**VTT Technical Research Centre of Finland**

# Fostering Knowledge Transfer in Poland, Europe and the World

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# Fostering Knowledge Transfer in Poland, Europe and the World

## Deliverable 2

**Review report on Knowledge Transfer (KT) needs and gaps of Łukasiewicz Research Network (Łukasiewicz) institutes and selected Polish R&I stakeholders and EU best practices on KT strategies relevant for the Polish context.**

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## 2021

Report to the 1KTS4Łukasiewicz project on "A single knowledge transfer strategy for institutes of the Łukasiewicz Research Network Poland". The 1KTS4Lukasiewicz project is funded by the European Union via the Structural Reform Support Programme and implemented in cooperation with the European Commission.

Łukasiewicz Research Network

1KTS4Lukasiewicz

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# Foreword

Fostering knowledge transfer (KT) amongst all European Union Member States has been at the core of the European Commission agenda to boost innovation and technology transfer in the European Research Area (ERA). In line with this goal, the **1KTS4Łukasiewicz project** has embarked upon a foresight-driven process aimed at supporting Poland to co-create "*a single knowledge transfer strategy for institutes of the Łukasiewicz Research Network (Łukasiewicz)*".

In addition to the expertise and know-how in the project consortium team, which consists of research organisations in four countries (AARC in Ireland, VTT in Finland, ISI Fraunhofer in Germany and EPRD in Poland), we have also established a Senior Technical Expert (STE) Panel consisting of representatives from the following seven target organisations: VTT (Finland), FRAUNHOFER ISI (Germany), TECNALIA (Spain), AIT (Austria), TNO (Netherlands), SFI (Ireland) and INESC TEC (Portugal). The STE Panel played a pivotal role in the identification of KT best practices that can be transferred or adapted to the needs of the Polish research and innovation ecosystem. In order to enable and facilitate absorptive capacities in Poland and the Łukasiewicz institutes, we have also designed and successfully launched a series of multi-stakeholder mobilisation and mutual learning (MML) activities, which are helping to codify and generate new knowledge on the needs and gaps and KT best practices of relevance in the Polish context. **This report represents the first concrete outcome of the 1KTS4Łukasiewicz project, by providing the Łukasiewicz Research Network with an understanding of its knowledge transfer (KT) needs and gaps.** The report also provides the foundations for a new KT strategy structured around three complementary focus areas: *knowledge valorisation*, *knowledge co-creation* and *knowledge sharing*.

The development of a single KT strategy is expected to allow the circulation of knowledge at three levels, namely:

- Exchange of knowledge between the employees of the Łukasiewicz Centre.
- Knowledge sharing horizontally (between organizations) and vertically (within organizations) in Łukasiewicz.
- Sharing of knowledge between the Łukasiewicz and third parties, notably business, but also public authorities and civil society.

This report will review Knowledge Transfer (KT) needs and gaps of the Łukasiewicz Research Network (Łukasiewicz) institutes and selected Polish R&I stakeholders and EU best practices on KT strategies relevant for the Polish context. The main content of the report is to frame the Polish context and create a view of best practises. These findings, while not giving direct policy recommendations to the network, allow the project to further the KT strategy. In addition and although the immediate beneficiary of the **1KTS4Łukasiewicz project** is the Łukasiewicz Centre that is responsible for coordinating the activities of the 30+ institutes within the Łukasiewicz, we can already foresee that the whole Polish research and innovation ecosystem will also benefit from the envisaged strategy, as well as a growing constellation of European and international players who already recognise the growing importance of the Łukasiewicz in Poland, Europe and the world.

**Dr. Rafael Popper,**
*Scientific and Technical Leader*
**1KTS4Łukasiewicz project**

# Executive Summary

In all, the report highlights the Knowledge Transfer issues that will be, during the course of the project, contextualised to form a single knowledge transfer strategy for institutes of the Łukasiewicz Research Network (Łukasiewicz). This executive summary, however, begins by presenting cross-sectional, general schemas. In this sense, the idea is to bring out topics that emerge from findings of the entire research process so far. These items could also be described as development schemas that we have found to be highly relevant for all Polish innovation system actors to consider. After creating this kind of more general view, the next section of "Key Messages for Łukasiewicz Institutes and Polish Stakeholders" presents a more focused summary on needs and gaps, which is simultaneously the primary contribution that this report shares for the use and development of the Lukasiewicz network.

Some research initiatives actively inform policy at the national level. Ideally, this can be seen as a positive interaction where research learns from wider perspectives, drives for societal impact, and creates linkages and spill-overs across regions and sectors. These kinds of societal frames should be developed actively in the future. There, interlinkages are constructed towards national development schemes and priorities, but also towards European innovation programs and global SDGs.

- Sustainability and meeting Sustainable Development Goals (SDGs) propose a generic, overarching theme for all actors from international spheres for the local level. Despite the vast environmental challenges that concern all actors, grand challenges also offer huge possibilities for frontier actors who advocate for environmentally benign technologies, solutions, and new ways of thinking and acting.
- Internationalisation proposes a key element for the renewal and progress of an innovation system. Existing international relations with a strong history establish an important factor for national competitiveness. International collaboratives should also be expanded and enriched in a continuous manner. This is due to continuously increasing global market integration and potential disruptions in business models and value chains. Examples of key activities related to internalisation cover supporting the export activities of SMEs, establishing intermediary actors helping companies with their internationalisation activities, and increasing younger generations' international mobility, language and cultural skills.
- Continuous new company creation establishes bases for renewal and success of an innovation system. Applying different instruments and incentives to support business creation requires strategic capabilities and steering the activities towards common goals in different levels of a system. Integrating strategic work into landscape-level drivers builds a basis for assuring longer-term leverage. As part of the larger organising of favourable financing conditions, the establishment of Seed or Venture Capital Companies is regarded as one essential element for enabling dynamic start-up ecosystems to emerge.
- One of the main challenges - and possibilities - for innovation is related to knowledge exploitation and commercialisation of research results from public research organisations and universities. In the future, research potential at public research facilities and universities can, and should, be exploited more systematically, be it in the form of science-business interaction (knowledge-transfer, patenting) or in a more direct way in the form of spin-offs.
- In parallel for constructing knowledge transfer in a more structural or technical sense, knowledge transfer should also be considered a socially situated activity, where individuals' motivations and beliefs (action-formation mechanisms), interactions (transformational mechanisms) and their

environments (situational mechanisms), are highly important elements for enabling learning and supporting innovation activities.

- Public procurement presents a possibility to renew the system through an existing mechanism. It is a way to advance introduction and implementation of, e.g., innovative technologies, sustainable solutions, as well as novel business and acting models. Governments could use public procurements as a platform to boost innovation, and, at the same time, learn how to create effective innovation policy. Additional opportunities lie in following open innovation approaches by incorporating end-users and opening up policy definition to societal actors. It is essential that public procurement is structured in interconnection with frontier topics and development schemes occurring at both the national and the international level.
- All possible means of promoting collaboration between different actors cannot be highlighted enough. Increasing complexity, globalisation and grand challenges represent macro forces behind this scene, where needs and challenges are responded to in an increasing multi-perspective and multi-disciplinary manner. Likewise, increased collaboration and knowledge sharing is needed when improving national innovation capabilities. There, the existence of research centres and networks, and research infrastructure (including test beds) are drivers for collaborative research aiming for impactful innovation and transition towards a digitalised, greener, and more inclusive society.

# Key Messages for Łukasiewicz Institutes and Polish Stakeholders

The key messages for the Łukasiewicz result from literature review and key consultations with Polish and European stakeholders. These messages contain needs and gaps that we have identified to be the most essential for the development of the Łukasiewicz. In parallel to identifying development schemas, this summary section includes some brief, key actions and activities that should be considered a part of the future development of a Łukasiewicz.

### Knowledge Valorisation and Exploitation

Knowledge valorisation and exploitation focuses on how to harness innovations into marketable solutions. Based on stakeholder interviews, Poland's intellectual property framework, public procurement, incubator and legal services, spin-offs and access to finances are of key importance along with enhancing soft skills and the entrepreneurial mindset of researchers

- Bureaucracy and formality create a substantial gap for agile research and development in many organisations. These factors should be systematically identified and resolved, ideally across different organisations simultaneously.
- There is a lack of competencies, standardised processes and know-how related to licensing and intellectual property management. This negatively influences the protection of technology, patenting and commercialisation activities.
- Applying for EU funding requires specific know-how that should be developed by a variety of actors within a network.
- Academic entrepreneurship is not a popular activity across the institutes of the Lukasiewicz. Enabling unique competence development paths for employees, building entrepreneurial skills, and strengthening human resources management capabilities in organisations are among the most needed activities to respond to the challenge.
- To develop a recognised brand for the institutes will improve unity and competitiveness in both national and international markets.
- Attracting and retaining a new generation of scientists requires creating improved understanding on changing values and motivations of them.
- Promoting standardisation in a united front should be considered one important conduit of knowledge valorisation.
- There is a need to enhance competence building in a more futures-oriented manner. This requires building institutes' strategies in liaison with landscape-level change factors.

### Knowledge Co-Creation

Based on the contextual understanding of Poland and stakeholder interviews, in knowledge co-creation, key needs and gaps relate to difficulties in retaining private and public R&D funding, communications, procedural factors as well as initiating new collaboration. Success factors consist of technological competence and expertise, systems expertise, the application of scientific methods and a high-quality research infrastructure.

- To institutionalise knowledge co-creation, novel practices for monitoring, evaluation, and verification of measurable results, are needed.
- Assuring access to well-advanced technical equipment is important for conducting research and offering high-quality research services. The modern infrastructure is followed by capable staff willing to improve their qualifications.
- Collaborative research is one of the main channels of knowledge transfer at the institutes. Increasing collaborative research has a direct impact on knowledge transfer, quality of research and innovation, and learning.
- Companies' willingness to invest in research and development is relatively low.
- Experts' capabilities to "speak the language of the companies" should be strengthened.
- Industrial co-operation should be increased. It builds on combining basic research with applied research.
- Building partnerships at the international level should be increased. As a partial domain, luring international scientists, and integrating one's own scientist into international arenas, has a direct impact of quality of science and innovation. Increasing internationalisation activities is also linked to a need to increase contract research among internationally operating customers.
- More horizontal organisation- and management culture would enable a smoother working atmosphere and effective execution of projects.
- External communication should be developed based on common, larger, shared goals. This desired, external image should rely on a future vision that the institutes and network should construct both separately as single institutes, and collectively as a network.
- Collaborating with universities and recruiting young talent are the cornerstones of creating an outstanding research profile of the future.

### Knowledge Sharing

Knowledge sharing focuses on how to build networks and relationships with different actors in the business ecosystem. Based on the contextual understanding from Poland and stakeholder interviews, internal team management culture, study and research mobility programmes, association memberships and communication tools are of key importance. The main gaps and needs result from teaching and research mobility.

- To facilitate better collaboration with industry, there are gaps in professional development, especially related to networking and collaboration management. To respond to this, more support and resources would be needed for professional development and advancing marketing capabilities.
- In advancing efficiency, innovation and learning in multi-cultural working environments, there is a need to develop both language skills and understanding of cultural differences.
- Some innovation networks should be developed based on regional needs and focus.
- Advancing understanding and skills of using digital and online tools compounds a basic need today. It enables achieving, e.g., fluent communication, efficiency in research, and building novel co-operation cost-efficiently.
- Developing inter-institutional research platforms and group work as a basis for new collaboration, competence development and solving more complex problems in a multi-disciplinary manner.

- Different kinds of mobility and education programmes are needed to create co-operation, learning and competencies for institutes. These programs may consist of different actors: institutes, industrial partners, and academia.
- Organizing industrial forums and events presents an example of activities that are continuously needed to understand and respond to societal/industrial problems collectively and in a dialogue.
- Ideally, according to some indications in the data, institutes would benefit from slim and decentralised network structure. This structure would have some common coordination, it would allow information exchange through different platforms, and it would gather different actors together to respond to emerging needs gaps.
- Building trust and transparency, both the interior and the exterior of the Łukasiewicz should be advanced. This facilitates further collaboration with external partners also creating a fruitful environment for commercialisation and licensing activities. For this, for example, an internal code of conduct could be useful.
- Finding a balance between basic research and business collaboration should be enhanced through mutual understanding of the value of basic research and business collaboration.

# 1. Introduction

1KTS4Łukasiewicz project is funded by the European Union via the Structural Reform Support Programme and implemented in cooperation with the European Commission. The main and immediate beneficiary of the 1KTS4Łukasiewicz project is the Łukasiewicz Centre, which is responsible for coordinating the activities of the 30+ institutes within the Łukasiewicz. Overall, the project is expected to produce the following outcomes:

- **Outcome 1:** The Łukasiewicz understands its KT needs and gaps.
- **Outcome 2:** A proposal for knowledge transfer strategy is available and has been validated with the stakeholders through a consultative process.
- **Outcome 3:** Stakeholders concerned are enabled to implement the Strategy through the Implementation Plan that will accompany the Strategy.

This report will review the KT needs and gaps of Łukasiewicz institutes and selected Polish R&I stakeholders and EU best practices on KT strategies relevant for the Polish context. The main outcome of the report is a framing of the Polish context and description in detail of the best practices related to KT. These findings, while not offering direct policy recommendations to the network, allow the project to further the KT strategy. The European Commission fosters international knowledge transfer (KT) amongst all Member States in order to boost the overall innovativeness, as well as to improve the research landscape, across Europe. One of the key areas for action, as identified by the EC,[1] is the KT between private research organisations, industry, and other third parties. In the context of Poland, efforts related to this ambition are of particular relevance since, within the EU, the country lags behind other Member States in many indicators according to the European Innovation Scoreboard (EIS), while at the national level, the links and cooperation between science and business remain rather weak compared to its peers, as reflected in various European Semester Country Specific Recommendations. With this in mind, the objectives and outcomes of the project are to address the bottlenecks in the Polish R&D ecosystem with a special focus on the Łukasiewicz by providing effective strategies, tools, and mechanisms to bridge the gap between science and economy, at the national level, as well as to improve the country's competitiveness within the EU Member States.

**This report represents the first concrete outcome of the 1KTS4Łukasiewicz project, by providing the Łukasiewicz Research Network with an understanding of its knowledge transfer (KT) needs and gaps.** The report also describes selected KT best practices and case studies in eight[2] EU countries (Austria,

[1] Commission Communication, Putting knowledge into practice: A broad-based innovation strategy for the EU, 13 September 2006, COM (2006) 502 final. See further, Commission Communication, Improving knowledge transfer between research institutions and industry across Europe: embracing open innovation, 4 April 2007, COM(2007) 182 final

[2] The research conducted on critical issues (see section 3. Critical Issues Analysis by Knowledge Transfer Area), hence the benchmarking, is based on eight EU case countries. The practical case studies (see section 4. Best Practices Analysis by Knowledge Transfer Area) are based on 7 RTOs situated in these case study countries (i.e. AIT from Australia, VTT from Finland, ISI Fraunhofer from Germany, SFI from Ireland, TNO from the Netherlands, INESC TEC from Portugal, and Tecnalia from Spain)

Finland, Germany, Ireland, Netherlands, the Czech Republic, Portugal and Spain), which show wide ranging possibilities for the Łukasiewicz to extend the cooperation to other relevant actors beyond the already established partners. The selected countries are strong innovators or innovation leaders, except for Spain and Portugal, which are moderate innovators.[3] Within these countries, we have focussed on the knowledge transfer activities pursued by major R&D&I organisations that share institutional and organisational commonalities with the Łukasiewicz and its institutes. This means that large RTOs that operate in multiple industrial sectors have been given priority in the case study selection.

As described in the methodology section below, the project was built on existing literature on the subject of KT strategies, and proposed relevant practices from other EU Member States' (MS) organisations with similar settings to the Polish Łukasiewicz that could be used and applied in the Polish context. In total, some 18 practices were identified from organisations with a track record of implementing frameworks and strategies supporting the commercialisation of science and other KT activities of relevance to the Polish Łukasiewicz. After this Introduction section, where the scope and methodology of the report are described, we present a Context section with an overview of the Polish Łukasiewicz (in terms of funding and personnel configuration of the Łukasiewicz institutes). We then look into needs and gaps with a focus on 21 innovation indicators and 11 contextual indicators where Poland is lagging behind the EU average in the European Innovation Scoreboard (EIS), which assesses the relative strengths and weaknesses of national innovation systems and helps countries identify areas they need to address.[4]

*Poland is an Emerging Innovator. Over time, performance relative to the EU has increased sharply. Poland's strengths are in Digitalisation, Intellectual assets and Use of information technologies. The top three indicators include Design applications, population with tertiary education, and environment-related technologies. The performance increase in the last two years is mostly due to strong improvements amongst Product and Business process innovators, Broadband penetration, Employment in innovative enterprises, and Public R&D expenditures. Poland has an above-average share of Non-innovators without disposition to innovate and is showing below average scores on the Climate change-related indicators.*

Source: European Innovation Scoreboard 2021.

By framing the methodology around innovation and contextual indicators where Poland is lagging behind the EU average, the project offers a well-defined and pragmatic approach to the identification of Łukasiewicz needs and gaps. The mapping required the systematic implementation of a *critical issues analysis* where 422 barriers, drivers, opportunities and threats were mapped against three knowledge transfer (KT) areas: knowledge valorisation, knowledge co-creation and knowledge sharing. The complementary analysis of EU best practices and case studies provides a better understanding of experiences and initiatives that can be transferred and adapted to the Polish context. This discussion is followed by a section on Polish ecosystem analysis by KT areas.

[3] European Innovation Scoreboard 2021.
[4] https://ec.europa.eu/growth/industry/policy/innovation/scoreboards_en

## 1.1 Scope

The need for a single knowledge transfer (KT) strategy for all Łukasiewicz institutes was identified in a previous project implemented by VTT Technical Research Centre of Finland Ltd. and supported by DG REFORM under the name "*Technical expertise on best practices from other countries in the context of upcoming establishment of new Polish Łukasiewicz Research Network (*Łukasiewicz*)*". The lack of a coherent KT strategy, as well as other issues identified in two SWOT analyses conducted by Łukasiewicz members in the abovementioned project and another "sister" project[5] on '*Increasing the participation of the Łukasiewicz Research Network institutes in R&D programmes financed by the EU*' commissioned by the Polish Ministry of Science and Higher Education, undermines Poland's potential to be a strong and leading player in the European research and innovation (R&I) ecosystem. Data, i.e., specific contextual and innovation indicators, from the 2021 European Innovation Scoreboard (EIS), provide clear and unequivocal evidence supporting a better understanding of the scope and challenges that Polish public research organisations (PROs) and all stakeholders in the Polish R&D system face today.

For over a decade, the European Research Area (ERA) priority on 'optimal circulation, access to and transfer of scientific knowledge, including via digital ERA' has been shaping the KT strategies of several MS that joined the EU in 2004, such as the Visegrad Group. An ERA implementation expert group (European Commission, 2013) emphasised the importance of knowledge sharing in the official ERA agenda. In particular, efforts to build effective digital research platforms, organise IP management training for both researchers and persons in charge of IP management, which foster an open-access culture with the help of mutual learning sessions, are some of the most significant issues and needs of Polish research and technology organisations (RTOs) (Deschryvere and Popper, 2018). Equally challenging is the Polish research and innovation (R&I) system's capacity to actively contribute to and benefit from the rapidly evolving European knowledge co-creation ecosystem and relevant financial instruments, which creates the need to establish better conditions and frameworks for applied and multidisciplinary research, especially when it comes to the assessment and management of societal challenges from different perspectives.

**With this in mind, a robust KT strategy for Łukasiewicz would need to consider how different fields of science, including social sciences and humanities (SSH) research could contribute to increase Polish stakeholders' understanding of societal challenges and promote the co-creation of relevant, new knowledge, responses and solutions.** The inclusion of a variety of disciplines in societal challenges research is also expected to reduce the fragmentation of the Polish R&I ecosystem. The abovementioned DG REFORM-supported project on Łukasiewicz further emphasised that Poland needs to facilitate knowledge sharing as today's world is highly interconnected and dynamically evolving. It calls for a KT strategy that considers the goals of the Łukasiewicz, as well as the individual needs and culture of each

[5] DIALOG project (No. 0171/DLG/2018 – *Zwiększenie uczestnictwa instytutów Sieci Badawczej Łukasiewicz (SBŁ) w programach B+R finansowanych przez UE*) led by Fundacja Partnerstwa Technologicznego TECHNOLOGY PARTNERS in collaboration with Tecnalia (Spain) and VTT (Finland).

Łukasiewicz institute. As Georghiou et al. (2008) recognised, "*from a policy perspective, there are considerations in terms of the European-wide conditions that foster knowledge transfer (access to data, IPR regimes, etc.); conditions at the very local level (such as the types of professional skills and attitudes that are encouraged and developed); and at the intermediary level, such as groups' ability to locate others who can contribute to resolving the problem of interest and the qualities of the conduits between these groups.*" **With this in mind, this report aims to foster knowledge transfer in Poland.**

A single KT strategy for the Łukasiewicz institutes will help Poland to introduce a "**policy mix**" influencing a wide range of policy areas:

- Research and innovation policy – by helping to develop and mobilise mutually reinforcing research capabilities in the public and private sector;
- Education and training policy – by improving the quantity and quality of competences and skills of the future workforce and necessary human resources;
- Competition and trade policy – by supporting innovative Łukasiewicz members to access and benefit from European and global markets;
- Industrial and regional policy – by helping to develop and maintain infrastructures supporting key sectors and industrial clusters;
- Social and health policy – by considering responsible research and innovation (RRI) as a means for, but also a result of, the improvement of quality of life;
- Environmental policy – by promoting pro-innovation regulations and incentives as important means to encourage value-creating responses to broader sustainability objectives, such as goals agreed by the European Council or the UN Sustainable Development Goals;
- Financial policy – by identifying and engaging financial institutions that are able to properly value innovation-related investments;
- Legal policy – by enforcing the rule of law, protecting innovation activities that are at risk against unbearable uncertainties (e.g., Covid-19); and,
- Regional development policy – by accelerating regional cohesion through R&I, while strengthening the role of Polish regions in ERA through more effective interregional R&I cooperation. There is urgency in the need to address the problem, acknowledged by the Ministry of Science and Higher Education and the members of the Łukasiewicz.

The previous Łukasiewicz implementation assessment project conducted by VTT concluded that the KT strategy of the Łukasiewicz has been prioritised at the right level. Therefore, the activities conducted under this project build on the positive momentum generated by previous Łukasiewicz -relevant initiatives and work towards the effective development and implementation of a single KT strategy capable of saving resources and at the same time improving productivity, preserving organisational knowledge and boosting the confidence amongst employees and members of the Łukasiewicz. Model for conducting Łukasiewicz Knowledge Transfer Strategy -process is presented in figure 1.

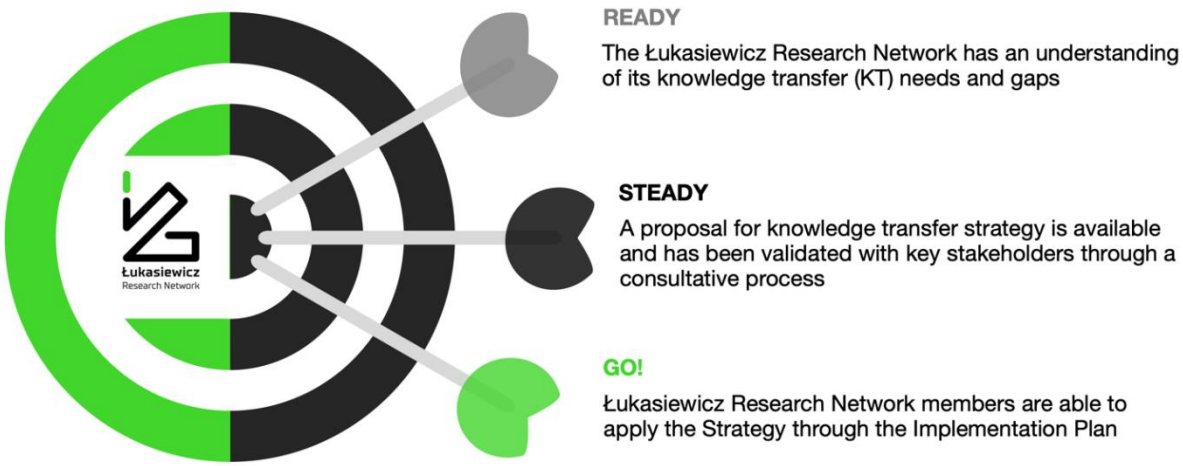


Figure 1: ŁukasiewiczKnowledge Transfer Strategy -process

## 1.2 Methodology

The methodology supporting this report (see Table 1) consisted of a combination of *foresight* and *sustainable innovation* assessment and management methodological frameworks and approaches supporting the following five complementary tasks, which are also enabling the remaining activities of the project and other deliverables. [6] In order to map the KT needs and gaps of the Network and Łukasiewicz institutes, we selected 7 RTOs out of the 8 EU case study countries and their top RTOs as 'good practice' case studies, that were to shed light into the underlying critical factors and indicators that Poland should focus on in the development of a single KT strategy for the Łukasiewicz institutes. The selection of eight countries includes three countries with similar moderate performance in the European Innovation Scoreboard (the Czech Republic, Portugal and Spain), two countries showing strong performance (Germany and Ireland), and three leading benchmarking countries (Finland, Austria and the Netherlands).

Table 1.Methdology and data

| Literature Review and Benchmarking | |
|---|---|
| Aim(s) | • Carrying out research with regard to KT needs and gaps of the Network, institutes and key partners cooperating with Łukasiewicz. Benchmarking Poland against 8 countries (AT, CZ, DE, FI, IE, NL, PT and SP) in terms of innovation and contextual indicators. |
| Method(s) | • Benchmarking, Desk research supported by data Analytics and Sense-making |
| Output(s) | • Mapping critical factors and indicators revealing KT needs and gaps of the Network, Łukasiewicz institutes and key partners.<br>• List of KT needs and gaps related to Innovation and Contextual Indicators. |
| Stakeholders Interviews and Focus Groups | |

[6] The methodology of the 1KTS4Łukasiewicz project blends a wide range of foresight and comparative approaches (see Keenan and Popper, 2008; Popper, 2008a,b; and Velasco et al., 2021), together with lessons learned from several research, mobilisation and mutual learning (MML) initiatives, in particular the EU funded VERA and CASI projects (see Popper et al., 2015, 2016, 2017 and 2020).

| | |
|---|---|
| Aim(s) | • Gathering data and conducting interviews/focus groups with key stakeholders |
| Method(s) | • Desk research, Interviews/focus groups |
| Output(s) | • List of KT needs and gaps related to Łukasiewicz –specific factors |
| Stakeholders Survey | |
| Aim(s) | • Design and carry out a survey to gather feedback from relevant stakeholders |
| Method(s) | • Desk research, Stakeholder Consultation Survey |
| Output(s) | • List of key KT needs and gaps of the Network, Łukasiewicz institutes and key partners<br>• Prioritised list of critical issues (barriers, drivers, opportunities and threats) |
| Case Studies | |
| Aim(s) | • Identifying and analysing 7 EU-relevant KT practices for the Polish context |
| Method(s) | • Case studies of 7 European RTOs from "best performing" or "peer" countries with 18 Best Practices, Desk research and Focus Group-style interviews with 7 organisations |
| Output(s) | • 7 case study reports with 18 best practices |
| Review Report | |
| Aim(s) | • Producing a comprehensive review report, mapping of the needs and gaps and identifying best practices and developing case studies relevant for the Polish context. |
| Method(s) | • Desk research |
| Output(s) | • Comprehensive review report (Deliverable 2) |

## 2. Context

Poland has started a very ambitious reform of its R&D policies aimed at boosting the country's productivity and competitiveness potential by merging Polish R&D works and fostering effective cooperation between science and business. This reform led to the adoption of the Act on Higher Education and Science (also known as the Constitution for Science), which entered into force on 1 October 2018 with the aim to consolidate and strengthen higher education institutions. The introduction of R&D tax incentives in 2016 and the subsequent increase in the deducible amounts provide valuable support for the business sector.

Amongst the persistent bottlenecks in the Polish R&D ecosystem lies the weak link between science and business. In 2018, 1.8% of Poland's total research publications were public-private co-publications, which is rather low compared to the EU average of 5.5%. Public R&D expenditure financed by business – which indicates public-private cooperation and knowledge flows - has been decreasing compared to 2007. Here, Poland is not only lagging behind the EU average, but also behind its peers from the Visegrad group. This is why a recurring, Country Specific Recommendation for Poland in the European Semester has been the need to strengthen the innovative capacity of the Polish economy and, in particular, the better valorisation of science-business links.

In an effort to establish a stronger bridge between science and economy, on April 1, 2019, the third largest research network in Europe, which is called the Łukasiewicz Research Network (Łukasiewicz), was launched in Poland. The Network is an integral element of the National Innovation System and part of the Strategy for Responsible Development for Poland. The basic task of the network is to conduct applied research and development in order to support the country's economic and innovation policies, as well as to facilitate the transfer of knowledge to the economy. The Łukasiewicz Centre overlooks and coordinates the activities of 32 institutes belonging to the Network.

The Network actively supports the commercialisation of the results of research and development carried out in the institutes. The strategic goal P6 on commercialisation principles and protection of intellectual property of the Łukasiewicz Action Plan for 2020 states that *"The implementation of unified principles of commercialisation of Lukasiewicz's intellectual property will increase the efficiency of knowledge transfer to the economy and ensure appropriate benefits within the Network. This methodology will allow for a unified approach to topics such as cost-effectiveness assessment, technical feasibility assessment and selection of a form of commercialisation, resulting in lower commercial risk for institutes in subsequent commercialisations. Also, the implementation of corrections of procedures in the cause-and-effect loop will allow further improvement of the principles of commercialisation in Łukasiewicz*".

According to the 2019 Act (Art 31), common rules for the Łukasiewicz Centre and the Network's Institutes shall be set up for the management of copyright and related rights and intellectual property rights, including the principles of commercialisation within the Network, with a particular focus on:

- rules and procedures for commercialisation
- the rights and obligations of the Łukasiewicz Centre, its staff, the Network's institutes and its employees regarding IPR, and principles for the remuneration of creators;
- rules on the distribution of funds obtained from commercialisation between the Łukasiewicz creator, either the Łukasiewicz staff member or the Łukasiewicz Centre or the Network Institute;
- rules governing the use of the Lukasiewicz's assets and the Network's institutes for the commercialisation and provision of research services.

Based on recommendations from a recently completed DG REFORM-supported project, "technical expertise on best practices from other countries in the context of upcoming establishment of new Polish Łukasiewicz" supported by and implemented in cooperation with VTT Technical Research Centre of Finland, a single knowledge transfer (KT) strategy for all Network Institutes should be created to facilitate sharing and disseminating of research-based knowledge among organisations to organise, create, capture and/or enhance the use of research-based knowledge. This aims to reduce the risk of duplication of efforts, avoiding coordination shortcomings, supporting transparency, improve R&D offer accessibility from the Network to external stakeholders, as well as become more cost-effective and efficient.

**The development of a single KT strategy is expected to allow the circulation of knowledge at three levels, namely:**

- **Exchange of knowledge between the employees of the Łukasiewicz Centre**
- **Knowledge sharing between institutes in various areas and at various levels**
- **Sharing of knowledge between the Łukasiewicz and third parties, notably business, but also public authorities and civil society.**

Łukasiewicz has, to some extent, worked towards this ambition by developing tools which facilitates communication and exchange of knowledge within the Network, including: i.) Intranet for the Network; ii.) a Customer Relationship Management System; and iii.) a Customer inquiry form on the Łukasiewicz website. Furthermore, "Competence Platforms" support the Network to jointly work and collaborate on thematic areas related to HR management, IT, communication. etc.

This report should take into account the findings of the previous project funded by DG REFORM and integrate them with relevant statistical data, stakeholder interviews and consultation survey, all of which will be used in the preparation of the KT strategy for the Łukasiewicz and member institutes.

## 2.1 Outward-looking analysis of Poland in the European Innovation Scoreboard

### Benchmarking Poland against the EU average in selected Innovation Indicators

Out of the 32 EIS indicators used to measure innovation performance in Europe, Poland shows a significant 'Innovation Gap' of over 50% vis-à-vis the EU average in 13 indicators, namely business process innovators (a 91% gap); employment in innovative enterprises (a 91% gap); foreign doctorate students (an 89% gap); patent applications (an 85% gap); product innovators (a 79% gap); new doctorate graduates (a 78% gap); innovative collaboration of SMEs (a 70% gap); venture capital expenditures (a 63% gap); lifelong learning (a 61% gap); innovation expenditures per employee (a 63% gap); resource productivity (a 57% gap); most cited publications (a 56% gap); and innovative sales share (a 51% gap). Furthermore, there are eight other innovation indicators with important additional gaps: Air emissions by fine particulate matter (a 49% gap), international co-publications (a 47% gap), export of knowledge-intensive services (a 46% gap), R&D expenditure in the business sector (a 45% gap); R&D expenditure public sector (a 44% gap), public-private co-publications (a 37% gap), trademark applications (an 11% gap) and medium and high-tech product exports (a 20% gap).

Poland only scored higher than the EU average in the following five indicators: design applications; population with tertiary education; broadband penetration; job-to-job Mobility of HRST, and environment-related technologies. Overall, the 2021 scoreboard figures make it evident that Poland needs to speed up the pace of reforms and actions to improve its position in these indicators, as the country is in fourth from the last position in the EU with higher performance than Romania, Bulgaria and Latvia.

Strong economic growth in Poland since 2015 has led to an overall innovation performance increase of 15 points compared to 2014. However, in terms of the *linkages* to the innovation dimension and in addition to the indicators in the 2021 scoreboard, public-private co-publications; SMEs innovating in-house; and private co-funding of public R&D expenditures are good proxies for KT. For this reason, these three indicators were included into the methodology even though they were measured in the EIS2020 report, and not in the EIS2021 report. In all of them, Poland is lagging behind significantly. This challenging context has created a general consensus that more resources could be devoted to the development of a sustainable and cross-sectoral collaboration culture within Poland as well as facilitating international cooperation. An incomplete national KT strategy increases the risks of Polish research and technology organisations' (RTOs) duplication efforts, at a time when access to national and European R&I resources is increasingly challenging and competitive. Overall, Polish RTOs, including the Łukasiewicz institutes, recognise the rationales and benefits of having a common KT strategy; however, there is also a shared view that a practical and cost-effective implementation of such strategy requires carefully and systemically organised multi-stakeholder mobilisation and mutual learning (MML) process such as the one to be conducted during this project. This can be easily understood given the significant heterogeneity in the size and R&D intensity across the Łukasiewicz institutes.

### Benchmarking Poland against EU average in selected Contextual Indicators

To better understand the innovation and KT performance challenges facing Poland we should turn our attention towards a set of 11 selected contextual indicators, two of which show significant gaps vis-à-vis the EU average: one related to the *business and entrepreneurship* context with 94% gap in the indicator measuring 'Top R&D spending enterprises per 10 million population'; and the other linked to the *Governance and policy framework* context where there is 55% gap in the 'Rule of law' indicator, which in the context of KT refers to IPR regulations, as well as rules for research contracts and consultancy services, etc. More challenges are also visible in some other nine contextual indicators, namely: GDP per capita (29% gap); share high and medium high-tech manufacturing (a 26% gap); basic-school entrepreneurial education and training (a 15% gap); employment share services (a 15% gap); government procurement of advanced technology products (a 14% gap); turnover share SMEs (a 7% gap); buyer sophistication (8% gap); and total entrepreneurial activity (a 3% gap).

Poland only scored higher than the EU average in seven contextual indicators: one related to the *Governance and policy framework* context (*ease of starting a business*); two related to the *Business and entrepreneurship* context (*FDI net inflows* and *Enterprise births with 10+ employees*) and three related to the *performance and structure of the economy* context (*average annual GDP growth, employment share manufacturing*; and *foreign-controlled enterprises – share of value added*). While deeper analysis of these indicators is not the focus of this study, such analysis would be beneficial for future research. In this study, these indicators provide a contextual understanding of where Poland situates within the European innovation context.

## 2.2 Inward-looking analysis of contextual and innovation indicators vis-à-vis Łukasiewicz

This section summarises the main findings from the Polish stakeholder engagement and literature review. Main **contextual indicators impacting knowledge transfer** in Poland today were 'Government procurement of advanced technology products', 'Top R&D spending enterprises per 10 mln population' and 'Rule of Law'.

- Lack of innovation policy in public procurement was underlined as very important by interviewed Polish stakeholders. A general approach in the public procurement policy was the preference to achieve the objectives as soon as possible, as cheaply as possible, and as easy as possible.
- The innovation policy should support Polish enterprises. Respondents felt that, Poland's current business support mechanisms are not sufficient. There are foundations of such policy, short-term policies, but this does not translate into specific programmes, like, e.g., public procurement programmes. This widely recognised challenge of promoting public-private partnerships is not only a matter of improving public procurement, but also loan guarantees and-, long-term financing of R&D projects. It is of key importance for Poland to create adequate procurement solutions. At the moment, it was stated that public procurement, innovative products or employment, highly technologically innovative products are being neglected and not seriously considered.

- According to stakeholders, Polish enterprises do not spend as much on R&D as would be desirable. It was indicated that it should not be solely up the Polish, but also those foreign firms which are established in Poland. The more they spend on R&D, the more innovative technologies could be created. It should be noticed that there must be a certain number of large companies and large number of small companies as specialist sub-suppliers of items or parts supplied to those large ones.
- To encourage international corporations to transfer their R&D to Poland, Poland should ensure a smooth and reliable operational environment. Poland should encourage such operational environment to assure foreign corporations that the law and clear rules are followed. Also, policies are needed to ensure that there are no major changes in the tax policies. It is important to create friendly regulations for common interest of business and science. Appropriate regulations must be in place with a framework and instruments, including those resulting from public sources for R&D. The importance lies not on spending but investing in relevant instruments. Poland still faces problems with lengthiness of court proceedings. When it concerns innovation and, copyrights issues, such matters should be solved quickly while in Poland it can last for years.

**From among innovation indicators**, 'SMEs innovating in-house', 'R&D expenditure public sector' and 'International co-publications' were highlighted by the Polish stakeholders among the top three innovation negatively impacting Polish KT activities.

- Respondents consider the ability of **SMEs to innovate in-house** to be limited, despite some efforts concerning services and technology Polish research units are generally perceived to lack research teams displaying the capacity to solve complex business problems and support market needs, and when cooperation exists with Polish firms, this tends to favour large state-owned companies.

- The dominant perception of participants is that **R&D expenditure by the public sector** must be strengthened yet ensuring higher levels of KT and innovation would equally require the strengthening of R&D expenditure by companies. Despite the fact that a slow improvement in this area in the last few years has been noticed, the general sentiment is that there is still scope for improvement, although at government level there are financial constraints impeding higher levels of spending. Concurrently, participants understand that R&D funding is mostly used exclusively by scientists who tend to overemphasise infrastructure and laboratory equipment and that there are insufficiencies in translating scientific outcomes into applicable knowledge. Additionally, increasing the profit margins for companies was also perceived by participants to enable companies to increase R&D expenditure.

- There is overall weak performance in creating **international co-publications.** This results from limited cooperation with international partners, which in turn limits the transfer of knowledge from international partners to Polish businesses.

### Main contextual challenges for the Łukasiewicz

- Inefficient application of the legal framework for intellectual property management results, for example, in difficulties retaining finance for innovations.

- The role of venture capital in Poland was indicated to be very limited. Venture Capital funds' approach to investing in intellectual property rights originating from higher education institutions and from risky projects was identified as a problem. Poland has no system to ensure venture capital support for R&D and knowledge transfer in an appropriate way.
- The lack of a comprehensive innovation policy and an insufficiently organised support system of innovative economy in Poland have been highlighted as the main problem from which many other barriers arise.
- Science-business collaboration is another key impediment in knowledge transfer resulting from the lack of a support system. There is a major problem at the interface between the public and private sector related to legal issues, valuation of knowledge, transfer of copyrights from universities to business, and responsibility.
- Entrepreneurship, SMEs innovation in-house and incorporating entrepreneurial training at all stages of education are other weak areas in the context of Poland and knowledge transfer therefore needs all actions aimed at increasing these are considered important. Limited entrepreneurial skills were underlined in relation to company creation by scientists.
- In addition, higher education institutions do not see the benefits (or see very limited benefits) of knowledge transfer activity. This results in a lack of collaboration in knowledge transfer and ideas are not being shared.
- Lack of public procurement of innovations. This originates from cultural factors relating to consumption habits. It was stated that Polish people tend to be very price-sensitive, which halts the procurement of innovative products.

