both before launching their company and whilst building their business. The Start-up Service regularly invites founders and young entrepreneurs to events covering topics relevant to starting out in business and provides information on competitions for founders and start-ups.

2. FAU innovation platforms and networks:[26] FAU's innovation platforms, networks, partnerships and collaborations cover all steps of the FAU Innovation Cycle: Discovery – Development – Evaluation – Decision-making. A selection of our current partners and networks that actively support the FAU innovation cycle. Here is a selection of our current partners and networks that actively support the FAU innovation cycle:

    a. Discovering Innovation: Curiosity and dedication are important factors in innovation processes. FAU thus invites talented individuals who have a great deal of curiosity and are highly dedicated to join us in discovering innovation. The FAU Digital Tech Academy is our launch pad for all those who would like to discover innovation with us. The Digital Tech Academy is the interdisciplinary hub for digitalisation and entrepreneurship at FAU. It is based in the Office of Knowledge and Technology Transfer and Continuing Education (wtt), which is the central point of contact for spin-off services, joint R&D projects, IP management, training and event management.

    b. Developing innovations: Would you like to develop innovations yourself? Then JOSEPHS®, the open innovation lab in Nuremberg city centre, is just the place for you. JOSEPHS® offers both individuals and entire organisations an exciting range of services for innovation. JOSEPHS was set up as a project in 2014 by Fraunhofer IIS with the support of the Chair of Information Systems 1 at FAU. The aim of the lab is to discover the future and experience the creative world of product and service development. Test new ideas in our workshop and play an active role in creating and improving innovations. Your feedback is passed on directly to the companies involved.

    c. Evaluating innovations: Do you have a great idea, an initial concept, maybe also a prototype and a strong team with which you'd like to start a company? Then you should put your ideas to the 'start-up test' and have your proposal evaluated. ZOLLHOF, the digital start-up centre at FAU, is the right place for you. With the help of talented entrepreneurs, you will quickly learn how you can turn your idea into a market-ready innovation or set up your own company. The digital start-up centre ZOLLHOF offers comprehensive support to start-ups in areas such as the Internet of Things, smart city and big data. It was set up in Nuremberg on FAU's initiative. Those starting their own companies can hire open office space including infrastructure, and are given practical assistance in developing their products and services, benefiting from connections to an

[25] https://www.fau.eu/outreach/innovation-and-start-ups/successful-start-ups/
[26] https://www.fau.eu/outreach/innovation-and-start-ups/innovation-platforms-and-networks/

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extensive network of companies and entrepreneurs cooperating with ZOLLHOF. ZOLLHOF offers its own 'Student Tech Accelerator' to students, giving them the opportunity to get in touch with start-ups and corporate innovators and to actively shape innovative products for the future as a full member of their team.

d. Deciding on innovations: For when things really start getting serious, you can choose to work with professionals from large corporations and medium-sized business to develop high-performance products and processes in the context of real entrepreneurial innovation. LZE is the right place for you in this case. The High-Performance Centre builds on the many years of intense collaboration between the Fraunhofer Institutes and FAU as well as the unique concentration of research and industry in the field of electronic systems in Erlangen and the surrounding Nuremberg Metropolitan Region. Excellent research and joint planning form the basis for an extensive long-term strategic partnership between Fraunhofer, FAU and industry. The pilot phase for the High Performance Centre for Electronic Systems started in January 2015 and is funded by the Bavarian State Ministry of Economic Affairs and Media, Energy and Technology.

3. FAU partnerships and collaborations:[27] Innovation thrives on strong partnerships and trusting collaborations. FAU maintains an extensive network with impressive connections to science, business and society. Large and small, public and private, national and international partner organisations work with us on research and innovation, joint talent and professional development, on further education and life-long learning and many other projects. Collaboration projects are always based on the specific needs of our partners and our common objectives.

4. FAU service for inventors:[28] FAU has always been home to inventors. Many things we take for granted today were either invented by scientists at FAU or would not have been possible without their initial research: the MP3 format, computer tomography, the first synthetic painkiller Antipyrine, endoscopy or the hydrogen carrier LOHC are just a few of the many examples. Erlangen is known as a patent metropolis and city of inventors. Patents come from various different areas such as robotics, medical engineering, coatings and tissue engineering. On average, research at FAU leads to more than 100 inventions and more than 70 patents being registered in any given year. Since the year 2000, more than 180 science and technology-based spin-offs have been established. Do you have an invention or do you want to apply for a patent? FAU's patent management team supports inventors during the entire process from registering an invention, to applying for a patent and conducting the necessary checks, to protecting intellectual property until it is licensed or sold and organizing the associated contracts.

5. FAU intellectual property policy:[29] The autonomy of the University means that it has both the opportunity and the obligation to exploit all potential of research results in a

[27] https://www.fau.eu/outreach/innovation-and-start-ups/partnerships/
[28] https://www.fau.eu/outreach/inventions-and-patents/service-for-inventors/
[29] https://www.fau.eu/outreach/inventions-and-patents/intellectual-property-ip-policy-of-fau/

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sustainable and targeted way. This general policy can be broken down to the following components:

a. Social duty: With its strength in both fundamental research and application-oriented research, FAU has a significant contribution to make towards driving scientific and academic progress in key areas of society. FAU sees it as its duty to make this contribution, based on the principle of the freedom of teaching and research. As a university which offers the entire spectrum of academic disciplines, FAU generates knowledge in a wide range of disciplines covering the humanities, social sciences, economics, law, medicine, natural sciences and engineering. FAU strives to promote the dissemination of findings, ideas, developments and technology from all research areas, thereby contributing to scientific and academic progress. Publishing results in scientific and academic publications takes precedence over all other transfer activities. FAU also contributes to the common good of society by constantly delivering knowledge and technology which can be used as the basis for designing specific innovations. Technology transfer in this context does not only refer to invention and patent management but also to ongoing scientific training and advice on spin-offs or other such activities.

b. Claim to exploitation: Research findings generated at FAU can serve as the basis for developing innovative products, technologies and services. This means that the research findings have an inherent economic value going beyond the relevant findings themselves. This value can only be generated, however, by developing a product on the basis of the research. FAU conducts active invention and patent management in order to ensure that this value can be used for the benefit the University. FAU is aware that the process of developing a product fit for the market can only succeed in collaboration with extramural partners and that these partners will have to make further investments along the way. In order to ensure the economic viability of such investments, mechanisms for the protection of intellectual property have to be triggered in good time. The active IP policy followed by FAU therefore helps to translate the inherent value of the IP into a financial return at the same time as creating the basis for the University to share in these financial benefits whilst representing the interests of its inventors as well as possible. FAU is also keen to involve independent inventors such as students or scholarship holders and gives them an equal standing to inventors employed by the University when sharing out proceeds generated by the commercial exploitation of IP. In the long term, FAU aims to generate proceeds for the University within the framework of university autonomy. In addition to the legally stipulated remuneration for the inventor (30 percent of generated income), the Chair behind a successful invention will receive a separate share of the proceeds which it can use as it wishes for research and teaching purposes.

c. Criteria for registering IP rights for exploitation: When safeguarding research findings and their exploitation, FAU pays particular attention to the interests of the inventors and the University, whilst bearing legal requirements (ArbnErfG, UrhG, BayHSchG) in mind always. FAU recognises that it is bound by generally accepted ethical and moral constraints of science, both regarding the implementation of research projects and to the exploitation of findings

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generated because of this research. FAU takes care to ensure that safeguarding suitable research findings and exploiting them in their capacity as IP does not interfere with the researchers' freedom to publish. The University draws on the expertise of law firms specialising in patents for safeguarding potentially patentable research findings to ensure that the requirements of the various disciplines are met. Inventions created at FAU are classed as either inventions covered by contracts which are transferred to industrial partners under the terms of individual or framework contracts or free inventions not bound to any contract in which case FAU is free to decide on their commercial exploitation. Joint inventions developed in collaboration with other research institutions are also classed as independent inventions. In all instances, the patent management team at FAU is the internal service provider and initial point of contact if you are an inventor seeking advice or would like to discuss a possible patent application strategy. They should also be consulted when selecting and commissioning external patent lawyers and can provide advice on the contents, administration and performance of contractual obligations. When deciding on whether to apply for intellectual property rights to an independent invention, FAU focuses not only on criteria set out in patent law but first and foremost on the economic criteria of market relevance, options for commercial exploitation and economic potential. With regard to options for exploitation, the decision to protect the IP generated by a research project is taken after considering the extent to which value has been created or is expected to be created within the academic sphere in question. Projects which have either already reached a stage in their development or which are forecast to reach a stage at which they have the potential to significantly improve the options for exploitation ought to be protected by a suitable IP strategy, even if this means FAU has to make a long-term commitment. Another point which is taken into consideration when coming to a decision is whether the invention is potentially of interest to FAU's industrial contacts and the Network of the Bavarian Patent Alliance (as the central patent exploitation agency for Bavarian institutions of higher education). Ideally, a successful transfer into the industrial sector should take place via existing networks of inventors or via FAU's own networks. If there are no specific contacts available for any individual project, then the very least that is expected is that possible contacts in industry are identified beforehand. Close collaboration between inventors, Chairs and the project management team or BayPAT significantly improve a project's chances of exploitation.

d. Know-how and copyright: In addition to exploiting IP by applying for a patent or other protection rights, results available in the form of know-how or material can be exploited directly by being licensed or sold. The term 'know-how' can refer to items such as valuable biological material, for example hybridoma cell lines used to produce monoclonal antibodies for scientific purposes, transgenic cell lines or organisms. The results protected by copyright can be rights to texts or images, or computer software. Along the lines of the remuneration paid to inventors, FAU also provides remuneration to scientists involved in generating results protected by copyright amounting to 30 percent of net proceeds. FAU makes all research results available to society in detail and without delay in the

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form of academic publications, irrespective of their potential for commercial exploitation as intellectual property.

e. Principles of exploitation: When deciding for commercial exploitation, FAU will pay consideration to the benefit to society as a whole and will prioritise this over short-term financial gain. If it becomes apparent that an invention is likely to be of particular significance, the University will choose non-exclusive arrangements over an exclusive contract to meet its obligations to serve the common good. In cases in which it is apparent that a prospective interested party does not have any genuine intention to develop the invention further and merely intends to restrict free competition (blocking patent), FAU will choose not to conclude a contract with this interested party. Inventions in military and arms technology, nuclear technology and secret communications engineering are a special case. In these instances, FAU will take a stance in each individual case after internal consultations. A statement is drawn up by the patent management team and submitted to the Executive Board which takes the decision. The inventor must refrain from publishing until a decision has been taken.

f. Exploitation routes: There are various routes which can be taken to make IP available for commercial exploitation, each of which entail opportunities and risks. Contractual obligations vis-à-vis third parties, third-party rights and other factors relevant to the inventions are taken into consideration accordingly. IP is transferred from FAU to the respective partners at normal market conditions applicable to the specific product environment. FAU retains in all instances a simple, indefinite right of use for research and teaching purposes. The freedom to publish remains unaffected, and legitimate interests of third parties shall be taken into consideration accordingly. IP rights belonging to FAU can be exploited via a licence or purchase contract. When arranging exploitation, the fair market value of the IP rights is taken as the basis for agreeing conditions, whereby FAU will strive to obtain a long-term participation in the invention's commercial success, which is also in the interests of its inventors. In addition, the financial expenditure for the patent application procedure should be re-financed with the proceedings from a patent sale or licence agreement.

g. Spin-off based on the invention: FAU explicitly encourages the establishment of companies (spin-offs or start-ups) based on the research results to drive their implementation into products ready for the market and thereby create jobs. Future-oriented, technology-based spin-offs and their financing by investors are based mainly on inventions and property rights. FAU will choose the route of transferring IPR in return for participation as a minority shareholder in order to get the best possible return from the IPR assets. Alternatively, the University will grant the right to use the IP by issuing a licence to the founding company. Within the framework of its legal possibilities, FAU will take the limited financial resources of university-based spin-offs which are just starting out into account in favour of a later participation in their success. FAU shall also stand by this principle if it becomes necessary to sell IP, for example within the context of financing rounds.

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ITU practices

With a long history in engineering education, ITU has been a prominent institution for 250 years. The presence of a science park in the main campus since the early 2000s has presented opportunities to adopt and nurture entrepreneurial perspective for ITU. The strategic plans (dating back to 2010s) and recent accreditation (ABET) documents are evidence of the dedication of the University in building and implementing entrepreneurship-driven institutions and mechanisms. ITU has been ranked third among the most entrepreneurial and innovative universities of 2021, after METU and Sabancı, with a score of 72.5. "Entrepreneurial and Innovative University Index" has been prepared for ten years by The Scientific and Technological Research Council of Turkey (TÜBİTAK).

At ITU campuses, there are different environments and support mechanisms at every step from the initial business idea stage to the stage of competition with the business model in related industries. ITU Çekirdek (ITU Seed- pre-incubation center), ITU Magnet (incubation center and acceleration program), ITU Seed Global, ITU Technology Transfer Office are all institutions supporting entrepreneurial activities. ITU GINOVA Entrepreneurship and Innovation Center is founded in May 2014 as the campus link of this entrepreneurial ecosystem. The Center aims to build bridges among the stakeholders of ITU entrepreneurship ecosystem such as incubation centers, technology transfer offices, student clubs, research centers. Main objectives of the Center are to inspire entrepreneurship culture at ITU, to encourage ITU students and academics to take an entrepreneurial initiative based on creativity and innovation, furthermore to provide them with necessary ground for improving their skills and abilities. The students meet with their entrepreneurial potentials at ITU GINOVA Entrepreneurship and Innovation Center. Ideas and teams that are formed here are supported by ITU GINOVA with coaching and mentoring services for nascent entrepreneurs. Entrepreneurs and wannapreneurs, who found an enabling environment for idea and team development through ITU GINOVA's Entrepreneurship courses, certificate programs, workshops, and mentorship, prepare for entrepreneurship competitions and pre-incubation centers that can provide them more resources. Being a meeting point for students from different engineering departments, ITU GINOVA promotes students to generate ideas together and guides them to bring their ideas into the use of society through trainings, workshops, and one on one coaching and mentoring services; once stronger in their skills and self-confidence, they move on to other organizations in the ecosystem for further resources.

SNS practices

SNS undertakes to support its community in the creation of new companies. In accordance with a specific set of regulations, researchers and lecturers can create a spin-off company, if the entrepreneurial project involves the valorisation of the results of research done at SNS. Undergraduate and PhD students may also find a spin-off. Support in this context includes:

- orientation towards training courses designed to develop entrepreneurial skills and knowledge, for future founding members;
- technical and market analysis of the feasibility and prospects of an entrepreneurial idea, assistance during the process of the establishment proposal;
- scouting of the funding opportunities (private and of investment funds);
- information for the licensing of patents in favour of the spin-off;

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- support for participation in initiatives such as the “Start Cup” and Hackathon, and for the development of Investor Pitch.