### Main opportunities for the Łukasiewicz

Polish stakeholders have also indicated several strengths of the Polish ecosystem in the context of knowledge transfer. Poland has a quite broad scale of knowledge-intensive services exports, mainly due to multinational companies' operations. More collaboration could be done to increase innovative activities of these companies in Poland. Increasing SMEs innovative activity and public procurement of innovative products is another key opportunity.

#### Contextual opportunities:

- Tax policies were highlighted as important opportunities to increase R&D activities in Poland. Poland has numerous legal acts and tax incentives supporting knowledge valorisation and exploitation.
- Internationalisation is another key opportunity for Poland. Poland has well qualified staff with high potential for innovation. There is great potential in Poland in terms of partners for collaboration within the international sphere. Learning good practices from these actors should be utilised through networking. This is very important in the context of Horizon Europe which constitutes a huge opportunity for Polish science stakeholders.
- European Green Deal and development of circular economy open doors to new projects with the entrepreneur and new ideas. These actions are a great way to generate income related to knowledge transfer

#### Łukasiewicz Specific opportunities:

- The Łukasiewicz Research Network offers numerous opportunities for innovation in Poland. The Institutes work in various areas and their competences are quite unique.
- Increasing participation in networks and events at both the local and the regional level is important for finding not only new partners and clients for collaboration but also for establishing cooperation on a larger scale. It is essential to increase such collaboration to promote the Institutes' own competences, especially in areas where they are able to help their clients in problem solving
- Development of a knowledge-based and circular economy is seen as an important opportunity that can increase commercialisation
- The Single Knowledge Transfer Strategy for the Łukasiewicz Research Network is another opportunity. This strategy can place Łukasiewicz in the broader context with special attention paid to science–business cooperation and international markets. Łukasiewicz and its Institutes must have clear rules for cooperation with businesses, other research partners in Poland, and on international markets.
- Enhancing workers skill development, for example language and entrepreneurial skills, increasing opportunities for young scientists and creating an environment where the specialists from outside of Poland are willing to work on their scientific development is seen important to increase the scale of contract research.
- Institutes have good research facilities, such as laboratories. This enables them to not only carry out testing services in accordance with the latest methodology but to meet the highest standards of testing required. This is a great opportunity in the sense of providing services for companies.
- Institutes would like to go beyond cooperation with the industry and work on the application projects. They want basic research to end with publications which then would be continued in application research.

The analysis of the Łukasiewicz institutes participation in EU-funded projects[7] in the period 2014-2021 shows that only 14 of the 32 Łukasiewicz institutes participate in EU-funded projects with six institutes showing EU funding for over 1M Euros (Łukasiewicz-ILOT, Łukasiewicz-IMIF, Łukasiewicz-PIAP, Łukasiewicz-IMN, Łukasiewicz-INOP, Łukasiewicz-ILIM), two institutes with funding between 0,5-1M Euros (Łukasiewicz-ICHP, Łukasiewicz-KIT), six institutes with funding below 5M Euros (Łukasiewicz-IBWCH, Łukasiewicz-ITR, Łukasiewicz-PORT, Łukasiewicz-ITD, Łukasiewicz-IMBIGS, Łukasiewicz-ITEE). Thus, increasing participation in the EU-funded projects also presents an important opportunity for the Łukasiewicz institutes.

Table 2. Participation of Łukasiewicz Institutes in EU-funded projects during the period 2014-2021

| Short Name | Participation of Łukasiewicz Institutes in EU-funded projects during the period 2014-2021 | EU R&I Funding in Euros | Number of Projects |
|---|---|---|---|
| Łukasiewicz -ILOT | Warsaw Institute of Aviation | 7 141 035 | 18 |
| Łukasiewicz -IMIF | Institute of Microelectronics and Photonics | 3 866 278 | 17 |

[7] The Łukasiewicz received 3,1% of the 720 342 753 Euros of H2020 funding for Poland by 19.7.2021

| | | | |
|---|---|---|---|
| Łukasiewicz-PIAP | Industrial Research Institute for Automation and Measurements | 3 447 541 | 12 |
| Łukasiewicz-IMN | Institute of Non-Ferrous Metals | 2 986 847 | 8 |
| Łukasiewicz-INOP | Metal Forming Institute | 1 219 200 | 2 |
| Łukasiewicz-ILIM | Institute of Logistics and Warehousing | 1 098 502 | 7 |
| Łukasiewicz-ICHP | Industrial Chemistry Institute | 819 000 | 1 |
| Łukasiewicz-KIT | Cracow Institute of Technology | 636 075 | 2 |
| Łukasiewicz-IBWCH | Institute of Biopolymers and Chemical Fibers | 482 742 | 2 |
| Łukasiewicz-ITR | Tele and Radio Research Institute | 298 500 | 1 |
| Łukasiewicz-PORT | PORT Polish Center for Technology Development | 220 500 | 3 |
| Łukasiewicz-ITD | Wood Technology Institute | 139 740 | 2 |
| Łukasiewicz-IMBIGS | Institute of Mechanised Construction and Rock Mining | 80 843 | 4 |
| Łukasiewicz-ITEE | Institute for Sustainable Technologies | 58 625 | 1 |
| **Total** | | **22 495 428** | **80** |

The combined funded received by the 14 Łukasiewicz institutes represent 3,1% of the 720 342 753 Euros of H2020 funding for Poland by 19.7.2021.

Table 3. Top 10 Polish Beneficiaries of EU R&I funding in Euros (2014-2021)

| **Top 10 Polish Beneficiaries of EU R&I funding in Euros (2014-2021)** | **EU Funding in Euros** |
|---|---|
| Fundingbox Accelerator Sp. z o.o | 63 435 620 |
| University of Warsaw | 32 219 514 |
| Institute of Bioorganic Chemistry of The Polish Academy of Sciences | 30 477 054 |
| **Łukasiewicz Research Network (Łukasiewicz)** | **22 495 428** |
| National Science Center | 19 340 055 |
| National Center For Nuclear Testing | 16 112 107 |
| AGH University of Science and Technology | 15 226 303 |
| Jagiellonian University | 13 924 472 |
| Warsaw University of Technology | 11 955 526 |
| SANO – Centre for Computational Personalised Medicine – International Research Foundation | 9 302 101 |

In terms of leadership and coordination roles in EU-funded R&I initiatives where institutes from the Łuckasiewicz have participated, figures from 79 selected projects show that Łuckasiewicz institutes have coordinated 13 projects while institutions from the following 14 countries have Łuckasiewicz coordinated the rest (see figure 2): Spain (13 projects), France (10), Germany (9), Belgium (7), Italy (7), Finland (5), UK (4), Sweden (3), Denmark (2), Greece (2), Austria (1), Switzerland (1), Estonia (1) and Netherlands (1).

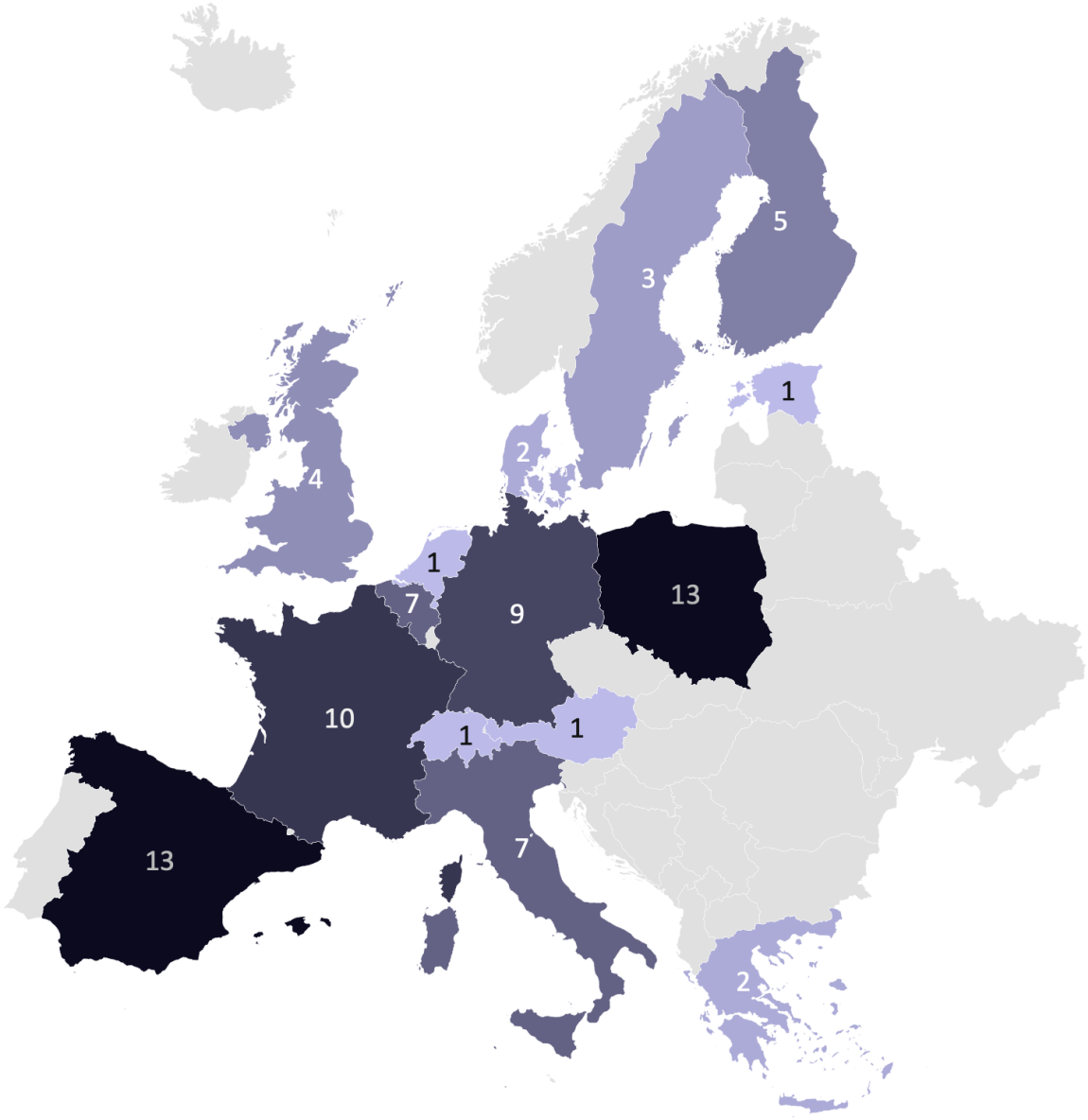


Figure 2. Number of coordinated EU projects by country

# 3. Critical Issues Analysis by Knowledge Transfer (KT) Areas

This section explores the critical issues, I.e. actions, barriers, drivers, opportunities and threats of each Knowledge Transfer (KT) Area discussed in this report. The analysis is based on the findings of desk research conducted on the eight case study countries (Austria, the Czech Republic, Finland, Germany, Ireland, the Netherlands, Portugal and Spain). The main objective of this section is not only to benchmark Poland against other good practice case study countries, but to shed light into the underlying critical factors and indicators that Poland should focus on in the development of a single KT strategy for the Łukasiewicz institutes. The section is divided by the three main KT areas discussed in this report, I.e., knowledge valorisation and exploitation, knowledge co-creation and knowledge sharing.

## 3.1 Key Highlights on KT Area 1: Knowledge Exploitation and Valorisation

This section targets the knowledge transfer area of knowledge exploitation and valorisation, i.e. the way new knowledge is used, applied and commercialised. The section is divided accorfing to the main subcategories of knowledge exploitation and valorisation, i.e., includes the company creation,, licensing, policy advice and others, such as academic entrepreneurship and commercialisation of intellectual property (IP).

The analysis of this section is based on a literature and document review targeting Austria, the Czech Republic, Finland, Germany, Ireland, the Netherlands, Portugal and Spain. In total, 74 critical issues (i.e., actions, barriers, drivers, opportunities and threats) were linked to this knowledge transfer area. They cover a broad spectrum, with company creation (23 issues) showing the highest number of issues, followed by licensing (13 issues) and other KT activities (11 issues). It is noteworthy that three of the above-mentioned activities company creation, licensing, and policy advice and analysis are covered by issues identified in the literature, complemented by 32 issues that are linked to other KT areas. This shows the high degree of interconnection between all three knowledge transfer areas.

The literature and documents were categorized in the following issue types: 17 actions, 14 barriers, 26 drivers, 11 opportunities, and 5 threats. They are addressing research and education, businesses, and government. With respect to knowledge exploitation and valorisation (see figure 3):

- Actions for enhancing knowledge exploitation and valorisation are to a high extent focusing on the economic level. They are also pursuing political goals or have a techno-scientific orientation. Various initiatives in this category refer to new (technology) ventures, incubating and accelerating, as well as to patenting and licensing, knowledge and technology transfer, or aspects of interaction and intellectual property rights as means to valorise and exploit research-based knowledge. Accordingly, they are mainly addressing businesses, research and education organisations.
- Barriers that hamper an efficient valorisation and exploitation of research-based knowledge may arise in relation to patent application strategies, formal and legal rules, through moderate efficiency of technology transfer or funding opportunities especially for young and small enterprises, and for

research and development activities. Further barriers are observed with respect to lacking knowledge concerning commercialisation of research-based knowledge and intellectual property aspects. Thus, barriers may occur on the economic, political, social and techno-scientific dimensions, and are primarily referring to stakeholders in the research and business sectors.

- Drivers are mostly targeting economic goals. Often, they refer to funding support such as venture capital investments or loans, support for research- and technology based companies, or technology expertise. Further drivers address collaboration and industry-academic partnerships. Drivers also refer to intermediary organisations such as platforms or specialised organisations whose mission is to bring together different types of stakeholders and provide support with respect to intellectual property management and contracting questions. Support for foreign companies and for foreign investment, and entrepreneurship education may boost knowledge exploitation and valorisation. In terms of stakeholders, businesses are of primary relevance, followed by research and education.
- Opportunities for knowledge valorisation and exploitation refer to techno-scientific and social dimensions, and are mostly addressing business stakeholders. They include incentives and other measures to foster science-industry collaboration and enhancing funds, as well as networking activities and specific strategies for intellectual property management. Focusing on the innovation system, strengthening innovation in SMEs and including a broad view of innovation (including social innovation) are considered as opportunities as well as knowledge transfer of large research infrastructures. In addition, the focus on value-added and impact for science and society are mentioned as opportunities for knowledge exploitation and valorisation.
- Threats were mainly observed on the economic dimension, and mostly address businesses and governments. They focus on strategic decisions of multinational enterprises, export activities and related destinations, lack of finance, and point to the focus on the society as a whole instead of individual companies when considering value-added of knowledge exploitation and valorisation.

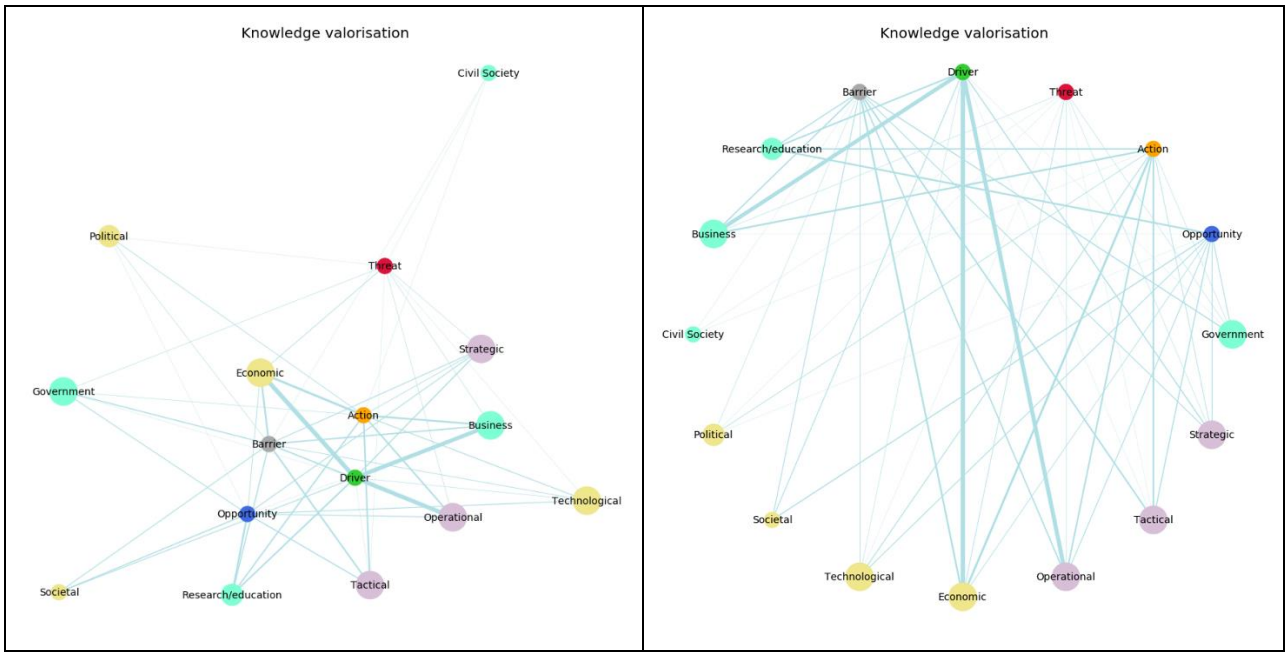

Figure 3: Knowledge valorisation

## Company creation

### Drivers

Drivers related to company creation are essential and therefore crucial in terms of structural features, actors and policy strategies. As the establishment of new companies or start-ups is a quite complex process and deeply embedded in national and regional techno-social systems, drivers can be both, related to the general institutional framework conditions as well as to the development of markets and the technological competitiveness of a country. Furthermore, social aspects, attitudes and entrepreneurial qualifications and skills can have significant impacts on the quality and intensity of entrepreneurial dynamics.

In most of the countries analysed for this study, the main drivers for company creation are in the field of (venture) financing and the institutionalisation of favourable start-up financing conditions in general. The establishment of (public) Seed or Venture Capital Companies is regarded as an essential element with regard to dynamic start-up ecosystems. VC companies usually fill the financing gap when it comes to early-stage high-risk firm foundations. Therefore, the availability of venture capital appears to be crucial for driving new companies and supporting growth. In most of the countries, public-driven VC companies closely cooperate with the private venture capital industry as these typically invest in the later phases of the company development.

In some countries, VC companies have been created on the regional level to complement the national approaches. Here, the focus is usually on regional/local development and the addressing of regional challenges. In most of these cases, regional innovation systems (RIS) are supported by these kind of activities as the renewal of the business communities within RIS is essential. The focus on improving regional framework conditions for the financing of new companies is advantageous because of better information and transparency for investors on start-ups and their business models.

In addition to the existence or establishment of Seed or VC companies more "traditional" financing instruments, like loans or grants are also important drivers for company creation. These instruments are likewise implemented in the case of market or system failures and complement the offers of the savings banks and private banks, which quite often shy away from financing new companies without guarantees. However, these instruments put emphasis on less growth oriented high-risk start-ups rather than on medium and low-tech companies, which are not interesting for VC companies.

Finally, measures related to improving the infrastructures for new companies are regarded as drivers, be it in the form of accelerators, incubators or local hubs. These can interact with other local hubs, universities and incubators to bring greater access to entrepreneurial support to every region. Depending on the specific start-up ecosystem, the elements of hubs, accelerators or incubators can be different, both in terms of the concrete offer (office space, technical infrastructure, advisory services, financing) and the model as such (part of a university's activitiy and/or of a policy programme or regional initiative.

## Actions

Concrete actions across the different countries can be manifold depending on the level of intervention, the concrete strategy and the identified gaps. In the course of the country analysis, for instance, a central platform between a national research organization and the national and international entrepreneurship ecosystems to boost knowledge valorization and exploitation has been established. As part of a program to intensify spin-off activities, the promotion of entrepreneurship and engagement in new ventures and a clear focus on the transfer of technologies and knowledge is at the core. In a more general perspective, incubation programs are further among the actions undertaken to promote new ventures.

In terms of special services offered to start-ups or self-employed, different funding or support institutions have been established in various countries. The offers range from a broad spectrum of support for preparing self-employment, setting up a business and expanding it. For instance, deep tech companies in the pre-foundation phase or innovative prototypes and first applications in different contexts are supported. In addition, incubators that support young, innovative people towards their first own company (with entrepreneurial spirit, guidance, resources, coaching, financial support and expert network) are among the services of such funding institutions. Financing instruments like guarantees (bank security), loans (to enable investments for setting up a company, modernising, growth and innovation), seed-financing (to bridge financing gaps of innovative start-ups), equity (to support start-ups with venture capital), growth Investment (to realise growth and innovation in order to strengthen the company's market position), or starting a business in rural areas (to support small technologically innovative enterprises that create added value in their regions) are among the main action implemented.

## Opportunities

Opportunities may exist on the one hand in a critical reflection of the wide-ranging prevalence of the Schumpeterian model of innovation at universities that have a narrow focus on commercialisation for profit generation. ‘Other’ types of innovation, such as social innovation, that emphasise multiple bottom lines needs pronounced attention. These ‘other’ types of innovations can contribute to socio-economic development agendas and need more explicit recognition and capturing of impact indicators tied to university research. Within this context, the paradigm of "Responsible Research and Innovation" which also includes the "third role" of public research and universities and highlights possible contribution to solve societal challenegs should be mentioned. On the other hand, a critical assessment of the common funding routines for public research can be re-considered, especially with regard to specific selection criteria for R&D pojects addressing societal challenges.

## Barriers and threats

The main barrier identified in the different countries relates to knowledge exploitation and commercialization of research results from public research organisations and universities. The second most prominent barrier - which is already mentioned above concerning drivers and actions - is the lack of capital for start-up, especially in the seed- and early stages. In many countries, the focus on these two bottlenecks constitute the main policy strategies and interventions. For instance commercialisation: in the last 20+ years, innovation policy in general and measures to boost start-ups recognized the fact that research potential of public research and universities has to be exploited more systematically, be it in the

form of science-business interaction (knowledge-transfer, patenting) or in a more direct way in the form of spin-offs. However, the pre-conditions within the different countries are quite heterogeneous. Therefore, the structural, institutional, organisational barriers, both on the supply-side and the demand-side (industry) have been focused upon more systematically than before. Barriers to successfully transfer knowledge from universities are mainly rooted in a different understanding and objectives of research compared to the rationales in the industry sectors. Thus, the foundation of start-ups from public institutions is not only an administrative issue but also related to motivation, incentives and alternative career paths of university researchers.

In addition, obstacles in the area of risky financing and the availability of a venture capital market are still relevant and can support company creation on the basis of results from public research.

## Licensing

### Drivers, actions and opportunities

Licensing is an important aspect in the context of knowledge valorisation and exploitation, in order to organise and define the rules for accessing and using intellectual property such as the knowledge produced through science and research related activities. With respect to knowledge transfer, licensing includes both knowledge creators and knowledge users, thus having a highly interactive and inclusive character.

From 13 issues linked to this activity, 7 are referring to actions, drivers and opportunities. Actions represent instruments to support the application and implementation of research results stemming from university and non-university research organisations. The main focus is to create and promote collaborative structures between research and industry which help to translate (pre-industrial) knowledge into marketable products and services. Those instruments represent an important step towards networking, collaboration, as well as to overcome potential weaknesses or bottlenecks. They may have an experimental character and aim to examine whether technologies developed in the pre-industrial stage are suitable to be used. Thus, they provide the first important step to show if, and which, part of the research findings are useful for industrial commercialisation, and which next steps are to be taken by entrepreneurs.

Identified drivers are strongly focusing on intellectual property management and contract-related topics. Here we find for instance a set of requirements for IP management in research organisations or points of reference for partnerships between science and industry including research commercialisation. A common feature of all drivers is the aim to provide guidelines and support for research commercialisation, either through recommendations and guidelines concerning IP-related questions, or through model agreements that can be used by organisations in order to commercialise their results. Activities of this type refer to research and transfer organisations and activities, but also to investors and private businesses. They help to organise knowledge valorisation, thus, to find efficient ways for bringing knowledge and technologies to market implementation. Another interested driver refers to venture-backed companies often being engaged in the build-up of absorptive capacity, while companies that receive public funds are more engaged in developing in-house R&D.

Our analysis includes one opportunity for knowledge valorisation and exploitation. This opportunity refers to a national framework for a standardized framework for intellectual property. Such a framework is helpful for research collaborations between different partners from research and industry. In addition, specialised third-party agencies support IP-related questions and coordinate stakeholders that generate and use knowledge and technologies.

### Barriers and threats

In total, 6 barriers and threats could be identified with respect to licensing. Hence, compared to drivers, actions and opportunities, these rather hampering aspects have a quite important role. Such refer, for instance, to administrative burdens and structural questions in large research organisations. In this case, legal and formal procedures may require a certain time span, especially in network structures with specific requirements of individual entities. The literature review also identified examples of low awareness of the need to protect intellectual property. This leads to difficulties related to the management of intellectual property in general, but also of documents which have been created. An additional aspect refers to the assignment of patent rights, which is a basic precondition for licensing and use of incorporated knowledge. In most EU countries, research organisations are responsible for patenting and patent applications, and they are consequently in charge of licensing questions. However, there are also cases where research organisations can limit patent rights to the national level. This might represent a barrier for knowledge use through licensing. As a consequence, knowledge transfer may be hampered, and licenses generate moderate revenues. In these cases, improving IP and license management could contribute to better exploiting the knowledge created through public research.

The analysis of barriers reveals another important aspect that is related to the general understanding of research, knowledge production and use. If knowledge transfer is understood as being separated from research-based knowledge creation, different types of actors and different activities are related to those separate activities. Apparently, researchers in some contexts tend to conceive knowledge transfer as step that is taking place after research has been completed. Thus, the processes of discovering new findings and applying their results are considered as completely separated from each other.

Finally, the literature review refers to one threat, which involves different roles of countries as locations for multinational enterprises. Generally, research and development activities in these companies take place in their home country and/or in research facilities in selected locations. Locations in other countries have comparative advantages for instance with respect to production costs. These countries benefit from jobs created through multinational enterprises but can expect small spill over effects from research activities or research and development delivered by local actors. As a consequence, R&D, innovation and patenting are activities from which those locations do not benefit.

## Policy advice and analysis

### Actions and drivers

Policy advice and analysis reflect in a way the complementary, non-technical dimension of the above-mentioned areas in terms of a systemic and ongoing evidence-based support process. Among the few issues

raised here, action is mentioned for instance regarding the need to differentiate between formal and informal modes of interaction among start-ups. Both types are associated with higher innovation performance in academic start-ups, but non-academic start-ups mainly benefit from continuous informal interactions. For non-academic start-ups, however, internal R&D is an important prerequisite for benefitting from access to scientific knowledge from public research. Policy instruments could also be designed such that they facilitate continuous knowledge transfer between start-ups and public research institutions more explicitly. It seems furthermore advisable to expand existing programs that include knowledge brokering services and assistance in (cooperation) partner search, support of public–private joint projects, and co-location of complementary actors to facilitate informal interaction as means to improve new firms' innovativeness and hence their beneficial impact on the economy and society.

### Opportunities

Opportunities arise from the fact that knowledge transfer is a socially situated activity, therefore individuals' motivations and beliefs (action-formation mechanisms), interactions (transformational mechanisms) and their environments (situational mechanisms) are important elements in understanding this process.

Another opportunity relates to the need to expand the existing list of knowledge transfer performance indicators by including also those that promote quality and not merely the number of outputs, such as new patents, licensing agreements and generated spin-offs. Policies at academic institutions must therefore not promote unconditional commercialization; exactly the opposite, they should carefully consider the scientific interests of academic researchers and characteristics of inventions before proceeding to the contractual relationships with the business sector.

A third opportunity may be the combination of research impact from an economic and societal perspective. Public research can boost its drive for societal impact and can create linkages and spill-overs across regions and sectors. For the societal impact, some research centres are very active in informing policy. This is also seen as a way for the centres to impact shaping of national research priorities, which is beneficial for the centres' core operations.

### Barriers

Barriers in this sub-category are related to financing initiatives to stimulate business R&D and innovation. The focus must be on the co-operation among STI actors; and to encourage the development of entre-preneurship and innovation in strategic sectors.

## Further activities

A couple of further activities are related to this knowledge transfer area of valorisation and exploitation, though not belonging to the five core activities mentioned above. 11 issues are classified as "other KT activities", while networking and events as well as consultancies are represented by 7 issues each. Other activities are collaborative research (6 issues) and professional development (1 issue).

## Drivers

In total, 11 drivers from different types of activities contribute to knowledge valorisation and exploitation beyond the five core activities mentioned at the beginning of this section. In our classification, drivers are linked to other KT areas (4 issues), collaborative research (3 issues), consultancies (3 issues), and networking and events (1 issue). For instance, there is the example of a small EU Member State with an early specialisation in selected sectors (information and communication technologies, and logistics). This early specialisation has driven the development of a strong service sector. As a consequence, those two sectors of information and communication technologies and logistics are nowadays responsible for a high share of the country's value added. Main driving forces were the favourable location of the country, traditional strengths, infrastructures and competences, and the development of related economic activities. This example shows that knowledge created in the frame of long-standing experience and further development of existing strengths contributes to knowledge application and commercialisation in adjacent sectors.

Another driver refers to specific intermediary actors that are helping local companies with their internationalisation activities. This refers for instance to initiating partnerships with other companies and/or research organisations in other countries. Furthermore, entrepreneurship education is seen as important precondition for creating awareness and increasing qualification is classified as driver; however, a specific budget is necessary for implementing teaching and qualification activities. Also, the entrepreneurial role of universities promotes knowledge exploitation and valorisation, since scientists include "entrepreneurial thinking" in their knowledge creation activities, i.e. developing ideas on how to valorise the knowledge created during their research activities.

The literature review identified three further drivers of knowledge exploitation and valorisation, which are linked to collaborative research. One issue mentions different incentive mechanisms for knowledge valorisation: while firms engaged in university cooperation (typically science based and R&D intensive small firms) often opt for patenting as important appropriation method, other small firms tend to prefer quick market introduction or secrecy for protecting and/or directly commercialising their knowledge.

We also find the example of promoting open innovation models for collaborations of small and young enterprises in a specific technology field, based on challenges identified by a selection of large industrial companies. This is an example for preparing the involvement of young, knowledge-intensive firms through creating conditions for collaboration and shared learning. Another example mentions business creation through demonstration projects that focus on priorities in the considered region. Those demonstrators include public-private dialogue processes and a networking platform.

Consultancy for driving knowledge valorisation and exploitation includes services delivered by venture funds, trade and investment promotion agencies or development agencies. Those intermediary actors bring in their expertise, help companies to develop their businesses, and provide funding.

Finally, drivers include specific services whose main activities are in networking. With a specific focus on knowledge valorisation and exploitation, networking events may also target commercialisation aspects.

## Actions and opportunities

Various types of actions can be identified in European countries. These cover legal departments that help to negotiate and draft project contracts, support from experts of patent offices, as well as promoting researchers in developing their start-up ideas, for instance through coaching, mentoring, qualification. There are also actions that link R&D and business partners in order to create closer proximity between knowledge creation and application. Other services are targeting start-ups, particularly concerning the provision of infrastructure, services, consultancy or expert advice related to intellectual property and knowledge transfer in the context of incubation and acceleration. This may complement the above-mentioned use of standardisation activities for valorising science-based knowledge.

Public procurement for the benefit of innovative technologies is a further action in this field, complemented by programme support for commercialising innovation through market-ready products or services.

Opportunities of collaborative research, consultancies, networking and events, and other KT activities directed towards knowledge exploitation and valorisation cover recommendations for small and medium-sized enterprises concerning their IP strategy, research collaboration and the integration of (internal or external) IP expertise in their activities. Opportunities also include incentives for knowledge valorisation through research-industry cooperation, such as matching grants in RTOs for research contracts on behalf of industrial companies.

In addition, (national) initiatives for identifying bottlenecks and obstacles in knowledge and technology transfer help to improve "knowledge channels". Other large (and supra-national) research organisations analyse different modes of knowledge transfer and use. Thus, further development of this aspect contributes to improving knowledge exploitation and valorisation in European countries. This is supported by defining assessment criteria for an appropriate set-up with high-quality output, aligned with institutional values and including added-value for science and the whole society.

## Barriers and threats

The literature review pointed at four barriers and 3 threats. While barriers occur in different types of activities (consultancies, networking and events, other KT activities, professional development), all threats are identified in other KT activities.

Important barriers are modest knowledge of the global patent system and commercial benefits from patent applications, as well as moderate capabilities to operate with intellectual property rights. Those capabilities and potential benefits may be increased through awareness raising among employees, commitment of firms' management and providing in-depth information about cost and benefits of IPR protection.

Further barriers refer to decreased public funding for research and development, and low levels of venture capital investment in risky assets, leading to low levels of venture capital investment in private businesses. In addition, patent application rules - especially the fact that patents are applied at a company's head-

quarter - lead to reduced innovation activities at subsidiary locations of an enterprise and to moderate levels of patent activities of local companies.

Finally, various issues can be a threat for knowledge exploitation and valorisation. First of all, companies tend to focus exclusively on the impact for their individual company, without taking impacts on other business actors and the society into account. Another threat is the focus of export activities on specific countries. Small export shares to emerging markets can be a future threat, as rather traditional markets may lose weight in worldwide trade structures. In addition, weak growth rates of the gross domestic product per worker (in purchasing power parity) are considered a threat with respect to knowledge exploitation and valorisation.

## 3.2 Key Highlights on KT Area 2: Knowledge Co-creation

This section analyses the actions, barriers, drivers, opportunities, and threats relating to knowledge co-creation. With knowledge co-creation, we refer to research where more than one type of partner is involved. Knowledge co-creation includes collaborative research, consultancy, contract research and publications-oriented research. The analysis is based on a literature review conducted on eight international case study countries (see figure 4), i.e., Finland, Germany, Austria, Netherlands, Spain, Ireland, Czech Republic, and Portugal. In total, 212 issues were linked to this knowledge transfer area. Most of them (112) related to collaborative research, followed by 74 issues linked to consultancy and 9 to contract research. Out of these 212 issues, 74% were of positive nature: 62 drivers, 60 actions, and 34 opportunities. Issues on the negative side consisted of 36 barriers and 20 threats.

- Actions to boost knowledge co-creation are primarily economic: setting various types of programmes to support collaborative research. These programmes target different sectors and types of companies. Some programmes aim at reaching the international top level, some aim at boosting the overall research activity in the country. Special subsidies are common to get SMEs to start innovation together with a consultant or a research organisation.
- Barriers to knowledge co-creation were mainly looked at from the research organisations' point of view. Setting up long-term collaboration between a research organisation and companies often requires long preparation and trust building. Company structure in a country may also be a barrier, as it is much more difficult to involve multinationals into research projects than locally owned companies. RTOs may also lack culture and skills to work in consulting-type of intensive projects at companies.
- Drivers for knowledge co-creations are national and European strategies for technology development and solving grand challenges as climate change, and funding instruments set up to address these chosen areas. Setting up research infrastructure and testbeds is another way to drive collaborative search.
- Opportunities to improve performance in knowledge co-creation are for RTOs to learn to work better and in closer contact with companies. Existing contacts should be utilised to the fullest to build long-term co-operation. Setting up business-like customer operations to help in creating new contacts to companies, and using existing contacts at RTO and RTO network level, are other opportunities for increasing collaborative research.

- Threats for knowledge co-creation stem from sudden changes in society. COVID-19 was a shock that for some time changed the way RTOs and companies could meet, and it also otherwise increased uncertainty among decision makers. Lack of stability and continuity in collaborative research funding was another important threat.

The critical issues analysis of knowledge co-creation is presented in three sections: collaborative research, consultancy and contract research combined, and publication-oriented research. Issues related to consultancy and contract research were combined for analysis because of the low number of issues for contract research and many commonalities.

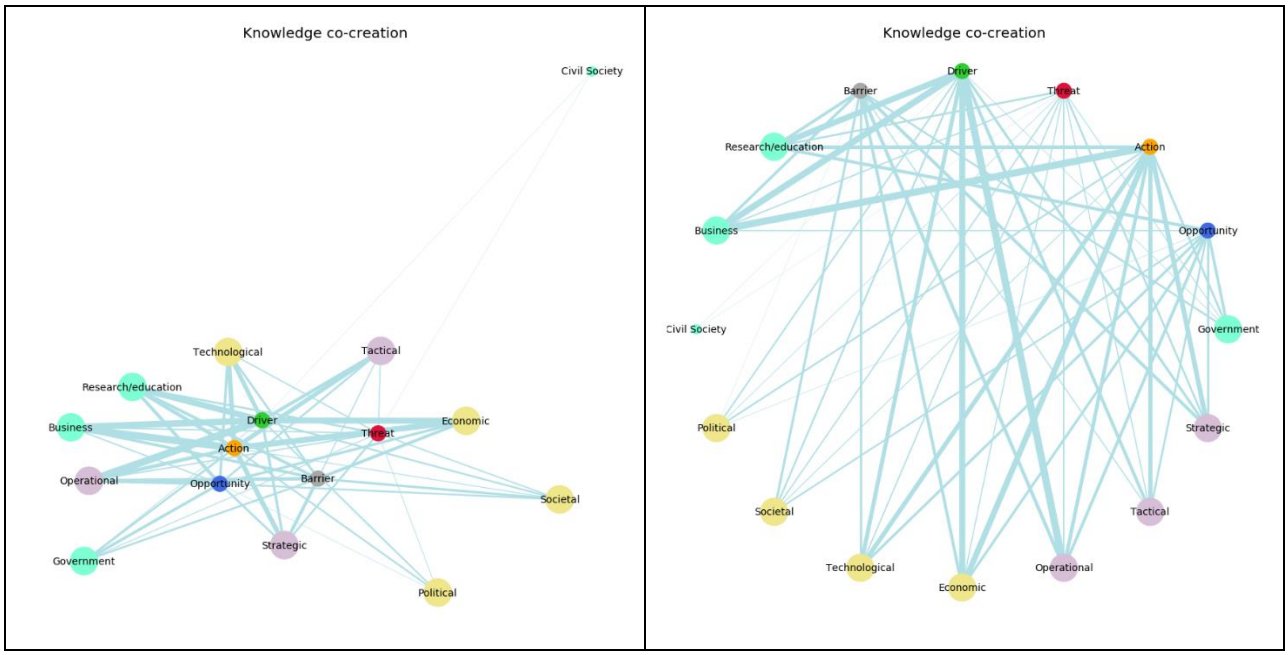

Figure 4: Knowledge co-creation

## Collaborative research

### Drivers

Collaborative research is the main activity in knowledge co-creation with two thirds of the issues linked to this activity. National and European funding instruments are in key role in boosting this activity with various financial funding sources. Funders define the terms for their support, often defining what should be researched, and they also define the requirements for organisations to be eligible for funding. These requirements define the type and size of the organisation as well as the minimum number and types of organisations participating in the project consortia. To balance with clearly focused funding programmes, our data also includes examples of funding programmes (e.g., Central Innovation Programme ZIM) that fund any sector or technology if the proposal otherwise fulfils the requirements.

National and European *strategies* for technological development are one of the main drivers for collaborative research. These strategies are often made for important sectors and/or to seize the opportunities in new technological developments or to address grand challenges like the European Green Deal to address the climate change. Examples of technological themes in our material are artificial intelligence, battery value chain, automated and connected driving, and digitalisation in material research, where the main focus of on digital processes in materials research and in the development of new materials based on biological principles.

As examples of national strategies, we can mention Austria and Ireland. Austria's RDTI Strategy defines strengthening the research, technology and innovation location of Austria and excellent fundamental research as the targets to reach through dynamic development of Austria's R&D expenditures, and public funding for university and non-university science and research. In Ireland in 2013, a national strategy defined participation in Horizon 2020 projects as a goal with the target of securing €1.25 billion in competitive EU funding over the lifetime of the programme. This target was almost reached with the result of about €1.1 billion.

Our material also includes an example of a regional strategy from the Basque country, where a strategic commitment to research and innovation has been made to accelerate the transition towards a digital, green and inclusive society. The Plan is aligned with Europe, and more specifically with the Horizon Europe Framework Program, the Digital Europe Program, the European Green Deal and the Next Generation EU Program. Three transitions were identified: technological-digital; energy-ecological; and social and health. The plan is based on four pillars: 1) Scientific excellence, 2) Industrial technological leadership, 3) Open innovation and 4) Talent as the central nucleus.

In addition to Horizon funding, other European funding mechanisms such as Eureka and European Social Fund are drivers for collaborative research and to cross-border cooperation between companies and their research partners. There are also sectoral collaborations, such as the Important Projects of Common European Interest on Microelectronics (IPCEI), where Germany, France, Italy, the UK and Austria jointly target to maintain and expand European microelectronics competences and know-how. Main goals are technology sovereignty, production capacities and highly qualified people. International Research Activities in SME (IraSME) promotes the initiation and development of transnational corporate

collaborations and networks, which provide the context for research, development and innovation projects.