Up to now, the Scuola has recognised three spin-off companies, which undergo a periodical monitoring, also for the purposes of the quality assessing of research.

UPB practices

In UPB, there are multiple ways that the concept of an “entrepreneurial university” is achieved.

UPBizz Entrepreneurship Center’s purpose[30] is to provide support and oversee the development and progress of student entrepreneurs while encouraging the entrepreneurial spirit among the student body. Moreover, the Center aims to consolidate UPB as an upholder of the business environment and student entrepreneurship by adding business-related workshops and events to the student program. UPBizz has three focus directions: Business Education, Mentoring, and Financing. The three directions are developed through seminars, workshops, counselling and mentoring sessions held by experts in various entrepreneurship-centered domains, with the purpose of establishing sustainable business plans for UPB graduates, as well as other vital events that can lead to starting a business. The Business Ed program seeks to bring a mix of successful entrepreneurs and professionals in front of the students. The aim is to inspire, teach and improve on the young entrepreneur’s skills. Furthermore, besides basic Business education events, the program inspire students to think like an entrepreneur – take calculated risks, have a critical approach towards business and a positive, problem-solving attitude. The Mentoring program helps students reach a certain goal – be it personal or professional. The mentors’ sole purpose is to guide, counsel and provide know-how to the students. In terms of the Financing direction, pitching sessions are organized in front of potential investors, banking products for young entrepreneurs are identified, and presentation sessions are organized to integrate students and graduates in potential projects developed at the university.

The *Faculty of Entrepreneurship, Business Engineering and Management (FEBEM)* is focused on the idea of entrepreneurship, called FEBEM[31], which ensures effective education, engineering and managerial training based on creativity and practice, offering its students real opportunities to compete on the labour market, including (and focused especially on) the entrepreneurial area. The faculty addresses both young people interested in building a career in the business environment (in industrial and other fields), and those who wish to develop their own business.

The teaching staff, nationally and internationally recognized, make the transfer of knowledge in an interactive manner, constantly connected to the practice, providing all the necessary conditions to stimulate thinking, experience and their own aptitudes.

FEBEM offers students a consistent material base, providing a modern library, equipped with books in the areas of interest related to the specialization “Business Engineering and Management”, such as: management, marketing, human resources management, organizational development, finance, project management, business communication, strategic management as well as other valuable monographs and books in specific related areas.

[30] http://antreprenoriat.upb.ro/en/
[31] https://upb.ro/en/faculties/the-faculty-of-entrepreuneurship-business-engineering-and-management/

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FEBEM also has modern teaching laboratories where useful software simulations are used in developing the students' managerial skills, such as for example: The Marketing Game, Primavera, Adonis, Adoscore, MS Project, etc.

Based on a biunivocal relationship between the academic environment and the business world, the faculty has close relationships with major international corporations (HP, Siemens, Porsche, Hornbach, Salesianner, etc.), graduates being able to successfully meet the selection criteria imposed by the demands of the employment grid. After the four years of undergraduate studies, master studies provided by FEBEM ensure great compatibility with the quality requirements imposed by European standards in terms of higher education, in the context of the EU labor market continuing evolution.

The Faculty of Automatic Control and Computers offers a master's program in *Management of IT*[32] for students interested in moving towards the entrepreneurship direction. It trains specialists in management of ICT organizations and products, since information and communication technologies have a critical role to play in the global economy and in the Romanian society. The program prepares ICT engineers and other professionals to manage opportunities and risks specific to new IT infrastructures and technologies, offering skills such as leadership and management required for a fast-paced careers in various organizations like financial management, information security, IT products and services, entrepreneurship and digital innovation, business strategies, etc.

The master's program contains specialized engineering disciplines in the field of Computers and Information Technology as well as disciplines specific to Management. In terms of acquired skills and abilities, the program offers: IT project and service management in various organizations, financial management, marketing management, information security management, ensuring the quality of IT products and services, computer systems modelling, competencies and abilities necessary for the scientific research activity.

BME practices

BME Z10 is the incubator for BME[33]. Z10 accelerator program is a student innovation competition combined with a 5-week startup training which takes place in every semester. Selected teams participating in the innovation competition receive an investment and continue their technology and business development work as members of the BME Z10 incubator.

Number of student innovation competitions is 6, number of participating students is 150+, number of participating teams is 45, number of new stratup companies is 20.

Z10 supports the implementation of the Hungarian Startup University Program (HSUP)[34], offering startup teams the opportunity to mentor and use the incubator and prototyping lab. The aim of HSUP is to acquaint Hungarian students with the world of innovation, modern entrepreneurial knowledge and especially the operation of startups, all through a new, common educational platform.

HSUP is a two-semester e-learning subject with a focus on learning about innovative thinking and the startup world in the first semester, while in the second semester. in the semester you

[32] https://acs.pub.ro/en/academics/master-of-science-studies/
[33] https://z10.bme.hu
[34] https://hsup.nkfih.gov.hu

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can acquire practical knowledge of building a business. HSUP stands for University Credits, Scholarships and Mentoring.

5.2 Courses strengthening the entrepreneurial skills

This section describes the most relevant curses the EELISA universities offer on the field of strengthening the entrepreneurial skills. Related to this topic, the EELISA Unfolds project has deliverables which cover this area as well. EELISA Unfolds has set the following objectives (see: "Distributed I&E Education" Deliverable No. D5.1.)

- Objective 1: Enhance the scale and scope of HEIs students' engagement in entrepreneurial activities. Phase 1: Scale-up HEIs strategies and practises to support students' engagement by means of the development of guidelines and organisational models for new units and/or the update of existing units.
- Objective 5: Development and deployment of innovation and entrepreneurship (I&E) resources. Phase 1: Preliminary identification and design of I&E basics modules, distributed activities, remote sessions, and business case-based activities (see Objective 1).
- Objective 7: Development of specific training programs. Phase 1: Integration of I&E resources developed in Objective 5 above into specific training programs for professors, professors-to-be and external experts so they can deliver both education in entrepreneurship and mentoring in venture creation.

In this report several initiatives have been described (e.g. Seasonal School, Strat Cup Toscana, Grow with UPBizz, Fii anteprenor 5.0, A night to innovate, Pépite 3EF, ME310 …etc.) This gives a strong emphasis on student innovation and entrepreneurial skills.

However, the aim of this chapter is to delve into the institutional practices with some of the initiatives summarized from this perspective.

The other input we rely on is titled as "Guidelines on how universities can scale-up institutional strategies and practices addressing student engagement", Deliverable No. D.2.1. which focuses on student engagement in entrepreneurship and innovation in higher education. The objectives of this deliverable is given as

- Objective 1: Propose a comprehensive framework to allow the identification and selection of student engagement practices.
- Objective 2: Describe the practices to identify common characteristics and cluster them.
- Objective 3: Develop a set of guidelines to support further activities within WP2 – Institutional Engagement and Change.

For example, D2.1 Guidelines on how universities can scale-up institutional strategies and practices addressing student engagement or D5.1 Distributed I&E Education.

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UPM practices

At UPM, there are several courses strengthening the entrepreneurial skills. Furthermore, UPM provides training courses on Research-Based Learning (e.g. courses offered by the EIT or KICs where UPM is involved).

The course *Introduction to Intra/Social entrepreneurship*[35] is an initiative by Universidad Politécnica de Madrid (UPM) to provide practical methods to manage innovative projects within a company or organization and/or to pursue their own intra/entrepreneurial endeavours following new approaches.

This course is derived from the idea that the new methods originated in the entrepreneurial arena in the last decade can be extremely useful for managers and intrapreneurs. The goal of this course is to develop a real intra-entrepreneurial project that complies with the needs of today's society by working on multidisciplinary teams. This practical course will follow the "Lean Start-up" method with additionally selected course-related content.

The major objectives of this course: (i) to provide students with some conceptual and practical tools to improve their management skills on innovative projects; (ii) to provide students with the general rationale and ordered logical steps when launching a social entrepreneurial project of their own; (iii) to know the basics on how to present and defend a successful entrepreneurial project; (iv) to provide hands-on knowledge on tools, methods and upcoming opportunities of interest to be applied in a project to be developed through the duration of the course; (v) to provide participants with some tools and concepts of digital prototyping; (vi) to provide participants with a vision of the challenges and opportunities of this new era; (vii) to train students to lead and manage high-performing teams in the online world; (viii) to connect students with start-ups, entrepreneurs, corporations and the university itself.

Sessions include work on projects to be developed and discussed during the classes. Participants work in international multidisciplinary teams. Furthermore, the course provides the opportunity for each team to work with an experienced mentor. Participants also have access to exclusive events related to entrepreneurship, where they can meet and learn from successful entrepreneurs and innovators

In UPM's innovation and entrepreneurship training in the subject *Engineering Design* (UPM-Master of Industrial Engineering) we have taken advantage of an online course created by UPM in the framework of EIT Digital the *Commercialization Strategies* course.

Engineering Design is a 12 ECTS, CDIO-based course, in which 25 students are conducted for the proposal and development of innovative product ideas. After a two-week period for the students to think about proposals, a voting is made from which 3 ideas are selected to be developed during the course. The development includes product planning (which in turn is composed by market analysis, product definition and technical and financial-economic viability checking by means of a business plan), concept design, basic and detailed engineering, prototype sourcing, manufacturing, testing and redesign, and product documentation (including social and environmental sustainability reports).

We employ 4 hours of this course for deepening in the commercialization alternatives – including the funding of a start-up – for each product with a 3 hour blended learning activity.

[35] https://blogs.upm.es/actividadesacreditables/introduction-to-intra-social-entrepreneurship-c31025/

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The first hour is devoted for a lecture about commercialization, which includes the necessary steps and information to gather for a correct product definition and business plan. After that, a 1 hour hands-on activity is performed, in which students, grouped in the 3 teams created for the development of the 3 product ideas selected, work on a final customer presentation. Finally, students are instructed to watch 7 online videos of the EIT Digital course on Commercialization Strategies, covering the following topics:

- Introducing to commercialization strategies
- Strategic options (what, when, where)
- Licensing
- Strategic alliances
- Creation of a spin-off
- Investments for Start-up
- Initial public offering

FAU practices

At FAU, there is a changing offer of courses every semester. Past Courses include, for example:

- Create Your FinTech Startup (CFTS)
- Business Plan Seminar (Master)

In the summer term 2022 the following lecture at FAU will be open for EELISA students: IP meets engineering[36].

ITU practices

The list of relevant undergraduate courses at ITU:

- BLG 442E Technology and Innovation Management for Information Technologies
- BUS 320 Entrepreneurship
- END434E Introduction to Strategic Management
- ISL 458E Intellectual Property Law
- ISL 478E Entrepreneurship
- ISL465E Introduction to Innovation and Entrepreneurship
- MIM432E Entrepreneurship in Construction Industry

The list of relevant graduate courses at ITU:

- ISL 517E Management of Technology
- MHY509E Management of Technology and Innovation

[36] https://eelisa.eu/events/eelisa-lecture-series-ip-meets-engineering/

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ISL 478E Entrepreneurship and ISL465E Introduction to Innovation and Entrepreneurship both can be run remotely. In ISL478E students are asked to work on their startup ideas in teams formed in the course, ending the course with an investor pitch. Successful ideas continue the Incubation Center at Sciencepark, Çekirdek.

In ISL465E, students are asked to find problems on the campus and work on these using the design thinking methodology ending the course at the ideation and soft prototyping level.

The capacity for each is 300 participants.

At ITU GINOVA Center for Entrepreneurship and Innovation, we have been running remote training programs with external partners, open to other university students successfully. The format allows learning by doing as well as letting students work in multidisciplinary teams from different universities.[37]

SNS practices

The SNS is engaged in the technology transfer of the activities developed by research groups, laboratories and individual researchers. It provides services for the various stages of the academic career of PhD students, researchers and lecturers in support of the protection, management and enhancement of intellectual property, training relating to entrepreneurship and the collaboration between university and company.

As a partner of the JoTTO[38] joint tech transfer office, SNS provides to its students and faculties members courses and training activities on the topics of intellectual property protection and entrepreneurship, especially by means of courses and workshops targeted to academic researchers, academic staff and entrepreneurs.

In collaboration with University of Pisa, SNS participates with its students to the "Contamination Lab[39], that aims to promote entrepreneurial culture and innovation, valuing ideas and interdisciplinarity. It allows participants from different disciplinary fields to get to know each other and work together on common projects, developing their Soft Skills, along with planning, organizational, and communication capabilities.

SSSA practices. The list of relevant courses at SSSA:

- High-tech Entrepreneurship Course: This course is designed to introduce participants, mainly PhD students from different disciplines (STEM, but also Social Sciences and Humanities) and also young researchers and post-docs to the basic knowledge and competences about high-tech entrepreneurship.
- Patent research at large: needed, tools, and practical examples?: Training seminar (about 4 hours long) on patent searches at large.

UPB practices. UPB courses listed here are part of the three entities presented above, but they are only the most relevant courses from UPBizz, the FEBEM faculty and the Management in Information Technology master's program. For the full curricula, feel free to check the official websites or require this information from UPB's representatives in WP6.

- Success Club

[37] https://ginova.itu.edu.tr/

[38] http://www.jointto.it/en

[39] http://contaminationlab.unipi.it/en/home-english/

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  - free program for identifying and developing professional and entrepreneurial competencies for UPB students
  - composed of two workshops, Business Mindset and Successful Mindset
    - Business Mindset: students work on their skills of evaluation, anticipation, decision-making, personal autonomy, useful for examining a business or product idea
    - Successful Mindset: students discover their own personal and professional identity, discovering their strengths, weaknesses, psychological barriers, areas of professional interest, personal values, as well as entrepreneurial, communication, leadership, or management abilities.

- Smart Start UP Romania
  - aims to promote entrepreneurship and identify ideas with great business potential
  - it is a program with fully private funding, the projects being funded with a value between 5,000 and 200,000 euros
  - is a necessary program for young entrepreneurs and encourages young people to take their first steps in the business environment and helps them develop at the highest level from an entrepreneurial point of view
  - helps student discover their originality, innovation, environmental impact, the possibility to be implemented globally.

- Public speaking
  - course that prepares students for the role of public speakers and helps them overcome any communication situation, whether we are talking about taking an exam, a public presentation, or a business idea in front of a group of investors
  - addresses topics such as removing inhibitions and increasing personal confidence, tricks to get out of trouble during a speech, the stages of preparing a speech, tricks for capturing attention, mindfulness strategies, speech techniques, creativity exercises through moments of improvisation, effort-dosing techniques.