Knowledge transfer to SMEs and increasing the R&D activity in SMEs is a common target in the surveyed countries. Drivers for boosting collaborative research among SMEs include requirements for including SMEs in research consortia as well as special funding instruments for SMEs.

The existence of research centres and networks, and research infrastructure including test beds are drivers for collaborative research. Test beds have been established for example for developing mobility solutions, and in the area of digital health. Mobility test beds aim at mobility solutions, such as automated driving, mobility-as-a-service, and intelligent traffic infrastructures. Nordic Test Beds (NoTeB), created in collaboration between hospitals and health innovation centres in Denmark, Finland, Norway and Sweden, is an example from the health sector.

Supply / value chains and ecosystems are also platforms for collaborative research. Value chains and ecosystem partners are natural collaborators for research as there are likely to be common interests and trust between members. Particularly for SMEs, this type of research collaboration has a low threshold for participation, and it gives good opportunities for absorbing the research results.

Trust between partners of all sizes and types is both a prerequisite and driver for collaborative research.
*At RTO level*, three main groups of drivers for collaborative research can be identified: scientific excellence, contacts to industry, and operational processes.

High scientific level makes an RTO an attractive research partner for companies and other RTOs. Research groups with top researchers in their field, shown in the form of high-level publications, drive research and company collaborations. If an RTO has managed to make a brand of itself, it will drive collaborations.

Having a good combination of business and scientific expertise in the management teams drives success. Hiring business managers who have industrial background and experience is one way of bringing contacts and industry expertise into an RTO. Persons with industrial experience will also be able to design meaningful ways of collaboration. However, the scientific lead in the RTO should be in the hands of top researchers.

Transparency is crucial to build trust and to enhance good collaboration with customers. It is also important that experts "speak the language of the companies" – i.e. be knowledgeable of company culture, objectives, and ways of operating

### Actions

The above-mentioned developments and targets have taken form in multiple concrete actions as funding programmes, initiatives and agreements. Research funding initiatives can be divided roughly into two main categories: those aiming at reaching high / top international level and those that aim at increasing

the R&D activities in SMEs and in less developed regions. Many programmes also have as an additional aim boosting collaboration between large and small companies as well as between research and companies.

An example of actions to reach top level is the leading-edge cluster competition in Germany. The aim is to support the most efficient clusters on their way to the top international group. Criteria for selecting leading-edge clusters include competence and profile with high innovation capacity, international networking and cooperation, as well as innovative science-industry collaborations. Further goals targeted qualification and promotion of young scientists.

Examples sectors and technologies that have funding programmes are:

- Mobility,
- Lightweight Construction Technology,
- Aviation (Electric hybrid flying),
- Battery value chain,
- Automated and connected driving,
- Artificial intelligence,
- Industry 4.0, and
- ICT-developments for addressing demographic change.

To address the environmental challenges, funds and networks have been established to enable launching projects in the area. We can give two examples from Ireland:

- '€10m Climate Enterprise Action Fund. The Fund will fund up to 850 companies at an early stage of exploring climate and sustainability to develop a high-level company action plan, which will enable them to measure their carbon footprint and identify projects leading to reduced emissions and greater resource efficiency. It will also fund up to 100 more advanced companies to develop comprehensive multi-annual business plans with climate change and sustainability actions integrated into the company's overall strategy. It will also support a small number of public/private partnerships working on high-impact feasibility projects that will enhance climate change and sustainability capabilities across Irish enterprise,
- 'CIRCULÉIRE industry-led innovation network. CIRCULÉIRE is the first cross-sectoral industry-led innovation network dedicated to accelerating the net-zero carbon circular economy in Ireland. CIRCULÉIRE is a €4.5m public-private partnership co-created by Irish Manufacturing Research (Secretariat), and three Strategic Partners; the Department of the Environment, Climate and Communications (DECC), the Environmental Protection Agency (EPA), and EIT Climate-KIC and 25 Founding Industry Members.'

The Basque Research and Technology Alliance (BRTA) is an example of actions between important regional parties. The alliance was set up as the result of a partnership agreement between the Basque Government, the SPRI Group, Álava, Bizkaia and Gipuzkoa Provincial Councils and 16 technology and science stakeholders belonging to the Basque Science, Technology and Innovation. Its main objective is to ensure a cooperation dynamic that allows the future industrial and technological challenges facing the Basque Country to be addressed and its international positioning improved.

A large number of varying actions are being taken to facilitate SMEs' entry into continuous research and development activities. One way to do this is to require that a research consortium needs to have SMEs to be eligible for funding; another to have an instrument for small-scale projects with reduced application forms and shorter processing times.

Small Business Innovation Research (SBIR) Ireland has a dedicated fund to co-support innovative and competitive challenges in public sector. The challenge is divided into two phases. During the first phase, from one to six companies undertake a technical feasibility study to understand the challenge and identify a potential solution to solve the problem; during the second phase, a smaller number of companies is funded to create a prototype through R&D.

Micro-companies in rural areas are addressed in a programme of Austria's Federal Ministry for Digitalisation and Economic Location (BMDW). A cooperation of at least three micro-enterprises can apply for funding (70% of the eligible project costs).

Czechia has a programme to incorporate post-graduate students to undertake a role in an SME. The student must be involved in at least one of the following activities: i) manufacturing process improvement, ii) development and innovation of new products and services, iii) process innovations in relation to the development and introduction of new products and services iv) business process improvement, including product certification process.

Last but not least to mention are tax incentives that are available for companies for their R&D costs in some of the studied countries. At least in Austria, both in-house and commissioned research are eligible for the tax reductions.

### Opportunities

The opportunities identified through the literature search and interviews mostly focused on how an RTO can improve its performance.

Good collaboration with companies is crucial to RTOs and the following issues were mentioned as opportunities to increase and deepen company collaborations. A customer operations department can help in initiating and collaborating with external partners, and act as a centralised connection function for finding new project partners. A centralised knowledge transfer office was also seen as a help in networking and matching industry with researchers. The centralised KT office is useful also for companies, when they are looking for collaboration partners. Companies often lack the expertise and knowledge as to where to find the right researchers. Sharing clear information about available services and forms of collaboration is important so that companies easily find what they are looking for.

Being quick to react to changes or shocks in the operating environment is another area for opportunities. For example, when external funding structures changed drastically in Finland, VTT launched a new

"Shared Benefits" project funding mechanisms which brought together companies and VTT to jointly fund projects.

Using collaborative research projects, as well as contract research and consulting services to nurture long-term partnerships between an RTO and companies is an opportunity for long-term success. RTO's internal code of conduct is important here to make sure that researcher are well-equipped for industry co-operation. Close collaboration with companies also helps in suggesting relevant, and not only interesting projects, which is particularly important for contract research when no public resources available.

When operating as a network of research institutes, being organised in thematic clusters gives benefits to the whole network. When institutes and departments join forces thematically and exchange information, it helps in coordinating work, using resources and presenting a unified image in the marketplace. Even though there are many shared benefits and even financial incentives for this way of working, competition between the members via-a-vis internal funds and the external market is hard to eliminate.

Allowing RTO researchers being affiliated also with a university is an opportunity both at individual and organisational level.

On governmental level, learning to make better innovation policies was identified as an opportunity. Governments could use public procurements as a platform to boost innovation, and, at the same time, learn themselves how to make effective innovation policy. Additional opportunities lie in following open innovation approaches by incorporating end-users and opening up policy definition to societal actors.

Finding ways to utilise resources to the full is another opportunity. Austrian Government envisages establishing a Technology Offensive, which targets research, innovation and digitalisation projects, as well as business start-ups and firm attractions, in order to strengthen RTI in innovative companies. Various measures are foreseen in order to transfer the results of fundamental research to the business sector, including knowledge transfer in performance agreements of scientific institutions, promoting spin-off activities and cooperative instruments at the interface between science, arts and business.

### Barriers

Collaborative research requires collaboration both between and among research organisations and companies. Weak or lacking collaboration between research and companies has been identified as a barrier for initiating research and reaching good results.

Engaging companies into large-scale and long research projects requires establishing personal relationships between the RTO and companies. This takes time and requires resources, which can become a barrier. The same applies to co-operation between research organisations, where existing contacts are valuable for joining future research consortia. Of course, not all companies are willing to invest in R&D and are rather seeking to avoid extra costs and wanting to pay as little as possible for R&D activities.

If a project consortium includes competing companies, information sharing, and collaboration are hampered. Research collaboration between competing companies works best in the pre-competitive, early phases of technology development before industrial applications are ready.

In countries with big multinational companies, difficulties in engaging multinationals to research cooperation with local research centres and universities, is a common theme. Companies in local ownership have been found to be much more likely to collaborate with local research sector.

Because contacts to industrial customers are so valuable, internal conflicts may emerge if several departments or institutes consider certain customers belonging to themselves and do not want their colleagues contacting or working with them.

Application-oriented research operates at the borderline between fundamental science and industrial application. This requires balancing between financial, scientific, industrial and qualification-oriented requirements. This can make it hard to compete for research grants.

In the case of Portugal, geographical imbalance and concentrated innovation system have been identified as barriers. The Portuguese innovation system is geographically concentrated in the capital region, and the fact that the industry R&D expenditures is concentrated in a handful of companies' places barriers for regional development and diffusion and spill overs of innovation activities. Lack of financial resources and knowledge of companies and business people are the biggest barriers for knowledge transfer activities. The main barriers to knowledge co-creation is SMEs relate to their skills and resources. Even though there would be funding available for SMEs, it does not lead to increased research activity if the companies cannot use the funding either for practical reasons (no resources for research planning and finding funding) or skills relating to research and development or applying research results.

### Threats

Sudden external shocks, such as COVID-19, external funding disruptions, and stagnation and offshoring R&D were the three main issues identified as threats. COVID-19 stopped personal meetings, which was harmful particularly for establishing new contacts and preparing new projects. As seen in this discussion of the issues, financial support from European, governmental and regional authorities is the key driving factor and any, and particularly sudden changes there, have a direct impact on collaborative research activities. Without a wide political agreement and commitment to keep R&D spending at stable level, economic cycles and political changes may cause considerable fluctuations in research financing.

## Consultancy and contract research

### Drivers, actions and opportunities

The most typical form of boosting knowledge transfer via consulting is the availability of vouchers or checks that an SME can used for contracting consulting or research services. Terms for using the voucher vary by country, but typically, they can be used to analyse the company's products, services or processes

in order to get the company started with actual research and development activities. In Austria, an SME can also apply once a year for a patent cheque to have an assessment on its IPR.

The Spanish Industry 4.0 programme includes tailored consulting for Spanish industrial SMEs. The programme, carried out by accredited and experienced consulting entities, includes 50 hours of advice, with specialized consultants who work in six areas of company growth: innovation, human resources, operations, digitization, marketing and commercialization, and finance.

Some countries have automated the first steps of SME support by creating an online questionnaire, that indicates whether and what type of support the company would be eligible for.
Some countries have programmes for boosting the digitalisation of SMEs, like for launching e-commerce projects, and enable companies to use consulting and implementation services in IT security, digitalised business processes and digital market development.

Some countries have established regional centres or hubs, which specialise in offering research services to SMEs. If an RTO gets a reasonable share of its funding from institutional sources, it helps an RTO also to provide high-quality research services, and there will also be motivation to be active on offering contract research.

One RTO has a programme where its researchers can work as employees in companies, where they map and recognise gaps in companies' innovation capacities. This programme has resulted in increasing projects and contract research and consulting with industry. These projects have been beneficial to both parties, and increased SMEs' innovation and R&D capacities, as well as improved their competitiveness in the market. Training and adequate professional development crucial for successful research mobility. Adequate training of team members who participate in industry partnerships is crucial to enable up-to-date and relevant skills. To succeed, researchers need to be flexible and committed to this type of collaborative work.

### Barriers and threats

RTO research culture may be unsuitable for consulting-like intensive projects at companies. Sometimes research culture is not conducive for high tempo, commitment-requiring projects. Consulting projects require a lot of working hours, flexibility, ability to work on evenings and weekends on an ad-hoc basis and the ability travel. For this, it can be a barrier to find motivated and skilled researchers to work in such projects.

### Publications-oriented research

#### Actions, drivers and opportunities

Securing funding for publication-oriented research has a key role for publication-oriented research. Strategy and support for securing H2020 funding has been one channel for being able to carry out this type of research. In some countries, there are national programmes for research in new areas and that way opportunity to publications. Linkages to industry and this way, to relevant research topics, was another driver to producing publications.

1000 Ideas Programme in Austria supports the promotion of completely new, daring or particularly original research ideas that lie outside the current scientific understanding. The programme supports ideas with outstanding scientific and transformative potential and may produce significant advance in scientific fields. Research in early stages, with high risk or new research designs, as well as visionary and interdisciplinary research ideas may be funded. International scientific publications and new ideas of high relevance for academic research and society are the expected outcomes.

Another Austrian programme, FFG Bridge, supports basic research projects conducted by scientific and industrial partners. It is open to all research topics. Though the programme is targeted at basic research, it also includes commercialisation aspects. The consortium must consist of at least two partners, one from science and the other from industry. This provides the base for joint publication activities.

#### Barriers and threats

Lack of funding and skills was cited as a barrier for producing top 10% cited publication.
There is competition for funding only between proposals but also between research types, competition of research funding between different types of research was identified as a threat to publications-oriented research. Increasing emphasis on top-sector research is one example of this competition.

Another risk for publication-oriented research is prioritising knowledge valorisation, which may divert attention away from research frontier.

## 3.3 Key Highlights on KT Area 3: Knowledge Sharing

This section analyses the actions, barriers, drivers, opportunities, and threats relating to knowledge sharing practices. With knowledge sharing, we refer to informal and formal activities concerning professional development, networking and events, teaching, publications and presentations and research mobility. The analysis is based on a literature review conducted on eight international case study countries (see figure 5), i.e., Finland, Germany, Austria, Netherlands, Spain, Ireland, Czech Republic, and Portugal. In total 103 issues were linked to knowledge sharing. The issues were categorized according to issue types: 29 actions, 10 barriers, 34 drivers, 19 opportunities and 10 threats.

- Actions to increase knowledge sharing in case study countries have mostly concentrated on the technological, social, economic, and political levels. The focus has been largely on boosting

collaboration between research and education institutes and business sectors. These actions have been taken on government, regional or on university and business sector level.

- Barriers to knowledge sharing concerned mainly research and business sector. Most barriers rise from lack of resources, financial or human capital. Sometimes barriers to knowledge sharing is seen to result from geographical boundaries or concentration of research activities to one or few key areas. Negative political atmosphere towards migration is seen to negatively impact attracting and retaining foreign students and researchers.
- Drivers of knowledge sharing consists of cultural, financial, and institutional factors. Culturally, a general positive attitude and general awareness towards learning and benefits of educations boosts knowledge sharing across the society. Financial drivers enable setting up programs and institutions that enhance knowledge sharing. Institutional factors consist of organizations, centres and other actors that are increase networking, matchmaking between research organisations and companies, and thus drive knowledge sharing.
- Opportunities in knowledge sharing relates to a good learning system, entrepreneurial training at schools and universities, industries' and firm's absorptive capacity, and availability and usability of knowledge sharing tools such as websites and newsletters.
- Threats for knowledge sharing concern lack of communication between industries and learning institutions which can lead to misalignments of educational system with labour market needs, R&D&I funding, especially competitive funding structures, quality of education and regional concentration of the innovation system.

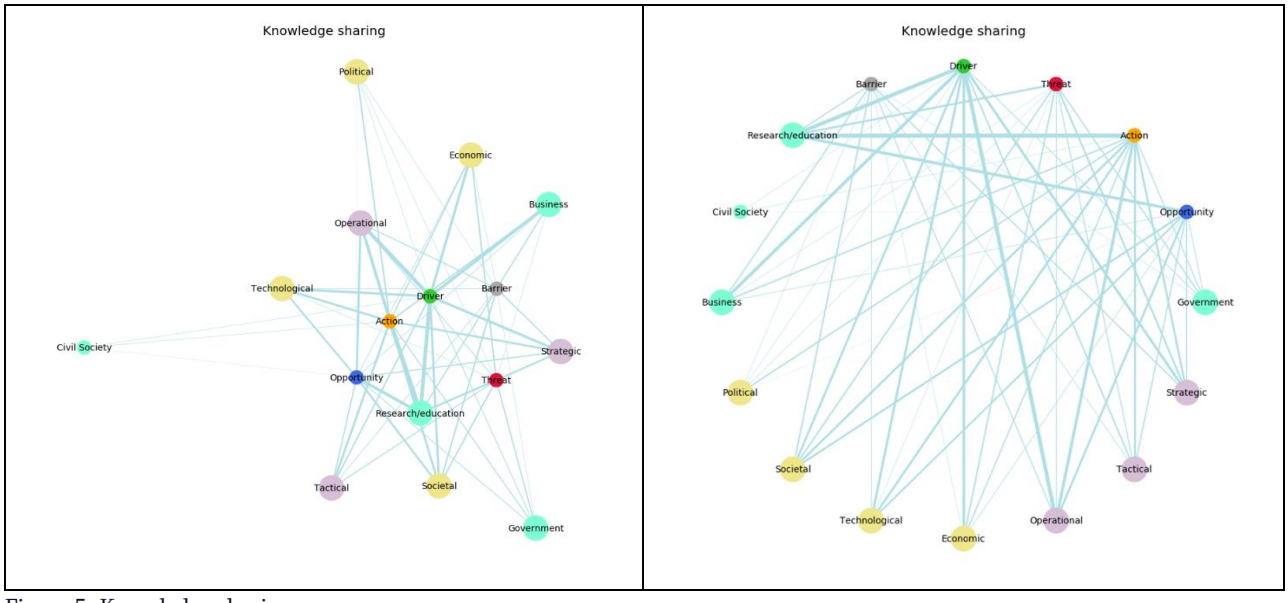

Figure 5: Knowledge sharing

## Professional development

### Actions

In general, knowledge sharing actions within professional development concern research and education. Actions aim to boost cooperation between research institutes and companies, and to increase citizens (i.e. non-student's) access to university courses and vocational trainings, e.g. through open courses or open university programs. One important action taken to boost societal professional development has focused

on increasing life-long learning opportunities. For example, in Finland universities have begun to offer non-university students right to attend courses. Non-university students can take courses in any fields of study, or in particular technologies such as Artificial Intelligence. Such actions are seen as important steps towards skills-updating and life-long learning, especially in times of increasing digitalization. To match labour market needs better with workers skills, centrally governed efforts to enhance and reskill worker's skills have been taken. This has been done for example through unemployment offices, who carry out assessment of educational needs of registered unemployed persons and directs them to suitable further education.

University and company collaboration are also part of the knowledge sharing action. In some countries, universities have started to offeri tailored training packages to companies based on the needs of the company. Universities are offering trainings in, for example, built environments, finances, digitalization, industrial engineering, project management, sustainability and research and development (Aalto University, 2021). Increasing university and company collaborations through technology transfer centres has in some countries enhanced knowledge sharing across sectors. This has been seen to have positive impact on university patent application activity as knowledge and skills in knowledge valorization are enhanced through institutional support (Maresova et al., 2020).

Other important actions to enhance knowledge sharing across educational institutes, research organizations and industry have focused on enhancing cross-sectoral cooperation through enhancing organisation's and companies project management and communication skills. Strengthening the quality of human resources and support services is seen important to boost publication outputs. However, diffusion processes among firms, universities and research organization are also an important part of knowledge sharing activities. For this, resources need to be allocated for networking activities and in boosting communication strategies.

### Barriers

Barriers for professional development concerned mainly SMEs inability and lack of resources to train professionals needed for more effective knowledge sharing practices. Lack of project management skills, especially in SMEs, constitutes a major barrier for professional development and knowledge sharing. Lack of qualified human resources in universities and research centres also form barriers for knowledge sharing, especially with regards to number and quality of publications. It has been studied that publication activity requires effective communications strategies and institutional communications support, which some universities and research centres are lacking (Maresova et al., 2020). Low quality university level education and poor teaching of relevant soft skills may constitute a barrier for knowledge sharing, especially for networking and publications. For example, if universities do not provide graduates with relevant soft skills, for example in communications and most up-to-date scientific knowledge, publications may not reach top journals and dissemination can be poor (Maresova et al., 2020).

### Drivers

Drivers of professional development consists of initiatives that aim to enhance national and regional level networking. Such initiatives can aim to strengthen universities' capabilities to network, to transfer ideas,

knowledge, and technologies. Historical factors also play an important part in driving professional development. For example, historically strong international relations of a country can be an important driver of international cooperation and professional networking, which is important for domestic professional development, too. Finally, human capital agendas which describe current and future skills that top sectors will likely require is a driving tool to not only map human capital demands but to shape educational programmes to respond to future human capital needs. This is important tool for foresight in professional development.

### Opportunities

Opportunities in professional development consists of enhancing education and life-long learning opportunities. Facilitating and enhancing opportunities for lifelong learning helps to respond to changing work life demands, and to reskill workers in times of increasing digitalization.

In addition, increasing international participation and engagement in projects is important to support foreign experiences, and to enhance English language skills which enable better international knowledge sharing. Enhancing international collaboration can increase successful international project applications, which can have benign implications on foreign funding. To benefit from international flow of ideas, institutions and countries have adopted projects to host foreign researchers, increasing younger generation international mobility and by increasing English language training.

### Threats

High national debt rate can lead to cuts and decreasing investments into research and development, which can negatively impact professional development from university education to research organisations human capital pools.

## Networking and events

### Actions

Actions to boost networking and events include establishment of knowledge hubs, technology transfer offices, hackathons and increasing effectiveness of communications via for example newsletters and websites. Overall, governments can play crucial role in creating large scale national or regional networking forums, which increase knowledge sharing activities within specific regional and knowledge expertise areas. Competence clusters are often formed in business areas which are seen strategically important for the nation or region. Competence clusters usually comprise of research teams and business sectors, and they aim to boost research and innovation within that sector.

Establishment of one stop-shop for technology transfers are important, as they offer services for companies' easy access to specific technologies. Such one-stop-shops are seen to lower the threshold of accessing information and assistance needed for companies to take on specific technologies. Moreover, one-stop-shops can enhance information dissemination and, in this way, boost promotional activities. Technology and innovation hubs are useful for bringing together small and medium size companies, scientific entities, and start-ups. Networking with regional industrial associations can boost regional

innovation capabilities. For this, some countries have established networks of technological and business experts to boost innovation activities and digital ecosystems. Increasing cooperation among academic environments and business spheres through technology transfer centres is also beneficial for boosting university patent activities. To enhance university collaboration with industries, actions have been taken to enhance human resource development and management skills at universities.

Actions to improve communications strategies are also important for networking and events. Technology developments newsletter is an example of a practical tool that is used to increase knowledge sharing across sectors and industrial spheres. Newsletters can increase companies and industrial sectors' awareness of future trends, which can boost networking and innovation activity.

### Barriers

Barriers to networking and events consists of language barriers, especially in international networking, regional concentration of research and innovation centres and lack of co-operation culture among regional innovation actors. Weak connections with businesses makes an overall and overarching barrier in knowledge sharing among research institutions and businesses.

### Drivers

Regional, national, and international networking events that gather start-ups and investors is an important driver in enhancing networking among crucial players. Within inter-institutional projects, effective communication, and project management tools, such as Microsoft Teams Planner can enhance communications and thus increasing likelihood of project success. Integration into global value chains (GVCs) is also important for the growth of the export sectors. Setting up single-point-contact hubs and institutes can increase networking and technology transfer as they usually facilitate encountering suitable project partners, for industries and research organisations alike. In some countries establishing membership networks of companies and research organisations have been used to increase mutual knowledge sharing. In Ireland, for example, the national Enterprise Ireland institute has established 15 Technology Gateway centres which deliver a variety of services to companies. They are open access points for industry of all sizes, and they act as local access points to the wider resources in the Irish research infrastructure. The centres deliver technology solutions for Irish industry close to their market needs. It is argued that regional technology transfer offices increase networking which is seen to positively impact knowledge sharing and collaborative partnerships (Mascarenhas et al., 2019).

### Opportunities

Open exchange of ideas and insights is seen important for the innovation activity as a whole. Opportunities can include increasing collaboration, matching of industries and research organisations and increased innovation activity within and among regions. To increase networking, some countries have aimed to develop an evaluation system that matches researchers and companies. Strategic use of social and traditional media tools are also important opportunities to increase networking. University spin-off companies also present an opportunity for enhanced knowledge sharing within the operating business environment. Forming collaborative networks with SMEs is also an important opportunity used to

enhance effective regional innovations ecosystems in situations where institutional funding is scarce or very limited.

### Threats

While national innovations strategies can be beneficial for R&D coordination, in some cases it can lead to centralised innovation ecosystem which hinders the development and diffusion of information to regional innovation systems. Central policies can increase regional disparities and have negative impact on regional patent activity and networking. This can lead to decreasing business sector investments into R&D, especially in regions which are not central or included into the national innovation policies.

## Teaching

### Actions

Actions taken to enhance knowledge sharing via teaching have focused on providing greater access to university teaching for companies and non-university students. This is seen to be important for increasing workers skills and to promote life-long learning across the society. In addition, in most of the case study countries there were several basic school education programmes to enhance entrepreneurial skills. Most programmes were targeted at basic school level, but few focuses also on entrepreneurial education.

### Drivers

Government support for educational institutions is important, especially for entrepreneurial education. In Finland, for example, the government supports entrepreneurial education with 1 million euros per year via various associations. Government support for education is partly dependent on general attitudes towards education. For example, in societies and contexts where education is highly valued, it is likely that a bigger share of government expenditure is directed towards education. For this, general awareness on the importance of education is an important driver of teaching.

Many countries also have taken actions to boost informal knowledge sharing practices, starting from early education. In several EU countries governments have adopted early school entrepreneurial training. These trainings have focused on enhancing pupils' entrepreneurial mindset, skills and knowledge in market understandings, finances, marketing, production, entrepreneurship. Materials for these trainings have been accessible for teachers online. (School Education Gate Way, 2021).

In some countries, for example in Ireland, their research organisations have adopted programmes that aim to increase engagement and scientific understanding of the public. Through the SFI Discover Programme, SFI aims to create "opportunities for dialogue between science and the public" and to improve diversity and inclusion in science" (SFI, 2021). Finally, research organisations in Austria, Spain and Ireland have implemented specific programmes to attract and facilitate PhD students undertake research at their organisations.

### Opportunities

Opportunities within teaching lie in developing and adopting digital tools and platforms for learning and teaching. This can in itself work as a tool to increase digital skills, but to also increase flexibility for students and learners from a variety of backgrounds, increasing opportunities for lifelong learning irrespective of organisational boundaries or geographical locations. Opportunities lie in also increasing research organisations and universities cooperation in facilitating bachelor's, master's and PhD dissertation projects to be taken up in RTOs activities.

### Threats

Threats to educational and teaching activities lie in cooperation between educational institutes and the business sphere. For example, lack of alignment of educational institutes' priorities and current and future labour market needs may result in mismatching recent graduates and labour markets. Moreover, a heavy increase in universities' commercialization targets have in some cases raised worries for being distracting on universities other basic activities. For example, some studies have found increase worry among university staff that high commercialisation targets might detract teaching staff and universities from their important contributions on the society, e.g., development of skills that diffuse across the economy and tacking societal challenges. Finally, lack of quality education in Universities of Applied Sciences and in tertiary education can lead to high dropout rates and as such lead to issues in responding to emerging labour market needs.

## Publications and Presentations

### Actions, Drivers and Opportunities

Actions, drivers, and opportunities to enhance publications and presentations consists of factors that aim to increase funding, either national or international, and of initiatives to enhance or maintain multidisciplinary research organisations. Inter- or multidisciplinary and mission-oriented research organisations are seen important drivers of innovation and for solving societal challenges innovatively and holistically.

Access to funding is crucial for enhancing the number and quality of publications. There are various strategies to increase quality and quantity of publications. For example, central independent funding for research can work as platforms to facilitate competitive funding schemes which can enhance research quality.

Government funding and centrally coordinated research organisations and initiatives that aim to target, fund, and launch top research are important for creating high quality publications. Focusing also on quality and not the quantity of publications is important for reaching high levels of internationally published papers. Innovation activity focusing on niche technologies is seen as an important driver for increasing innovations and spill overs across sectors.

### Barriers and Threats

Barriers and threats to publications and presentations consists of lack of quality in human resources in graduate education as well as in research organisations. Human resources are important in supporting

publication activities within research institutes and organisations. They are often involved in promotion and diffusion of publications. In graduate education, especially lack of teaching in soft skills and up-to-date scientific knowledge is also important for enabling later high-level publications of graduate students. In addition, competitive funding and decreasing stable public funding can pose a threat to research activity, especially in those research areas which are not directly aimed to be valorised or exploited for commercial purposes. Changing funding bases and rules may, especially for universities, divert their focus from their primary roles in producing curiosity driven research towards research and other activities that do not contribute to their scientific agendas. Moreover, due to changing funding bases more time can be dedicated in creating alliances and partnerships which reduces time used to research. This can impact negatively on publication quality and quantity alike.

## Research mobility and other knowledge sharing practices

### Drivers and Actions

Attracting and retaining international students and researchers is seen important for knowledge sharing, and especially for increasing international flow of ideas. Historically versatile international relations have been an important driver for facilitating international collaboration, and international flow of researchers and students. International relations are also important in boosting global industrial relations. Foreign students, especially at PhD level increases research mobility and international networking. It is also seen to maintain continuous supply of researchers.

Some countries have adopted measures to increase the number of international students by simplifying and streamlining admission and residence permit application processes. For example, in the Netherlands, attracting more foreign students to higher education is facilitated by simplifying admission processes and streamlining higher education admission with migration procedures, e.g. residence permit applications. In the Netherlands, for example, foreign students who have recognised sponsorship or educational institutions as sponsors can have their applications handled through a fast-track residence permit processing. Netherlands is also promoting study opportunities in third countries via national embassy networks to attract more international students.

Domestic research mobility is also an important driver for domestic knowledge sharing. In Spain research mobility has enhanced industry – RTO knowledge sharing. This is seen as an important driver for other knowledge transfer areas, such as collaborative research and contract research, as researcher mobility increases networking and social relationships with different stakeholders. Such activities are supported by research organisations through specific mobility programmes.

### Barriers

Barriers to international researcher mobility consist of negative political climate towards migration and limited resources for supporting and facilitating domestic and international researcher mobility. Political climate towards migration can be seen to hinder attracting foreign students, but also in retaining students as workforce after graduation. Strict immigration laws also hinder attracting and retaining international researchers.

Research mobility programmes are also resource intensive in terms of financial resources but also in terms of human resources. For this they have limited applicability and their usability depends on the available human resources. Researcher mobility in industrial fellowship programmes can be either paid by the company or by the RTO. Depending on the financier there can be barriers whether there are enough resources to hire or send researchers to mobility programmes.

# 4. Best Practices Analysis by Knowledge Transfer (KT) Areas

From our eight case study countries, we have conducted closer analysis on best practices in seven leading RTOs s in order to identify best practices on knowledge transfer that could be applicable to Łukasiewicz in the Polish context. The selected countries – Finland, Germany, Spain, Austria, The Netherlands, Ireland and Portugal – are strong innovators or innovation leaders except for Spain and Portugal that are moderate innovators.[8] Within these countries, we have focussed on the knowledge transfer activities pursued by major R&D&I organisations that share institutional and organisational commonalities with the Łukasiewicz and its institutes. This means that large RTOs that operate in multiple industrial sectors have been given priority in the case study selection. The data used in the case studies is based on the interviews with the key personnel of the target organisations, such as managers and heads of units, and desk research on the material retrieved from the interviewees and public sources. Following the categorization used in this report, the case studies focus on best practices in the following three knowledge transfer areas:

1) Knowledge exploitation and valorisation, such as academic entrepreneurship and licensing
2) Knowledge co-creation, such as collaborative and contract research with industry
3) Knowledge sharing, such as networking activities and researcher mobility between academia and industry

The R&D&I organisations addressed by the case studies:

- VTT Technical Research Centre of Finland Ltd (VTT), Finland
- Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e. V. (FRAUNHOFER), Germany
- Fundación TECNALIA Research & Innovation (TECNALIA), Spain
- AIT Austrian Institute of Technology (AIT), Austria
- Netherlands Organisation for Applied Scientific Research (TNO), The Netherlands
- Knowledge Transfer Ireland (KTI), Ireland
- Science Foundation Ireland (SFI), Ireland
- The Institute for Systems and Computer Engineering, Technology and Science (INESC TEC), Portugal

The best practices on knowledge transfer identified within the above-listed organisations are introduced in the table below (table 4). In the following sections, these practices are reviewed and findings concerning drivers, barriers and lessons learned that are relevant in the Polish context are put forward. More detailed case accounts can be found in Appendix 3: On EU Best Practices.

Table 4: Best practices by organisation

| Best practices by organisation & KT area | Knowledge valorisation | Knowledge co-creation | Knowledge sharing |
|---|---|---|---|

[8] Esuropean Innovation Scoreboard 2020.

| | | | |
|---|---|---|---|
| **VTT (FI)** | VTT LaunchPad | Shared Benefit project model | Online communications platforms |
| **FraUnhofer (DE)** | AHEAD Programme | Contract research model | The Fraunhofer Groups |
| **Tecnalia (ES)** | Tecnalia Ventures | Orainn initiative | Networking strategy |
| **AIT (AT)** | - | Ingenious partner as brand essence | PhD programme |
| **TNO (NL)** | Tech Transfer Programme | N/A | N/A |
| **KTI, SFI (IE)** | KTI National office for knowledge transfer | SFI Research Centres | SFI Fellowship Programme |
| **INESC TEC (PT)** | LET-in | Innovation Ecosystem | INSEC TEC Higher Education Network Strategy |

## 4.1 Key Highlights on KT Area 1: Knowledge Exploitation and Valorisation

### VTT (FI): VTT LAUNCHPAD

#### Description

Operating since 2019, VTT LaunchPad is an in-house business incubator that aims at creating fundable spin-off companies built on technologies developed by the researchers working at VTT Technical Research Centre of Finland. In order to enter VTT LaunchPad, the business idea must 1) be based VTT's IPR that can be spun off, 2) show market potential and be scalable, 3) benefit society and the customer, 4) be built on a demonstrated technology and 5) be run by a team that evolve into a fundable spin-off venture. Through VTT LaunchPad, VTT is a pre-startup and startup phase investor. VTT LaunchPad funding is used for exploration of commercialization paths and execution of predefined customer-centred activities for a one-year period utilizing the Lean Startup methods. VTT may also co-invest into the new company. This co-investment usually comprises the IPR developed and other assets valued at the market value. In comparison to other pre-seed funding instruments, the added value of VTT LaunchPad is its focus on entrepreneurial competence development. The research team participating in the VTT LaunchPad activities is complemented with an external business expert, such as a former CEO of a spin-off company, and the whole team participates in a team development programme with shared and individual development targets. In addition to funding and team development, VTT LaunchPad offers active IPR development, facilitation of contacts with investors, partners and mentors, as well as entrepreneurship training. In addition to the continuous internal call, workshops are arranged for collecting new business ideas at early stages and additional support is provided for applying public funding for commercialization activities.

#### Drivers

- The core idea of VTT LaunchPad is its focus on entrepreneurial competence development. This is greatly enhanced by utilizing the Lean Startup methods (advocated by Eric Ries), including fast cycles of testing and piloting.
- The recruitment of external business experts to teams in addition to researchers.

#### Barriers

- The researchers who are capable to develop promising business ideas are, in many cases, valuable researchers whose commitment to the VTT LaunchPad activities may cause short-term lack of personnel resources in other research projects.

#### Lessons learned

- The startup activities call for operational autonomy and the level of project bureaucracy should be kept minimal in order to support these activities in the most effective way.

## FRAUNHOFER (DE): AHEAD PROGRAMME

### Description

AHEAD is an internal technology transfer programme that focuses on the transfer of Fraunhofer technologies and promotion of start-ups. AHEAD is run by Fraunhofer Venture that is a dedicated department founded in 2001 with the purpose of providing comprehensive support for Fraunhofer spin-off projects. AHEAD acts as a venture building programme that actively promotes Fraunhofer spin-offs and supports innovative projects participated by researchers and entrepreneurs. The programme gives spin-off projects the opportunity to become market- and investment-ready within a maximum of two years. Each team receives support in terms of funding, training, networking and business intelligence support as needed. The key features of the AHEAD programme:

1) Entrepreneurs first: Sophisticated team building and development mechanisms are used for identifying entrepreneurs inside and outside of Fraunhofer, help them to build a team and develop it to high-performance.
2) Focus and simplification: By creating one single brand and programme, a more effective marketing inside and outside of Fraunhofer is enabled, in addition to synergy benefits.
3) Need-based programme structure: The programme structure reacts according to the needs of the projects via on-demand workshops, coaching, network, etc.
4) Market interaction: Market interaction of the projects is fostered from day one, including customer interviews, co-creation and testing activities.
5) Transparent deals: Standardized term sheets are provided and the conditions related to shareholdings are standardized to a large extent.

### Drivers

- Fraunhofer Venture supports the spin-off teams legally and financially while their home institutes give support in terms of technology.
- External coaches provide information about the environment, including investment opportunities.
- A clear set of criteria and close advisory services are in place.

### Barriers

- Despite AHEAD being an internal programme, it is implemented by a special department, Fraunhofer Venture, which - from the viewpoint of the individual institutes and researchers - is regarded as an external unit. Thus, the challenge is to adapt the programme into different institutional settings and technological contexts.
- Fraunhofer Venture operates in one location (Munich), and, therefore, it has limited access to the institutes in other areas.

### Lessons learned

- By applying for AHEAD, a team can get access to the whole word of spin-off support with one application. Business, product and IP strategy development is supported in combination with project financing and networking services.

## TECNALIA (ES): TECNALIA VENTURES

### Description

Tecnalia Ventures is a subsidiary of Tecnalia set up in 2013 for acceleration, incubation and venture building services. It aims at transforming technologies developed at Tecnalia into technology-based business opportunities to be commercialized via new licences or spin-offs. The specific focus of Tecnalia Ventures is on deep-tech spin-offs that are supported through the Omega incubation and accelerator programme. Business opportunities that are approved by an investment committee enter the Omega programme that provides funding for carrying out business and technology development activities needed for achieving a prototype or product that could trigger a private capital investment. The project teams of the Omega programme comprise researchers from Tecnalia's divisions and commercialisation specialists coming from Tecnalia Ventures. In addition to the Omega programme, Tecnalia Ventures takes actively part in ecosystem building in the region (Basque Country) in order to foster technology transfer activities. The key idea of ecosystem building is to enhance interaction between technology developers, entrepreneurs and investors via networking activities.

### Drivers

- Transforming a research project into a technological product that solves a problem that has a positive P&L impact on the end user companies.
- Protecting technology in a way that will maximise its future economic value.
- Creating teams made up of both technological profiles and business/marketing/sales profiles, including people outside Tecnalia.
- Making connections to smart investors in the region, including corporations, venture companies (VCs), family offices etc.

### Barriers

- It is challenging to find a right composition for an entrepreneurial team and match technical profiles with business profiles.
- There is a short-term personnel problem when research teams lose key experts who decide to participate in the venture building activities.

### Lessons learned

- Deep-tech spin-off creation requires working in a coordinated way at multiple levels: 1) individual (interactions between people and teams), 2) organisational (interactions between tech transfer unit and host organisation) and 3) ecosystem (interactions between regional ecosystem actors) levels.
- Technology-minded people should not be forced to become entrepreneurs.

## TNO (NL): TECH TRANSFER PROGRAMME

### Description

Starting its operations in 2017, TNO's Tech Transfer Programme aims at introducing TNO technology faster to the market by supporting creation of spin-off companies and technology licencing. The programme focuses on the pre-seed phase when preparatory activities for company creation are conducted, such as market research, business planning and collaborative agreements. The internal call for applications for Tech Transfer Programme is open the year around. After the approval made by the board of the programme, € 30,000 is allocated for the implementation of Phase 1 activities, including drafting a strategy for bringing the technology, which constitutes the basis for the foreseen spin-off, to the market. If the results of Phase 1 are approved, Phase 2 starts with a maximum budget of € 50,000. During this phase, the project team will draft a business plan, a dedicated spin-off team that consists of TNO researchers supplemented by an internal/external business developer will be formed, and agreements on collaboration and IPR issues will be made between the spin-off, TNO, and other stakeholders. The final decision on the launch of the spin-off is subsequently made by the TNO's Executive Board based on the business plan and the foreseen agreements. Recently, TNO has started a close collaboration with a private Dutch venture-building accelerator, HighTechXL, by suppling technologies for venture development in cases when there is TNO's personnel available to participate in the spin-off activities.

### Drivers

- Getting clear support from the line management of the unit where the technology has been developed.
- Making collaborative contracts between the spin-off company and TNO resulting in new projects where these companies are TNO's clients.
- A spin-off company should be run always more than one person.