- Information Tools for Entrepreneurship and Technological Management (MTI)
  - a master's course that develops students' knowledge and skills required to design and implement a technical project in an entrepreneurial spirit, be it as a startup or in other organizational forms
  - the first part of the course clarifies the diversity of present-day entrepreneurial practices, familiarizes students with product vision, with assessing current developments in technology – including limitations, trends, and associated opportunities to position a novel solution for an old or new customer need
  - in the second part of the course, students develop competencies in understanding and managing emotions for themselves and well as in relation to their team collaborators, in time management, in introductory elements of financial planning, and in computer supported collaborative work – including the study of dedicated information solutions
  - in the third part of the course students are trained in delivering public presentations for a product, in conceptual, ethical and legal issues concerning

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intellectual property, in branding approaches and techniques, and in market research and marketing
    - the course has an important practical dimension, where students follow the development of a product from design to public presentation of its various stages, exploring multiple facets of such a project through group and interactive activities, through familiarization with multiple information solutions for communication, design and teamwork, and through public presentations of ideas or projects.

- Financial Management (MTI)
    - a master's course that shows students how finance help them understand how firms meet their objectives, emphasizing the financial aspects of management decisions
    - the focus of this course is on explanation of financial tools and techniques, which can be used to help firms maximize value by improving decisions relating to capital structure, capital budgeting, and working capital management.

- Business Policies and Strategies (MTI)
    - master's course designed to develop a strategic thinking on businesses, understanding competitive environments, and decision-making implications of industries approached, and competitive strategies used
    - the course relies on lectures and analyses of case studies

- Marketing (FEBEM)
- Organization Management (FEBEM)
- The Basics of Management (FEBEM)
- Human Resources Management (FEBEM)
- Entrepreneurial Culture (FEBEM)
- Engineering of Human Capital (FEBEM)
- Communication Techniques (FEBEM)
- Industrial Leadership (FEBEM)
- Managing Human Capital (FEBEM)
- Innovation and Technological Development in Industrial Organizations (FEBEM)

During the pandemic, some of these courses were also held online, but now they all require physical participation (since they are mostly oriented towards UPB students). However, this may change if/when the laws are updated to allow for online teaching in Romania.

We believe that the novel education program would be better suited as a set of separate courses. This way, each university would be able to offer their own courses to any interested parties, either directly as they are presented to their own students or adapted for an external audience. This way, we would be able to ensure a certain level of flexibility regarding what courses are offered, who offers them, and the manner that they are offered in (duration, format, audience, etc.).

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BME practices

At BME, there are several courses strengthening the entrepreneurial skills, most of them are available on Hungarian:

- Starting and running innovative businesses
- Startup Management
- Innovation management
- Entrepreneurship Development and Innovation (Innovative Entrepreneurship)
- Infocommunication and intellectual property rights
- Basic knowledge of industrial property rights and copyright
- Patent product novelty

5.3 What are the needs of the entrepreneurial world from universities?

The concept of entrepreneurial university on the one hand covers the field of university-industry cooperation including market activities (university competences and also infrastructure as a capacity), technology transfer activities, and startup and spinoff programs and services. On the other and entrepreneurial university are concerned with endowing the students with entrepreneurial skills.

UPB view

The Amway Global Entrepreneurship Report 2018[40] analyses five elements that help the development of the entrepreneurial environment: tax management, existing rules and regulations in each country, the education system as a provider of necessary skills, available technology, and the economic situation in each country. According to statistics, Romania is below the global average in terms of each of these five components, so there are still important steps to be taken, in terms of improving policies and public procedures for the entrepreneurial environment.

However, entrepreneurship has grown in popularity in Romania and is now seen as a career opportunity for Romanians. A local study by iVOX[41] at the beginning of March 2019, at national level, shows that 1 in 2 Romanians in the urban environment would like to become entrepreneurs. The same study also shows that the main obstacles identified by the respondents are the unpredictability of the tax environment and the high level of taxes (74%).

Another study[42] shows that other obstacles identified by Romanian entrepreneurs in starting a business include bureaucracy (which they see as the main problem), legislation (unclear, unstable), relationship with state authorities (difficult to approach, with mostly incompetent employees), corruption (especially among institutions) or bribe. Another identified impediment refers to local mentalities.

[40] https://www.amwayglobal.com/amway-global-entrepreneurship-report/
[41] https://www.retail-fmcg.ro/servicii/studii-de-piata/studiu-ivox-raiffeisen-bank.html
[42] https://www.impacthub.ro/wp-content/uploads/2020/09/Studiu-ROWIN-12sept.pdf

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Statistics also show that 36.75% of Romanians would choose to build a business from scratch, while 33.4% would develop a business based on their own hobbies and skills. Regarding the adjacent sources of accessed funding, there can be seen a preference for grants, followed by funds from angel investors. The funding sources used are similar in proportion to trends observed at European level: 88% of entrepreneurs financed their business with their own funds (exclusively or in combination with other sources), 76% financed their business from a single source, 63% used exclusively their own funds to start their own business.

People who do not see entrepreneurship as a viable option for them mention as reasons important factors such as high competition in the market, responsibilities that come with the status of entrepreneur, business partners that do not fulfil their payment obligations, fear that they will not have enough free time.

The study also shows that the 3 main business priorities of an entrepreneur, in the next 6 to 12 months after starting a company, are: finding customers, attracting investments, accessing support programs. Furthermore, entrepreneurs are interested to participate in events dedicated to them as follows: 64% of those who participated in business programs are motivated by the desire to learn, especially about business administration, and 35% also refer to networking opportunities. 18% are looking for personal/business development in terms of some specific opportunities such as: project financing, client identification, or even the recruitment of team members.

To access a range of relevant local market information, entrepreneurs can have access to a series of professional networks. Starting in 2011-2013, entrepreneurship hubs appeared in Romania, which concentrate entrepreneurial communities, in addition to the workspaces they provide. Their evolution is on an upward trend both in number, surface, but also geographical coverage. These hubs contribute to the feeling of belonging to a community, a network of professionals, so this is something that we believe that the universities also need to offer to entrepreneurs.

As a conclusion, we believe that the main needs of the entrepreneurial world in Romania now can be summarized as follows:

- further education on working with state institutions,
- further education on understanding taxes and obligations towards the state,
- opportunities for getting investments and customers,
- accessing support programs,
- being part of a supportive network of professionals.

UPB has several official spinoffs that were started by UPB members to push their new ideas towards the market. One such example is SmartRDI[43], which aims to bring innovation in mobile computing and IoT systems through a technological transfer from research to development and, finally, to market.

Furthermore, a project for Developing the University's Institutional Capacity is currently being implemented in UPB, which has a component concerning the creating of an intelligent platform for integrating UPB's offers, opening the education, research, innovation and career

[43] https://www.smartrdi.net/

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development offer towards the general public. This also involves opening the digital competencies offer of UPB towards the communities, so that interested companies or investors can connect with a researcher to start a spin-off, or to start bringing to production the ideas of UPB's researchers.

BME view

Entrepreneurial world in a university requires active collaboration with industrial partners (common RDI projects), furthermore the mechanisms, forums and supporting environment for startup and spinoff companies.

Research opportunities open the door for students toward a successful career. Students are happy to take part in projects within the scope of independent laboratories, dissertations, diploma projects, and scientific students' association's programs, where they also see that the results of their work are utilized.

The participants in the master's program and the doctoral students are involved systematically, which has always worked effectively at the universities. It can cause a problem that the latter group of students is exposed to a great temptation from the side of the industry, as the labour market awaits them with a multitude of promising job opportunities; therefore, they can leave university soon.

This should be considered because otherwise, the university will have a reduced base consisting of talented doctoral students who can contribute very usefully to the implementation of RDI projects.

The formula is simple. We are about to open the university towards SMEs and large companies. They have to see what the technology can do, what the university can do.