### Barriers

- In case of deep-tech, the initial funding instruments are not on a sufficient level.
- Using TNO's facilities is expensive for new companies since pricing is made on commercial basis.

### Lessons learned

- The spin-off teams should be exposed to the interaction with investors already at a very early stage of their life-cycle, even before they are investment-ready. This contributes to the further shaping of their plan.
- Ecosystem activities and collaboration have been intensified in order to obtain competences, which are lacking in the spin-offs.
- The duration of the spin-off projects has been extended from the set-up phase to the first financing round in order to increase the probability of success.
- Only the most entrepreneurial-minded researchers should apply to the programme.

## KTI (IE): NATIONAL OFFICE FOR KNOWLEDGE TRANSFER

### Description

Founded in 2013, Knowledge Transfer Ireland (KTI) acts as a national knowledge transfer institute helping business to benefit from the access to Irish expertise and technology. KTI is a centralised point of reference for industry-academia partnerships and research commercialization in Ireland. It manages and provides support with issues concerning intellectual property, licencing, funding and consultancies. KTI is hosted by Enterprise Ireland (EI), the government agency responsible for supporting Irish business, and funded by EI with co-financing from the Irish Universities Association (IUA). KTI provides a portal for industry and entrepreneurs through its website through which users may navigate across the entire public research sector in terms of knowledge transfer issues. For business, KTI offers a suite of resources, including template model agreements, practical guides and funding tools. In some cases, KTI offers practical support, especially in case of complex multi-party arrangements. A key role of KTI is to raise awareness of and to promote the successes arising from co-developed ideas and the opportunities available for co-development, in order to attract new companies to engage in research and contracting with public research organisations.

### Drivers

- In Ireland, research projects are usually performed by multiple partners, including universities, companies, and technical research organisations. For effective collaboration, it is helpful to have a standardized intellectual property framework nationally. It fosters cooperation between different partners, especially when intellectual property questions are relevant, because a third party can coordinate agreements between collaborating actors in a transparent and impartial manner.
- As a centralised institute, KTI is useful for companies when they are looking for universities or research organisations with whom to collaborate within the national R&D system. Via KTI, they have a one-stop contact point to find relevant partners.
- Having a national KT institute ensures consistency in R&D activities and knowledge transfer. KTI also plays important role in providing help, matchmaking, and consultancies to companies of all sizes.

### Barriers

- It is important to avoid the system from becoming too bureaucratic. Especially, the Irish Universities should be encouraged to keep the tech transfer process simple, uniform and with the minimum of bureaucracy and fast speed.

### Lessons learned

- KTI provides assistance and services broadly to the whole society by promoting a culture shift in professionalism and openness when it comes to R&D. Industry stakeholders have found it useful to have one point of contact to find research expertise and access ideas and technology created by public research performing organisations.

## INESC TEC (PT): LET-IN

### Description

LET-In (Laboratório de Empresas de Base Tecnológica) is INESC TEC's proof of concept innovation lab (pre-incubation services), which provides a range of services to technology-based projects with high innovation profile. These services range from organization of workshops for new product development, business model ideation and prototyping, to coaching and mentoring, technological and business consultancy or advanced training for entrepreneurial capacity building. LET-In acts as INESC TEC's umbrella for a series of projects involving relevant regional, national and international stakeholders in the fields of technology valorisation and technology-based entrepreneurship. Although LET-In was initially created to support internal entrepreneurs and researchers, it was later made available also for external promoters. LET-In contributes to the following knowledge transfer activities:

1) Development and implementation of acceleration programmes supported by new methodologies and tools to foster the development of technological entrepreneurial projects.
2) Development of tools and provision of direct support to researchers in the process of turning knowledge and technologies into business (technological development, IP, business model, investment roadmap).
3) Support for proof of concept, including development of attractive investment project proposals for external investors.
4) Development of open innovation campaigns (Call for Challenges & Call for Solutions) to facilitate knowledge and technology exploitation and interactions between companies and researchers.
5) Provision of personalised mentorship for potential INESC TEC spin-off projects (Intellectual property management, data management and protection, legal services, product and service design, business model design, implementation roadmap, investment strategies, partnerships, etc.).

### Drivers

- Creating a sustainable service is challenging and this was achieved with the development and implementation of a business model for the operation. Specific methodologies and tools were developed or adapted to maximize the complementarities between the LET-In team and the existing knowledge, experience and partnerships across the entire organization of INESC TEC.
- The multiple INESC TEC partnerships with companies in different sectors were particularly relevant to facilitate access to the market intelligence and support the "proof of concept" activities.
- INESC TEC's capability to invest its own resources in the development of minimum viable product (MVP) and proof of concept activities proved to be an important attracting factor.
- INESC TEC's multidisciplinary centres and supporting services were a driver for knowledge transfer activities.
- Industry is more open to co-create and test emerging technologies, which facilitate the development of the proof-of-concept phase, while researchers are more aware about knowledge valorisation and entrepreneurship.
- The increase of specialized seed funds nationally and at the European level is a positive transformation (e.g., EIC pillar of Horizon Europe Programme).

### Barriers

- The lack of entrepreneurial education and training of researchers is a significant barrier, calling for a significant effort both from their side and also from INESC TEC services.
- Since INESC TEC does not have an investment fund, its funding capabilities are limited and depend of national and European public programmes and/or private investors.
- The significant increase of employment rate in the fields of emerging technologies (particularly digital ones) is reducing the number of candidates for entrepreneurship.
- The average value of seed investment per project is still low in Europe.
- The proliferation of acceleration initiatives, entrepreneurship programmes, etc., causes some times promoters to become dispersed, losing focus on project and business development.

### Lessons learned

- The vast majority of investment programmes and funds (both public and private) have difficulties and limitations to properly value science-based innovation, particularly when entrepreneurs are looking for seed capital for start-ups. A proof of concept stage can significantly contribute to reduce this gap and increase the value of the proposal for the evaluators/investors.
- To execute the proof of concept stage (moving from ideas to business model), a set of specialized skills is needed. It is necessary to combine the specific scientific and technological knowledge with skills on marketing, science-based start-ups, IPR management, etc. To do this effectively, organizations need to master and integrate these skills, or otherwise the process becomes too long and expensive. Physical proximity between team members is also very important at this stage. The time and resources needed to cover this stage depend heavily on the area.

## 4.2 Key Highlights on KT Area 2: Knowledge Co-creation

### VTT (FI): SHARED BENEFIT PROJECT MODEL

### Description

The Shared Benefit (SB) project model is a joint funding activity, which brings together VTT and at least 3 business partners to innovate and research on a shared topic. There are no external financiers involved but all the funding of SB projects is provided by VTT and participating companies. This activity was launched as a proactive measure by VTT in 2017 when external funding structures for jointly funded research changed in Finland, and many business collaborations were inclined to stop. VTT initiated the SB project model for enabling the continuation of application-driven projects that are of core interest to VTT and its partner companies. In general, the SB project model requires 70% of business funding, while a maximum of 30% of funding is provided by VTT (government grant).

### Drivers

- Coordination: Weekly meetings with the business partners are crucial for successful communication, knowledge sharing and progress monitoring of the research work. These meetings function as a binding element, which boosts commitment to the project.
- For the project management, VTT's horizontal organization and management culture are important. It enables smooth working atmosphere and is a key success factor for effective project realization.

- Project partners' motivation and engagement in projects increase if the subject matter addresses their needs.
- The flexibility of the SB project model in many regards (e.g. the possibility of in-kind funding by project partners) is useful for VTT and project partners.

### Barriers

- Trust: The conflicting business interest of partner firms might create trust issues and hinder their participation and trust towards the SB project.

### Lessons learned

- When initiating a SB project, legal support is crucial, especially in case of project contracts and IPR issues. Also, the presence VTT's in-house sectoral experts is important for the projects to be attractive and meaningful for the companies to join.
- The SB project model has proved its usefulness in situations when other funding opportunities are limited.

## FRAUNHOFER (DE): CONTRACT RESEARCH MODEL

### Description

Fraunhofer Gesellschaft is a non-university research organisations that focuses on application-oriented research for immediate benefit to the economy and society. The high level of application orientation is achieved through various channels. These are immediately contributing to ensure efficient knowledge and technology transfer between research and society and/or economy. The general "Fraunhofer model" (application-oriented research based on research contracts) strongly contributes to pursuing a philosophy of knowledge and technology transfer, due to strong collaboration with (research) partners and customers - primarily from industry. Fraunhofer institutes answer to calls for proposal or tenders or are directly approached by individual companies, thus conduct research requested by industry or policy. The collaboration rationale is grounded in Fraunhofer's mission. Fraunhofer's close relations to universities and non-university research organisations on the one hand and to business and public customers on the other hand contribute to a thorough understanding of clients' needs and challenges, thus to continuous exchange processes.

### Drivers

- The main success factors lie in the business model of Fraunhofer as such, combined with a quite autonomous structure of the different institutes. Another factor are the different incentives, like co-funding in the case of manufacturing contracts, internal research programmes.
- Strong cooperation with universities: the cornerstone in this regard is the joint appointment of outstanding researchers as professors at the university and Fraunhofer institute management. Due to the close personal integration at all levels, results from university research can be efficiently applied and the joint offer in the field of knowledge and technology transfer can be expanded in a targeted manner. At the same time, the integration of Fraunhofer scientists into university teaching enables a broader range of courses for students.

### Barriers

- Due to the size of Fraunhofer-Gesellschaft, administrative burdens are becoming evident. Legal contract reviews can take a long time, as well as other formal procedures.
- The profit-center model of Fraunhofer can result in a structure where institutes (and within institutes even departments) can become competitors which prevents co-operation between those organisational units.

### Lessons learned

- The Fraunhofer business model as such represents a public-private partnership approach in terms of both, public funding of approx. 30% plus additional funding (70%) coming from third parties in a competitive procedure. Each institute is organised as a profit center and therefore has to look for funding opportunities and income sources. The main contractor in all projects is Fraunhofer-Gesellschaft as a legal entity, not the different institutes.

## TECNALIA (ES): ORAINN INITIATIVE

### Description

Tecnalia's contract research activities are divided into two operational strategies based on company size or level of innovation (SMEs and large companies). The SME contract research program, *Orainn* (eng. Now), aims to boost innovation and R&D activity within customer company. The collaboration lasts for one year. Companies pay an annual fee to Tecnalia and Tecnalia sends one of their experts to the company during the assignment with the company. Tecnalia's experts participate in day-to-day work at the company for one year and analyse company's competitive position at markets, create innovation strategy and R&D projects with the help of Tecnalia Researches of the required fields, help company to reach R&D finance through e.g. public programmes or tax exemptions and other supporting activities to increase SMEs innovation capacity.

### Drivers

- Transparency is crucial to build trust and to enhance good collaboration with customers. It is also important that experts "speak the language of the companies" – i.e. be knowledgeable of company culture, objectives, and ways of operating. This can be sometimes quite different from general RTO work, and as such it is an important success factor to enable smooth collaboration.
- Orainn projects are highly demanding and require a lot of personal effort from experts. The working pace is fast, and clients require satisfactory results. Commitment of employees is crucial.
- Adequate training of team members is crucial to enable up-to-date and relevant skills. Companies where people work vary by nature and expertise a lot. Tecnalia's experts need to have a strong skillset that fit to diverse needs. Weekly meetings among Tecnalia's expert team are crucial for information exchange, brainstorming and support.
- Projects can result in long-term relationship with companies, which boosts collaboration in innovative projects. During the assignments in companies, experts identify further opportunities for collaboration based on companies' needs and gaps. Focus is on targeting relevant projects, which is crucial when initiating joint projects with companies when there are no public resources available.

### Barriers

- Sometimes research culture is not conducive for high tempo and commitment requiring projects. The projects require a lot of working hours, flexibility, ability to work on evenings and weekends on an ad-hoc basis and the ability to travel. For this, it can be a barrier to find motivated and skilled personnel to work for such projects.
- Companies often do not have any prior experience in R&D, and there is no easily available public funding to launch projects. This may hinder companies' interest to join in projects because they do not see value for their operations.
- Scaling highly human resource intensive programmes is difficult.

### Lessons learned

- Building trust with companies through transparency is crucial. Tecnalia's staff needs to be committed to the projects. Sales department and top management need to have understanding of how to convey these projects to the company sphere in order to attract attention and seal contracts. Customer satisfaction needs to be high for enabling future collaboration and spillovers.

## AIT (AT): INGENIOUS PARTNER AS BRAND ESSENCE

### Description

The Austrian Institute of Technology (AIT) has a specific brand identity on scientific excellence and a self-image as ingenious partner for industry and public bodies. Together with the claim "Tomorrow Today", AIT offers research support for (national and international) companies, in order to help them to prepare for future challenges. AIT's services for its clients include technologies, methods, tools and demonstrators, which are implemented in cooperation with industry. Main vehicles are contract research, IPR licensing or spin-offs. AIT also offers public support though foresight processes, analyses and studies, evaluations, or the development of concepts and programmes. In order to contribute to overcoming industrial risks and to support developing new markets, strategic thinking of AIT includes (1) in-depth knowledge of international research activities, (2) knowledge of clients' needs and strategies of possible clients, (3) shaping new technologies, tools, and simulations.

### Drivers

- The main success factor is the achievement of the defined objectives, based on successful projects for industrial and public clients. These are rooted in AIT's business model and its structure: technological competence and expertise, systems expertise, the application of scientific methods and a high-quality research infrastructure, complemented by thorough industry and market knowledge and close relationships with clients.
- Engagement in networks enables knowledge exchange with other national and international partners.

### Barriers

- Application-oriented research at the interface of fundamental science and industrial application is highly challenging and has to respond to financial, scientific, industrial and qualification-oriented requirements. This leads to situations of competition for research grants and contracts.

In addition, research units have to respond both to scientific and to market-oriented requirements.

### Lessons learned

- AIT has a specific structure, vision and business model in order to conduct industry-oriented research and respond to future-oriented challenges of its clients. The clear branding as ingenious partner is a key factor for AIT's research work, leading to specific values and strategic thinking. This vision and the future orientation of AIT's work are key cornerstones for gaining industrial contracts and for further developing scientific activities and networks in AIT's Research Centers.

## SFI (IE): SFI Research Centres

### Description

The SFI Research Centres were established to deliver significant scientific, economic, and societal impact for Ireland. The Research Centres facilitates networking of scientists, academia, and industry across fields. In total 16 centres operate under the SFI framework. The centres operate within universities, which ensures excellence in research. The aim of the centres is to bring best practitioners in academia, technical research, and industry together in areas which are strategically attractant to industry and to Irish national priorities. The centres lay foundations for an effective and productive academic and industrial partnership.

### Drivers

- It is important that each centre director can operate flexibly and make relatively autonomous decisions based on their internal academic and business understanding.
- Maintaining high scientific quality and hosting several researchers drives industry engagement.
- High scientific success is understood as an important branding strategy as well as an attractant for industry interest.
- Leadership, management, and strong operations team play a crucial role in the centre's success. The Centre manager along with other top managers usually have a strong scientific background from the field where the centre operates. This enables the centre to have relevant and in-depth understanding of the fields academic and business environments. It is also important and useful that the business development manager comes from the industry itself, as they will be able to bring contacts and expertise from the industry to the centre. This helps in networking as well as designing meaningful collaborations.
- Leverage funding model ensures centres aim to secure autonomous and sustainable funding base, and it directs centres to collaborate with industries actively. This boosts private co-funding of R&D and knowledge transfer across sectors.
- Evaluation after the first four years of their first six-year funding is crucial for enabling a smooth transition from phase 1 to phase 2. Here the international panel evaluates the centre's success and progress with a decision on Phase 2 funding announced prior to year 6 of Phase 1. This allows Centres to maintain momentum from both a scientific and industrial collaboration perspective.

### Barriers

- In general, companies usually seek to avoid extra costs and as such they want to pay as little as possible for R&D activities. This is a factor that can sometimes hinder companies' willingness to participate.
- Establishment of networks and industry engagement takes time.
- Recruitment of qualified staff for the operational team is key for success. For this, brain drain can pose challenges in recruitment of qualified staff.

### Lessons learned

- Centres need to have autonomy and decision-making power to decide on the projects which they think are useful and worthy of proceeding.
- Evaluation of project proposals by industries is based on centres' managements academic and industrial understanding.
- Quantitative and qualitative evaluations are needed to measure centres success. Key for success is a well-functioning operations team and strong scientific leadership.

## INESC TEC (PT): Innovation Ecosystem

### Description

The main objective is to promote the creation of and/or to actively participate in innovation eco-systems related with INESC TEC's the main application areas/markets, aiming at:

1) Developing and implementing collective research and innovation agendas, namely via collaborative research projects and other activities;
2) Gathering all relevant stakeholders to cover the entire innovation cycle, from research to market uptake, including education and training;
3) Mobilizing the necessary funding sources, including private and public, regional, national and international (namely, European);
4) Developing and implementing collective research and innovation agendas, namely via collaborative research projects and other activities.

### Drivers

- The need to address the diversification and speeding of technological development and to ensure return of the related investments is pushing stakeholders to work closer together and to implement more effective and efficient frameworks.
- The growing recognition of importance of eco-systems as a key component for successful implementation of science-based innovation is a strong driver.
- The existence of specific programmes or special conditions in the regular ones that promote and incentivize collaborative work (Roadmaping, R&D, education and training, etc.) is also a major driver.
- INESC TEC positioning, as an intermediary organization between academia and business, potentiates and facilitates its role as promoter, facilitator and/or orchestrator of this type of initiatives.
- INESC TEC accumulated experience and expertise, resulting from working at the different levels (European, national and regional) and with different types of sectors and companies (from low to high tech; from large corporations to SME's) provides the basis for a solid understating of the

multiple dynamics that can be generated and also of the specific organizational models and supporting methodologies and tools that need to be customized to promote and support them.

### Barriers

- Setting-up and operate sustainable innovation eco-systems is a mid to long term activity that calls for patience, persistence and significant investments (mainly in human resources) before it starts to generate benefits and impact.
- Complementary, it's important to refer that several of the related costs are not eligible for support by public programmes, meaning that they need to be supported by the organizations. In many areas, the number of existing organization and initiatives is very high, making the respective landscape difficult to understand, address and manage.

### Lessons learned

- The existence of solid innovation eco-systems is a key factor for the successful implementation of science-based innovation.
- RTOs can play a relevant role, both as promoters of these initiatives and also in the dynamization of several of the related activities.
- Well formulated and (particularly) stable policies and supporting instruments are also crucial.

## 4.3 Key Highlights on KT Area 3: Knowledge Sharing

### VTT (FI): ONLINE PLATFORMS FOR INDUSTRY INFORMATION SHARING

### Description

When more than fifty companies are participating in an industrial research project, traditional communications tools are not sufficient for effective communications and information sharing activities. In order to overcome this challenge, VTT has introduced online communications platforms for jointly-funded research projects. Via these online platforms, the partner firms can learn about the upcoming project activities, such as test runs, in a detailed and timely manner, which helps the firms to participate in and contribute to the project activities. Lately, the use of online tools has been upscaled at increasing pace at VTT due to COVID-19. Microsoft Teams is used as the main software platform for the project level communications activities (e.g. for meetings, material folders and information sharing), and, especially, Microsoft Teams' activity cards are used for disseminating information on project steps and progress in details.

### Drivers

- Microsoft Teams Planner as a project management, time management and information board has been useful in disseminating information, engaging participation, and organizing events and meetings with the industry. In Teams Planner, each task is described with respective person in charge and schedule included. This enables partner firms to foresee upcoming tasks and to indicate their interest to contribute to an activity or share knowledge and resources.

### Barriers

- Intellectual property rights can hinder information sharing activities. Especially, the presence of competitors can be a barrier as it can be difficult to engage and involve corporations that see

each other as competitors. Sometimes, companies do not want to disclose information and rather observe others than contribute to the project.

- Barriers relate to how to engage and involve new firms into the projects. This has been slightly more difficult during the COVID-19 pandemic, as organizing large in-person meetings is not possible.

### Lessons learned

- Microsoft Teams Planner has played a key role as an online communication platform due to its customizability. It has been used for disseminating information, organizing meetings and as a tool to engage project partners.
- Teams Planner was used for organizing "Result online session" - a one-hour webinar where the project coordinator regularly informs participating companies about progress and results of the project. Webinars include lecture and Questions & Answers (Q&A) parts, and are used for networking purposes.
- In large projects, language barriers can halt cooperation. As such, participants need to be able to communicate in common language for collaboration to be smooth and effective.
- Trust is important factor among companies. Internal code of conduct is very important in maintaining and creating conditions for fruitful collaboration. Project communications has to focus on disseminating generic research results in order to avoid IPR issues. Also, attention must be given to the GDPR issues. When maintaining a list of email addresses, a consent has to be asked from each partner on the list.

## FRAUNHOFER (DE): THE FRAUNHOFER GROUPS

### Description

Fraunhofer-Institutes, sub-institutes or independent departments can thematically join forces and exchange information in the form of Fraunhofer-Groups, which are devoted to specific research areas. Institute associations are decided by the board of directors. The groups appear together on the R&D market and are involved in corporate policy, as well as in the implementation of the functional and financing model of Fraunhofer-Gesellschaft. An important incentive to become a member in one group is the fact that R&D programmes implemented by the Fraunhofer Headquarters are often targeted towards a specific group and that strategic decisions by the president of Fraunhofer-Gesellschaft are often aligned with the interests and objectives of a group.

### Drivers

- The success factors are the slim and decentralized structure with a common coordination and information exchange platform, and, at the same time, maintaining the business model at the level of the single institutes.
- The existence of single R&D programmes to support the different groups is another success factor. Here, the strategic interest of Fraunhofer-Gesellschaft as a whole is implemented by financial incentives for the groups and its members. At the same time, even within one group, competition between the members via-a-vis internal funds and the external market is not eliminated.

### Barriers

- The success factors mentioned above on the other side may also be barriers. This is the case in networks where incentives, the need for cooperation and at the same time competition between the actors are typically existing at the same time. In the case of the groups, the business model "profit center" is not transfered to the groups, which means that the financial KPIs (earnings from contract research as a whole and from manucaturing companies in particular) are still measured at the level of the single institutes. In consequence and from the perspective of a single institute, there is a potential conflict between cooperation and competition (manifested for instance regarding the "protection" of markets/key clients which are considered to "belong" to my institute).

### Lessons learned

- Combination of a decentralized, multiple structure with a coordination office and funding opportunities per group from Fraunhofer Headquarters.
- Involvement of the groups or their chairman in strategic discourses and agenda-setting carried out on the level of the board of directors (of Fraunhofer-Gesellschaft).

## TECNALIA (ES): NETWORKING STRATEGY

### Description

Tecnalia has an institutionalised networking strategy through which Tecnalia ensures that it is connected with relevant companies and stakeholders across Tecnalia's core sectors. This networking activity consists of participating in various forums, for example industry associations, technological platforms and work groups. Networking activity includes taking part in different recognised key forums where Tecnalia has an active role in e.g. sharing information on trends in technological development, markets etc. which local SMEs companies may not have resources to observe. Knowledge sharing takes place via webinars, presentations and white papers to forum participants. Tecnalia also develops activities in cooperation with local companies within these forums to create impact with local businesses. Each main department and team in Tecnalia have their own database of relevant local stakeholders and each team is member in approximately 20 relevant organisations.

### Drivers

- The main success factor is belonging to various forums from the very beginning. This brings advantage in having an active role in the ecosystem and market creation. Furthermore, this enables Tecnalia to have an active role in determining the nature of activities and orchestrating complex opportunities. As Tecnalia's mandate is to seize large-scale, complex opportunities which involve large enterprises and SMEs, and have a broader impact on the society, it is crucial that Tecnalia has an active role from the start.
- Focusing on the right and most relevant associations and working groups.
- Active participation in relevant forums brings many opportunities, for example proposals, publications, new initiatives that can sometimes lead to next generation.
- Tecnalia plays crucial role in disseminating EU-wide development and opportunities at the local level.

### Barriers

- The main barrier is to keep members of forums engaged in joint work. Sometimes certain forums, for example industrial forums, like to see return of investment in a short period of time. This is difficult as often research-based activities materialise over a long period of time.
- Difficulty of making cost-benefit analysis: Belonging to various forums where results are not delivered in short term can lead to undervaluation of benefits. Sometimes this might lead to leaving a certain forum due to its low performance. However, the threat is that a certain forum might have been abandoned too early.

### Lessons learned

- Identifying relevant forums might be difficult and time consuming, and, to some extent, the benefit depends on the attitude of the part taking organisations. Having a proactive role creates opportunities not only for Tecnalia, but also for the broader ecosystem at the local level. This is important and brings reciprocal benefits to all stakeholders. Active participation in various forums enables transparent and up-to-date communication with relevant stakeholders.

## AIT (AT): PHD PROGRAMME

### Description

Young scientist qualification is one important cornerstone of AIT's research profile. Training and supporting PhD students not only contributes to career development of the students, but also enhance excellent research at AIT. In the frame of their research projects, PhD students develop new ideas, explore and apply new approaches, and engage in various scientific networks. They are involved in AIT research projects and benefit from needs-based research questions, and in turn bring in their scientific ideas, theories and models. This model allows to develop scientifc knowledge and practical experience for mutual benefit for the PhD student and AIT's research projects. In the frame of the PhD programme, students gain access to AIT's research infrastructure, scientific support, networking and qualification opportunities (seminars, conferences and further events). In addition, all PhD theses are conducted in cooperation with (national and international) universities, and the development of PhD theses are supervised by both organisations. So the students benefit from scientific input and support from different research perspectives.

### Drivers

- Integration of PhD students in AIT research projects for mutual benefit for AIT and the PhD student, leading to successful PhD theses in AIT's research fields.
- Support activities in terms of coordination and supervision of theses, support of PhD students through AIT's PhD programme, training, qualification in applied research, access to infrastructure, engagement in scientific networks, exchange with industrial clients, etc.

### Barriers

- Barriers are related to research fields that are not part of AIT's strategic research topics.

### Lessons learned

- AIT implements a structured PhD programme, which aims at creating beneficial situations for PhD students and for AIT. For young scientists, this programme is a cornerstone in their career development since it allows them to enhance scientific and professional knowledge and

experience, in addition to the successful completion of their PhD theses. The work of PhD students is integrated in AIT's projects and thus increases the scientific base in AIT's research fields.

## SFI (IE): INDUSTRY RD&I FELLOWSHIP PROGRAMME

### Description

Industry RD&I Fellowship Programme funds academic researchers at Irish research institutes, at any level from Postdoctoral Researcher to Professor, to spend up to one-year full time in any company worldwide. The companies can be of any size, and any location. During the fellowship the researcher joins the company as a researcher and SFI covers the salary expenses. The programme does not entail any responsibilities after the one-year time. The criteria for selection for the fellowship are that the researcher is currently employed at an Irish research institute, and that the work tasks at the company focus on research.

The fellowship programme is inherently about capacity building, skills development, and networking, and the program has several objectives:

1) The fellowship programme aims to attract people in academia to consider career in industry.
2) The programme aims to give researcher in academia an opportunity to experience industry research to build capacity on industry knowledge.
3) From a broader perspective the programme aims to enhance industry capacities to absorb research, especially at the SMEs and micro company level.
4) The programme aims to create networks between non-Irish companies and Ireland.

### Drivers

- Simple application process, high success rate, no post award restructure conditions.
- The programme is managed by SFI staff. There is a LinkedIn page for companies and researchers to post their profiles and SFI also organises matchmaking events. Applications are straightforward and internationally peer reviewed.
- SFI organise career workshops for postdocs at which Industry Fellowship one to one matchmaking events are held with industry plus SFI promote the programme widely.

### Barriers

- Sufficient SFI budget to fund the increasing number of applications.

### Lessons learned

- The fellowship programme is important for the development of industry ecosystem in Ireland. It attracts researchers to industry and creates linkages between industry and academia. It also attracts new foreign companies to Ireland. Moreover, the programme is important for internal skills development and industry knowledge.
- The programme success can be measured through popularity of the programme (i.e. number of participants), number of jobs offers participants receive from fellowship companies, and the number of part-taking companies who seek to span operations to Ireland. Yearly the programme facilitates 100 researchers' fellowships. 100% of participants receive a job offer either from the company where they did the fellowship or from a competitor. Almost 50% accept the job offer.

From the second half who declines the offer, 30% establish own company, 25% join another SME or micro company. Around 1-2 persons return to academia.

### INESC TEC (PT): INESC TEC Higher Education Networking strategy

#### Description

"The best way to transfer knowledge is through people". This concept is implemented at INESC TEC via the combination of advanced education (Master, PhD and Pos-doc programmes) with collaborative R&D projects with companies. Young researchers, supported by INESC TEC own grant programme or by public programmes, are involved in the execution of collaborative R&D projects with companies. This allows them to progress in their studies (towards an academic degree) and to have a first contact with the market and its reality. At the same time, they are a first level of already trained human resources to further develop and scale-up the new technologies, either in existing companies or through the creation of new start-ups. In many cases, these young researchers are contracted by the companies involved in the collaborative projects, thus benefiting from their skills and knowledge and allowing them to real incorporate the new knowledge. For INESC TEC, this also boost new opportunities for collaboration with those companies.

#### Drivers

- Companies need highly skilled human resources, capable of developing and/or absorb new knowledge and use it to develop innovative solutions (science-based innovation).
- The acceleration of technological development processes demands for a reduction of the time window between knowledge creation and market exploitation. It also calls for a better combination and alignment between technology development and education and training (particularly, advanced training).
- The close collaboration between INESC TEC and Universities and Polytechnic Schools, particularly the involvement of academic teachers and researchers in collaborative R&D projects with companies, create the right framework to attract students and to involve them in those projects.
- On the other end, the development of strategic partnerships with individual companies or sectorial organizations (such as technology centres or clusters) allows for a better understanding or joint development of technological roadmaps, setting the scene for mid/long term integrated research and education action plans. This is critical to identify and attract the right students for these activities.

#### Barriers

- In several cases, it's still difficult to support R&D and education and training activities in the same project (for example, it implies to use different funding instruments).

#### Lessons learned

- Companies need new knowledge / new technologies to feed their science-based innovation processes. But they also need the human resources with the right skills, necessary to develop and scale-up the new solutions.
- The organizations that are able to provide them the two "components" have a solid competitive advantage.

- RTOs are particularly well positioned to implement this type of approach.

# 5. Polish Ecosystem Analysis by Knowledge Transfer (KT) Areas

This section analyses the literature review and Polish stakeholder's understanding of needs and gaps in the Polish innovation ecosystem. The section is divided in contextual indicator analysis, broader stakeholder analysis and Lukasiewicz Research Network stakeholder's analysis on the three main Knowledge Transfer Area, namely knowledge valorisation and exploitation, knowledge co-creation and knowledge sharing.

To set the scene, this section will begin by exploring how Polish stakeholder's view the impact of different contextual and innovation indicators on their knowledge transfer practices.

## Contextual indicators

Indicators related to 'Governance and Policy Framework' conditions were selected as having the leading negative impact on KT (9 selections). 'Rule of law' (referring to e.g. IPR regulation) has been selected two times as the most important negative impact. The second group comprises indicators grouped as 'Business and Entrepreneurship' (7 selections), where top R&D spending enterprises per 10 million population has been selected two times as the most influential negative factor.

Table 5: Relevance of contextual indicators according to stakeholder consultations

| Contextual indicator | No. of selection as top 3 | No. of selection as no. 1 |
|---|---|---|
| PERFORMANCE AND STRUCTURE OF THE ECONOMY (4) | | |
| 4. GDP per capita (Thousands of €) | + (1) | – |
| 3. Employment share Services (NACE G-N) (%)- of which Knowledge-intensive services (%) | – | – |
| 5. Employment share Manufacturing (NACE C) (%) - of which High and Medium high-tech (%) | + (1) | + (1) |
| 7. Employment share Services | – | – |
| 9. Turnover share SMEs | + (1) | – |
| BUSINESS AND ENTREPRENEURSHIP (7) | | |
| 11. Total Entrepreneurial Activity (TEA) | ++ (2) | – |
| 1. Top R&D spending enterprises per 10 million population | ++++ (4) | ++ (2) |
| 10. Buyer sophistication | + (1) | – |
| GOVERNANCE AND POLICY FRAMEWORK (9) | | |
| 6. Basic-school entrepreneurial education and training | + (1) | – |
| 8. Government procurement of advanced technology products | ++++ (4) | + (1) |
| 2. Rule of law | ++++ (4) | ++ (2) |

| | | |
|---|---|---|
| TOTAL | 20 | 6 |

**Top R&D spending enterprises per 10 million population** is considered to be a very important indicator. Polish and international firms based in Poland are not perceived to spend as much on R&D as desirable, which impacts negatively on the development of innovative technologies. A related issued noted by participants has been the need for an integrated supply network where a larger number of smaller firms is able to operate as suppliers of components for larger companies.

The lack of **government procurement of advanced technology products** and lack of innovation policy in public procurement was identified by participants as a very important factor negatively impacting knowledge transfer activities. The currently dominant approach in public procurement policy typically entails achieving objectives as soon as possible, as cheaply as possible, as easily as possible. This approach is not perceived to adequately support innovation for Polish enterprises, beyond the existence of, short-term policies that do not translate into specific programmes such as public procurement programmes, public-private partnership schemes, loan guarantees, and long-term financing of R&D projects. Overall, participants convey the understanding that novel procurement solutions are needed to stimulate employment and the development of technology-based innovative products.

Participants also highlighted **the legal framework** in innovation protection as one of the most important contextual indicators impacting Knowledge Transfer. In their understanding, in order to encourage international firms to transfer their R&D to Poland, the operating environment must feel efficient and safe from the regulatory, judicial system, intellectual property and tax perspectives. Therefore, it is important to create friendly regulations for the common interest of business and science. Appropriate regulations must be in place, including frameworks and instruments with a special focus on R&D investment. The importance lies not on spending but investing in relevant instruments.

### Innovation indicators

Among the set of innovation indicators, 'SMEs innovating in-house', 'R&D expenditure public sector' and 'International co-publications' were highlighted among the top three innovation indicators negatively impacting Polish KT activities.

Respondents consider the ability of **SMEs to innovate in-house** to be limited, despite some efforts concerning services and technology and, albeit with limited cooperation with. Polish research units are generally perceived to lack research teams displaying the capacity to solve complex business problems and support market needs, and when cooperation exists with Polish firms, this tends to favour large state-owned companies As a consequence, SMEs are perceived to have limited potential to introduce innovation, due to inadequate support policy. The National Centre for Research and Development (NCBiR) was acknowledged for their two-year grants, yet this level of support is insufficient as more interventions and financial tools are claimed at the levels of government procurement and loan guarantees. Overall, there is the sentiment that stimulating SMEs to innovate without easy to access to relevant financial support will not bring about significant economic impacts. In line with this argument, some informants reported that the indicators concerning 'SMEs innovating in-house' and 'Innovative SMEs collaborating' are the most significant weakness impacting Polish innovation.

Size and scale were also perceived to play a role, with 200 out of Poland's 500 largest companies comparing fairly in scale with their European counterparts, and the largest ones being state-owned or international corporations. Nevertheless, respondents assert that the capacity to develop new products is stronger within small and medium-sized companies.

Table 6: Relevance of innovation indicators according to stakeholder consultations

| Innovation indicator | No. of selections | Sub-group |
|---|---|---|
| FRAMEWORK CONDITIONS (14) | | |
| 3. New doctorate graduates | +++ (3) | Human resources |
| 17. Lifelong learning | – | |
| 9. International co-publications | +++++ (5) | Attractive research system |
| 13. Most-cited publications | +++ (3) | |
| 2. Foreign doctorate students | +++ (3) | |
| INVESTMENT (12) | | |
| 10. R&D expenditure public sector | ++++++ (6) | Finance and support |
| 12. Venture capital | +++ (3) | |
| 18. R&D expenditure business sector | ++ (2) | Firm investment |
| 15. Enterprises providing ICT training | + (1) | |
| INNOVATION ACTIVITIES (28) | | |
| 4. SMEs innovating in-house | +++++++ (7) | Innovators |
| 5. Product or process innovators | +++ (3) | |
| 1. Marketing or organisational innovators | ++ (2) | |
| 11. Innovative SMEs collaborating | ++++ (4) | Linkages |
| 6. Public-private co-publications | ++++ (4) | |
| 14. Private co-funding of public R&D expenditures | ++++ (4) | |
| 8. Patent applications | +++ (3) | Intellectual assets |
| 19. Trademark applications | + (1) | |
| IMPACT (6) | | |
| 21. Share Knowledge-intensive services (%) | + (1) | Employment impact |
| 20. Medium and high-tech product exports | + (1) | Sales impact |
| 16. Knowledge-intensive services exports | ++ (2) | |
| 7. Innovative sales share | ++ (2) | |
| **TOTAL** | **60** | |

The dominant perception of participants is that **R&D expenditure by the public sector** must be strengthened yet ensuring higher levels of KT and innovation would equally require the strengthening of R&D expenditure by companies. Despite the fact that a slow improvement in this area in the last few years has been noticed, the general sentiment is that there is still scope for improvement, although at government level there are financial constraints impeding higher levels of spending. Concurrently, participants understand that R&D funding is mostly used exclusively by scientists who tend to overemphasise infrastructure and laboratory equipment and that there are insufficiencies in translating

scientific outcomes into applicable knowledge. Additionally, increasing the profit margins for companies was also perceived by participants to enable companies to increase R&D expenditure.

**International co-publications** is connected with research collaboration with innovative SMEs collaboration and in this domain the perception is that there is overall weak performance, limited cooperation with international partners, which in turn limits the transfer of knowledge from international partners to Polish businesses.

Some of the interviewees hold the opinion that this set of indicators is not relevant for the Polish reality. Their view is that if the country aspires to transfer technology, then the first requirement is determining what it wants to achieve and why. Therefore, it is understood by some participants that looking at these indicators constitutes some form of reverse engineering that might not work. Nevertheless, there is strong agreement that collaboration and internationalisation are of key importance, and the same is valid for PhDs of high quality, as well as Industrial PhDs.

Some informants report that this set of indicators does not reflect the real situation in Poland and challenge the use of different methodologies for obtaining and reporting data at European level, which impacts comparability of performance across countries.

Nevertheless, participants recognise value in these indicators as they can help shaping up national regulations. When turning specifically to Lukasiewicz, participants indicate the need to understand more in-depth what the network is working on and exploring whether its focus is on creating patents or spin-off companies and integrating international or national partnerships.

When this is established, it should be possible to delineate what to do next. Indicators such as buyers' sophistication, MHT or KIS employment, R&D spending enterprises and others did not appear to be recognised as relevant by the participants. Similarly, it was reported by participants that commenting on the set of indicators through providing subjective responses was challenging as not all of the indicators were easy to understand. Participants therefore call for the use of interviews based on qualitative expert assessment rather than on quantitative statistical data, as well as for the use of findings emerging from previous projects implemented for Łukasiewicz aimed at addressing internal organisational challenges.

## 5.1 Key Highlights on KT Area 1: Knowledge Exploitation and Valorisation

From among the five activities included under the area of knowledge transfer, the interviewees identified the implementation of four of them across the Institutes. The activity pursued most actively is commercialisation of IP. Licensing and Policy advice and analysis are also often implemented. Company creation is not an established trend yet, but several Institutes mention it as an area of interest and an objective of future actions. Academic entrepreneurship is not a popular activity across the Institutes of the Łukasiewicz Research Network.

The main barriers and threats linked to this KT area are mainly connected with financial issues on both sides of the innovation process: scientific Institutes and businesses. On the one hand, Łukasiewicz Institutes are faced with limited financial resources for research, poor co-financing by the state, an environment that favours high-tech industries, and overall high costs of patents. On the other hand,

businesses struggle with limited funds for investments and R&D activities - a situation that has worsened due to the Covid-19 pandemic. This is closely related to the business structure in Poland where a large number of companies are one person self-employed companies with no budget for innovation. Additionally, SMEs have low potential to innovate and there is limited cooperation between large companies with foreign capital and Polish science. Another barrier that was emphasized by the interviewees was the absence of entrepreneurship culture generally in Poland. This has roots in social and psychological aspects such as science-business communication problems, limited trust associated with potential loss of intellectual capital, scientists' reluctance to work with business and commercialise considered as kind of disparagement. Among the most severe problems identified by Polish stakeholders in the interviews were those related to legal issues such as the complicated regulations concerning intellectual property rights and valuation, competition, new company creation, and commercialisation of results emerging from projects co-financed by the EU. Both, the entrepreneurship culture and complicated legal framework relate to contextual barriers, however the knowledge transfer strategy should pay attention on how to enhance these at the Łukasiewicz institutes.