Therefore, the suggestions and requirements from the business side:

- Business level service to provide RDI service on a business basis: RDI infrastructure (measurements), R&D capacity, even joint publication,
- Background support as a professional service (e.g. innovation centre)
- Proactive behaviour, suggestions, initiations from the universities,
- Business proposal is to sign long-term framework contracts, e.g. for 5 years, between companies and the university. This means appropriate planning on business side and a career path from a human point of view on the university side
- It is worth defining what the competitive advantage is for a particular university
- Clear rules, appropriate business skills, project management, relevant and regular feedback,

In summary, proactivity, transparent behaviour and clear communication.

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5.4 Industrial chairs supporting university-industry cooperation and path towards entrepreneurial university

Industrial Chairs are strategic and long-term partnerships between companies/institutions and the University to carry out education, research and knowledge transfer activities in an area of common interest.

UPM practices

UPM implements the industrial chair asset in the following way.

Duration. The minimum duration of a chair is three years.

Activities. Industrial Chairs can put in place teaching, dissemination and knowledge transfer, as well as R&I activities, as agreed by the Monitoring Committee of the Chair:

- Teaching activities: participation in the design and implementation of training and teaching programmes; awarding of student grants; awards to teaching activities, to academic careers; conferences and workshops, etc.
- Dissemination and knowledge transfer activities: congresses, publications, reach-out activities, etc.
- Research and innovation: promotion of research lines, implementation of R&I projects (it is important that the project is not and cannot be construed as a service provision), grants for doctoral thesis, etc.

Governing. The governing bodies for the Chair are:

- The monitoring committee, made of an equal number of representatives from the company and the university. Its mission is to adopt the annual work plan and the budget and monitor their fulfilment.
- The Director must be a professor at UPM with an excellent track-record in the field of the Chair. His function is to guarantee the implementation of the work plan and activities adopted by the monitoring committee.

Location. Chairs must have a physical space for the development of their activities. That space is granted by the University.

Funding. The company must commit a budget for the implementation of the Chair activities. The minimum budget to be allocated by the company is 30,000€ yearly.

Creation of chair and advising services. The Office for Research Results Transfer Activities (OTRI) offers support for the creation of chairs.

There are over 70 UPM Industry-University Chairs[44], out of which more than 10 are related to sustainability and SDGs. Fields: Politics, Economy and Social Sciences (12%), Agro-food and Biotechnology (7%), Building and Infrastructures (14%), Energy and Environment (18%), Health (3%), TIC (24%), Transport, Security and Space (22%).

ENPC practices

[44] http://www.upm.es/observatorio/vi/index.jsp?pageac=proyectos/panel_proyectos.jsp&tp=catedras&ambito=Catedras

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At ENPC, there are 14 actives industrial chairs. They are more focused on scientific research and not to specific entrepreneurial programs.

FAU practices

At FAU, there are 18 actives industrial chairs.

5.5 Supporting contests and prizes

Contests and prizes may an important role to motivate students and to convey the spirits of entrepreneurial world. EELISA InnoCORE should take stock of the corresponding institutional practices and develop its alliance-wide contests which can integrate some of the elements listed below:

UPM practices

The most important contests organised by UPM are two of the programmes described above: ActúaUPM and UPM 2T.

ENPC practices

At ENPC, there are three different prizes: Une Nuit pour Entreprendre[45]; Tous Labelisés; and the Best thesis prize.

FAU practices

Start-up competitions: Depending on their focus, competitions revolving around start-ups are aimed at either student, inventors, those who want to start their own business or young entrepreneurs.

- *Northern Bavarian Business Plan Competition*: The Northern Bavarian Business Plan Competition focuses on innovative ideas with a substantial potential for growth. It is open to all start-ups and entrepreneurs based in Northern Bavaria. Anyone not currently living or working in Northern Bavaria can only participate if they can give plausible reasons justifying their plans to move to Northern Bavaria in future. The project is open to people who are aiming either to launch a start-up or to extend an existing business idea. The competition is split into three phases, but participants can join at any of these phases. In each phase you are provided with written assessments which you can use to fine-tune your business plan. The competition is held every year.
- *German Entrepreneur Award*: The German Entrepreneur Award is conferred annually in five categories: Student, StartUp, Rising Star and Lifetime Achievement. The award is presented to entrepreneurial role models in various phases of business – from simulation contests for school pupils to an award for lifetime achievement. A special award is also presented to entrepreneurs whose success is based on an unorthodox approach. The German Entrepreneur Award is a joint initiative between stern, Sparkassen, ZDF and Porsche.

[45] https://www.ecoledesponts.fr/une-nuit-pour-entreprendre-7eme-edition

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- *Entrepreneur of the Year*: The award presented annually by Ernst&Young is awarded in the categories industry, trade, services, ICT technologies/media and start-up. The prize is awarded to entrepreneurs who demonstrate initiative, foresight and a flair for innovation. In the categories of industry, trade, services and ICT technologies/media, the competition is open to entrepreneurs whose companies are at least four years old, have at least 40 employees and have their headquarters in Germany. For the start-up category, companies must have completed at least one business transaction and have been set up no more than four years ago but are not required to have at least 40 employees.
- *ICT Start-Up Challenge*: The Gründerwettbewerb IKT (ICT start-up challenge) run by the Federal Ministry of Economic Affairs and Energy (BMWi) promotes innovative ICT start-ups. It follows on from the successful 'Gründerwettbewerb – mit Multimedia erfolgreich starten', the BMWi challenge aimed at encouraging start-ups in the multimedia sector.
- *Chamber of Commerce and Industry Start-Up Award*: The Nuremberg Chamber of Commerce and Industry for Middle Franconia awards the annual Chamber of Commerce and Industry Start-Up Award for Middle Franconia once a year. The competition is open to owners/partners of companies belonging to the Chamber of Commerce and Industry with their headquarters in Middle Franconia. The award is intended to encourage those who want to set up a business and reward young entrepreneurs for their courage and dedication.
- *Science4Life*: Science4Life is an annual industry-specific start-up competition run throughout Germany in the emerging areas of life science and chemistry. The competition is aimed at students, doctoral candidates and research associates at universities, universities of applied sciences and research institutions as well as other innovators in the area of life science and chemistry. Companies which would like to participate in the competition must have started business after 1 September 2008.

ITU practices

ITU GINOVA is offering certificate programs on entrepreneurship and innovation since 2014. In 2020, the certificate program has been co-organized with Boğaziçi University Entrepreneurship Center (BRIGHT) under the title of "FireUp: Change Maker Program" and supported by The University Innovation Fellows (UIF) Program. The UIF program is offered by Stanford D-school and it empowers students around the world to become agents of change in their school. Four ITU students (from departments of environmental, management, mechanical and mining engineering) have been selected as University Innovation Fellows and empowered to conduct their own projects to bring innovative solutions to campus related problems and represented ITU at Stanford University international meeting.

As part of its mission, the Center has recently opened its resources to a wider community along with an industry collaboration project. One of the leading companies in chemistry industry brought challenges for sustainable future and called for innovative solutions from student teams with the help of ITU GINOVA. In total, 140 students applied from 25 universities around Turkey and received a training for two months. "Let's Innomind" challenge resulted with 2 groups of students getting support from the company.

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SNS practices

SNS is a partner of *START CUP Toscana*[46], a business ideas competition based on the results of scientific, technological, social and humanities research.

The best ideas are presented by the participants in the form of a Business Plan pitch to a scientific and entrepreneurial commission. The best ideas among those presented will receive a cash prize and/or in kind for the establishment and development of new businesses, and will participate at the national competition[47], the so-called National Award for Innovation (PNI).

SSSA practices

At SSSA, there are joint internship programs, efficient talent mining and management, and shaping the *final product of education* programs:

The Italian Ministry for University and Research has allocated funds through the NOP "Research and Innovation" 2014-2020 for additional doctoral scholarships on actions IV.4 "Doctorates and research contracts on innovation issues" and "Action IV.5 "doctorates on green issues". This fund allowed the SSSA to open a call for 28 new positions in existing PhD Courses. The Program entails a compulsory industrial training period of at least 6 months, but the first students were admitted in 2021, thus at this stage they haven't started their industrial training, yet.

Based on Italian regulations an internship involves three subjects: the trainee, the promoter and the host company or entity. The university tutor (a university professor), and the company tutor (not necessarily coinciding with the legal representative), who guide and follow the intern in carrying out the intended task, are also part the training path.

Joint training programs are currently limited to the ones based upon agreements with other national and international Universities that are allowed to issue doctoral degrees at the end of the Course. Joint training programs @SSSA are for the time being and foreseeably for the next 3 years limited to the ones that have academic curricula

Every internship must be based upon a research project. Once the internship project has been identified, a formal Agreement rules the student's position, as well as all administrative, financial and insurance details.

Talent mining is quintessential to the highly selective nature of SSSA and similar public Institutions that are expected to educate the future leadership. We start our mining process at a very early stage with high schools.

- ME.MO Project: ME.MO. is an orientation program that aims to support the path towards the university choice of high-merit students from fragile socio-economic backgrounds. As shown by the data published every year by AlmaLaurea on the profile of graduates, the family of origin plays an important role in the choices of education, work and life which, especially in the delicate phase of choosing for the continuation of studies, increasingly influences incisive, severely limiting the affirmation of the central role of education and training in the development process of the country system.

[46] START CUP Toscana
[47] https://en.pnicube.it/lacompetizioneimsa

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Attention to social mobility is an identifying element of university high schools with a special system, which in the university system have the role of guaranteeing excellent training for talented young people, regardless of their family and social background. For the Scuola Superiore Sant'Anna merit and social mobility therefore represent a strategic priority necessary for the full realization of its institutional mission.

ME.MO. 2.0 consists of an individual orientation and mentoring program aimed at students enrolled in the penultimate year of specially selected upper secondary schools to whom to offer an orientation path to support and support them in the delicate phase of university choice that develops with meetings at regional level, jobs group, remote activity which is accompanied by the mentoring activity of the team of the students of the School. The program is completely free and takes place from November 2021 to July 2022 and includes a 3-day residential internship that will be carried out in the summer period, compatibly with the provisions related to the COVID emergency.

The project is aimed at 360 students: we count on the collaboration of the schools to identify the participants of ME.MO. 2.0. based on the information contained in a circular sent in recent days to upper secondary schools with all the information for reporting students. By November 19, each school will have to identify among the students enrolled in the penultimate year (1 student every 2 sections) those they deem most suitable for the path based on merit criteria (both in terms of academic results and potential and intellectual curiosity), context socio-economic origin (educational qualification of the parents), and in line with the aims of the project which are to reduce the barriers to access to university education and offer talented students from less favoured socio-cultural backgrounds same educational opportunities as their peers. Among the reports received, the Scuola Superiore Sant'Anna will select the 200 participants also taking into account the criteria of adequate regional representation.

- Honor students pre-selection: The Call for admission to undergraduate courses is published every year by march. The competition is divided into 3 steps: the Pre-selection (the TOLC or TOLC@home test), two written tests and the oral test. Candidates for the Medical Sciences competition do not have to take the TOLC/TOLC@casa, but must be eligible for the national test, with a score that makes it possible to enrol at the University of Pisa.

  The TOLC is the OnLine Test CISIA is an orientation test and assessment of initial skills that is used by over 40 Italian universities both for the verification of initial knowledge and for access to limited number degree courses. Since 2020 it has been included in the admission competition to ordinary courses as a pre-selection test for admission to the written tests.

  The TOLC takes place at universities and, from May 2020, following the Covid-19 emergency, a new test method, the TOLC @ home, is planned to be carried out directly from home using a PC and a smartphone.

- PhD students call: PhD Programmes of Sant'Anna School aim to link basic and applied research in dynamic fashion, with a strong focus demands for innovation by industry and public institutions. Sant'Anna's PhD programmes last three or four years: they are designed for bright young graduates, from Italy and abroad, who are admitted after a selective examination which values candidates' educational background and their

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attitude for scientific research and interdisciplinary approach. All positions are fully funded: the PhD student scholarship is renewed annually following a successful assessment. There are no tuition fees for the enrolment to the PhD.

- Internal tutor: All students are supervised by an internal tutor. It is the Tutor's duty to closely monitor the student's teaching and study activities, as well as the fulfilment of the obligations of evaluation of the teaching provided, also by periodically viewing the personal booklet of each student, offering information and suggestions for the best outcome of the training itinerary of the student. It is also his task to welcome, guide and support the student's inclusion in the campus life.

As stated above, it is intrinsic in the nature itself of the School that admits very limited number of students, that they are essentially shaped into a community, thus working as a team per se.

- E-SHAPE YOUR CAREER: Getting to know the professional world, students might feel in the need to have a clear idea of main behaviours, tools and operations' functioning of companies' recruiting policies.
- The E-CUBED 2 project: It is an annual event dedicated to the professions and the world of work and sees the participation of alumni, coming from both the private and the public, they meet the pupils of all six sectors of the School in order to establish an informal dialogue and answer questions / doubts with a view to career orientation and development future professional. It is a project developed jointly by the Scuola Superiore Sant'Anna and the

  Scuola IMT Alti Studi Lucca to carry out initiatives aimed at integrating the training courses of their students with the information, tools and skills necessary for development of professional career.

  Starting from the positive experience achieved in the previous project E-Cubed: Explore, Engage, Empower, starting from a series of initiatives and collaborations between the two schools in the context of placement, the goal is to develop a policy of shared placement, to develop a structured intervention plan framed in the

  broader program of the actions of the Third Mission, with the aim of producing value and impact for the community, pursuing a close synergy with research and training.

The **Start Cup Toscana** was originally limited to the province of Pisa. Since 2006 it has expanded into the regional context and represents the first phase of a national competition, called "National Innovation Award", which rewards the ideas of innovative companies and since 2003 it +has evaluated over 2000 projects involving more than thirty Italian universities.

Start Cup Toscana is a competition that rewards the best entrepreneurial initiatives with high technological content and coming from the world of research and offers the opportunity to transform an idea into a business, with the support of training activities and assistance in the drafting of the business plan.

Start Cup Toscana is organized alternatively by one among: University of Florence, University of Pisa, University of Siena, Scuola Superiore Sant'Anna, IMT Scuola Alti Studi Lucca and Scuola Normale Superiore and is sponsored by Tuscany Region, within the framework of Giovani sì, the regional project that promotes initiatives by youngsters.

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The winning ideas are selected based on submitted documentation, i.e. the Project Board, the executive summary and the business plan, and through an audition to be held during the final event in Pitch mode. Applicants should specify the technological or market scope of the project at the time of submission within the following four (possibly specifying relationships or transversality with other technological or market areas): Life Science - Med Tech; ICT; Cleantech & Energy; Industrial.

The winning ideas from the regional editions will enter the national competition for the National Innovation Award, NIP, if they meet all the necessary conditions.

UPB practices. Regarding contests and prizes that can help encourage the entrepreneurship spirit of UPB students, there are several events such as hackathons or innovation presentations that take on this role.