The drivers and opportunities for knowledge valorisation and exploitation include a supportive legal framework, including tax incentives. Financial aspects were indicated by the interviewees amongst the key stimulating factors, including an increase in revenue by Institutes and employees, and the desire for greater availability of funds and support programmes. Staff competences, development of soft skills related to communication, collaboration, dissemination, partner engagement, mobilisation and collaboration were also identified as key drivers in both the literature review and interviews. The ability to establish a recognised brand and reputation for the Institutes is closely connected with the factors outlined above. The changes that have recently taken place in the Network aiming at standardisation and simplification of procedures and the introduction of the Challenges system were assessed very positively as factors strengthening the knowledge exploitation and valorisation activities[9]. Finally, call for greater internationalisation have also been made by Polish stakeholders.

[9] The Challenges operating from November 2019 in the Łukasiewicz constitute a unique system for initiating R&D works. Companies having technological problems or looking for innovative solutions can submit them to the Łukasiewicz by filling in an online form (https://lukasiewicz.gov.pl/biznes/). After clarifying all the details with the client, this need is announced on the intranet of Łukasiewicz as a Challenge. For each Challenge a Host (Challenge supervisor from the permanent Challenge Hosts team, who is an employee of one of the Łukasiewicz Institutes) is nominated. Within 15 working days Łukasiewicz free of charge provides a company with ideas and recommend a team of experts and equipment facilities to conduct R&D works. Moreover, as part of Łukasiewicz's Challenges, it is possible to identify a potential source of research funding. Łukasiewicz's experts support in preparation of project applications too. Łukasiewicz's Challenges are also the opportunity for ordering a service (e.g. certification or testing) or inquiries about product availability in all Łukasiewicz Institutes at the same time. This offer is prepared in 5 days.

## Company creation

### Actions, drivers and opportunities

Unique competences of employees, their entrepreneurial skills, and human resources management skills of team leaders were indicated as the most crucial factors contributing to the success of company creation. Close cooperation of team members and business and administrative staff and the legal department was highlighted by the interviewees as necessary factors to set up spin-off companies. Gaining third-party investors contributes to further development of new enterprises which can be considered an opportunity. Successful implementation of this activity results in increase of the Institutes' revenues and higher incomes of the staff which is an important driving force of these undertakings.

Another opportunity for the Institutes to develop in this area is the new generation entering the labour market who come to work in order to fulfil themselves professionally, express their personalities, which can be e.g. through a spin-off. They focus e.g. on creation of a companyand not on a job or money in itself.

### Barriers and threats

According to the interviews, problems and hindering factors related to company creation are those having roots in the social and political spheres. First of all, limited activity in this area results from the lack entrepreneurship culture in Poland. Second, people's lack of willingness of risk taking is seen as a significant barrier resulting in small number of spin-offs deriving from Łukasiewicz Research Network units.

According to the literature review, knowledge valorisation and exploitation in Poland has significant spectrum of barriers related to company creation, company size and company employment. Poland has many self-employment companies. Indeed, out of 2.5 million companies only 900 thousand employ workers and about 1.7 million are self-employment entrepreneurs with no potential to innovate. The innovation maturity Index (WDI) for SMEs is between 18-25 while for large companies almost 40 points. SMEs have very limited staff capacity and limited or simply no budget for innovation. Most of them are not able to apply for public support for innovative projects and ensure so called "own financial input" (30 – 50% of project costs), delegate competent staff for management of such projects as well as exploitation of its results. Poland has limited number of spin-offs and spin-out enterprises (academic entrepreneurship). Institutes and academia are establishing special centres for technology transfer and are partners in academic entrepreneurship incubators and effectiveness of such activities is rather limited and only very few of them can presents measurable results.

## Licensing

### Actions and drivers

According to the literature review, the main driving force in technology transfer in Poland and its valorisation and exploitation are large and medium-sized companies with employment of 50 people and more dedicated budgets for RDI type of projects. Such companies often have own research units and broad collaboration with independent scientists or research units and universities. Yet, such companies receive

good support from freelancer consultants or well recognized consulting companies to ensure support at all stages of RDI projects, i.e., from application for public grants through implementation, reporting, dissemination and exploitation of projects results. It is noticeable that most of the large companies with foreign capital have no or very limited cooperation with Polish science for reasons relating to large research units in home countries, financial efficiency or national IPR protection schemes. They very often employ Polish scientist as regular staff or contact points with Polish research and universities, to be able to follow scientific activity in Poland or to support various registration procedures of their products if needed.

Economic aspects are the most significant factors stimulating this kind of activities. Meeting market and business needs and adjusting the Institutes' offer to the market demand is considered a key to success. Financial factors, e.g., revenues from licenses, have been also listed among important drivers. Other important actions include standardisation of procedures within the whole Network. This is argued to facilitate more efficient communication with the clients. Furthermore, the interviewees highlight that the unification of terms and conditions of licensing within the Łukasiewicz Institutes and better communication of the Institutes, would not only benefit licensing but create good working environment and positive energy, which are considered important drivers of working environment in general.

Finally, building trust between all members of the licensing process is important. With all members of licensing process, the interviewees indicated to those involved at the Institute level as well as external actors.

### Opportunities

Opportunities in licensing result from collaboration with entrepreneurs. Interviewees highlighted that the benefits include, among other things, increasing the synergy effect, future collaboration in R&D projects both with the client already acquired as well as building recommendations for other prospective customers. However, in order to make this transfer work, entrepreneurs have to understand the need to bear the costs of innovations. Increasing technological development of clients is also considered an opportunity for intensification of licensing activities.

### Barriers

The literature in this subject highlighted that Polish science institutes and universities (PSI&U) licencing and commercialisation of IP is at a very low level compared to the average in developed countries. Only 20% of PSI&U patents have been transferred into commercialisation when in developed countries such transfer is above 50%. This relates directly to low level of science – business cooperation and rather weak staff capacity on both sides to communicate, disseminate and exploit research outputs and results. Poland takes 13$^{th}$ place in the EU in terms of the number of patent applications and 18$^{th}$ place per 1 mln population.

This was also highlighted in the interviews. Low level of technologies used in SMEs is considered a factor hindering the activities in the field of licensing.

The barriers include those internal and organisational factors connected with the fact that the Łukasiewicz Institutes as public institutions are bound by the public procurement law and therefore it is difficult for them to implement economic activity. Doing it externally, e.g. through companies would not be a solution as this is the Institutes' reputation that attracts clients.

The social aspects play a major role also in the area of licensing. Lack of trust, fear of the older scientists of sharing their ideas that may be stolen, results in creating solutions that not based on the state-of-art technologies are among other issues hindering licencing activities. This is linked to the problem with the valuation of licenses and patents and the rights of the invention creators. High fees of patent protection are an interconnected aspect of this problem.

### Threats

The future development of these activities is hindered mainly by the financial aspects. The limited financial sources for research and limited number of research projects make the Institutes focus on market orders which usually do not focus on innovation, but on client's expectations. This in turn results in decreased motivation, routine, and apathy of the scientists. Lack of funds leads also to lack of competences. There is also a threat of bypassing patents and license agreements by partners or competitors.

## Commercialisation of IP

### Actions

The actions undertaken and needed to increase the scale of IP commercialisation include inter alia organisational and internal issues. The Institutes indicate the need to simplify the procedures, relieve researchers from administrative work and apply clear and stable rules of remuneration. More motivational interviews with employees and their managers is also expected. On the other hand, close collaboration between employees of the research division and employees responsible for commercialisation and knowledge transfer is necessary. The activity of employees in industry organisations is considered important to intensify commercialisation.

The new organisational structure and the system of Challenges introduced by the Łukasiewicz Centre is highly valued in the Network. It creates the possibility of establishing a consortium between Network Institutes and presenting a joint offer for an entrepreneur while a given Institute may answer the inquiry without having a full solution. It is important that businesses and entrepreneurial partners understand the shared costs of IP in the total costs of project implementation. As such, smooth collaboration and knowledge transfer requires companies to understand that the products they need are not ready, but new knowledge e.g., a product or service with new characteristics, has to be created which takes time. Hence, working out a good consortium agreement with an industrial, private partner is necessary.

Institutes also mention the need for support in promoting the results of their activities, and in finding new ways to strengthen their activity in attracting new clients. The gaps related to this activity include consultancy relating to protection of intellectual property.

Certain policy actions should also be taken to enhance the commercialisation processes in the Institutes. This includes changing the method of intellectual property valuation. It has also been suggested that focus on achieving tangible economic effects outside of research should cover the possibility of developing business activities based on the results of projects.

### Drivers

Economic factors and incentives stimulate commercialisation of IP. Implementation of orders for fee, generating income and obtaining sources for additional activities are considered key drivers for knowledge transfer. Pro-sale attitude of the and the ability to track market demand and adjust operations to it are considered necessary drivers of commercialisation of IP. Understanding economic and political trends related to specific industries are also seen important in this context. For example, increasingly stringent environmental regulations and environmental policy, or consumer preferences favouring pro-ecological solutions impact solutions needed for the forest sector. Such changes in key sectors which are conducive to development impact on market demand and can lead to increasing innovation demand (e.g.). In general, high interest in new technologies and demand for R&D work is considered a driving force moving forward the commercialisation activities.

Internal issues related to Institutes' resources and organisation including large diversification of activities, technological advantages and values like certification or certified laboratories, concessions that enable the implementation of projects in specific industries, low failure rate of the equipment as well experienced, specialised research staff are of utmost importance for commercialisation of IP, too. All these issues contribute to good reputation that many Institute value as a driving force for further knowledge transfer. Each successful project raises the public image of an Institute and as such strengthens its position in the markets. Successful projects also increase technical skills of researchers, and the level of technological expertise that the Institute can offer.

Good collaboration and communication are also seen as key drivers for commercialisation of IP. For example, good communication with clients in the target industry, companies' involvement at the research stage facilitates the implementation of project results and contributes to higher customer satisfaction. These in turn open possibilities for obtaining further financing from these partners and establishing cooperation with new partners, increasing the number of customers at the same time. Successful works stimulate expansion of knowledge, its transfer in the form of patents and publications, and the search for further applications.

### Opportunities

Policies play an important role in creating good conditions for IP commercialisation. First the development of a knowledge-based and circular economy is seen as an important opportunity that can increase commercialisation. Second, availability of financing for Institutes' KT activities, both national and international, is considered very important. This covers state budget support for economic and science innovations, support programmes for the implementation of anticipatory research and development projects aimed at future commercialisation as well as joint bilateral research funding competitions.

The Institutes point out strategic issues like international expansion, indicating that Knowledge Transfer Strategy should be directed at international markets too. This requires investments in patent solutions valid not only in Poland, but also European patents and those valid in the USA as well as IP rights protection. Relatively low salaries in Poland in comparison with foreign partners facilitate internationalisation and result in the Network's competitive advantage.

Economic and social factors play a crucial role in this context too. The reduction of technical staff in industry creates better opportunities for Institutes' experts' work. Implementation of "market pull" instead of the "market push" model is considered a key to successful commercialisation activities. However, it requires a deep and difficult change in the scientists' approach to the knowledge transfer within the Łukasiewicz Institutes.

**Barriers and threats**

Legal, financial and economic, technological, organisational and social factors constitute major impediments for IP commercialisation.

According to the literature review, Polish research units and universities have a very limited capacity, skills and success rate in business cooperation. Limited number of scientists have experience in working with business or in being involved in company creation or academic entrepreneurship. Many of the research units have an employment structure not conductive for RDI and knowledge valorisation and exploitation. In some Institutes only 23 to 40% of staff is working on RDI.

The issues of low legal stability, frequent changes of regulations, implementing measures adopted with delays and many associated risks created, e.g. related to accounting and taxes, even entailing criminal liability, are frequently raised as barriers by the Institutes. This includes unclear regulations related to commercialisation, which in its current form is laborious. The commericalisation process is complex to understand. Moreover, lack of understanding how to business partners and too detailed public procurement law are seen to hinder the pace of commercialisation processes. Complicated regulations regarding intellectual property rights, IP valuation, contractual provisions and competition regulations unfavourable for the creators of this property have been strongly emphasized. Furthermore, barriers resulting from complicated legal framework regarding new company creation and commercialisation of results of projects co-financed from the EU sources, both national and international ones (e.g. from Horizon 2020) have been raised as key concerns.

Lack of financing is therefore another significant hindering factor. Strong competition for project financing and preference for high-tech industries in financing programmes constitute other barriers. On the other hand, in some sectors (e.g. biotechnology) the financial scale of projects constitutes a problem that impedes obtaining financing. Too weak co-financing by the state is creating a threat in some sectors.

Another financial barrier is linked to the restrictions related to the Covid-19 pandemic that in many cases entailed introducing austerity in R&D financing, which led to a minimum funding. This in turn resulted

in postponing the dates of R&D projects and it can be expected that the effects of the recession will be clearly felt in the following months and maybe even years.

Some Institutes face a barrier of limited market for the products they offer, partly due to decline in demand and industrial production in the economic sectors cooperating with the Institute. Currently this is often linked to the Covid-19 crisis. Risk of negative result of the pilot implementation or declared results of the project or questionable economic efficiency of the developed technology is sometimes considered a threat.

The Institutes also struggle with clients' withdrawal at different points in the implementation of projects including utilisation of the knowledge already obtained from the Institute on their own. Excessive outflow of knowledge to the recipient may result in recipients' independence and the end of collaboration. Potential stealing of know-how has been raised as a potential threat in this process. Limited funds for investments in companies is another interconnected problem. However, the risk of losing customers is also related to the emergence of competition on the market from research and development centres of enterprises as well as private specialized research laboratories.

The IP commercialisation is also hindered by organisational factors. These are problems with the structure, with the lack of centralised organisation processes, too extensive and laborious bureaucratic system, rigid processes, detailed reporting and planning and frequent organisational changes in the Network. On the other hand, loss of identification as an individual unit in such a large structure as Łukasiewicz Research Network has been indicated as a threat. Excessive workload for substantive staff with knowledge transfer and resulting limited time for research works or inability to carry out other R&D tasks have also been mentioned among risks. There is also a threat of inability to ensure competitive payment terms for well-qualified and experienced staff.

The barriers for commercialisation are also of social and psychological nature. On the one hand we have the unwillingness of scientists to commercialise, their reluctance to work with business and the recognition of for-profit activities as incompatible with the ethos of scientific activity. Low awareness and knowledge of research workers about technology transfer mechanisms and the principles of intellectual property protection increases the problem. On the other hand, high assertiveness of entrepreneurs in implementing new technologies still exists. They are not determined to implement new solutions which require investments, in particular in the period economic slow-down related to pandemic.

## Policy advice and analysis

### Actions and drivers

Among the key factors driving the development of policy advise and analysis activities, the competence of people at various levels, their long-term experience in the analysed area, knowledge about the market and the processes were emphasized in the interviews. Teamwork, internal meetings and discussions, "brainstorming" stimulate knowledge transfer activities of this kind.

Interviewees also highlight other important success factors, such as the realism of clients' expectations, their awareness of and ability to take reasonable risks. Therefore, it is very important to define expectations and obligations clearly from the very beginning, eliminating not promising, and poor projects.

The literature review indicates that in order to increase capacity of research units and universities in knowledge valorisation and exploitation major activities and support has to be directed in the development of applied science, significant improvement of soft skills related to communication, dissemination of research, partners engagement, mobilisation and collaboration with business and networking with other science partners within the country and on international markets.

### Opportunities

Conducive economic and policy factors create good opportunities for development of activities in this area. This includes growth in some sectors and policies favouring the solutions elaborated by the Institutes. On the other hand, underdevelopment of certain sectors creates opportunities for the Institutes working in these areas as they competences are quite unique. National Recovery Plan and other EU programmes, development of a knowledge-based and circular economy is again among driving forces for policy advice and analysis services. A great opportunity is also considered recruiting employees from abroad thanks to ability to offer salaries at an international level.

Tax policies were highlighted as important opportunities to increase R&D activities in Poland. Poland has numerous legal acts and tax incentives supporting knowledge valorisation and exploitation. Among the most attractive are: (i) costs of any RDI works undertaken by the company can be deducted from its income in 100%, (ii) costs of RDI for companies with Research Centres Status can be deducted from its income in 150%, (iii) preferential tax of 5% for incomes generated from sale of IP rights (known as IP Box).

The whole country is treated as a special economic zone (SEZ) and all investors in any place in Poland can benefit from tax regulations applied in SEZ (new investors can benefit from support regardless of the geographic location of the investment). Only qualitative and quantitative parameters as supporting criteria specifically defined for specific investment are taken into account for tax relief. R&D is one of the premium areas.

### Barriers and threats

Poorly developed markets and related lack of clients constitute a significant barrier. The Institutes also indicate bureaucratic and formal restrictions, excessive complication of legal provisions at very preliminary stages of work as the problems they face. Lack of continuity in the Institute's activities in terms of interruption of intellectual investments started some time ago or change of Institute's development strategy often as the result of lack of immediate results is considered a significant threat.

While good specialists are drivers in this area, some Institutes face a problem of insufficient number of specialists to be involved in policy advice and analysis. The key barrier indicated in this field is also insufficient documentation of research results by scientists that is expected by their business partners.

The literature review highlight that significant problems relate to lack of international cooperation and lack of skills in human resources. For example, relating to international cooperation, weak knowledge of foreign languages, especially English constitute threats to international cooperation. Growing number of young scientists undertaking international cooperation as individuals is noticeable but very seldom it is undertaken as research teams or as whole science unit or group of science units from Poland. Research units have limited skills in filling in its gaps by cooperation with external specialists from professional consulting companies, or persons from business with needed skills. Partnership and networking as a key activity to gain capacity needed by the market is one of the weakest points in knowledge valorisation and exploitation and should be addressed by PSI&U and broadly supported by public programmes.

## 5.2 Key Highlights on KT Area 2: Knowledge Co-creation

Knowledge co-creation as a dimension of knowledge transfer has been increasingly acknowledged. Therefore, it is crucial to identify barriers, threats, opportunities and drivers that might have an impact on successful knowledge transfer.

The following main factors are presented in more detail below: collaborative research, consultancies, contract research, research services and publications-oriented research.

Significant amounts and types of data are an integral component of the different types of research undertaken contract research, collaborative research and research services, all of which entail contractual arrangements. Consultancy and publications-oriented research provide comparatively less data, but also worthwhile analysing from the perspective of knowledge co-creation

Knowledge co-creation understood as the joint production of innovation between research and industry and other stakeholders requires partners to identify problems and achieve results. From across the **threats and barriers** identified, partnership and networking were highlighted, although the existence of limited or in some cases the absence of legal support were also identified as areas of need when it comes to formulating policy to support a knowledge co-creation environment. Concerning **drivers and opportunities**, participants identified a range of institutional and financial factors: research potential, enabling entrepreneurs to find individuals who can respond to their technological or scientific-research needs, and the ability to be open to innovation.

**Actions** to enhance knowledge co-creation activities concerned mainly SMEs and the opportunities emerging from an increase in involvement in R&D work, especially at the levels of cooperation between science and industry. This relates to both economic and human factors.

## Collaborative research

### Barriers and threats

From the literature review, the main barriers identified for knowledge co-creation generally are (i) low innovativeness of the Polish science sector, (ii) limited public and private spending on RDI, (iii) limited innovative research in primary sectors (agriculture, forestry, blue-economy), (iv) business – science collaboration, (v) tax law regulations with significant impact on international cooperation.

The literature review highlights that important factors follow from low innovative collaboration with SMEs (five times lower than the EU average). Low innovative collaboration is argued to result from lack of trust in business partners, lack of communication skills and relatively small potential of existing business self-governmental units (business chambers etc.) in the field of business – science cooperation. Spending on RDI by business sector is quite low in Poland. According to statistics[10] most of the RDI spending (more than 50%), in Poland resulted from large companies, despite of the fact that most of the large international investors spending on RDI in Poland is very limited. Most of the Polish SMEs are equipped with very modern technologies, often delivered by foreign companies. Quite significant number of Polish SMEs have a very good cooperation with worldwide corporations (like in automotive or chemical industry) and work for them as subcontractors.

However, limited innovative research in primary sectors is constitutes a major problem for Polish innovation system. Poland has a large economic potential in agriculture, forestry, blue-economy, and processing of primary sector products. For example, agriculture is 4$^{th}$ highest export sector in Poland with over 32 billion Euro export value in 2020. At the same time, its support from Polish science is rather limited. Taking into consideration Polish conditions (i.e., low and not equal rainfall over the year, not too high quality of Polish soils, and ownership structure of Polish agriculture - average farm less than 10 ha) there is a need to undertake broad spectrum of research activities aiming on low energy and water consumption, ecological farming, niche farming and highly specialised production to help Polish farmers to even better compete on the EU and international markets. Most of the innovations in agriculture and food processing is delivered by suppliers of seeds, machinery, chemicals and other goods needed for production, and not from Polish research units or universities.

Another important factor in knowledge co-creation is the capacity for international cooperation. Issues regarding this concern social capital, human resources, and employment skills. For example, communication, collaboration, networking, foreign languages are among the factors hindering collaborative research, especially in foreign contexts.

In addition, Withhold Income tax (WHT) from non – residents is seen as a barrier for international cooperation. WHT for services creates a long list of additional duties for companies, universities or research units when they need to employ non-Polish experts or non-Polish business or project partner

[10] Report "Financial results of enterprises by sectors of R&D intensity", Statistics Poland https://cbies.stat.gov.pl/

for project implementation. Accounting departments along with legal advisers very often advise a company or scientific unit not to be a partner and for sure not to take a lead in international project to avoid serious difficulties during implementation or tax offices inspection. Since in such cases financial departments are the main decision makers in research units or universities, it is almost impossible to-have any impact on international projects' related decisions made at the Universities.

Similarly, interviewees understood collaborative research as research involving coordination between the Institutes and entrepreneurs, large companies, or SMEs. Therefore, in their answers a reference to the business and industry can be found very often especially when talking about the barriers and threats to collaborative research. Research work requires investments- financial and human resources wise. Due to insufficient financial resources to cover comapanies' own contributions, companies do not participate in the implementation of R&D projects. There is also a low awareness of a possibility of applying for funding from the external agencies which narrows down companies' fields of activity.

According to interviewees, one of the main issues hindering collaborative research is that entrepreneurs are often not aware of how research and development projects are financed. Many companies are afraid of applying for R&D funding or entering a project. There is often a fear of having to invest their own resources in these projects.

Another issue mentioned in the interviews is there are often either large enterprises who are not interested in collaborative research due to own research facilities, or SMEs who do not have enough resources to undertake R&D activities. It was highlighted that more attention should be paid to SMEs and maybe offer them preferential terms to undertake R&D activities. Lack of companies willing to carry out scientific and research projects and implementing related can be understood as a barrier.

Interviewees also highlight that many entrepreneurs don't understand that research develops over extended periods of time, and the innovations and solutions may not be found within the project timeframes. On the other hand, projects may be ended before the agreed end of projects due to outflow of knowledge. This results in leaking project information and innovation knowledge.

Market and economic conditions also have significant impacts on collaborative research. The literature review identifies this as one of the most prominent aspects. The barriers also include human factors such as lack of people on the labour market, lack of competences, inability to engage substantive staff at the same time to carry out other R&D tasks.

Legal aspects are also visible in that area as a significant barrier, especially changes in the legislative environment and in investment costs. Specific regulations included in calls for proposal cause exclusion of some of the partners. Another aspect is primarily the distribution of rights to results and issues related to the processing of personal data included in projects or data management plans.

When it comes to the economic conditions in a large scope, co-financing of the branch of economy to which knowledge is transferred by the state is too week.

### Opportunities and drivers

In knowledge co-creation the main drivers rely on few RDI and business development EU founded programmes. The most recognised ones are: Smart Growth Operational Programme (SGOP) 2014-2020 (to be closed shortly), Industrial Doctoral Program or Top 100 Economy Innovators, "Click" service (Serwis "Pstryk!"), FENG European Funds for Modern Economy 2021 - 2027.

Significant drivers are a chain of institutes responsible for implementation of programmes run in Poland or responsible for supporting of Polish researchers and businesses in Horizon 2020, Horizon Europe or other programmes financed by international donors. The main ones are: National Centre for Research and Development (NCBiR), Nacional Science Centre (NCN), Polish Agency for Enterprise Development (PARP) and National Contact Point (KPK).

The interviews indicated that what seems to be a barrier is also seen as an opportunity. Changes in the legislative, challenges and new calls under the European Green Deal open doors to new projects with the entrepreneur and creating new ideas. These actions are a great way to generate income related to the transfer knowledge. It also calls for action of concentrating on good contracts and formulating clear regulations of division of the common ownership of rights and disposition of these rights.

### Actions

The interviewees indicated that human factor is also being indicated as an important driver for collaborative research. The Institutes indicate that thorough preparation of projects is necessary to simplify the process and improve effectiveness of each step of the collaborative research. Opening up Institutes for students before they obtain a degree to start the collaboration early is being recommended. Lack of knowledge regarding how to apply for funding is also mentioned as important actions to be taken. Working closely with employees and providing them training on how to write applications for funding as well as creating cooperation teams where the partners of the consortium trust each other is considered a significant factor in the smooth collaboration. Increasing awareness about employees' impact of the knowledge transfer in the research collaboration is seen as a great step towards improving the process.

The literature review highlights the following programmes as important actions for increasing collaborative research in Poland. For example, the Smart Growth Operational Programme supports: 1) R&D activity of enterprises; 2) environment and capacity of enterprise for R&D&I activity; 3) innovation in enterprises; 4) increasing the research potential. Industrial and Applied Doctoral Program run by the Ministry of Science and Education constitutes a chance for entrepreneurs to hire a talented scientist who will solve the technological problem faced by the company. A PhD student (focused on solving a specific technological problem) works in two places - in an enterprise and a research unit (university, research institute) and receives a monthly scholarship from the Ministry. The programme of Top – 100 Economy Innovators enhances employees' competences in the R&D management and commercialisation of research results through their participation in a foreign internship at foreign research units and companies having experience in R&D. Entities with legal personality (and not being scientific units) including enterprises (in particular having the status of a research and development centre) may apply for funding. "Click" service (Serwis "Pstryk!") is a simple tool (portal) that allows entrepreneurs to find people who can respond to their technological or scientific research needs and solve specific technological problems

through innovation brokers. It is expected that new 7,9 bln EUR programme 2021-2027 for Polish entrepreneurs and RDI financed from EU Funds will be a significant driver for RDI for the next 7 – 10 years and will establish long term ground for knowledge transfer and science – business collaboration not only in Poland but along with Horizon Europe also on international market.

Internationalisation processes of Polish Academy of Sciences and universities (later on referred as PSI&U) require several specific actions. Key recommendations are: (i) strengthening the system of comprehensive support for researchers (institutional, instrumental), which will promote international research and publication cooperation; (ii) provide PSI&U with financial support in the development of internationalisation strategies; (iii) continuing the support aimed at improving staff management competences by co-financing the implementation of projects consisting in the establishment and / or development of "Competence Centres / Offices" (iv) ensure financial support to PSI&U in assuring its own financial input to H2020 and Horizon Europe projects.

Furthermore, according to the literature review, Poland should pay special attention to tax law regulations. The key aspects are related to Withhold Income tax (WHT) from non – residents (people whose place of residence is not Poland). Withholding tax is an income tax (both corporate and personal) withheld by remitters on certain types of income including dividends, interest, royalties and – in Poland – also services.

## Consultancies

The offer of advisory services for enterprises is of vertical nature i.e. it is often branch oriented. According to the interviewees, some companies approach the Institutes directly. Their consultants implement projects after contractual arrangements concerning companies' expectations with the aim of earning money.

### Barriers and threats

The main barriers and threats mentioned by the Institutes to consultancies were lack of funds for research and development, and the Covid-19 pandemic situation. Companies' lack of willingness to invest in development and high indirect costs are those hindering factors. It can be said that the economic factors combined with a low knowledge of the need for development and establishment of new business culture obstruct this area from thriving.

### Opportunities, drivers and actions

Economic aspects are the most significant factors impacting consultancies. All of the Institutes interviewed mention the need for development market understanding to enable growth of operations This means closely monitoring overall global and market trends. Moreover, close monitoring is needed for markets to enable staying in the competition.

Good market situation and increase in income in this area allows for development of key research fields which can be considered as a driver. In addition, well organised processes, support in acquiring customers and competent employees contribute to the future development of this area.

## Contract research

### Barriers and threats

Financial, cultural and social issues constitute main barriers and threats for contract research in Poland. Low innovativeness of Polish science sector results from several issues. In parametric assessment of science-research units, innovative achievements are often of secondary importance. Low interest in development of applied research in science policy, and defective research planning system with limited knowledge of the principles of industrial and intellectual property protection within the academic staff constitute key barriers. In addition, almost full coverage of operational costs and new investments by the state is seen to lead to underestimating the potential of external funding to finance innovative for science units and universities. Even though state support is often insufficient, Polish science institutes and universities (PSI&U) have still limited offer for business and are not building own units and networks aiming on broader collaboration with business. Having limited resources deters them (businesses/research units / universities?) to incentivise innovative resources through financial means. Many researchers (if not the most of them) earn additional income as independent experts or consultants.

The literature review indicates that only 20% of patents from Polish Academy of Sciences (PSI) have been transferred to commercial application, while the average for developed countries is above 50%. PSI&U do not spend enough effort on implementation of their patents and knowledge. Lack of cooperation and collaboration are a serious issue in Poland. Less than 50% of PSI&U undertake any business cooperation. Moreover, Poland has a very low proportion of innovative SMEs collaborating (five times lower than the EU average). It could be explained by limited trust to business partners and rather small potential of existing business self-governmental units (business chambers etc.) ready to initiate such collaboration.

According to the literature, nationwide only 14 per cent of innovative SMEs run any in-house innovative activities. From this, average spending is only 3 per cent of total pro-innovative expenditure. More than 90 per cent of spending on innovations are own resources and only 6% of innovations relates to cooperation with PSI&U. The main reason for limited in-house innovation of SMEs are competence of own staff and limited own resources plus over-formalised procedure to gain public Polish or EU grants. Procedures are defined in detail along with any new call for grants and require high quality professional assistance for SMEs to succeed. Most of the innovations relates to procurement of equipment, staff, or specific knowledge.

The interviews indicated that the Institutes find it difficult to separate contractual and collaborative research as both are provided under contracts. Most interviewees indicate that the aim of the contract research is producing new solutions for the industry. Each project is carefully analysed and written for specific expectations of the companies.

Contract research projects are carried out upon direct request of entrepreneurs who both finance the entire project, and who are the main recipients of the research result in the form of a report, product prototype or implementation support.

Therefore, the Institutes indicate economic barriers as the most significant for contract research. Limited funds for investment, insufficient subsidy, and strong competition for project financing are only a few mentioned during the interviews. There are also technical barriers such as implementation of lengthy projects with some unforeseen obstacles along the way. This may be caused by the political and cultural barriers with a lack of business culture conditioning openness and mutual trust as being mentioned most often.

Due to the fact that contract research results in selling the outcome of the project, risks of failure to achieve the required the new solutions can have a negative impact on signing the contracts. Financial barriers related to SMEs that do not have sufficient funds to cover costs of investments that are a prerequisite to implement new technological solutions are also indicated. In the long term this results in declining in demand and industrial production of economic sectors cooperating with the Institutes. Besides economic barriers, a threat of obtaining a negative reputation in reviews if the project fails getting a so-called "bad note" can result in having difficulties in obtaining more subsequent agreements and funds. This, according to the interviewees is one of the main concerns.

The human resources and skills, which have their base in the educational and cultural system, seems to be a barrier as well. The Institutes observe poor communication, no rewards for positive actions and behaviour of employees as well as something that was referred as a culture of discouragement.

Knowledge co-creation requires partners to identify problems, co-design, co-create and co-effectuate. Creating partnerships and networking are one of the weakest's points of Polish research units. Many scientists complain not only on external partnership but also very limited collaboration skills within individual units of the research network.

In the literature review, main threats relating to collaborative research concern research units' staff capacity in collaboration, communication, dissemination, and exploitation. Such limits create the easily visible lack of successes in science – business partnerships and networking in Poland and at the much broader scale, on the international market. The best measurement of such situation is a small success rate in H2020 grants. Poland has 3,23% input to H2020 and only 1,25% of H2020 as grants goes to Polish applicants. Without dedicated action from Polish government along with research units, businesses and business supporting organisations (like specialised consulting companies) it is a significant risk to continue applying for the sources under Horizon Europe.

Finally, many scientists and company managers have raised concerns about complicated rules of law (mainly tax related) and lack of support from public administration. Companies using tax incentives, including the ones relating to RDI, are taking serious risks of additional and complex tax control, which may cost serious penalty and what is worst, is demanding and time consuming according to managers. Serious progress in knowledge transfer and in particular knowledge creation can be made when law regulations are clear with limited gaps for subjective interpretation by tax officers.

**Opportunities and drivers**

The measurable results of finalised projects are the achievement of further milestones and the achievement of agreed end goals. Measurable end results of the project are, according to the Institutes, most often the improvement of production indicators as well as performance parameters and quality of products. To increase the efficiency of knowledge transfer in the form of selling R&D results, it is important to simplify procedures, relieve researchers from administrative work and apply clear and stable rules of remuneration.

It noticeable that the Institutes find it important to focus on their employee development. Progress of employees is one of the opportunity factors mentioned in regards to both economic and social aspects of the future of research done under contract. Gaining experience for young scientists and creating an environment where the specialists from outside of Poland are willing to work on their scientific development is seen important to increase the scale of contract research.

Institutes also mention close contact of science with industry. New perspectives can be obtained from cooperation with entrepreneurs. Moreover, it is seen important to engage in collaborative projects dealing with the latest existing technologies and future innovative solutions, as they that require research and as such provide important learning opportunities. The implementation of one project often results in subsequent project and opportunities to obtain more funds. It is important to stress that the Institutes regard high demand for collaborative research as an opportunity to increase contract research projects.

Legal framework has also been renewed to facilitate contract research. Poland has recently amended new legal acts aiming at creating opportunities in knowledge creation. All of them are dedicated to support collaborative and contract research, research services and disseminative publications. The most important are two Innovation Acts introducing incentives for innovative businesses and researchers and encouraging the commercialisation of research findings that entered into force in 2017 ("small" Innovation Act) and 2018 ("big" Innovation Act). Opportunities in knowledge sharing follow also from tax incentives like IP Box as preferential 5% tax for incomes generated from sale of IP rights and tax release for companies registered as research centres. For such companies costs of RDI can be deducted from its income in 150%.

Act on supporting scientific activity from the Polish Science Fund which forms the basis and mechanism for financing scientific activities conducted in the innovative formula of a virtual research institute (WIB) is another opportunity for knowledge transfer. "A virtual research institute is a form of work organisation of selected, internationally competitive research teams, conducting scientific activity with high potential for socio-economic applications, under the guidance of a leader with recognized scientific achievements, whose aim is to commercialise its results."[11]

### Actions

A few programmes and institutions dedicated to support innovation, knowledge co-creation and business – science cooperation at local, regional, national and international level have been established in Poland. Some of them are financed by municipalities, poviats (districts), regions (e.g., Marshal's Offices), state or

[11] Article 5 (2) of the Act of April 4, 2019 on supporting scientific activities from the Polish Science Fund (Journal of Laws 2019, item 823)

directly by EU as international partnership projects. What is needed is a monitoring and evaluation of the scope of activities, and verification of measurable results. This is necessary in order to avoid multiplication and duplication of the activities since similar support is at the same time provided by the business environment institutions (BEI) and as part of projects implemented by the Polish Agency for Enterprise Development (PARP).

Among quite long list of actions and activities indicated in the literature aiming on knowledge co-creation the leading ones are: (i) need to increase effort to commercial applicability of R&D, (ii) support in-house innovation in SMEs and assist SMEs in increasing RDI staff competence (iii) stimulate SMEs collaboration on knowledge co-creation along with science-business cooperation, (iv) support internationalisation process of PSI&U.

It is also necessary to make entrepreneurs as partners aware of the costs of intellectual property in the process of realisation and sale of research results and implementation of new technology. The Institutes emphasize the necessity of change in the method of intellectual property valuation to enable giving more focus on achieving tangible economic impacts outside of research. This would include the possibility of developing various new business activities based on the results of projects. The interviewees indicated that one of the most important goals of contract research, apart from getting an income, should be conducting research with high publishing potential.

## Research services

### Opportunities and drivers

According to the majority of the Institutes the aim of research services is solving the entrepreneur's problem in accordance with national or international standards. The Institutes are proud to have well equipped laboratories. This enables them to not only carry out testing services in accordance with the latest methodology but to meet the highest standards of testing required.

Research services are conducted in close collaboration with the industry. Through this collaboration the Institutes learn about the directions of companies' development pathways. This enables the Institutes to offer more possibilities of R&D works which is also an important source of income for the Institutes and subsistence for their employees. Good relations with clients is seen to result in a long-time cooperation and an increase in the number of orders as the Institute becomes a recognisable brand. For this maintaining high quality of cooperation is important.

Institutes also highlight that having a technologically well-advanced equipment is important for research services. This enables conducting research according to the latest standards. The modern infrastructure is followed by highly qualified staff willing to improve their qualifications. Along with this, understanding technological needs of the market and an exchange of knowledge, experience and good practices create good opportunities for development of activities in this area. Some areas of expertise require constant need for certain tests and approvals (e.g. admittance of transport, electrostatic measurements) regardless current situation. That along with an ability to compete on the international market is considered very important in the field of opportunities. The country's economic development was indicated as a driver.

This has led to companies' growth and becoming more technologically advanced. This boosts the need for the research services. This is again emphasized in regard to the visible increase in the experience and competences of managers and owners of Polish enterprises in the field of new product development policy.

**Barriers**

Obtaining the funding from the clients is seen as the most significant barrier to research services. Limitations lie on the side of the entrepreneurs and their investment in research as well as the lack of knowledge of the importance of the research conducted and a need to guarantee a solution both proven and innovative. Buyers usually concentrate more on price than the quality of services.

Beyond economic factors, legal factors also constitute barriers for research services. For example, barriers resulting from public procurement law has led to changes in regulations. This has resulted decreasing number of certain tests and fewer orders.

Finally, one of the indirect effects of lack of research services is the maintenance of personal, informal ties between companies and R&D sector units and other institutions, where the specialists are getting engaged and not the institutions. Putting individual, private needs of the scientists before the Institutes' interests results from reluctance to cooperate and the lack of conviction about the measurable benefits of formal cooperation in relation to expenditure incurred. The Institutes emphasise a close correlation of that process and difficulties in winning research projects.

**Threats**

Among the key factors which are seen as threats for the development of research services the financial one is indicated as the most important one. The presence of competitive companies which are much better equipped and have much larger budget offer the same services. This, as mentioned by the Institutes constitutes threat to the Institutes research services.

On the other side of the financial spectrum there is a potential threat of break-up of the team due to decline in wage attractiveness and a failure of the research process. Human factor is once again mentioned when the need to transfer the external financing towards improving the qualifications of the employees and to the scientific and research base is indicated as a threat.

### Actions

In some cases, the Institutes find themselves unable to provide a research service and are forced to refuse it which results in not signing a contract with the client. If the Institutes are limited by their knowledge and know-how only and not by the technical capabilities, they would treat that inability as a trigger for a development. In such situations they are willing to invest in a specialist training for their employees, build instrumentation or perform preliminary test. Research services also lead to a visible increase in the experience of owners of Polish enterprises which was already mentioned as driver above.

Research services are a significant source of income for the Institutes. To perform them, the bilateral commission contracts related to the performance of research and the development of expertise for other

scientific units, state administration bodies, as well as foreign contractors are signed. Due to an importance of such when there is a need the necessary changes in the structure of the departments involved in the services are being implemented.

### Publications-oriented research

#### Opportunities, drivers and actions

In most cases the research at the Institutes is carried out from public funds (National Science Centre, National Centre for Research and Development) and international grants. The settlement of these grants is the publication, so the aim of the research will be the publication. On the other hand, what the Institutes would like to improve is not the approach that they only cooperate with the industry and work on the application projects. They want basic research to end with publications which then would be continued in application research.

All employees are obligated to prepare presentations. The directors of Institutes need to assess publication-oriented work and give permissions. When a human factor is involved here is always the area of decision risk and mistakes as i there is no algorithm nor the right mechanism in place Therefore recruiting good leaders is a necessity as the opportunities lie in the minds of recruited leaders. They are innovative breakthrough ideas in their minds.

#### Barriers and threats

As a threat and a barrier slowing down the research process once again the public procurement law was mentioned by the interviewees as the second factor the interviewers indicate lack of continuity. Once the problem or ideas is worked on, it should not be changed, nor the new direction selected due to a lack of results within two years of work.

## 5.3 Key Highlights on KT Area 3: Knowledge Sharing

Knowledge sharing generally requires partners with common goals and capacity to work together. While there is a growing awareness of knowledge as key for company's or research unit's value, the idea of sharing remains difficult to accept mainly by business staff. Importance of open innovation, co-design, and co-creation takes time to be accepted by partners.