The previously cited Innovation Labs, which is a pre-accelerator for young tech founders and startups. The program targets students and graduates from technical universities and from communication, business and creative fields for the 3-month mentoring adventure of teamwork, intensive prototype development and mentorship, exploring Romania's growing startup ecosystem. The pre-accelerator has predominant activities within the University POLITEHNICA of Bucharest (mentioned in many of their press releases). Innovation Labs offers students (and even more experienced researchers and developers) the chance to pitch their ideas and participate in a pre-accelerator that can lead them on the path of getting an investment in their product. The participants are empowered to develop proof-of-concept solutions and products using cutting edge tech with the support of top mentors in the ICT and business industry. The teams accepted in the program will work during the mentoring program to develop prototypes for their idea through user testing, design work, business modelling and product validation in weekly courses and workshops in a variety of fields. Innovation Labs gives participants the chance to take part in demo days, hackathons, presentations in front of potential investors, etc.

UPBizz offers entrepreneurship competitions as well, such as the "Be an Entrepreneur" business idea competition.

Furthermore, student organizations (such as LSAC, LSE, Best Bucharest, etc.) offer competitions and hackathons for students, which are often built-in collaboration with large companies such as Deutsche Bank, Keysight, Huawei, etc.).

BME practices. The most important contests organised by BME are two startup programmes: BME Z10 Accelerator programme and Danube Cup, that is an International Entrepreneurial Pitch Competition for University Students along the Danube.

5.6 Summary and synopsis for joint actions

Implementation practices of the concept "entrepreneurial university" currently boils down to start-up and incubation programs, methods to support spinoff companies, innovation platforms and networks, various services for inventors and IP management. Entrepreneurial university include university-industry cooperation and the move to market activities (university competences and infrastructure as a capacity), technology transfer activities, including start-up and spinoff programs and services. In summary, the needs of the entrepreneurial world include proactivity, transparent behaviour and clear communication. The concept can be

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supported by contests (mainly start-up competitions) and prizes providing the finances for the incubation phase and for the mentoring services.

Proposed joint actions

There are several courses and seminars strengthening the entrepreneurial skills at the partner universities. However, most of them are available only on national languages. One of the possible steps is to open these courses for other EELISA partner universities on English language and make them available either online or in a summer school form.

Industrial Chairs are strategic and long-term partnerships between companies/institutions and the University to carry out education, research and knowledge transfer activities in an area of common interest. The example set by UPM should be analysed and considered by other partner institutions, regarding how to set up the mechanism for industrial chairmanship.

Another type of cooperation can be launched on contests and prizes. Having such a great variety of different contests at the member institutions some of them should be lifted to alliance-wide contests in which students from any member universities can participate. This can also serve the purpose of opening the gate to a larger industrial environment where students form member universities could be embedded into a larger innovation ecosystem.

The planned schedule is detailed in the roadmap.

The proposed joint actions are planned to follow the roadmap summarized below.

Entrepreneurial programme:

Date	Action
2022 December	Discussion of joint curriculum
2023 March	Devising course thematic
2023 July	Announcing the program
2023 October	Launch of the program (attendance is offered electronically)

Table 2: Roadmap of the entrepreneurial programme

Joint contests and prizes:

Date	Action
2022 December	Selection of contests for joint participation
2023 March	Details of participation worked out
2023 May onward	Participation

Table 3: Roadmap of the joint contests and prizes

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The aforementioned plans and proposals should be taken as a preliminary proposal or preliminary roadmap by InnoCORE WP6 leader, to be further analysed and decided upon among EELISA partners in coordination with EELISA InnoCORE WP7 and Unfolds project. The depicted roadmaps had not yet been agreed upon by partners.

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6 Learning from each other and promoting tangible contributions for future practices

The joint use of PhD students and possible involvement of them in research projects provides several benefits like real use-cases that offer a great potential for validation, awareness of knowledge in different research group, broadens the range of expertise, perspectives, world-views available to the student, broadens the range of personalities available to the student. As new perspectives, the supervisor develops more links with other staff on research groups, extends their knowledge, may learn different skills from joint supervision, shares responsibility for the PhD student. In this joint supervision, the student can tap into more resources and networks, different research capabilities and important resources, the Ph.D. student can share needs and demands around, may be less likely to have to move in one direction. Regarding the results, the Ph.D. thesis can be more broadly prepared, and may be more likely to pass, considering that different supervisors can fill different positions of value to the PhD student. Although the SSSA at present does not have an industrial PhD program, the institution is investigating the possibility of a common administrative ground for designing joint industrial PhD courses based on the other partners' successful industrial PhD programs.

The added value of a joint PhD course would be the innovative training tools that each partner can provide as well as the addition of companies that are experienced in dealing with the challenges of a highly specialized academic context. This strategy would be less time-consuming. The Alliance could also lean on the IP practices used at the member universities and treat it under the common umbrella of European regulations.

A subcommittee can embark on organizing joint research seminars based on the 10 key topics of mutual interests:

1. *Artificial intelligence, High Performance Computing*
2. *Connectivity*
3. *Social sciences and humanities*
4. *Digitalization*
5. *Health*
6. *Smart industry and space technologies (Engineering Sciences)*
7. *Advanced material science and engineering*
8. *Culture, creativity and inclusive society*
9. *Climate, energy and mobility*
10. *Natural Sciences*

It is important that PhD students should participate of these seminars. This may lay the groundwork for developing joint PhD courses which can then be taken for credits and attended via electronic means.

The Alliance must promote the concept of entrepreneurial university. There are several courses and seminars strengthening the entrepreneurial skills at the partner universities.

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However, most of them are available only on national languages. One of the possible steps is to open these courses for other EELISA partner universities on English language and make them available either online or in a summer school form.

Industrial Chairs are strategic and long-term partnerships between companies/institutions and the University to carry out education, research and knowledge transfer activities in an area of common interest. The example set by UPM should be analysed and considered by other partner institutions, regarding how to set up the mechanism for industrial chairmanship.

The rich choices of contests and prizes can be another source of joint actions, some of them should be lifted to alliance-wide contests in which students from any member universities can participate. This can also serve the purpose of opening the gate to a larger industrial environment where students form member universities could be embedded into a larger innovation ecosystem.

The joint actions are summarized in the following table:

Type of joint actions	Description	Effect	Timing
Harmonizing the work with Unfolds	Making complementer contributions to the objectives of the projects	Better utilization of the intellectual resources of the project	2022 June
Joint involvement of PhD students	Opening research topics for the joint pool of PhD students	Increased RDI performance, filling regional needs	2023 January
Joint contests	Opening contest for students form the member universities	Higher visibility for a larger talent pool	2023 May
Developing a joint Entrepreneurial program	Courses encompassing different entrepreneurial skills	Students with entrepreneurial mindset and broad knowledge to stimulate regional entrepreneurship	2023 October

Table 4: Summary of joint actions

As another joint action, WP6 of InnoCORE should also focus an effort on a strong collaboration with Unfolds. There are similarities in the objectives and complementary efforts are needed to map out the university-industry relationship providing original contributions from both InnoCORE and Unfolds. Therefore, we will set a joint agenda (workshops …etc.) to enforce the complementary nature of the contributions.

The aforementioned plans and proposals should be taken as a preliminary proposal or preliminary roadmap by InnoCORE WP6 leader, to be further analysed and decided upon among EELISA partners in coordination with EELISA InnoCORE WP7 and Unfolds project. The depicted roadmaps had not yet been agreed upon by partners.

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