The leading aspects related to knowledge sharing identified in the literature are: improvement in KT support programmes, increase in number of innovative SMEs staff, supporting in-house innovation in SMEs, supporting the internationalisation of PSI&U staff by personal professional development, highly indexed publications, mobility within Poland and internationally, improving communication with other researchers and with business people an dissemination skills.

In their knowledge sharing activities, the Institutes of the Łukasiewicz Research Network focus on professional development, networking and events and publications and presentations. Teaching and researcher mobility are also mentioned in some cases, but as those rarely implemented.

The Covid crisis constitutes both an opportunity in terms of development and use of online tools and ICT technologies for knowledge sharing, representing increased access to some activities, and removing barriers such as the financial cost traditionally associated with physically attending international events. Challenges related to IP protection have also been found to impede knowledge sharing.

## Professional development

### Drivers and opportunities

Drivers of professional development relate to -personal development and education. It is indicated by the Institutes that the general atmosphere in the workplace encourages personal growth. Fair and properly functioning bonus system was also mentioned as a driver for personal development.

The Institutes identify scientist independence as the primary value. To support scientific independence, scholarships and financial allowances for independent research reports were highlighted. In general, it is noticeable that the financial aspect plays a key role in a professional development of the employees. The Institutes also specify keeping up with domestic and foreign competition as well as a high demand from industry for new qualifications and knowledge, closely corelated with financing of cooperation from EU funds as an opportunity.

The literature highlights that knowledge sharing drivers consists largely from programmes supported by Polish or EU funds. These funds aim, for example, at supporting scientists in their own professional development, improving teaching quality, cooperation with companies and researchers' international as well as domestic mobility. Programmes such as Industrial and Applied Doctoral Programme, "Click" service and Erasmus programme are among the most popular. Most of the programmes are run by the Ministry of Science and Education with a primary aim at professional development of scientists and solving technological problems in companies. In addition, the programmes aim at helping SMEs to match with professionals who respond to their RDI needs and help implement research projects. In order to find relevant experts, companies often hire innovation brokers. At international markets, Erasmus programme is broadly used for knowledge sharing.

During the last two years and increasingly since the implementation of the Covid-19 restrictions, ICTs have become increasingly used for organising seminars, webinars, workshops and conferences. In most of these events, there is no limitation for participants and very low cost of participation. This has increased access to knowledge. Yet, limited interaction and lack of face-to-face meetings can hinder professional development as they place restrictions on networking capabilities.

### Barriers and threats

Most barriers with regards to professional development result from financial limitations. Lack of career paths and possibility for promotions at the Institutes are indicated as barriers. Difficulties in finding financial resources are seen as a cause of losing highly qualified employees. At the same time, employers' lack interest in providing their employees opportunities for scientific development. For example, lack of

willingness to cover additional costs of trainings and conferences, which are vital for increasing the qualifications and competences of employees, constitute a major barrier.

In addition, the literature highlights those cultural differences on national, organisational and professional level are to be taken into consideration in knowledge sharing practices. The level of effectiveness of knowledge sharing practices depends how cultural differences of participants' organisational cultures are understood. This is evident in projects where partners come from different backgrounds. Some of the partners are large traditional public Higher Educational (HE) organisations with own inflexible rules and regulations and other partners are Small and Medium sized Enterprises (SMEs) trying to network for improved acknowledgement on the market as training providers and for potential profit making (both current and future). In such settings, using effective technology-based communication tools is emphasised among enablers for increased KT between dispersed partners, who usually do not know each other.

Finally, demographic changes in staff and available employees may impact knowledge sharing practices across sectors in the near future. These include aging staff structure, limited PSI&U budgets to stimulate staff and inadequate structure of researchers 'employment. In many of PSI&U most of the key science staff is close to the retirement age. At the same time, there are limitations for hiring young scientists due to very low attractiveness of wages. In fact, average Polish young scientist earns only up to 20 per cent more than minimum wage in the country. Additionally, low competence in foreign languages (mainly English) and other key so-called soft competence are the main problems related to knowledge sharing and internationalisation of PSI and universities.

### Actions

Actions taken to improve functioning of professional development relate to a support system for both young and experienced scientists. For young researchers, actions include, for example, involving researchers in the implementation of projects coordinated by more experienced researchers in cooperation with companies. In addition, there is a general need to support development processes of young researchers to help them acquire and carry out research and service work independently.

Professional development of senior and more experienced employees may also arise from incorporating different members of staff in joint implementation of projects which are mainly coordinated by scientists from the Institutes and industry specialists. The implementation of R&D projects by mixed teams including scientists employed by the Institutes and industry specialist coming from entrepreneurs is beneficial for both parties - the Institute and the enterprise.

There are various internal actions taken to improve professional development in the Institutes. For example, interviewees highlighted that actions include Institutes own commitment to internally funded projects, sending delegations to trainings, participation in symposia and conferences and organisation of foreign internships play a significant role in employees professional development.

The Institutes also suggest that mastering methodological skills and operating selected research equipment on a semi-technical and industrial scale is another action worth considering.

Also publishing own research results in the form of scientific articles and presentations at conferences and symposia plays a significant role in the process of knowledge transfer as doctorates, including industrial PhDs are an advanced form of acquiring knowledge.

Staff competence is also a key aspect for PSI&Us. This relates mainly to communication, collaboration, networking, partnership, etc. on the Polish market. Internationalisation is also an important aspect, but it require additional actions, starting from training in foreign languages (English), with special focus on professional terminology. This could be enhanced through various ICT tools, international mobility, and increasing recruitment of foreign scientists and academic entrepreneurship.

## Networking and events

### Actions and drivers

One of the actions related to networking implemented in the Łukasiewicz is the "Creative coffee 24" initiative. In this highly valued initiative where people involved in knowledge transfer meet and discuss these issues in a creative, free-floating way sharing information on innovative solutions, good practices from individual Institutes' work e.g. their experiences on spin-offs creation. New ideas emerging the collaborations of Research Groups of the Network (Health, Smart Mobility, Sustainable Economy and Energy, and Digital Transformation gathering Institutes working in specific areas established as the result of Łukasiewicz creation) were indicated as important networking results in this context, too.

Drivers of networking include having relevant people involved in a so-called 'right people in the right places' -manner. In addition, involving highly qualified and dedicated staff, and valuing networking activities are important. The importance of bearing a culture of openness and trust are among the factors most frequently mentioned in the interviews. Networking is also driven by renown experts employed by the Institutes, who are known in specific sectors. This attracts new invitations for collaboration

The institute should also pay attention to the importance of promotion. Promotional strategies should be adjusted according to Institutes' profiles and sales channels. his includes the need to simplify initial offers and clarifying benefits for businesses.

Recommended actions also include hiring or nominating specific individuals to be responsible for information dissemination in the Institutes. These could be, for example 'information officers' or 'information architects', who would be in charge of regularly delivering important information regarding their Institutes to the person responsible for communication. Such information dissemination, according to interviewees, should be done in a visual manner in order to be as user friendly as possible. However, such actions cannot be forced. As such, it is necessary to find motivated employees.

Interviewees also highlighted the need to create regional innovation networks. This is interesting, as the literature review highlights that effective use of existing potential of the institutional knowledge transfer in Poland could play a bigger role in helping especially SMEs. According to the literature, the low indexes

of SME innovativeness indicate that only four per cent of SMEs in Poland are highly innovative, 16 per cent with medium innovative approach. Only 14 per cent of innovative SMEs run any in-house innovative activities. More than 95 per cent of finance to innovation come from SMEs own resources. Interestingly, only six per cent of innovation activities are conducted in cooperation with PSI. Most of the innovation relates to procurement of equipment, staff, or specific knowledge. This indicates that, as highlighted by the interviewees, that regional innovation networks bear huge potential to increase innovation activities across Poland.

### Opportunities

Participation in networks and events is important for finding not only new partners and clients for collaboration but also for establishing cooperation on a larger scale. This results in new projects, new invitations to apply for and implement joint projects, and as a result, new experiences and competences as such collaborations result also in learning. Taking part in numerous events can lead to establishing close relations with potential partners and clients. They can also facilitate participation in international conferences, sometimes thanks to informal invitations Such collaboration is also important for reflecting Institutes own competences, especially in areas where they are able to help their clients in problem solving. Interviewees placed emphasis on networking with regional partners rather than with partners located at a greater distance. Yet internationalisation was mentioned as an important opportunity related to participation in networking and events. The ability to manage such network of contacts in order to utilise it effectively and benefit from these relations is of key importance too.

Developing networking activities is also important for government and regional strategic programmes as well as for the utilization of EU funds.

The chances in networking and events lie also in accelerating the development of online tools for reaching people (e.g. for e-conferencing). These have substantially evolved during Covid-19 pandemic.

Interestingly, Poland has a vast system of knowledge transfer supporting units. For example, there are over 200 knowledge transfer institutions such as Science Parks, Centres of Technology Transfer, Academic Incubators, Technology Parks etc. Some of them are very well organised but with rather limited in scope of services for tenants. In most cases a leading service of these institutes is renting of spaces such as, offices, laboratories, to companies (, and only minority of services relate to support in company development. Poland has such units and it is a matter of strategic decision what should be done to use them in a proper way with special aim related to RDI.

Utilizing the public procurement system is also a good opportunity to increase knowledge sharing in Poland. Innovative opportunities are provided by law, such as pre-commercial procurement or innovation. Previous activities focus on very large projects (NCBR - New Formulas R&D Programme) or very small applications (GovTech). It is necessary to create SMEs innovation support mechanisms in medium-sized projects (one-off support up to approx. PLN 1-2 million).

Many of the company managers notice increase market value of the enterprise when running RDI projects. The development of innovative solutions, R&D allows entrepreneurs to build a competitive advantage over rivals. Here knowledge is one of the most important sources of competitive advantage of modern enterprises. However, Polish companies often understand research and development companies as procurement of new machinery or ready technology and rarely as is in-house developed innovation.

**Barriers and threats**

The interviewees indicated the Covid-19 crisis as a barrier for networking and events. Similarly, in other areas of knowledge transfer, opportunities and barriers are closely interrelated in networking and event activities, too. For example, travel and gathering restrictions resulted in limited opportunities for participation in events. This bears certain weaknesses such as low effectiveness and difficulties of embedding virtual collaboration of on-line events compared to face-to-face meetings. The work in research groups has been indicated in this respect as time-consuming and difficult due to rigidly imposed people for collaboration.

Many barriers for networking and events relate to finances. Participation in some events, in particular international ones, is very expensive. It is often though that these activities do not translate into financial result of the Institute. Hence, it is important to create a belief that these activities are valuable and even if they consume money and do not bring visible profits in short term perspective, they will bear fruit in the long run.

The financial aspects are also s inherently linked to broader economic and market situations. When there is a lack of resources and if e.g. people running companies are struggling to survive, they are likely not to participate in networking activities. At the same time, there is a risk that participation and paying for some events may be indeed a waste of time and money. Hence, it is important to act with moderation when making decisions on participation in such events. These activities need also to be coordinated in order not to be duplicated.

The human factor plays a role here too. Traditional distrust towards other individuals in Polish society that hampers knowledge sharing through networking and events. This results in that enterprises, public administration, R&D institutions, innovation centres often operate in isolation, and they know little about each other's offers needs. This creates difficulties in suggesting or initiating joint collaboration in networks.

In some narrow, highly focussed specialisations, barriers relate to availability of relatively small number of industry events and cooperation networks. Contrary to this, another risk is also low number of participants and low interest in some events caused by a huge number of events organised.

To conclude, Poland has a good institutional system of knowledge transfer supporting institutions with special responsibilities in knowledge sharing. Most of the services provided by such units are free of charge (public support) or paid at symbolic level. Channels of knowledge sharing exist but they are inefficient. Issues relate to knowledge sharing via international collaboration. Only 15% of Polish

companies from high technology sectors engage in international cooperation in the R&D field. The main reason for this is a low staff capacity to implement international collaboration which results mainly from lack of language skills. Most of the science and business units from Poland do not participate in international networks or events at all. The most common is international partnership come in the form of subcontracting, which applies to companies as well as research units.

## Publications and presentations

Publications are a requirement in many projects conducted by the Institutes. The Institutes often publish the research results in books, chapters, newsletters and peer-reviewed journals and research results are presented at seminars, conferences in Poland and abroad.

It can be said that the Institutes are proud of their publications. Few of the institutes have a good status as scientific publishing houses, and they publish books themselves. Institutes are interested in enabling their scientists delivering quality publications but to maintain high scientific reputation of their scientists.

Publications and presentations are also a part of the events organised by the Institutes as well as the external ones. The Institutes disseminate knowledge and share their experience by organising scientific conferences.

### Drivers and opportunities

Drivers of publications and presentations consist of motivational factors such as rewarding and recognition of employee achievements. The Institutes indicate that rewarding their employees for the highest number of citations has a significant impact on the number of publications. It also stimulates "positive" competition among scientific staff. This also has a great impact on employees' willingness to develop professional skills and quality of publications. Employee's internal motivation strive for promotion and preparation of doctoral dissertations have further positive impacts on employee's profession development regarding publishing processes.

It is also important to mention that publications increase credibility of the Institutes as partners. Indeed, the Institutes have tried to develop an image as a reliable and credible partner over the years. Thanks to this, the knowledge of their brand is being expanded.

On the other hand, it seems to be very important to build a stable cooperation between the research centres across Poland and abroad, as well as with entrepreneurs. This would facilitate applying in joint applications and publications, which could increase the number of requests for collaboration made to the Institutes.

Finally, there is also a need for establishing a mobility policy which will support joint research. The Institutes underline this, as the need for networking is seen as a promising factor in the area of publications and presentations. Usage of social media, that is podcasts is, according to the interviewees, an opportunity to increase number of presentations. Podcasts along overall diversification of media outputs could increase interest to collaborate with the Institutes more broadly.

### Threats

The main threat listed in the interviews is the inability to provide original content that is not protected by IPR yet in presentations and publications. The scientists are eager to present their achievements, however that is not always possible if the results need to be patented.

In addition, the global pandemic situation has limited the Institutes' activities in the organisation of subsequent editions of scientific conferences and seminars that used to be organise on an annual basis. In addition to the threats posed by the Covid-19 pandemic, competition, limitations resulting from a lack of financial resources needed for publications in scientific journals and participation in conferences constitute important threat factors.

### Barriers

All interviewees mentioned funding as the main barrier regarding publications of research results. Large costs are associated with running this activity which itself does not always bring a lot of income. Limited funds within granted subsidy and lack of funds for participation in major conferences are a few indicated by the Institutes. The lack of sufficient financial motivation for the individual scientists is also mentioned.

Many of the Institutes indicate that apart from the economic situation and the Institutes' financial abilities to host and participate in events, small number and insufficient quality of publication is a barrier as well. Also, the lack of positive research results, reluctance of journals to be printed, bad reviews in the journal are seen as limitations. The literature review indicates that scientists and university teachers publish a lot in the journals and magazines of their study fields, but not in the area of research and innovation.

### Actions

The basic entrepreneurial knowledge and the ability to sell innovations among employees, especially young employees is important for creating high quality publications. The Institutes emphasize that there is still a lack of researchers, especially managers, that have competences in the field of commercialisation, which has a close connection with publishing the results of works and impact on the development of the knowledge transfer.

As already mentioned above, the Institutes emphasize that the financial support is necessary. That support would be used as fees for the articles and gratuities for authors, as well as establishing international cooperation. This would attract authors including researchers with considerable achievements and a position in the scientific community.

Finally, in order to make knowledge sharing more intensive and reach scientific excellence, it is necessary to implement direct activities that involve collaborative publications in scientific journals with high impact factor, participation in international conferences, supervising for PhD and Master students, and participation in special sessions in the framework of international conferences.

## 5.4 Key Highlights on Other Stakeholder's Consultation

The critical issues raised by other Polish stakeholders have been identified in particular on the basis of their comments on contextual and innovation indicators and their negative impact on knowledge transfer in Poland in the context of the Łukasiewicz KT Strategy.

**Barriers and threats**

First of all, the lack of a comprehensive innovation policy and a poorly organised support system of innovative economy in Poland have been highlighted as the main problem from which many other barriers arise.

Lack of innovation policy in public procurement has been underlined as a very important impediment concerning low government procurement of advanced technology products. A general approach in the public procurement policy focusing on achieving results as soon as possible, as cheaply as possible and as easily as possible is a serious problem in Poland.

Polish stakeholders assess R&D expenditure of companies as not sufficient emphasizing that the more they spend on R&D, the more innovative technologies will be created. This concerns not only Polish companies, but also those firms which are established in Poland. R&D expenditure in the business sector is still considered extremely low. Reporting any expenses related to innovation has not been profitable for companies, but relevant changes in legislation have been recently introduced. In terms of private co-funding of public R&D expenditure, insufficient collaboration in Public-Private-Partnerships formula was mentioned.

Science-business collaboration is another key impediment in knowledge transfer resulting from the lack of a responsive support system. There is a major problem at the interface between public and private sector related to legal issues, valuation of knowledge, transfer of copyrights from universities to business, and responsibility, for example. In addition, higher education institutions do not see benefits (or see very limited benefits) in this activity. This results in lack of collaboration in knowledge transfer and ideas are not shared. Furthermore, mobility of researchers and collaboration outside their home institutions are seen as deficiencies in this process.

Entrepreneurship and education in this field are other weak areas in the context of Poland and knowledge transfer therefore all actions aiming at increasing it are considered important. Limited entrepreneurial skills were underlined in relation to companies' creation by scientists.

Internationalisation was indicated as one of the serious issues. Modest results in international co-publications indicate that this is a very weak area of Polish science. It can be seen to result from limited research cooperation with international partners.

The role of venture capital in Poland was indicated to be very limited. Venture Capital funds approach to investing in intellectual property rights originating from higher education institutions and from risky projects was identified as a problem. Poland has no system to ensure venture capital support for R&D and knowledge transfer in an appropriate way. Private venture capital's modes of operation act on the basis of capitalist extortion, aiming at overtaking small companies and then re-selling them further. This was highlighted as a serious threat to well-functioning venture capital schemes.

SMEs are considered the driving force of the economy. Therefore, their low capacity to innovate in-house is poses a serious barrier to knowledge transfer and innovation ecosystem as a whole. Their limited potential to introduce serious innovation results from the lack of adequate support policy. Incentivising SMEs to innovate without access to required financial support is a barrier to increase innovative activities within SMEs. The collaboration of innovative SMEs has been pointed as another important interlined weakness of Polish innovation. SME managers perceive enterprises and themselves as competitors rather than collaborators. In addition, SMEs have too limited resources to innovate while large companies are not interested in collaboration with SMEs.

Another serious weakness of Polish innovation relates to limited number of patents. Indeed, patents are often treated by scientists as a waste of time, especially when scientists do not see any subsequent use for patent inventions at later stages. Vast majority of patents are created to meet project indicators. This can be seen to result from low patent culture and limited trust in IPR protection in Poland. On the other hand, research units cannot afford the protection.

Finally, interviewees highlighted that cultural factors relating to consumption habits constitute a barrier for innovation ecosystem. The interviewees stated that Polish people tend to be very price-sensitive, even though some changes are seen. However, the choice between quality or price depends on the sector. While are more traditional sectors that focus on price and there are innovative sectors where the price is not so important.

### Actions and drivers

Actions and drivers of knowledge transfer are closely interlinked with the above-mentioned barriers and focus on overcoming these challenges.

The need to develop long-term, state of the art innovation policy and translating it into specific programmes, such as public procurement programmes are seen as crucial for the improvement of the innovation ecosystem. In addition, supporting Polish enterprises in developing highly technologically innovative products is also seen important. This is widely understood as a need to increase public-private partnerships that cover not only public procurement, but also loan guarantees and long-term financing of R&D projects.

Policies need to be well-thought, adjusted to clear objectives, such as defining clearly the directions in which the Polish innovation ecosystem and services should be built on. A supra-ministerial coordination, such as innovation policy council is needed to develop policies and to oversee the implementation of these policies in a correct and smooth manner.

Knowledge transfer from science to business must also be ensured by including relevant sources at universities in knowledge transfer strategies. Indeed, in other countries there are e.g. academic investment funds as investment tools supporting the projects implemented by the science.

Increasing R&D expenditure in public and business sector is necessary. This requires creating a a system which allows transforming knowledge into economic results. Poland does not have a well-developed system which would enable public money to be optimally transferred into applicable knowledge. Some research units and universities are overinvesting in laboratory equipment, yet research outputs remain very limited. This indicates that the issue is not only about the amount of money available, but the way it is utilised.

The development of entrepreneurial education and training and implementing this in the education system, in particular in secondary schools and universities, is also indicated among the necessary actions. However, education in this field, including innovation and creativity, should start as early as possible, so that students develop entrepreneurial skills from early on. Educating people to think in a entrepreneurial and innovative way is also important.

The actions should also focus on increasing staff mobility and facilitate entering international networks. More attention should be paid to staff training, lifelong learning and upgrading staff skills in digitalization. Poland should be able to attract doctoral students from abroad. This could not only improve image and reputation of Poland's academic centres but also contribute to better quality research. Mixing ideas, cultures and personal experience is very important for innovation and KT. It has been highlighted that collaboration, philosophy of networking and internationalisation are of key importance for the system to function well.

To increase the number of patents and their protection, the Polish Chamber of Commerce for High Technology has advocated to introduce the 'provisional patent' system. Such system has been functioning e.g. in the USA for many years. Due to the provisional patenting system, obtaining provisional patents and protection for research results has become easier after a quick verification

The recommended actions also include those related specifically to the Lukasiewicz Research Network. Interviewees suggested that this project (A Single Knowledge Transfer Strategy for Institutes of the Lukasiewicz Research Network) should place Łukasiewicz in the broader context with special attention devoted to science – business cooperation and international markets. Łukasiewicz and its Institutes must have clear rules for cooperation with businesses, other research partners in Poland, and on international markets. More attention must be paid also on analysing activities undertaken by Łukasiewicz, their networks of collaboration, future actions of the Network and identifying areas where public or business support will be needed. The creation of the existing overarching Research Groups (Health, Smart Mobility, Sustainable Economy and Energy, and Digital Transformation) has been indicated as a good step and successful action in terms of enhancing collaboration between different Institutes and with business partners. It has been suggested that the Łukasiewicz should not focus on licensing, because this is the area in which universities in Poland are in the lead and should engage more e.g., in creating spin-offs.

The Polish stakeholders have underlined that it is very important to consult the draft of KT Strategy for Łukasiewicz with institutions operating in the field of knowledge transfer, research, and innovation at the next stages of the project.

### Opportunities

Polish stakeholders have also indicated several strengths of Polish ecosystem in the context of knowledge transfer. Poland has quite a broad scale of knowledge-intensive services exports, despite the majority of them being delivered by foreign companies with only their branches in Poland. Poland has experienced successes in certain branches such as gaming industry or fin-tech. It is necessary to continue development in these areas especially as they are linked with venture capital and other financial instruments. Poland has well qualified staff with high potential for innovation. There is great potential in Poland in terms of partners for collaboration within the international sphere. Learning good practices from these actors should be utilised through networking. This is very important in the context of Horizon Europe which constitutes a huge opportunity for Polish science stakeholders.

## 5.5 Łukasiewicz links with business

### Collaboration and activities

The main forms of Łukasiewicz collaboration with companies include contract research and collaborative research understood as implementation of common R&D projects. Those financed from public funds focus on research, while contracts closer to the market with a higher readiness of the technology are of more commercial nature. The Institutes also provide consultancy services, including preparation and obtaining financing, laboratory analysis, certification services and preparation of expert opinions. Consultancies are usually considered as a first step to collaboration on a larger scale. The activities concentrate mainly on solving problems of clients. This includes development of a new technology, the development of a new or improvement of a product, patent or any other solutions that can be presented to business and commercialised.

Now the collaboration often starts under the Challenges system, which was introduced and managed by the Łukasiewicz Centre. The Challenge system is a systemic generation of mechanisms of cooperation between science and business. Under this this scheme, any company, irrespective of its scale or ownership structure, may, by filling out a form at www.lukasiewicz.gov.pl, report a technological problem that may be solved in a research and development project (Łukasiewicz, 2021). This includes the P+S path, i.e. Product + Services ("quick challenges"), which involves contract research. This is called 'Business to Łukasiewicz' service, but the Łukasiewicz also applies the 'Łukasiewicz to Business' model. The collaboration with business is primarily based on direct, personal contacts. Clients usually recommend the Institutes' services to each other.

At the level of the Institutes, Research Directors are in charge of management and development of collaboration with enterprises. In some of the Institutes, Directors for Commercialisation are appointed and special units dealing with commercialisation are being created now. They are responsible for sales of products and services, and business development. In line with their organisational structure, Institutes have people assigned to specific industry areas that deal with contacts with clients.

Making new contacts is done mainly under the Challenges system, however, it is assumed that the Institutes identify new partners themselves too. Knowing that companies prefer face-to-face contacts, Łukasiewicz experts visit enterprises in order to establish better relations and understand their needs. Then they are also responsible for maintaining the contact with a company. At the beginning, Institutes often offer small services that have real value for the entrepreneur and aim at developing the relationship, usually as part of a project. If the Institutes know that there is an opportunity for a new funding which will be announced soon, they inform entrepreneurs with whom they already cooperate. Interviewees assessed that 80% of their clients come back to them. Both parties value close, personal relations. The Łukasiewicz has also appointed brokers whose task is to provide the Institutes with new business contacts.

Other methods of developing collaboration with business include the organisation of training courses, both theoretical and practical, industry meetings and international conferences where specialists from other countries present new solutions and materials. This includes industry hubs concentrating services from various entities that gather i.a. Institutes and companies that provide good opportunities to start collaboration.

The managing staff of the Institutes and Łukasiewicz indicate the pandemic and all related problems including suspended calls for proposals as the challenges in collaboration with business. Companies need co-financing in order to enter a project, as they consider R&D activity as the one with a high level of risk and this risk has to be leveraged somehow. The insufficient competences of the employees in preparing applications for EU funds is another problem, and support of professional economic consulting companies would be helpful. This includes poor language skills that are necessary e.g. for participating in Horizon Europe projects. Another interlinked challenge is creating the awareness of the scientists that all the activities they undertake need to be oriented at collaboration with business and bringing benefits for the economy, so that this is not only pure science for science. Management of the Institutes also highlight the need of organisation of training for their staff on the collaboration with clients including communication, body language, dress code, behaviour, methods of presentation of science to business and sales. Lack of information management on clients, contracts and collection of lessons learnt is considered a serious problem too.

The challenge related strictly to collaboration with business is the lack of understanding of the cycle of the R&D process and its time span by the representatives of companies who expect the results 'here and now'. They also often consider Institutes which are research entities as institutions that provide their services free of charge.

Another challenge indicated by the Institutes' management is preparation for changes that are introduced by the EU regulations which usually give little time to adapt, especially with regard to production and technological changes. Hence, the Institutes' services include anticipating certain needs and indicating directions that they know will be technological problems in a given area in the near future. Institutes strive to monitor them on an ongoing basis and keep the business informed, extending the time for adjustment this way.

### Targets, effectiveness and impacts

The main objective in collaboration with business are common projects, either R&D projects or services commissioned by companies (contract research) financed by them which aim at the elaboration of new products and services that will be placed on the market. This collaboration constitutes the main source of income of the Institutes and they aim at increasing the revenues from these sources. Hence, the aim of the management of the Institutes is establishing long-term collaboration so that companies consider them their technical support able to solve their problems. It is therefore important to build a customer base, but also to increase the number of clients with whom the relations are close, based on trust, involving professional but warm relationships with decision makers in companies. The desire of Institutes' management is also the situation when companies approach them at the stage of designing, implementation of certain ideas, not when they have specific problems as at this stage companies often cannot afford such consultancy services.

On the other hand, contact with companies, with the real market, entails benefits for the Łukasiewicz too as the implementation of commercial contracts is essential to keep abreast and maintain an offer that is attractive to companies.

The managing staff of the Łukasiewicz assesses the effectiveness of their collaboration with business as good. The collaboration is systematically monitored and assessed both at the Institutes and at the level of the Network. This is done at a few levels. First, in annual reports of the Institutes and reports on utilisation of subsidies. The Centre has a system where all data about project portfolios in the Institutes is gathered. The Institutes also have defined KPIs in strategic areas including targets for collaboration with business (like sales indicators) which are monitored. Growth of income, the number of inquiries regarding the research services is a good source of knowledge on the Institutes' effectiveness. There are also statistics related to the Challenges system, Institutes' participation, submitting ideas, etc. The Centre has a good picture of the projects implemented by the Institutes and those implemented in collaboration with business. Through such analysis, development areas are defined. For instance, when a certain indicator has been exceeded, this indicates an area with good knowledge to be transferred and developed further.

Institutes also assess the collaboration themselves. On a monthly basis, they monitor the number of acquired and implemented projects and decrease or increase in the number of orders they execute for other entities. If needed, corrective or remedial actions are implemented on a regular basis. Once a year, Institutes check in their databases how many new clients have been gained. One of the methods of assessing effectiveness includes questionnaires filled in by companies' representatives after meetings where they report if they are satisfied with the information provided and propose topics to be discussed in the future. Also, projects co-financed from grants provided by public institutions contain indicators of success that have to be achieved. Regular audits of quality standards are conducted too.

However, it should be taken into account that the Network was created in 2019 so it is hard to assess the Łukasiewicz collaboration with business in longer term. E.g. under the Challenges system there is a very small percentage of projects that have been finalised now. One of those being the Łukasiewicz Accelerator program[12], where the first edition of the programme was successfully finalised in the end of 2021. The program is addressed to employees of the Łukasiewicz Research Network with the aim of supporting the commercialization of the results of scientific research. In total five winners were selected in the first edition of the program.

Another factor to be considered when assessing the effectiveness of the Łukasiewicz activities in this area is difficult external environment and lack of funds due to lack or very limited project competitions launched in 2020 and 2021. A challenge in assessing the effectiveness of this collaboration is lack of clear guidelines on how this should be done, e.g. if this is better to gain one big order from the market or rather a number of small orders when their total value is similar.

The impact of this collaboration is i.a. the increase in competitiveness and innovation of entrepreneurs as well as creation of new or maintaining job places in enterprises. As the professionalism on the side of business grows, Institutes have to ensure relevant quality standards themselves.

[12] This project aims at building the competences of Łukasiewicz's scientists, enabling the creation and management of companies as well as the development of technology and attracting investors. Employees with a business idea receive support in the area of intellectual property protection and management, modern marketing and sales.

## Development needs and priorities

The Łukasiewicz fulfils the targets set, including those set by the Ministries that oversee their activity. The Network aims at intensification of its collaboration with business. This includes increasing the number of Challenges ending up with common projects or signing contracts. Apart from the Challenges system that involves a rather demand-side approach, the Łukasiewicz also implements Łukasiewicz programmes representing a supply-side approach. On the basis of business needs, strategic areas where it is worth to undertake certain activities are identified. Then the Institutes implement projects with the aim of commercialisation through the sale of IP, licensing or creation of start-ups. These projects are financed from the targeted subsidies that are forwarded to the Institutes by the Łukasiewicz Centre.

The development needs are linked to the challenges faced and include enhancing skills in the area of preparation of EU applications, increasing awareness of the scientists on the necessity of commercialisation and communication with business. Relevant training activities could be organised at the level of the Łukasiewicz. Increasing participation in Horizon Europe constitutes a challenge and necessitates an increased recognisability of Institutes to function better at the European level. However, the Łukasiewicz representatives realise that this is a long process staggered over a period of a few years. The Institutes raise also the need for support in their marketing and sales activities that, together with funds, are needed to create their brands and market visibility. Mechanisms at the level of the Network supporting collaboration between the Institutes instead of competing with each other would be helpful too.

The Łukasiewicz representatives also suggest that the Ministries responsible for management of support programmes should take certain actions and launch the competitions in order to facilitate implementation of common science-business projects. The management of the Institutes also highlights the need to provide them with funds to conduct research called "anticipatory", i.e. research that has not yet been commissioned by any company, as they are too far from the market current needs to be profitable to invest for any company in Poland in the current market situation. National financing programs in which institutes could prepare an offer and build competences ahead of what is available on the market would therefore help a lot.

To conclude, the development priorities, rising from the current needs in the Łukasiewicz science-business, include establishing frameworks to enable closer cooperation of not only the Łukasiewicz Network Institutes with businesses, but also with other institutes within the network. Moreover, establishing communication channels with entrepreneurs and businesses and training for current employees in EU applications are seen as priorities to increase science-business collaboration at the level of the Łukasiewicz.

# 6. Conclusions and Way Forward

This report summarises the project results for task 2: "gap analyses and best practices". It provided a comprehensive review covering (i) mapping of the needs and gaps of Polish stakeholders at a contextual level and (ii) identifying best practices and developing case studies relevant for the Polish context. This section summarises key findings and shows the direction on a way forward by mapping the KT priority areas in the context of the Łukasiewicz Research Network.

Key findings are divided along the key *Knowledge Transfer areas, i.e. knowledge valorisation and exploitation, knowledge co-creation and knowledge sharing.* Way forward adapts key findings in the context of Poland. Emphasis is put on two key areas: future collaborative links that could be established between the Łukasiewicz and the public and private sector and enhance knowledge valorisation, as well as the identification of good practices about *what* and *how best practices could work in the Polish context*.

## Key Findings

As mentioned, this study strived to create two different vantage points. First, the report described a best practise analysis followed by a contextual analysis on the status quo of the knowledge transfer of the Łukasiewicz Research Network. A central element that frames the report is that it does aim to provide the Łukasiewicz Research Network with an understanding of its knowledge transfer (KT) needs and gaps and does so by also providing a best practises analysis. While the report also describes the context of the network, it is only the subsequent parts of the project that evaluate the generalisability of the findings to the Łukasiewicz Research Network.

In analysing the findings of the project, the first thing to observe is that the best practises findings are from very different innovation systems, with different type of structural issues. Highlighting issues such as the relevance of entrepreneurship or internationalisation of commercialisation are important findings but it is as clear that Poland innovation system has other structural issues that should be considered more relevant. Examples of this could be for example the overall low amount of collaboration between innovation system stakeholders, the lack of overall investment in RDI and the legal framework for intellectual property, which all create interlinked and systemic challenges for the Łukasiewicz Research Network, too. Only through deeper consultation with the Łukasiewicz Research Network representatives, can there be a better understanding on which recommendations would be most timely for the Institute and even more broadly to the Polish innovation system.

**Knowledge valorisation and exploitation** emphasises new company creation, licencing, academic entrepreneurship, commercialisation of IP as well as policy advice are at the core of the key opportunities. Continuous new company creation is in the core of renewal and success of an innovation system and harnessing innovations into marketable solutions. Currently, the Łukasiewicz Research Network faces challenges in not only providing marketable solutions to customers, but in analysing market needs and gaps. This along with bureaucratic challenges regarding IP management and licensing create gaps in commercialisation and company creation. Furthermore, different instruments and incentives to support business creation is needed, and it requires strategic capabilities and steering the activities towards

common goals in different levels of a system. To secure favourable financing conditions, the establishment of Seed or Venture Capital as well as more "traditional" financing instruments, like loans or grants are in focal role to support new company creation and to enable dynamic start-up ecosystems to emerge.

Be it in the form of accelerators, incubators or local hubs, improving the infrastructure of new companies is regarded as a driver. . Depending on the specific start-up ecosystem, the elements of hubs, accelerators or incubators can be different both in terms of the concrete offer (office space, technical infrastructure, advisory services, financing) and the model as such (part of a university's activity and/or of a policy programme or regional initiative). While there is a substantial infrastructure for such network activities in place in Poland, links between network actors and the Łukasiewicz needs to be advanced.

Intellectual property management and contract-related topics emphasises the requirement for IP management in research organisations or points of reference for partnerships between science and industry including research commercialisation. In the context of the Łukasiewicz, subsequent steps shall aim to provide guidelines and support for research commercialisation, either through recommendations and guidelines concerning IP-related questions, or through model agreements that can be used by organisations in order to commercialise their results. They help to organise knowledge valorisation, thus, to find efficient ways for bringing knowledge and technologies to market implementation.

From the perspective of policy advice, opportunities arise from the fact that knowledge transfer is a socially situated activity, therefore individuals' motivations and beliefs (action-formation mechanisms), interactions (transformational mechanisms) and their environments (situational mechanisms) are important elements in understanding this process. Here, the opportunity for the Łukasiewicz relates to the need to expand the focus on commercialisation beyond the techno-financial value and the related performance indicators, by including also those that promote quality and societal impact. This means that 'other' types of innovations can contribute to socio-economic development agendas and need more explicit recognition and capturing in impact indicators tied to university research. Within this context, the paradigm of "Responsible Research and Innovation" which also includes the "third role" of public research and universities and highlights possible contribution to solve societal challenges should be mentioned.

In addition, public procurement presents a possibility for the Łukasiewicz valorisation and exploitation. Public procurement remains an underused path, even though best practice cases present it being a good way to advance introduction and implementation of, e.g., innovative technologies, sustainable solutions, novel business and -acting models. Enhancing cooperation between the Łukasiewicz and governments at all levels could enhance Łukasiewicz's use of public procurements as a platform to boost innovation, and, at the same time, learn how to make effective innovation policy. Additional opportunities lie in following open innovation approaches by incorporating end-users and opening up policy definition to societal actors. It is essential, that public procurement is structured in interconnection with frontier topics and development schemas occurring in both national and international levels.

**Knowledge Co-Creation** includes collaborative research, consultancy, contract research and publications-oriented research. Collaborative research requires collaboration both between and among research organisations and companies. Best practices highlight that key opportunities to increase and deepen company collaboration are; 1) a customer operations department tohelp in initiating and collaborating with external partners, and act as a centralised connection function for finding new project partners; 2) a centralised knowledge transfer office to facilitate networking and matching industry with suitable researchers. The centralised KT office is useful also for companies, when they are looking for collaboration partners.

Generally, at RTO level, three main groups of drivers for collaborative research can be identified: scientific excellence, contacts to industry, and operational processes. High scientific level makes an RTO an attractive research partner for companies and other RTOs. Research groups with top researchers in their field, shown in the form of high-level publications, drive research and company collaborations. Having a good combination of business and scientific expertise in the management teams drives success. Hiring business managers who have industrial background and experience is one way of bringing contacts and industry expertise into an RTO. Persons with industrial experience will also be able to design meaningful ways of collaboration. However, the scientific lead in the RTO should be in the hands of top researchers.

In the context of the Łukasiewicz, collaboration with existing KT offices offers an interesting opportunity to increase networking with regional, national and international partners. Moreover, balancing between scientific excellency and commercial projects will need to be developed. While many institutes are recognised partners in specific fields, some focus more on "science for science". As such streamlining and creating guidelines and processes stemming from the needs of each institute shall be developed.

In addition, challenges in attracting and retaining collaboration partners remain persistent. In particular in the context of Poland, SMEs present a significant opportunity but also a challenge. In line with this, trust between partners of all sizes and types is both a prerequisite and driver for collaborative research. According to the study at hand, trust within the Łukasiewicz institutes and among SMEs needs to be enhanced to enable an environment that boosts collaboration. Here, transparency is crucial to build trust and to enhance good collaboration with customers. It is also important that experts "speak the language of the companies" – i.e. be knowledgeable of company culture, objectives, and ways of operating.

From the perspective of consultancy, the best practices show that most typical form of boosting knowledge transfer via consulting is the availability of vouchers or checks that an SME can be used for contracting consulting or research services. Terms for using the voucher vary by country, but typically, they can be used to analyse the company's products, services or processes in order to get the company started with actual research and development activities. In addition, increasing research mobility between companies and research organisations is an effective way to increase collaborative projects and contract research and consulting with industry. Yet, research mobility, both international and national remain challenge for the Łukasiewicz institutes, mainly due to financial and other structural factors, such as lack of language skills. Training and adequate professional development is crucial for successful research

mobility. Adequate training of team members who participate in industry partnerships is crucial to enable up-to-date and relevant skills. To succeed, researchers need to be flexible and committed to this type of collaborative work.

National and European strategies for technological development accelerates collaborative research. These strategies are often made for important sectors and/or to seize the opportunities in new technological developments or address grand challenges like the European Green Deal to address climate change. In the context of the Łukasiewicz, building partnerships at the national and international level should be increased. In addition, support for securing H2020 funding should be enhanced as being one channel for being able to carry out publication-oriented research. In some countries, there are national strategies and programmes for research in new areas and that way opportunity for publications. Linkages to industry and this way, to relevant research topics, is an effective way to producing publications and besides generate impactful results in the economy and society.

**Knowledge sharing** refers to informal and formal activities relating to professional development, networking and events, teaching, publications and presentations and research mobility.

Actions to increase knowledge sharing have mostly concentrated on the technological, social, economic, and political levels. The focus has been largely on boosting collaboration between research and education institutes and business sectors. These actions have been taken on government, regional or on university and business sector level.

Current gaps in knowledge sharing at the Łukasiewicz level consists of lack of international mobility, both inward and outward, difficulties in attracting and retaining young scientists as well as lack of institutionalised networking strategies. Current relationships with regional or national stakeholders are based on individual institutions' historical relations, which causes that there is a lack of renewal in collaboration partners as well as research focus in general. By enhancing these, the Łukasiewicz could increase its visibility at all levels (regional, national and international) which has several benign impacts on not only knowledge sharing, but co-creation and valorisation, too.

Yet, barriers to knowledge sharing concerned mainly research and business sector. Most barriers rise from a lack of resources, financial or human capital. Case studies indicate that sometimes barriers to knowledge sharing are seen to result from geographical boundaries or concentration of research activities to one or few key areas. Moreover, a negative political atmosphere towards migration is seen to negatively impact attracting and retaining foreign students and researchers.

Case studies indicate that drivers of knowledge sharing consist of cultural, financial, and institutional factors. Culturally, a general positive attitude towards and general awareness of benefits of learning and educations boosts knowledge sharing across the society. Financial drivers enable setting up programs and institutions that enhance knowledge sharing. Institutional factors consist of organisations, centres and other actors that are increase networking, matchmaking between research organisations and companies, and thus drive knowledge sharing.

Opportunities in knowledge sharing relates also in boosting external communications, for example via availability and usability of knowledge sharing tools such as websites and newsletters. Here an opportunity for the Łukasiewicz lies in advancing understanding and skills in using digital or online tools. This enables achieving, e.g., fluent communication, efficiency in research, and building novel co-operation cost-efficiently.

All means to promote collaboration between different actors cannot be highlighted enough. Increasing complexity, globalisation and grand challenges represent macro forces behind this scene, where needs and challenges are responded in an increasing multi-perspective and multi-professional manner. Likewise, increased collaboration and knowledge sharing is needed when improving national innovation capabilities. There, existence of research centres and networks, and research infrastructure including test beds are drivers for collaborative research aimed at impactful innovation and transition towards a digitalised, greener, and more inclusive society.

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| **AIT** | - | Ingenious partner as brand essence | PhD programme |
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# Appendix 1: On EIS Analysis

This appendix uses 21 Innovation Indicators and 11 contextual indicators where Poland shows significant gaps against the EU average (see last column in blue in the two tables below). In order to better structure the literature review and the selection of best practices from selected EU countries, we have identified the top best practice performers in the selected indicators (see cells in dark green), the second best practice performers (see cells in light green) and top peers to Poland (see cells in red). The purpose of including countries with similar challenges to those faced by Poland was mainly to learn about experiences and initiatives implemented by leading organisations in order to better manage the innovation and contextual landscapes.

## Innovation Indicators Analysis

| Innovation Indicators | Austria | Czech R. | Germany | Finland | Ireland | Netherland | Portugal | Spain | PL 2021 | PL 2020 | EU |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Foreign doctorate students | 79 % | -2 % | -37 % | 21 % | 63 % | 137 % | 57 % | -9 % | -89 % | -89 % | 118,8 |
| Product or process innovators | 36 % | -10 % | 52 % | 28 % | -6 % | -6 % | -21 % | -70 % | -85 % | -72 % | 137,05** |
| Patent applications | 58 % | -76 % | 109 % | 155 % | -43 % | 61 % | -71 % | -57 % | -85 % | -64 % | 86,8 |
| New doctorate graduates | 13 % | 13 % | 52 % | 39 % | 26 % | -13 % | 0 % | 65 % | -78 % | -87 % | 88,5 |
| Innovative SMEs collaborating | 33 % | -5 % | 25 % | 137 % | 83 % | 19 % | 41 % | -48 % | -72 % | -60 % | 146,5 |
| Venture capital | -65 % | -78 % | -19 % | 81 % | 21 % | 38 % | -26 % | 3 % | -63 % | -59 % | 168,2 |
| Lifelong learning | 39 % | -63 % | -26 % | 179 % | 18 % | 88 % | -3 % | -2 % | -61 % | -51 % | 110 |
| Most -cited publications | 10 % | 56 % | 7 % | 26 % | 17 % | 59 % | 11 % | -7 % | -56 % | -59 % | 98,3 |
| Innovative sales share | 33 % | 12 % | 32 % | 26 % | -10 % | 33 % | 6 % | 44 % | -51 % | -67 % | 86,9 |
| International co-publications | 44 % | -6 % | -8 % | 62 % | 33 % | 54 % | 20 % | -12 % | -47 % | -64 % | 131,1 |
| Knowledge-intensive services exports | -46 % | -46 % | 14 % | 20 % | 52 % | 26 % | -63 % | -72 % | -46 % | -52 % | 105,9 |
| Share Knowledge-intensive services (%)**** | -44 % | -46 % | 14 % | 20 % | 52 % | 26 % | 63 % | -72 % | -46 % | -13 % | 105,9 |
| R&D expenditure business sector | 55 % | -18 % | 52 % | 26 % | 67 % | 0 % | -51 % | -54 % | -45 % | -46 % | 111 |
| R&D expenditure public sector | 40 % | 2 % | 47 % | 138 % | -82 % | 6 % | -16 % | -35 % | -44 % | -60 % | 96,5 |
| Public-private co-publications | 119 % | 13 % | 49 % | 105 % | 73 % | 108 % | 15 % | 8 % | -37 % | -71 % | 87,9 |
| Medium and high-tech product exports | 3 % | 27 % | 26 % | -26 % | 10 % | -15 % | -36 % | -28 % | -19 % | -20 % | 109,6 |
| Enterprises providing ICT training | -13 % | 33 % | 27 % | 120 % | 47 % | 27 % | 20 % | 0 % | -13 % | -56 % | 100 |
| Trademark applications | 36 % | -21 % | 10 % | 21 % | 25 % | 14 % | 8 % | 12 % | -11 % | -32 % | 105 |
| *Marketing or organisational innovators (2020 data)* | *65 %* | *-15 %* | *44 %* | *41 %* | *57 %* | *-14 %* | *52 %* | *-33 %* | *N/A* | -100 % | N/A |
| *SMEs innovating in-house (2020 data)* | *48 %* | *10 %* | *40 %* | *95 %* | *29 %* | *32 %* | *95 %* | *-70 %* | *N/A* | -81 % | N/A* |
| *Private co-funding of public R&D expenditures (2020 data)* | *-1 %* | *-30 %* | *48 %* | *-17 %* | *-63 %* | *27 %* | *-54 %* | *-29 %* | *N/A* | -56 % | N/A*** |
| Innovation Indicators | Austria | Czechia | Germany | Finland | Ireland | Netherland: | Portugal | Spain | Total | | |
| **Primary best practice performers (by # indicators)** | 2 | 1 | 2 | **8** | 2 | 2 | 1 | 2 | 20 | | |
| **Secondary best practice performers (by # indicators)** | 9 | 1 | 6 | 5 | 7 | 9 | 2 | 0 | 39 | | |
| **# Top peers to Poland (by # indicators)** | 3 | 10 | 3 | 1 | 3 | 1 | 7 | 13 | 41 | | |

# Contextual Indicators Analysis

| Contextual Indicators | Austria | Czechia | Germany | Finland | Ireland | Netherlands | Portugal | Spain | PL2021 | PL2020 | EU |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Top R&D spending enterprise | 128 % | -92 % | 61 % | 284 % | 286 % | 85 % | -72 % | -73 % | -94 % | -95 % | 16,2 |
| Rule of law (SD)***** | 73 % | 0 % | 45 % | 82 % | 27 % | 73 % | 0 % | -9 % | -55 % | -52 % | 1,1 |
| Employment MHT manufactu | 16 % | -6 % | 14 % | 34 % | 81 % | 50 % | -35 % | -19 % | N/A | -41 % | N/A |
| GDP per capita (Thousands of | 28 % | -8 % | 23 % | 11 % | 90 % | 29 % | -21 % | -8 % | -29 % | -29 % | 30,8 |
| Share High and Medium high | 2 % | 11 % | 37 % | -2 % | -9 % | -18 % | 4 % | -16 % | -26 % | -25 % | 37,9 |
| Basic-school entrepreneurial | -17 % | n/a | 0 % | 20 % | 10 % | 70 % | -5 % | 0 % | -15 % | -18 % | 2 |
| Employment share Services (S | 3 % | -13 % | -4 % | -2 % | 13 % | 13 % | 0 % | 18 % | -15 % | -15 % | 41,2 |
| Government procurement of | -3 % | -11 % | 31 % | 11 % | 0 % | 14 % | 0 % | -9 % | -14 % | -14 % | 3,5 |
| Turnover share SMEs (SD) | 24 % | 4 % | -7 % | 8 % | -15 % | 29 % | n/a | 5 % | -7 % | -11 % | 36,5 |
| Buyer sophistication (SD) | 3 % | -19 % | 24 % | 24 % | 16 % | 22 % | 0 % | -5 % | -8 % | -8 % | 3,7 |
| Total Entrepreneurial Activity | 63 % | 9 % | -10 % | 0 % | 54 % | 63 % | 93 % | -7 % | -3 % | -2 % | 6,7 |
| Innovation Indicators | Austria | Czechia | Germany | Finland | Ireland | Netherlands | Portugal | Spain | Total | | |
| Primary best practice performers (by # indicators) | 0 | 0 | 3 | 2 | 2 | 2 | 1 | 1 | 10 | | |
| Secondary best practice performers (by # indicators) | 5 | 1 | 0 | 3 | 2 | 6 | 0 | 0 | 17 | | |
| # Top peers to Poland (by # indicators) | 1 | 6 | 3 | 1 | 1 | 1 | 4 | 6 | 23 | | |

# Appendix 2: On Critical Issues Analysis

This appendix provides some example of the 400+ critical issues (barriers, drivers, opportunities and threats) we have gathered during the first phase of the project. These issues were the result of a structured literature review supported by multi-stakeholder interviews in Poland and seven EU countries. We have analysed these critical issues to better understand the KT needs and gaps of Poland presented in this report and to provide inputs on potential insights for the Delphi survey on priorities and focus areas for the single KT strategy of the Łukasiewicz.

## On Barriers

| Critical Issue Title | Short Description of Critical Issue | Insight for Delphi Statement |
|---|---|---|
| **Central incubator programme difficult to implement in network-based research organisation** | Despite AHEAD being an internal programme, it is implemented by a special organisation (Fraunhofer Venture), which - from the viewpoint of the individual institutes and researchers - is regarded as an external unit. Thus, the challenge is to implement the programme into different institutional settings and technological contexts. Furthermore. Fraunhofer-Venture acts from one location (Munich) and therefore has a limited physcial access to the different institutes. | Institutional settings and -technological contexts establish an essential barrier for enabling new ventures to be born. |
| **IP protection** | Awareness of the need to protect IP weak, which has led to insufficient management of documents and overall management of IPs. | Awareness of the need to protect IP is weak in Polish companies, which shows in insufficient management of documents and overall IPR management. |
| **Reason for low funding is dependence of EU Structural Funds** | One of the reasons for low KT activities between universities and business is the dependence of project funding deriving mainly from EU Structural Funds | Universities and business depend too much on EU Structural Funds for project funding. |
| **Science-Industry gap** | Reason for low level of innovativeness: – very **high number of SMEs**;<br>– **unequal territorial distribution** (innovative companies are concentrated in Catalonia, Madrid, and Basque Country);<br>– **shortage of university-firm interface mechanism**s;<br>– **absence of a collaborative culture with firms**, due to the **linear vision of knowledge transfer** on behalf of scientists in the public sector;<br>– mutual **climate of distrust**, especially by academics, who favour the re-production of this social and cultural gap. | There is some lack of trust between academia and industry, that prohibits more intensive co-operation to occur |
| **Lack of commercialisation knowledge in research teams** | Academic research teams with inventions do not have the knowledge needed for commercialising their invention. | Most academic research teams with inventions do not have the knowledge needed for commercialising their invention. |
| **SMEs' perception of IPR (2018)** | Six representative executives or HRM managers from technology driven SMEs in Finland were interviewed by using semi-structured interviews. | IPR management should be seen as a core and mission-critical process for growth aspiring SMEs |

| | | |
|---|---|---|
| | IPR knowledge base in firms is often key person centric and the recognition of IPR is not made explicit in the company. The management of IPR is not aligned with the business practises, and the shortage of resources can lead to the outsourcing of strategically important activities, such as IPR processes or sales. It can be claimed that IPR management should be seen as a core and mission-critical process for growth aspiring SMEs. Value of knowledge and intellectual capital is recognised relatively well in the firms, but there are many practical challenges that the managers are facing. Firstly, too often the value of IPR is evaluated only from the conventional (patenting) perspective, and secondly, the optimal value creation level and value capture is not achieved mostly due to the scarce resources available | |
| **Social and personal mechanisms drive (2021)** | Generative Mechanisms for Scientific Knowledge Transfer in the Food Industry (2021) sharing. **Knowledge transfer is a socially situated** activity, therefore individuals' motivations and beliefs (action-formation mechanisms), interactions (transformational mechanisms) and their environments (situational mechanisms) are important elements in understanding this process. | Researchers' motivations and beliefs are sufficiently taken into consideration when planning knowledge transfer strategies. |
| **Companies who participate in Orainn may not have any prior experience in R&D** | Companies often do not have any prior experience in R&D, and there is no easy availability of public money to launch projects. This may hinder companies' interest to join consultancy projects because they do not see value for their operations. | Local level SMEs have great interest in developing internal capacities for R&D through consultancy services. |
| **Number of top 10% cited publication remains low because of lack of funding and skills** | " The country underperforms given its level of public R&D investment (Graph 3.4.6). Even in scientific areas where the country has historically been specialised (27) the performance is subpar. | Lack of long-term funding restrain Polish researchers to write journal articles that reach the top 10% cited publications. |
| **Number of top 10% cited publication remains low because of lack of funding and skills** | " The country underperforms given its level of public R&D investment (Graph 3.4.6). Even in scientific areas where the country has historically been specialised (27) the performance is subpar. | Lack of technical skills restrain Polish researchers to write journal articles that reach the top 10% cited publications. |
| **Fluctuation in public funding** | Level of public R&D financing varies a lot depending on the economic cycle (absence of political agreement on R&D). | The level of public R&D financing varies too much depending on the economic cycle. |
| **Language barriers in projects can halt smooth and dynamic cooperation** | In large projects, language barriers can halt cooperation. As such, participants need to be able to communicate in common language for collaboration to be smooth and effective. | Language barriers prevent knowledge sharing in international research consortia, such as H2020 projects. |
| **Lack of staff with expertise in project management biggest barrier for SME in-house innovation** | Paper studies differences in SMEs capabilities to innovate based on their project management capabilities. Paper finds that project driven companies innovate much more than non-project driven companies. Paper finds that lack of skilled employees is most limiting factor in innovation in manufacturing industries. Second one is governmental and bureaucratic restrictions and third lack of finance. | Research institutes should support internationalisation through multiple actions, such as supporting foreign internships and mobility, networking to obtain contacts for project preparation, host experienced foreign researchers, give presentations at international conferences, and support learning English. |

## On Drivers

| Critical Issue Title | Short Description of Critical Issue | Insight for Delphi Statement |
|---|---|---|
| **Purpose-driven startups** | "Purpose-driven" companies are companies that are focused on making a positive impact through business activities that align with the "core sustainable impact" or "sustainable development goals" set by the United Nations. A substantially larger share of purpose-driven companies has been funded in Finland and the Nordics than in the rest of Europe over the last 10 years. 16% of Finnish and 17% of Nordic startups have been purpose-driven companies, while only 6% of European startups have been purpose-driven. It seems that purpose-driven companies are "doing well by doing good" in terms of VC funding. Across all geographies, we found that purpose-driven companies are able to raise more funding on average compared to non-purpose-driven. | Innovation should be encouraged to align with the "core sustainable impact" or "sustainable development goals" set by the United Nations. |
| **National startup accelerator programme** | Three national programmes: Accelerator, Pre-Accelerator and Master Class. Locally embedded across Ireland's ecosystem, partnering with best-in-class innovation hubs across the regions of Ireland. Hubs in Cork, Galway, Kerry and Dublin interact with other local hubs, universities and incubator to bring greater access to entrepreneurial support to every county in Ireland. | National programmes, like Pre-Accelerator, Accelerator and Master Class, should be set up to help start-ups to scale-up. |
| **Innovatiekrediet** | Innovatiekrediet is an instrument used to support TNO spin-offs. <Funded by the Netherlands Enterprise Agency (RVO). RVO is involved in policy delivery of instruments originating from the Dutch Ministry of Economic Affairs and Climate | A policy instrument used to support RTO spin-off finance is needed to boost company creation and licensing. |
| **KTI Knowledge Transfer Ireland** | Knowledge Transfer Ireland is Ireland's central point of reference for industry-academia partnership and research commercialization. They work with business, investors, research funders and TTOs to review, recommend and implement changes to the way in which Ireland approaches managing IP and contracting. They gather information about available technologies to commercialise and offer support and guidelines as to how to go about with the process. | A central platform is needed for business, investors, research funders and TTOs to review, recommend and implement changes to the way in which Poland approaches managing IP and contracting. |
| **Technology transfer offices important in innovation life cycle** | According to the paper TTOs in PT play an important role in innovation life cycle. They speed up transfer of knowledge and technology to the society and they are seen to strengthen universities' entrepreneurial role | Poland's technology transfer offices could play an important role in strengthening universities entrepreneurial role. |
| **Basic school entrepreneurial education** | NL has a specific budget at national level for the development and implementation of entrepreneurship education more generally. | A national level budget for the development and implementation of entrepreneurship education is needed. |
| **Research to Business funding** | Research to Business funding from Business Finland is intended for public research groups and researchers in public research organizations, who want to build new business based on their research and make it real by commercializing their idea. | There should be a special form of funding to support commercializing research results after a successful research project. |
| **Innovation Attaché Network** | Innovation attachés are based at Dutch embassies and consulates. They assist Dutch companies doing business | Innovation attachés based at embassies and consulates could boost knowledge valorisation |

| | | |
|---|---|---|
| | abroad. For instance, by introducing them to potential partners, like research institutions or other companies. | by introducing foreign companies to potential domestic partners, like research institutions. |
| **Specialization in ICT and logistics drive employment in services** | NLs geographical location and early specialization in ICT and logistics have driven strong service sector development. Now 40% value added from ICT + logistics | Poland should place priority to help commercializing such innovations that are in line with its comparative advantages (e.g. geographical location, export sector). |
| **Consulting services for foreign investors** | Helsinki Business Hub is the international trade and investment promotion agency for the capital of Finland. They help foreign companies to set up business, grow, and develop in Helsinki. Their activities focus especially on (but not limited to) the following fields:<br>- Information and communication technology, with special focus on software development, industrial internet, and digital infrastructure<br>- Health, with special focus on personalized health & med tech<br>- Smart & clean technologies, with special focus on smart buildings and smart mobility<br>- Hotel investments | Promotion agencies are needed to attract foreign investments. |
| **Institutional funding of Fraunhofer-Society for applied sciences** | The Fraunhofer-Gesellschaft is the world's leading applied research organization. With its focus on developing key technologies that are vital for the future and enabling the commercial exploitation of this work by business and industry, Fraunhofer plays a central role in the innovation process. FhG currently operates 75 institutes and research institutions throughout Germany. Institutional funding of the Fraunhofer Society (about 30% of the total budget) originates from the Federal Government (90%) and the German Federal States (10%). About 70% of Fraunhofer's budget results from contract research. | At least 30% of total budget should originate from government funding. |
| **Top Sector Human Capital mapping** | Top sectors have drawn up human capital agendas, describing how demand for and supply of skilled workers will develop in the years ahead | Improved foresight capabilities are needed to create understanding on qualifications of human capital in future. |

## On Opportunities

| Critical Issue Title | Short Description of Critical Issue | Insight for Delphi Statement |
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| **Not only to use narrow measures to knowledge transfer from universities to companies.** | Our findings suggest that there is wide-ranging prevalence of the Schumpeterian model of innovation at universities that has a narrow focus on commercialisation for profit generation. 'Other types of innovation, such as social innovation, that emphasize on multiple bottom lines needs pronounced attention. These 'other' types of innovations can contribute to socio-economic development agendas and need more explicit recognition and capturing in impact indicators tied to university research. (The new inclusive role of university technology transfer: Setting an agenda for further research, 2021) | Innovation commercialisation focuses too much on profit generation and does not take into account other types of innovations, such as social innovation and impacts. |
| **Remove obstacles relating to investing in venture capital funds.** | There are currently limitations as to how foundations and retirement funds can place funds in venture capital funds. This is a proposal made by Finnish Venture Capital Association. | Foundations and retirement funds should be allowed to place funds in venture capital funds. |
| **Academic-industry knowledge transfer in life sciences (2016)** | A systematic analysis and synthesis of 135 articles published between 1980 and 2014. One of their recommendation also applies to national and EU policy makers, who should expand the existing list of knowledge transfer performance indicators by including also those that promote quality and not merely the number of outputs, such as new patents, licensing agreements and generated spin-offs. Policies at academic institutions must therefore not promote unconditional commercialization; exactly the opposite, they should carefully consider the scientific interests of academic researchers and characteristics of inventions before proceeding to the contractual relationships with the business sector. | Knowledge transfer indicators should put more emphasis on the quality and not only on quantity. |
| **Academic-industry knowledge transfer in life sciences (2016)** | A systematic analysis and synthesis of 135 articles published between 1980 and 2014. One of their recommendation also applies to national and EU policy makers, who should expand the existing list of knowledge transfer performance indicators by including also those that promote quality and not merely the number of outputs, such as new patents, licensing agreements and generated spin-offs. Policies at academic institutions must therefore not promote unconditional commercialization; exactly the opposite, they should carefully consider the scientific interests of academic researchers and characteristics of inventions before proceeding to the contractual relationships with the business sector. | Knowledge transfer indicators should put more emphasis on the quality and not only on quantity. |
| **Intensive research mobility periods require flexibility and commitment from researchers** | As part of the Orainn programme, researchers are sent to intensive projects in industries. This can be sometimes quite different from general RTO work, and as such it is an important success factor to enable smooth collaboration. Orainn projects are also highly demanding and require a lot of personal effort from experts. The working pace is fast, and clients require results for satisfaction. As such commitment of own employees is crucial. | Commitment and flexibility of workers enable Łukasiewicz Research Network institutes to undertake intensive consultancy services |

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| **Industry collaboration projects can nurture long-term partnerships** | Projects can result in long-term relationship with companies which boosts collaboration in innovative projects. During the assignments in companies, experts identify further opportunities for collaboration based on companies needs and gaps. Focus is on targeting relevant, not interesting projects, which is crucial when initiating joint projects with companies when there are no public resources available. | The Łukasiewicz Research Network institutes do have many long-term relationships with companies. |
| **National strategy Industry 4.0** | National strategy Industry 4.0. (special focus on car part and textile industries) | National priorities and educational programmes are aligned and support innovations in national key sectors. |
| **Technology classroom** | University of the Basque Country (UPV/EHU) and the TECNALIA have set up a Technology Classroom that will be used to carry out undergraduate dissertation projects, master's dissertation projects and doctoral theses co-directed by TECNALIA staff, as well as training in entrepreneurship, among other activities. | Universities or a specific university and technology centers should make long-term co-operation related to students' master's and doctoral theses. |
| **SFI Industry Fellowship programmes are important for networking and research mobility** | The fellowship programme is important for the development of industry ecosystem in Ireland. It attracts researchers to industry and creates linkages between industry and academia. It also attracts new foreign companies to Ireland. Moreover, the programme is important for internal skills development and industry knowledge. | An industry fellowship programme is a good way to boost research mobility and increase networking with businesses. |
| **Retaining international doctorate graduates** | Since 2013, the government has implemented a project "Fast Track Prodecure for Granting Residence Permints to Foreigners - Foreign Students from Third Countries" to ease the arrival of foreign students into CZ. Under this scheme students are issued a long-term visa or long-term residence permit for study in an accelerated procedure | More actions should be conducted to increase Poland's attractiveness for foreign students and researchers. |

## On Threats

| Critical Issue Title | Short Description of Critical Issue | Insight for Delphi Statement |
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| **National economy dependency on MNCs make domestic strategic decision-making weak - leads to less patent applications in companies** | As the CZ economy depends on MNCs, most strategic decisions w.r.t. future direction are implemented outside of the CZ. While significant space for innovation applicable in traditional fields, the domestic SMEs have significantly lower export capability. Moreover, this impacts innovation and R&D as most decisions taken outside the country. According to the paper, this leads to the fact that patents, innovation and technology transfer are key issues for the CZ as an open economy | Strong presence of multinational companies impacts domestic strategic decision-making and keep the patenting activity low. |
| **Heavy increase in prioritising knowledge valorisation risks diverting attention of top research away from research frontier** | The high increase in prioritising knowledge valorisation can risk diverting attention away from top research universities away from the research frontier, which can threaten their strong international positions and capabilities. | Universities should be steered towards novel research frontiers by increasing their specialization and experimental work |
| **Concerns over UAS teaching quality and drop-out rates** | There are increasing concerns over teaching quality and drop-out rates in Universities of Applied Sciences. | Bad teaching quality in Universities of Applied Science leads to high drop out. |
| **Too narrow focus when evaluating innovation potential.** | Companies have a too narrow focus on the impact potential when making their decisions on which innovations to develop further. An innovation may have significant impact on other companies and society in addition to its direct impact on the own company. | Companies often have a too narrow focus when making their decisions on which innovations to develop further. An innovation may have significant impact on other companies and society in addition to its direct impact on the own company. |
| **Little exports to emerging markets may halt NLs export sectors in the future** | NL exports relatively little to emerging markets (5% compared to DE & SE 10%). This might imply difficulties in sustaining future export growth if not changed, as traditional destination markets lose weight in overall world demand. | Relatively low shares of exports to emerging markets poses a threat to economic growth. |
| **Research funding structure - drop in open "curiosity driven research"** | There has been a significant drop in successful curiosity driven research calls | Lack of funding for curiosity driven research threatens the whole innovation system. |
| **Innovation policy in Portugal is nationally coordinated and no regional innovation policies are formulated** | As Portugal's innovation policies are nationally coordinated, there is a lack of regional innovation policy formulation. According to the paper this promotes increasing disparities among the Portuguese regions. This has negative impacts on patent activity, networking and business sector R&D expenditure. | Too strong national coordination of innovation policy can halt development of regionally expertise innovation activities. |
| **Tertiary education has challenges in maintaining quality and responding to labour market need** | While NL has highly educated workforce, tertiary education faces challenges in maintaining quality and in responding to emerging labour market needs | Education and research sector's inability to keep track of on-going labour market trends poses a threat to access quality and relevant education |
| **Concerns over UAS teaching quality and drop-out rates** | There are increasing concerns over teaching quality and drop-out rates in Universities of Applied Sciences. | Dropout rates in Universities of Applied Science is a concern for future viability of innovation activities. |

## On Actions

| Critical Issue Title | Short Description of Critical Issue | Insight for Delphi Statement |
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| **A common incubator platform in research network organization** | Fraunhofer has established a central platform between the Fraunhofer-Gesellschaft and the national and international entrepreneurship ecosystems to boost knowledge valorization exploitation. The Ahead program aims to intensify the previous spin-off activities of the Fraunhofer Group and take them to the next level. In detail, the company builder AHEAD basically promotes entrepreneurship and engagement in new ventures, puts a clear focus on transfer (suitability of idea as basis for spin-off, potential customers, relevant market), R&D funding only to a limited extent (here other (internal) programs are relevant)and adapts it to contract research at Fraunhofer: Creation of freedom for Fraunhofer scientists: to pursue a transfer / start-up idea, e.g. carrying out market research, drawing up a business plan, etc. | In boosting new ventures, the most crucial issue would be to support development of spin-off activities within RTOs |
| **Centralised database of VC investors for startup** | Website gathers VC investors for different stages of startups | All venture capital investors should be gathered in one database / website to promote and boost networking. |
| **Start-up support of Austria Wirtschaftsservice Gesellschaft mbH, the promotional bank of the Austrian federal government** | aws offers a broad spectrum of support for preparing self-employment, setting up a business and expanding it. Among them are aws Preseed to support deep tech companies in the pre-foundation phase, aws Creative Impact that supports innovative prototypes and first applications in the frame of digitalization, design, architecture, and/or audiovision, and aws First Incubator that supports young, innovative people towards their first own company (with entrepreneurial spirit, guidance, resources, coaching, financial support and expert network). The programme line "Setting up a business" adds aws Guarantee (bank security), aws erp-Loan (to enable investments for setting up a company, modernising, growth and innovation), aws Seedfinancing (to bridge financing gaps of innovative start-ups), aws Equity (to support start-ups with venture capital), aws Protecting innovation (for developing IP strategy), aws Digitalization (to enable digital change), aws Energy&Climate (to introduce energy management and build up energy know-how), aws Growth Investment (to realise growth and innovation in order to strengthen the company's market position), aws Processing of Agricultural Products (prooting SME, agricultural farms and cooperations), aws Starting a business in rural areas (to support small technologically innovative enterprises that create added value in their regions). | There should be a centralized start-up support service for all the stages from setting up a company to IPR protection, and financing. |

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| **Research Studios Austria** | The Research Studios Austria programme promotes the application and implementation of results from pre-industrial research, thus strengthening collaboration between Austrian science and industry. Research Studios Austria are small and flexible research units that are usually affiliated to existing institutions. RSA may be established alone or in collaboration with a partner with the aim to translate research results into marketable products and services in a short period of time. The programme is part of the Cooperation and Innovation Initiative of Austria's Research Promotion Agency FFG structural programmes. Research Studios support networking activities and help to overcome structural bottlenecks and weaknesses and adapt existing structures to new challenges on a continuous basis. This approach is designed to enhance the competitiveness and innovative strength of companies in the long term. The target groups include universities, universities of applied sciences and their transfer offices, cooperative and non-university research institutions, Research Studios as independent legal entities (spin-offs). | Establishing small and flexible research units, usually affiliated to existing institutions, should be funded to translate research results into marketable products and services in a short period of time. |
| **TNO Technology Cluster** | "TNO Technology Cluster is a project in which existing TNO knowledge is transferred to a group of at least five SMEs. As a result of a Technology Cluster, it becomes clear whether the technology is suitable to be used and which steps are to be taken by the entrepreneur." | Establishing technology clusters which consist of Łukasiewicz and SMEs could help to identify business needs and commercialisation potential of technological innovations |
| **Innovation Strategy of the Czech Republic 2019–2030 aim to increase public procurement of innovative technolog** | Via the framework of the Public Procurement Act, the Czech government aims to prepare a methodology sheet to take into account best value to enable public procurement system to purchase of innovative technologies | The Polish government needs to define a framework and methodology of how to enable the public procurement system to purchase of innovative technologies. |
| **FFG Patent.Scheck** | With the help of PATENT.SCHECK, experts from a patent office will research the current state of the art with the company and sound out your further options. The programme targets SMEs, new technical or scientific innovation ideas, and can be used once a year. The funding enables to pay for additional services such as patent registration and patent monitoring (optional phase 2), from which FFG assumes up to 80 %. Small and medium-sized enterprises (SMEs), start-ups and enterprises in the process of being established can apply for this funding on an ongoing basis and without any subject restrictions. | There should be a service for SMEs to consult them in patenting. |

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| **EIC Accelerator - funding for the development of prototypes to market maturity** | This programme addresses small and medium-sized enterprises (SMEs) that have the potential for strong growth by implementing an innovative idea. The company must submit alone but can be supported by others in the implementation of the project. The programme covers implementation of all innovation activities of a business plan to a market-ready product/service and subsequent scale-up of the company. The project can be research based but may also focus on other issues such as business models. The projects are primarily about implementation. | There should be a national or regional service that helps companies and organizations with new technical or scientific innovation ideas to commercialize them. |
| **Attracting and retaining foreign students** | To attract more students, the admission systems for international students have been designed to be facilitating and service providing | University admission system for international students' needs to be redesigned towards service-oriented approach to attract more foreign students |
| **Tecnalia's knowledge co-creation programme Orainn boosts collaboration with industry** | The programme has resulted in increasing collaborative projects with industry. As part of the project, Tecnalia's researchers are sent to part-taking industries as employees. the projects, Tecnalia's experts map and recognise gaps in innovation capacities in customer companies. This has led to increasing collaboration with SMEs in a broader sense. Tecnalia provides, for example, technological and technical expertise to companies. The projects have increased SMEs innovation and R&D capacities. This has also impacted positively on their competitiveness in markets. Number of Orainn contracts has increased substantially, being financially very positive to Tecnalia. | A co-creation programme focusing on increasing research mobility to SMEs is a feasible strategy to boost local R&D activities. |

# Appendix 3: On EU Best Practices

## Best practices from VTT (Finland)

### VTT (FI): VTT LaunchPad

| KT Area: | Knowledge valorisation |
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| **Description of activity:** | Operating since 2019, VTT LaunchPad is an in-house business incubator that aims at creating fundable spin-off companies built on technologies developed by the researchers working at VTT Technical Research Centre of Finland. In order to enter VTT LaunchPad, the business idea must 1) be based VTT's IPR that can be spun off, 2) show market potential and be scalable, 3) benefit society and the customer, 4) be built on a demonstrated technology and 5) be run by a team that evolve into a fundable spin-off venture. Through VTT LaunchPad, VTT is a pre-startup and startup phase investor. VTT LaunchPad funding is used for exploration of commercialization paths and execution of predefined customer-centred activities for a one-year period utilizing the Lean Startup methods. VTT may also co-invest into the new company. This co-investment usually comprises the IPR developed and other assets valued at the market value. In comparison to other pre-seed funding instruments, the added value of VTT LaunchPad is its focus on entrepreneurial competence development. The research team participating in the VTT LaunchPad activities is complemented with an external business expert, such as a former CEO of a spin-off company, and the whole team participates in a team development programme with shared and individual development targets. In addition to funding and team development, VTT LaunchPad offers active IPR development, facilitation of contacts with investors, partners and mentors, as well as entrepreneurship training. In addition to the continuous internal call, workshops are arranged for collecting new business ideas at early stages and additional support is provided for applying public funding for commercialization activities. |
| **Objectives:** | The objective of VTT LaunchPad is to develop fundable spin-off ventures with great impact while creating value out of VTT-owned IPR by investing it into growth companies. |
| **Sector(s):** | Multisectoral. |
| **Time span:** | VTT LaunchPad was launched in 2019. The typical time span of VTT LaunchPad project is 1-2 years. VTT offers funding only for a one-year period. |
| **Resources (person years/budget):** | The incubator activities of VTT LaunchPad are run by a manager, a senior specialist and an IPR manager. For each VTT LaunchPad project, there is internal VTT funding available up to one FTE. In addition, the project may apply for external funding from Business Finland. |
| **Management/ coordination:** | Before a VTT LaunchPad project is launched, the line managers of VTT's business areas have approval over participating research personnel and IPR issues. The manager of VTT LaunchPad is a direct subordinate to the CEO of VTT. |
| **Support activities:** | VTT's IPR unit provides IPR management support, such as novelty and patent landscape studies. The legal affairs of VTT provides help in contracts. VTT's HR services provides support in team trainings and recruitments. The heads of business development who work in different business areas of VTT provide business management support, especially during the early stages of VTT LaunchPad projects. Market analyses are conducted either in-house or by utilizing external service providers as needed. |
| **Results/impact (measurable):** | VTT LaunchPad activities are monitored and assessed on the basis of external equity investments invested in spin-off companies. So far, two spin-off companies have finalized their first investments rounds. |
| **Success factors:** | ○ The core idea of VTT LaunchPad is its focus on entrepreneurial competence development. This is greatly enhanced by utilizing the Lean Startup methods (advocated by Eric Ries), including fast cycles of testing and piloting.<br>○ The recruitment of external business experts to teams in addition to researchers. |
| **Barriers:** | ○ The researchers who are capable to develop promising business ideas are, in many cases, valuable researchers whose commitment to the VTT LaunchPad activities may cause short-term lack of personnel resources in other research projects. |
| **Lessons learned:** | ○ The startup activities call for operational autonomy and the level of project bureaucracy should be kept minimal in order to support these activities in the most effective way. |
| **Further information:** | https://www.vttresearch.com/fi/vtt-launchpad |

## VTT (FI): Shared Benefit project model

| KT Area: | Knowledge co-creation |
|---|---|
| **Description of activity:** | The Shared Benefit (SB) project model is a joint funding activity, which brings together VTT and at least 3 business partners to innovate and research on a shared topic. There are no external financiers involved but all the funding of SB projects is provided by VTT and participating companies. This activity was launched as a proactive measure by VTT in 2017 when external funding structures for jointly funded research changed in Finland, and many business collaborations were inclined to stop. VTT initiated the SB project model for enabling the continuation of application-driven projects that are of core interest to VTT and its partner companies. In general, the SB project model requires 70% of business funding, while a maximum of 30% of funding is provided by VTT (government grant). |
| **Objectives:** | The SB projects are used as a tool to pool funding and continue or initiate application-driven projects, which require large resources while no other public funding resources are available. The objectives of each SB project are aligned according to VTT's core strategy and the needs and interests of the participating companies. VTT is the owner of the IPR created while research results are made public in most cases. |
| **Sector(s):** | Multi-sectoral. |
| **Time span:** | The SB project model was initiated by VTT in 2017. A typical SB project time span is 6-12 months. |
| **Resources (person years/budget):** | The resources and personnel needed vary according to the project needs. The typical SB project size is 100k-500k €. The participating companies pay a participation fee or contribute to the project via in-kind contributions, e.g. facilities, materials or work. |
| **Management/ coordination:** | VTT is main the main coordinator of the SB projects and allocates at least one project coordinator and necessary project personnel to the project. Each participating company has at least one member in the project steering group. Project progress is monitored in the steering group meetings. |
| **Support activities:** | VTT's customer operations unit and legal department provides support to the SB project in two ways. First, the customer operations unit helps in finding suitable project partners. Second, the legal department aids in drafting the project contracts and solving IPR questions when needed. VTT's standard project management tools and procedures are in use. |
| **Results/impact (measurable):** | The results of the SB projects are concrete technologies or innovations serving the needs of the participating companies. The results are mostly public, and related publications are actively disseminated e.g. via blog posts or scientific articles. The ownership of research results, reports, inventions or IPR remain with the creator, VTT. The financial or in-kind contributions of participating companies do not create ownership over the results. Companies have a right to use the final report and published results. They have also a right to negotiate on the user rights to the results, but not the ownership. |
| **Success factors:** | ○ Coordination: Weekly meetings with the business partners are crucial for successful communication, knowledge sharing and progress monitoring of the research work. These meetings function as a binding element, which boosts commitment to the project.<br>○ For the project management, VTT's horizontal organization and management culture are important. It enables smooth working atmosphere and is a key success factor for effective project realization.<br>○ Project partners' motivation and engagement in projects increase if the subject matter addresses their needs.<br>○ The flexibility of the SB project model in many regards (e.g. the possibility of in-kind funding by project partners) is useful for VTT and project partners. |
| **Barriers:** | ○ Trust: The conflicting business interest of partner firms might create trust issues and hinder their participation and trust towards the SB project. |
| **Lessons learned:** | ○ When initiating a SB project, legal support is crucial, especially in case of project contracts and IPR issues. Also, the presence VTT's in-house sectoral experts is important for the projects to be attractive and meaningful for the companies to join.<br>○ The SB project model has proved its usefulness in situations when other funding opportunities are limited. |
| **Further information:** | For an example of a shared benefit project, see:<br>https://cris.vtt.fi/en/projects/multimodaalisen-joukkoliikenteen-digitaalinen-infrastruktuuri |

## VTT (FI): Online communications platforms for industry information sharing

| KT Area: | Knowledge sharing |
|---|---|
| **Description of activity:** | When more than fifty companies are participating in an industrial research project, traditional communications tools are not sufficient for effective communications and information sharing activities. In order to overcome this challenge, VTT has introduced online communications platforms for jointly-funded research projects. Via these online platforms, the partner firms can learn about the upcoming project activities, such as test runs, in a detailed and timely manner, which helps the firms to participate in and contribute to the project activities. Lately, the use of online tools has been upscaled at increasing pace at VTT due to COVID-19. Microsoft Teams is used as the main software platform for the project level communications activities (e.g. for meetings, material folders and information sharing), and, especially, Microsoft Teams' activity cards are used for disseminating information on project steps and progress in details. |
| **Objectives:** | By using customized online platforms, VTT enhances its cooperation and knowledge sharing activities with partner companies. The broader objective is to develop, up-scale, demonstrate and valorize VTT's innovations and technological advancements in industry collaboration. |
| **Sector(s):** | Multi-sectoral. |
| **Time span:** | The average project time span is 3-5 years. The online platforms are used throughout the project time span. |
| **Resources (person years/budget):** | The use of online platforms and related IT support is included in the overhead costs of jointly-funded research projects. The typical budget of industrial research project with wide industry participation is 2-3 € million. |
| **Management/ coordination:** | VTT as the project coordinator is responsible for overall management and coordination of online communications platforms in jointly-funded research projects. The projects are divided into work packages, and each work package leader who is usually a senior expert is responsible for communications activities of his or her work package. |
| **Support activities:** | VTT's IT support helps VTT researchers and partners in use and access of online platforms. |
| **Results/impact (measurable):** | According to the project coordinators, the online communications platforms have greatly enhanced information sharing activities with industry during the jointly-funded research projects. They are also used for impact assessment purposes. The Teams Forms questionnaire directed to the companies is disseminated in the project steering group meetings every 3 months. The questionnaire aims to understand if and how companies have commercialized research outputs, continued their internal development work etc. Questionnaires are usually generic and do not ask precise questions about product development for the sake of IPR protection. |
| **Success factors:** | ○ Microsoft Teams Planner as a project management, time management and information board has been useful in disseminating information, engaging participation, and organizing events and meetings with the industry. In Teams Planner, each task is described with respective person in charge and schedule included. This enables partner firms to foresee upcoming tasks and to indicate their interest to contribute to an activity or share knowledge and resources. |
| **Barriers:** | ○ Intellectual property rights can hinder information sharing activities. Especially, the presence of competitors can be a barrier as it can be difficult to engage and involve corporations that see each other as competitors. Sometimes, companies do not want to disclose information and rather observe others than contribute to the project.<br>○ Barriers relate to how to engage and involve new firms into the projects. This has been slightly more difficult during the COVID-19 pandemic, as organizing large in-person meetings is not possible. |
| **Lessons learned:** | ○ Microsoft Teams Planner has played a key role as an online communication platform due to its customizability. It has been used for disseminating information, organizing meetings and as a tool to engage project partners.<br>○ Teams Planner was used for organizing "Result online session" - a one-hour webinar where the project coordinator regularly informs participating companies about progress and results of the project. Webinars include lecture and Questions & Answers (Q&A) parts, and are used for networking purposes.<br>○ In large projects, language barriers can halt cooperation. As such, participants need to be able to communicate in common language for collaboration to be smooth and effective.<br>○ Trust is important factor among companies. Internal code of conduct is very important in maintaining and creating conditions for fruitful collaboration. Project communications has to focus on disseminating generic research results in order to avoid IPR issues. Also, attention must be given to the GDPR issues. When maintaining a list of email addresses, a consent has to be asked from each partner on the list. |
| **Further information:** | For an example of a jointly-funded research project with wide industry participation, see: https://www.vttresearch.com/en/news-and-ideas/vtt-and-over-50-companies-cooperate-reduce-need-plastics-using-natural-fibres |

## Best practices from FRAUNHOFER (Germany)

### Fraunhofer-Gesellschaft (DE): AHEAD programme

| KT Area: | Knowledge valorisation |
|---|---|
| **Description of activity:** | AHEAD is an internal technology transfer programme that focuses on the transfer of Fraunhofer technologies and promotion of start-ups. AHEAD is run by Fraunhofer Venture that is a dedicated department founded in 2001 with the purpose of providing comprehensive support for Fraunhofer spin-off projects. AHEAD acts as a venture building programme that actively promotes Fraunhofer spin-offs and supports innovative projects participated by researchers and entrepreneurs. The programme gives spin-off projects the opportunity to become market- and investment-ready within a maximum of two years. Each team receives support in terms of funding, training, networking and business intelligence support as needed. The key features of the AHEAD programme:<br>1) Entrepreneurs first: Sophisticated team building and development mechanisms are used for identifying entrepreneurs inside and outside of Fraunhofer, help them to build a team and develop it to high-performance.<br>2) Focus and simplification: By creating one single brand and programme, a more effective marketing inside and outside of Fraunhofer is enabled, in addition to synergy benefits.<br>3) Need-based programme structure: The programme structure reacts according to the needs of the projects via on-demand workshops, coaching, network, etc.<br>4) Market interaction: Market interaction of the projects is fostered from day one, including customer interviews, co-creation and testing activities.<br>5) Transparent deals: Standardized term sheets are provided and the conditions related to shareholdings are standardized to a large extent. |
| **Objectives:** | The objective of the AHEAD programme is to promote technology transfer, entrepreneurship and engagement in new ventures, and, thus, act as a central platform between the Fraunhofer-Gesellschaft and the national and international entrepreneurship ecosystems. |
| **Sector(s):** | Multisectoral. |
| **Time span:** | AHEAD started in January 2019 as a pilot measure. The time span of a spin-off project funded under AHEAD is up to two years. |
| **Resources (person years/budget):** | The programme has an annual budget of € 9 million. The programme support is provided in the form of grants, starting at € 50 000. |
| **Management/ coordination:** | The management of AHEAD is taken over by Fraunhofer Venture, which is an independent department located within the headquarters of the Fraunhofer-Gesellschaft in Munich. |
| **Support activities:** | The spin-off teams get support in the form of team, business, product and IP-strategy workshops and individual coaching sessions. They also get access to support network, including Fraunhofer Venture and the Fraunhofer Technologie Transfer Fonds. |
| **Results/impact (measurable):** | AHEAD has not been evaluated yet. The impact of AHEAD is measured by the number and development of start-ups their impact on other companies and Fraunhofer itself. |
| **Success factors:** | ○ Fraunhofer Venture supports the spin-off teams legally and financially while their home institutes give support in terms of technology.<br>○ External coaches provide information about the environment, including investment opportunities.<br>○ A clear set of criteria and close advisory services are in place. |
| **Barriers:** | ○ Despite AHEAD being an internal programme, it is implemented by a special department, Fraunhofer Venture, which - from the viewpoint of the individual institutes and researchers - is regarded as an external unit. Thus, the challenge is to adapt the programme into different institutional settings and technological contexts.<br>○ Fraunhofer Venture operates in one location (Munich), and, therefore, it has limited access to the institutes in other areas. |
| **Lessons learned:** | ○ By applying for AHEAD, a team can get access to the whole word of spin-off support with one application. Business, product and IP strategy development is supported in combination with project financing and networking services. |
| **Further information:** | https://www.ahead.fraunhofer.de/en.html |

## Fraunhofer-Gesellschaft (DE): Contract research model

| KT Area: | Knowledge co-creation |
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| **Description of activity:** | Fraunhofer Gesellschaft is a non-university research organisations that focuses on application-oriented research for immediate benefit to the economy and society. The high level of application orientation is achieved through various channels. These are immediately contributing to ensure efficient knowledge and technology transfer between research and society and/or economy. The general "Fraunhofer model" (application-oriented research based on research contracts) strongly contributes to pursuing a philosophy of knowledge and technology transfer, due to strong collaboration with (research) partners and customers - primarily from industry. Fraunhofer institutes answer to calls for proposal or tenders or are directly approached by individual companies, thus conduct research requested by industry or policy. The collaboration rationale is grounded in Fraunhofer's mission. Fraunhofer's close relations to universities and non-university research organisations on the one hand and to business and public customers on the other hand contribute to a thorough understanding of clients' needs and challenges, thus to continuous exchange processes. |
| **Objectives:** | The contract research model of Fraunhofer is implemented through more than 84 facilities and 74 different institutes, which are acting quite autonomously in Germany and abroad. The main objective of Fraunhofer's mission is to carry out research for and with manufacturing companies. This primary goal is incentivised by a co-funding mechanisms in the form of matching-grants: for each Euro which comes from a contract with a manufacturing company, 30cents are added from the Fraunhofer budget (public money). |
| **Sector(s):** | Multi-sectoral, particular focus on manufacturing sector; several institutes perform research for the public sector. |
| **Time span:** | The Fraunhofer model was institutionalised right from the beginning in 1949; as for individual projects, any time spans are possible. |
| **Resources (person years/budget):** | The resources and personnel needed vary according to the concrete projects. In total, Fraunhofer employs a staff of 29.000 persons. The annual research budgets amounts to 2.8bn Euro from which 2.3bin Euro are for contract research. 70% of the contract research budget are earned via contracts with industry and publicly financed research projects. |
| **Management/ coordination:** | Fraunhofer-Gesellschaft has a management structure consisting of the president, an executive board, supervision committees and advisory committees. Each institute is managed by one or two directors and a deputy. Furthermore, an advisory board (board of trustees) supports the different institutes. Approx. every 4 years, each institute is scientifically evaluated by external experts. |
| **Support activities:** | Apart from the model itself, Fraunhofer-Gesellschaft is supporting its mission in the form of providing incentives in the case of contracts for the manufacturing sector. Furthermore, internal R&D programmes for strategic areas are designd and implemented. Fraunhofer headquartes are also responsible for the legal review of the contracts, supports new ventures and firm foundations through its own Venture Group and it also active in different countries in the form of liasion or representative offices. |
| **Results/impact (measurable):** | The results or impacts of Fraunhofer-Gesellschaft are manifold. Apart from the growing input factors (public budget, number of employees and institutes), the main output can be measured in the budget or earned income (see above) as well as the number of R&D projects, new firm foundations, patents and publications, and the number of doctoral students. The concrete impact for Germany's technological competitiveness is usually measured by the indicators mentioned above. However, there are many other more indirect effects as well. |
| **Success factors:** | ○ The main success factors lie in the business model of Fraunhofer as such, combined with a quite autonomous structure of the different institutes. Another factor are the different incentives, like co-funding in the case of manufacturing contracts, internal research programmes.<br>○ Strong cooperation with universities: the cornerstone in this regard is the joint appointment of outstanding researchers as professors at the university and Fraunhofer institute management. Due to the close personal integration at all levels, results from university research can be efficiently applied and the joint offer in the field of knowledge and technology transfer can be expanded in a targeted manner. At the same time, the integration of Fraunhofer scientists into university teaching enables a broader range of courses for students. |
| **Barriers:** | ○ Due to the size of Fraunhofer-Gesellschaft, administrative burdens are becoming evident. Legal contract reviews can take a long time, as well as other formal procedures.<br>○ The profit-center model of Fraunhofer can result in a structure where institutes (and within institutes even departments) can become competitors which prevents co-operation between those organisational units. |
| **Lessons learned:** | ○ The Fraunhofer business model as such represents a public-private partnership approach in terms of both, public funding of approx. 30% plus additional funding (70%) coming from third parties in a competitive procedure. Each institute is organised as a profit center and therefore has to look for funding opportunities and income sources. The main contractor in all projects is Fraunhofer-Gesellschaft as a legal entity, not the different institutes. |
| **Further information:** | https://www.fraunhofer.de/en/research/range-of-services/research-and-development.html |

## Fraunhofer-Gesellschaft (DE): The Fraunhofer Groups

| KT Area: | Knowledge sharing |
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| **Description of activity:** | Fraunhofer-Institutes, sub-institutes or independent departments can thematically join forces and exchange information in the form of Fraunhofer-Groups, which are devoted to specific research areas. Institute associations are decided by the board of directors. The groups appear together on the R&D market and are involved in corporate policy, as well as in the implementation of the functional and financing model of Fraunhofer-Gesellschaft. An important incentive to become a member in one group is the fact that R&D programmes implemented by the Fraunhofer Headquarters are often targeted towards a specific group and that strategic decisions by the president of Fraunhofer-Gesellschaft are often aligned with the interests and objectives of a group. |
| **Objectives:** | Their purpose is to coordinate work on related fields of research within the Fraunhofer-Gesellschaft, to pool essential resources in core disciplines, and to present a unified image in the marketplace. |
| **Sector(s):** | There are currently seven Fraunhofer-Groups: Fraunhofer ICT Group; Fraunhofer Group for Innovation Research – INNOVATION; Fraunhofer Group for Life Sciences; Fraunhofer Group for Light and Surfaces; Fraunhofer Group for Materials and Components – MATERIALS; Fraunhofer Group for Microelectronics; and Fraunhofer Group for Production. |
| **Time span:** | The structure of the Fraunhofer-Grouops is pretty stable and has no concrete time span; the latest formation of a Fraunhofer Group related to Innovation Research, as the four respective instututes until then were members in different (technology-oriented groups). |
| **Resources (person years/budget):** | There are additional resources allocated to the Fraunhofer groups. Each group has an office with a staff of 3-4 persons (usually the managing director, a speaker of the director and a prss officer). |
| **Management/ coordination:** | The management and coordination of the different groups are organized by the participating instututes themselves. For instance, the Fraunhofer Group for Production is managed by the Group Chairman, which at the same time is the institute director of Fraunhofer-Institute for Machine Tools and Forming Technology (IWU). The number of group members depends on the concrete research area, in the case of Fh Group for Production for instance there are 12 institutes. Coordination and integration is organized through regular meetings and information exchange in the case of important calls or research opportunities. Furthermore, the groups have established special offices to ccordinate the activities. |
| **Support activities:** | There are no specific support activities from the top, rather than horizontally between the different group members. For instance, the Fraunhofer ICT Group defines and works on the predominant topics crucial for the future of business and society through interdisciplinary initiatives at the highest conceptual level. In pursuing its vision, the Fraunhofer ICT Group works closely with trade associations, scientific organizations, and the body politic, as well as engaging the public through its information channels as well as educating the coming generation. Each group has established internal information channels and an external webpage to present its competencies, research areas, plus cooperations and activities. As mentioned above, the groups are usually primary target groups for specific internal R&D programmes of Fraunhofer. |
| **Results/impact (measurable):** | There are no measurable figures available regarding results and impcats of the Fraunhofer Groups. However, given the organizational structure and the addidtional staff of the groups, impacts are mainly observable with regard to single institutes and different cooperations (within the group). Given the objective of the Fraunhofer Groups as a whole to coordinate activities regarding contract research within one technology area and exchange information regarding technolgies, funding opportunities, market developments etc., the concrete activities in terms of joint research or setting-up of consortia usually happens on the basis of different institutes rather than the whole group. So, the measurable impact is more on the level of the single institutes (as profit-centers) and not soi much on the level of the groups as such. The groups are primarily a vehicle to joint forces and react as Fraunhofer-Gesellschat and be visible in a single area. |
| **Success factors:** | The success factors are the slim and decentralized structure with a common coordination and information exchange platform, and, at the same time, maintaining the business model at the level of the single institutes. The existence of single R&D programmes to support the different groups is another success factor. Here, the strategic interest of Fraunhofer-Gesellschaft as a whole is implemented by financial incentives for the groups and its members. At the same time, even within one group, competition between the members via-a-vis internal funds and the external market is not eliminated. |
| **Barriers:** | The success factors mentioned above on the other side may also be barriers. This is the case in networks where incentives, the need for cooperation and at the same time competition between the actors are typically existing at the same time. In the case of the groups, the business model "profit center" is not transfered to the groups, which means that the financial KPIs (earnings from contract research as a whole and from manucaturing companies in particular) are still measured at the level of the single institutes. In consequence and from the perspective of a single institute, there is a potential conflict between cooperation and competition (manifested for instance regarding the "protection" of markets/key clients which are consedered to "belong" to my institute). |
| **Lessons learned:** | Combination of a decentralized, multiple structure with a coordination office and funding opportunities per group from Fraunhofer Headquarters. Involvement of the groups or their chairman in strategic discourses and agenda-setting carried out on the level of the board of directors (of Fraunhofer-Gesellschaft). |

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| **Further information:** | https://www.fraunhofer.de/en/about-fraunhofer/profile-structure/structure-organization/fraunhofer-groups.html |

# Best practices from TECNALIA (Spain)

## TECNALIA (ES): Tecnalia Ventures

| KT Area: | Knowledge valorisation |
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| **Description of activity:** | Tecnalia Ventures is a subsidiary of Tecnalia set up in 2013 for acceleration, incubation and venture building services. It aims at transforming technologies developed at Tecnalia into technology-based business opportunities to be commercialized via new licences or spin-offs. The specific focus of Tecnalia Ventures is on deep-tech spin-offs that are supported through the Omega incubation and accelerator programme. Business opportunities that are approved by an investment committee enter the Omega programme that provides funding for carrying out business and technology development activities needed for achieving a prototype or product that could trigger a private capital investment. The project teams of the Omega programme comprise researchers from Tecnalia's divisions and commercialisation specialists coming from Tecnalia Ventures. In addition to the Omega programme, Tecnalia Ventures takes actively part in ecosystem building in the region (Basque Country) in order to foster technology transfer activities. The key idea of ecosystem building is to enhance interaction between technology developers, entrepreneurs and investors via networking activities. |
| **Objectives:** | The strategic objective of Tecnalia Ventures is to support Tecnalia´s mission of transforming technology into GDP. Tecnalia Ventures has annual targets related to patenting activities and new company creation. Moreover, a special attention is paid on the turnover development of the companies created during a five-year observation period. |
| **Sector(s):** | Energy, health, digital technologies, construction and transport. |
| **Time span:** | Tecnalia Ventures has operated since 2013. The typical time span of a project funded under the Omega programme varies from two to six years. |
| **Resources (person years/budget):** | 20 FTEs. |
| **Management/ coordination:** | Tecnalia Ventures is an independent legal entity managed by its CEO who also participates in the Tecnalia's leadership board. |
| **Support activities:** | Tecnalia Ventures gets support from Tecnalia in the form of legal services, business support, event promotion, personnel training, internal fund management and value-creation roadmapping. In addition, external marketing services are purchased occasionally. |
| **Results/impact (measurable):** | Tecnalia Ventures plays a key role in the EPO patent filing activities of Tecnalia that is in the top five of the EPO patent ranking of Spain. The new technology-based companies (NTBCs) supported by Tecnalia Ventures in 2017-2020 generated € 33.5 million annual turnover, employed 261 employees and gathered € 9 million equity from private investors. |
| **Success factors:** | ○ Transforming a research project into a technological product that solves a problem that has a positive P&L impact on the end user companies.<br>○ Protecting technology in a way that will maximise its future economic value.<br>○ Creating teams made up of both technological profiles and business/marketing/sales profiles, including people outside Tecnalia.<br>○ Making connections to smart investors in the region, including corporations, venture companies (VCs), family offices etc. |
| **Barriers:** | ○ It is challenging to find a right composition for an entrepreneurial team and match technical profiles with business profiles.<br>○ There is a short-term personnel problem when research teams lose key experts who decide to participate in the venture building activities. |
| **Lessons learned:** | ○ Deep-tech spin-off creation requires working in a coordinated way at multiple levels: 1) individual (interactions between people and teams), 2) organisational (interactions between tech transfer unit and host organisation) and 3) ecosystem (interactions between regional ecosystem actors) levels.<br>○ Technology-minded people should not be forced to become entrepreneurs. |

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| **Further information:** | https://www.tecnalia.com/tecnalia-ventures |

## TECNALIA (ES): Orainn initiative

| KT Area: | Knowledge co-creation |
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| **Description of activity:** | Tecnalia's contract research activities are divided into two operational strategies based on company size or level of innovation (SMEs and large companies). The SME contract research program, *Orainn* (eng. Now), aims to boost innovation and R&D activity within customer company. The collaboration lasts for one year. Companies pay an annual fee to Tecnalia and Tecnalia sends one of their experts to the company during the assignment with the company. Tecnalia's experts participate in day-to-day work at the company for one year and analyse company's competitive position at markets, create innovation strategy and R&D projects with the help of Tecnalia Researches of the required fields, help company to reach R&D finance through e.g. public programmes or tax exemptions and other supporting activities to increase SMEs innovation capacity. |
| **Objectives:** | In the SME programs Tecnalia aims to increase SMEs innovative capacity to boost competitiveness and R&D activities. Long term goal is to increase joint projects with customer companies. |
| **Sector(s):** | Multisectoral. However, because of Tecnalia's own sectoral specialization, most projects focus on industrial sectors. |
| **Time span:** | The Orainn program was established in 2016 and has since become institutionalised in Tecnalia. |
| **Resources (person years/budget):** | A team of 10 experts in Tecnalia work full time with Orainn projects. Each team member manages 4 companies per year. |
| **Management/ coordination:** | A special team has been established in Tecnalia. Team members work one day per week per company, total 4 workdays per week, and meet jointly once a week to discuss on-going issues in their respective companies. Weekly meetings are used to share best practices together. It is also an important support for team members. |
| **Support activities:** | Each team member has received training in technology management, innovation cycle, project management and innovation strategy. Teams also receive standard project support from Tecnalia, e.g. for contract legal requirements. Each team member has access and support by key researches in the required areas per client. |
| **Results/impact (measurable):** | Qualitative results include increasing number of projects at Tecnalia. In addition, as part of the projects, Tecnalia's experts map and recognise gaps in innovation capacities in customer companies. This has led to increasing collaboration with SMEs in a broader sense. Tecnalia provides, for example, technological and technical expertise to companies. The projects have increased SMEs innovation and R&D capacities. This has also impacted positively on their competitiveness in markets. Number of Orainn contracts has increased substantially, being financially very positive to Tecnalia. |
| **Success factors:** | ○ Transparency is crucial to build trust and to enhance good collaboration with customers. It is also important that experts "speak the language of the companies" – i.e. be knowledgeable of company culture, objectives, and ways of operating. This can be sometimes quite different from general RTO work, and as such it is an important success factor to enable smooth collaboration.<br>○ Orainn projects are highly demanding and require a lot of personal effort from experts. The working pace is fast, and clients require satisfactory results. Commitment of employees is crucial.<br>○ Adequate training of team members is crucial to enable up-to-date and relevant skills. Companies where people work vary by nature and expertise a lot. Tecnalia's experts need to have a strong skillset that fit to diverse needs. Weekly meetings among Tecnalia's expert team are crucial for information exchange, brainstorming and support.<br>○ Projects can result in long-term relationship with companies, which boosts collaboration in innovative projects. During the assignments in companies, experts identify further opportunities for collaboration based on companies' needs and gaps. Focus is on targeting relevant projects, which is crucial when initiating joint projects with companies when there are no public resources available. |
| **Barriers:** | ○ Sometimes research culture is not conducive for high tempo and commitment requiring projects. The projects require a lot of working hours, flexibility, ability to work on evenings and weekends on an ad-hoc basis and the ability to travel. For this, it can be a barrier to find motivated and skilled personnel to work for such projects.<br>○ Companies often do not have any prior experience in R&D, and there is no easily available public funding to launch projects. This may hinder companies' interest to join in projects because they do not see value for their operations.<br>○ Scaling highly human resource intensive programmes is difficult. |
| **Lessons learned:** | ○ Building trust with companies through transparency is crucial. Tecnalia's staff needs to be committed to the projects. Sales department and top management need to have understanding of how to convey these projects to the company sphere in order to attract attention and seal contracts. Customer satisfaction needs to be high for enabling future collaboration and spillovers. |

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| **Further information:** | https://www.tecnalia.com/en/agenda/innovate-in-your-company-with-orainn |

## TECNALIA (ES): Networking strategy

| KT Area: | Knowledge sharing |
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| **Description of activity:** | Tecnalia has an institutionalised networking strategy through which Tecnalia ensures that it is connected with relevant companies and stakeholders across Tecnalia's core sectors. This networking activity consists of participating in various forums, for example industry associations, technological platforms and work groups. Networking activity includes taking part in different recognised key forums where Tecnalia has an active role in e.g. sharing information on trends in technological development, markets etc. which local SMEs companies may not have resources to observe. Knowledge sharing takes place via webinars, presentations and white papers to forum participants. Tecnalia also develops activities in cooperation with local companies within these forums to create impact with local businesses. Each main department and team in Tecnalia have their own database of relevant local stakeholders and each team is member in approximately 20 relevant organisations. |
| **Objectives:** | To build reciprocal and local opportunities for Tecnalia and local companies, to innovative technology-based opportunities based on Tecnalia's foresight on current trends in technology around the world. |
| **Sector(s):** | Multisectoral. Mostly focus on logistics, energy, industry and public administration. |
| **Time span:** | This type of networking activity has been ongoing for decades in Tecnalia. |
| **Resources (person years/budget):** | No specific resources are allocated for such activity. However, Tecnalia tries to measure impact of participating in networking forums through measuring the amount of time allocated to networking divided by tangible results e.g. project proposals. Participation in relevant forums is voluntary, but an average participation is 1-4h / week / person. |
| **Management/ coordination:** | Tecnalia's departments and teams maintain a database of important forums which are relevant to their business area. Databases are divided according to areal focus, i.e. national, regional, or international. The units and departments have a database of relevant forums where they need to participate in. Team managers follow and coordinate the databases and follow participation in the forums. Each week the team recognises most important on-going activities for that week, and allocates team members the forums and events they should participate in. |
| **Support activities:** | Tecnalia provides institutional assistance e.g. travel expenditures and human resources. |
| **Results/impact (measurable):** | Active participation in forums brings various results, most of which are often hard to measure and materialise over a long period of time. In other words, return of investments is achieved over a period of long time. Yet, most importantly, Tecnalia's strong positions in forums leads to dissemination of information, concrete project proposals, collaboration opportunities, and contract research agreements, for example |
| **Success factors:** | ○ The main success factor is belonging to various forums from the very beginning. This brings advantage in having an active role in the ecosystem and market creation. Furthermore, this enables Tecnalia to have an active role in determining the nature of activities and orchestrating complex opportunities. As Tecnalia's mandate is to seize large-scale, complex opportunities which involve large enterprises and SMEs, and have a broader impact on the society, it is crucial that Tecnalia has an active role from the start.<br>○ Focusing on the right and most relevant associations and working groups.<br>○ Active participation in relevant forums brings many opportunities, for example proposals, publications, new initiatives that can sometimes lead to next generation.<br>○ Tecnalia plays crucial role in disseminating EU-wide development and opportunities at the local level. |
| **Barriers:** | ○ The main barrier is to keep members of forums engaged in joint work. Sometimes certain forums, for example industrial forums, like to see return of investment in a short period of time. This is difficult as often research-based activities materialise over a long period of time.<br>○ Difficulty of making cost-benefit analysis: Belonging to various forums where results are not delivered in short term can lead to undervaluation of benefits. Sometimes this might lead to leaving a certain forum due to its low performance. However, the threat is that a certain forum might have been abandoned too early. |
| **Lessons learned:** | ○ Identifying relevant forums might be difficult and time consuming, and, to some extent, the benefit depends on the attitude of the part taking organisations. Having a proactive role creates opportunities not only for Tecnalia, but also for the broader ecosystem at the local level. This is important and brings reciprocal benefits to all stakeholders. Active participation in various forums enables transparent and up-to-date communication with relevant stakeholders. |

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| **Further information:** | For more information on strategic partnerships of Tecnalia, see: https://www.tecnalia.com/en/strategic-alliances |

# Best practices from AIT (Austria)

## AIT (AT): Ingenious partner as brand essence

| KT Area: | Knowledge co-creation |
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| **Description of activity:** | The Austrian Institute of Technology (AIT) has a specific brand identity on scientific excellence and a self-image as ingenious partner for industry and public bodies. Together with the claim "Tomorrow Today", AIT offers research support for (national and international) companies, in order to help them to prepare for future challenges. AIT's services for its clients include technologies, methods, tools and demonstrators, which are implemented in cooperation with industry. Main vehicles are contract research, IPR licensing or spin-offs. AIT also offers public support though foresight processes, analyses and studies, evaluations, or the development of concepts and programmes. In order to contribute to overcoming industrial risks and to support developing new markets, strategic thinking of AIT includes (1) in-depth knowledge of international research activities, (2) knowledge of clients' needs and strategies of possible clients, (3) shaping new technologies, tools, and simulations. |
| **Objectives:** | AIT's business concept and vision is to act as ingenious partner for industrial clients and public authorities and thus to provide expertise for clients' needs. AIT's specific objectives are: (1) enabling innovative services, (2) research and development for future developments, (3) providing advanced technologies and processes. These objectives are pursued through a specific approach that combines scientific methods and systemic knowledge, technological expertise and a favourable research infrastructure. |
| **Sector(s):** | AIT engages in various sectors, which are pursued in AIT's Centers: Energy; Digital Safety & Security; Health & Bioresources; Low-Emission Transport; Vision, Automation & Control; Technology Experience; Innovation systems & policy. Each Center engages in a number of research topics and develops specific solutions. |
| **Time span:** | AIT was founded in 1956, initially in the field of nuclear power, but since its foundation being committed to application-oriented research. The current structure, organisation, locations and name is existing since 2009. |
| **Resources (person years/budget):** | AIT's shareholders are the Republic of Austria through its Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (50.46%) and the Federation of Austrian Industries, a voluntary representative of the interests of the Austrian industry (49.54%). AIT gains about 62% of its budget through third-party funds (from which about 50.2% private and 49.8% public bodies in 2019). In 2019, AIT's staff amounted to 1,278 headcount (1,136 FTE). |
| **Management/ coordination:** | AIT's management structure consists of two Managing Directors, the management and heads of the seven Centers, the heads of Competence Units and four subsidiary enterprises (from which two are separate brands with distinct profiles). The Supervisory Board is supported by the Strategic Research Advisory Board, which provides recommendations, statements and comments. It is composed of five internationally renowned scientists. |
| **Support activities:** | AIT implements a risk management and controlling system, and develops mitigation instruments to face economic, legal, financial and further risks. All Centers and Research Areas of AIT have a clear management structure and a high degree of autonomy. However, cross-sectional key functions are centrally managed. The internal controlling system refers to factual and financial control both in the different entities and on the central level. All business processes are monitored by internal auditing processes. |
| **Results/impact (measurable):** | In addition to and embedded in research contracts and cooperations based on AIT's business model and brand identity, AIT's performance indicators refer to financial aspects, human resources development, patent applications, publications, teaching, lecturing activities and qualification aspects, internationalisation, gender and equality topics, etc. |
| **Success factors:** | ○ The main success factor is the achievement of the defined objectives, based on successful projects for industrial and public clients. These are rooted in AIT's business model and its structure: technological competence and expertise, systems expertise, the application of scientific methods and a high-quality research infrastructure, complemented by thorough industry and market knowledge and close relationships with clients.<br>○ Engagement in networks enables knowledge exchange with other national and international partners. |
| **Barriers:** | ○ Application-oriented research at the interface of fundamental science and industrial application is highly challenging and has to respond to financial, scientific, industrial and qualification-oriented requirements. This leads to situations of competition for research grants and contracts. In addition, research units have to respond both to scientific and to market-oriented requirements. |

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| **Lessons learned:** | ○ AIT has a specific structure, vision and business model in order to conduct industry-oriented research and respond to future-oriented challenges of its clients. The clear branding as ingenious partner is a key factor for AIT's research work, leading to specific values and strategic thinking. This vision and the future orientation of AIT's work are key cornerstones for gaining industrial contracts and for further developing scientific activities and networks in AIT's Research Centers. |
| **Further information:** | https://www.ait.ac.at/en/about-the-ait/brand-identity |

## AIT (AT): PhD programme

| KT Area: | Knowledge sharing |
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| **Description of activity:** | Young scientist qualification is one important cornerstone of AIT's research profile. Training and supporting PhD students not only contributes to career development of the students, but also enhance excellent research at AIT. In the frame of their research projects, PhD students develop new ideas, explore and apply new approaches, and engage in various scientific networks. They are involved in AIT research projects and benefit from needs-based research questions, and in turn bring in their scientific ideas, theories and models. This model allows to develop scientifc knowledge and practical experience for mutual benefit for the PhD student and AIT's research projects. In the frame of the PhD programme, students gain access to AIT's research infrastructure, scientific support, networking and qualification opportunities (seminars, conferences and further events). In addition, all PhD theses are conducted in cooperation with (national and international) universities, and the development of PhD theses are supervised by both organisations. So the students benefit from scientific input and support from different research perspectives. |
| **Objectives:** | Under the motto of "Make Ideas Work", AIT developed its PhD programme that aims at scientific supervision of the PhD theses in close collaboration with universities, and at preparing PhD students for a career in science or industry. AIT maintains close collaborations with (national or international) universities in order to support and supervise PhD theses.<br><br>The PhD programme defines the model of the PhD theses, including the shared supervision by an academic supervisor and AIT. The approach (duration, involvement in AIT projects, supervision, etc.) is defined in a three-year-contract. In total, AIT offers a "springboard" for PhD students and their scientific or industrial career. In addition to the scientific PhD work, AIT and partner offers training in the fields of knowledge valorisation (exploitation, patents) and entrepreneurship. |
| **Sector(s):** | In order for create benefit for both the PhD student and AIT, the PhD research topic is expected to fit with strategic goals of AIT. These are represented by AIT's seven Centers and their research topics: Energy; Digital Safety & Security; Health & Bioresources; Low-Emission Transport; Vision, Automation & Control; Technology Experience; Innovation systems & policy. |
| **Time span:** | PhD contracts have a duration of three years, and it is expected that the theses are completed within this period. PhD contracts start in accordance with the project (no specific application period). AIT publishes current vacancies, but also invites interested students to submit spontaneous and unsolicited applications. |
| **Resources (person years/budget):** | AIT employs and supports around 200 national and international PhD students (end of 2018: 213, end of 2019: 197 students). The programme is coordinated by AIT's Recruitung and Human Resources Development, and has a specific Coordinator. |
| **Management/ coordination:** | The programme is clearly structured and scientifically embedded in research projects of AIT's Centers. Human resource development is managed by the PhD Coordinator (see above). |
| **Support activities:** | Various activities support PhD students in their work: PhD students are supervised on the academic and the research project level (universities and AIT Centers), they have various opportunities for qualification and training. Further, they gain access to the AIT research infrastructure, to networks and collaboration structures with clients and thus to industrial needs. AIT also offers various opportunities for exchange and networking such as seminars, platforms, mentoring, etc. |
| **Results/impact (measurable):** | The main indicator is the successful completion of PhD theses at AIT. Further measurable impacts are participation in training and qualification, networking activities, etc. |
| **Success factors:** | ○ Integration of PhD students in AIT research projects for mutual benefit for AIT and the PhD student, leading to successful PhD theses in AIT's research fields.<br>○ Support activities in terms of coordination and supervision of theses, support of PhD students through AIT's PhD programme, training, qualification in applied research, access to infrastructure, engagement in scientific networks, exchange with industrial clients, etc. |
| **Barriers:** | ○ Barriers are related to research fields that are not part of AIT's strategic research topics. |
| **Lessons learned:** | ○ AIT implements a structured PhD programme, which aims at creating beneficial situations for PhD students and for AIT. For young scientists, this programme is a cornerstone in their career development since it allows them to enhance scientific and professional knowledge and experience, in addition to the successful completion of their PhD theses. The work of PhD students is integrated in AIT's projects and thus increases the scientific base in AIT's research fields. |

# Best practices from TNO (Netherlands)

## TNO (NL): Tech Transfer Programme

| KT Area: | Knowledge valorisation |
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| **Description of activity:** | Starting its operations in 2017, TNO's Tech Transfer Programme aims at introducing TNO technology faster to the market by supporting creation of spin-off companies and technology licencing. The programme focuses on the pre-seed phase when preparatory activities for company creation are conducted, such as market research, business planning and collaborative agreements. The internal call for applications for Tech Transfer Programme is open the year around. After the approval made by the board of the programme, € 30,000 is allocated for the implementation of Phase 1 activities, including drafting a strategy for bringing the technology, which constitutes the basis for the foreseen spin-off, to the market. If the results of Phase 1 are approved, Phase 2 starts with a maximum budget of € 50,000. During this phase, the project team will draft a business plan, a dedicated spin-off team that consists of TNO researchers supplemented by an internal/external business developer will be formed, and agreements on collaboration and IPR issues will be made between the spin-off, TNO, and other stakeholders. The final decision on the launch of the spin-off is subsequently made by the TNO's Executive Board based on the business plan and the foreseen agreements. Recently, TNO has started a close collaboration with a private Dutch venture-building accelerator, HighTechXL, by suppling technologies for venture development in cases when there is TNO's personnel available to participate in the spin-off activities. |
| **Objectives:** | The strategic objective of Tech Transfer Programme is to put technologies and knowledge developed at TNO into practice by ensuring that they are converted into business activities and high-quality employment. The underlying principle of TNO technology development is that once a technology is mature the market should take over. |
| **Sector(s):** | Multisectoral. |
| **Time span:** | Tech Transfer Programme has existed since 2017. The duration of a typical spin-off project is one year, including both Phase 1 and Phase 2 activities. |
| **Resources (person years/budget):** | Tech Transfer Programme: 7 FTEs; individual projects: 0,6 FTEs. |
| **Management/ coordination:** | Tech Transfer Programme is operated internally at TNO. The decisions on IPR are made by TNO's line managers who are located in sectoral business units. |
| **Support activities:** | TNO's IPR department helps in issues that concern patenting, licencing and technology benchmarking. TNO's legal department assists in shareholder agreements. TNO's HR drafts employment contracts. In addition, Tech Transfer Programme is supported by multiple business developers of sectoral business units. |
| **Results/impact (measurable):** | On average, 7 spin-off companies have been created through Tech Transfer Programme annually since 2017. In addition to the number of spin-offs, their survival rate, invested capital, and number of employees are monitored on a regular basis. |
| **Success factors:** | ○ Getting clear support from the line management of the unit where the technology has been developed.<br>○ Making collaborative contracts between the spin-off company and TNO resulting in new projects where these companies are TNO's clients.<br>○ A spin-off company should be run always more than one person. |
| **Barriers:** | ○ In case of deep-tech, the initial funding instruments are not on a sufficient level.<br>○ Using TNO's facilities is expensive for new companies since pricing is made on commercial basis. |
| **Lessons learned:** | ○ The spin-off teams should be exposed to the interaction with investors already at a very early stage of their life-cycle, even before they are investment-ready. This contributes to the further shaping of their plan.<br>○ Ecosystem activities and collaboration have been intensified in order to obtain competences, which are lacking in the spin-offs.<br>○ The duration of the spin-off projects has been extended from the set-up phase to the first financing round in order to increase the probability of success.<br>○ Only the most entrepreneurial-minded researchers should apply to the programme. |
| **Further information:** | https://www.tno.nl/en/focus-areas/techtransfer/ |

# Best practices from KTI/SFI (Ireland)

## KTI (IE): National office for knowledge transfer

| KT Area: | Knowledge valorisation |
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| **Description of activity:** | Founded in 2013, Knowledge Transfer Ireland (KTI) acts as a national knowledge transfer institute helping business to benefit from the access to Irish expertise and technology. KTI is a centralised point of reference for industry-academia partnerships and research commercialization in Ireland. It manages and provides support with issues concerning intellectual property, licencing, funding and consultancies. KTI is hosted by Enterprise Ireland (EI), the government agency responsible for supporting Irish business, and funded by EI with co-financing from the Irish Universities Association (IUA). KTI provides a portal for industry and entrepreneurs through its website through which users may navigate across the entire public research sector in terms of knowledge transfer issues. For business, KTI offers a suite of resources, including template model agreements, practical guides and funding tools. In some cases, KTI offers practical support, especially in case of complex multi-party arrangements. A key role of KTI is to raise awareness of and to promote the successes arising from co-developed ideas and the opportunities available for co-development, in order to attract new companies to engage in research and contracting with public research organisations. |
| **Objectives:** | The aim of KTI is to enhance networking, connecting, and engaging of research organisations, such as technical research centres, state research organisations, and universities, with businesses, investors, and research funders, and to provide a national set of IP licencing guidelines and protocols. |
| **Sector(s):** | Multisectoral. |
| **Time span:** | The Knowledge Transfer Ireland was established in 2013. |
| **Resources (person years/budget):** | Estimated budget of the KTI per year is over € 50 million. |
| **Management/ coordination:** | KTI is accountable to the Department of Enterprise, Trade and Employment (DETE). It is advised by a group of commercially experienced people drawn from industry (SMEs and multi-nationals, Irish and overseas) and the investment community. It engages with the broader knowledge transfer community through the KT Stakeholder Forum representing Irish public research organisations, technology transfer offices, research funders and government agencies. |
| **Support activities:** | KTI provides support for business and research organisations on number of knowledge valorisation and exploitation related issues, for example on intellectual property, licensing, collaboration, research, funding, technology transfer offices, spin-off companies, and consultancies. |
| **Results/impact (measurable):** | By the end of 2019, the KTI has contributed to two-hundred licences on average (options and assignments) each year and creation of almost thirty new spin-off companies. |
| **Success factors and drivers:** | ○ In Ireland, research projects are usually performed by multiple partners, including universities, companies, and technical research organisations. For effective collaboration, it is helpful to have a standardized intellectual property framework nationally. It fosters cooperation between different partners, especially when intellectual property questions are relevant, because a third party can coordinate agreements between collaborating actors in a transparent and impartial manner.<br>○ As a centralised institute, KTI is useful for companies when they are looking for universities or research organisations with whom to collaborate within the national R&D system. Via KTI, they have a one-stop contact point to find relevant partners.<br>○ Having a national KT institute ensures consistency in R&D activities and knowledge transfer. KTI also plays important role in providing help, matchmaking, and consultancies to companies of all sizes. |
| **Barriers:** | ○ It is important to avoid the system from becoming too bureaucratic. Especially, the Irish Universities should be encouraged to keep the tech transfer process simple, uniform and with the minimum of bureaucracy and fast speed. |
| **Lessons learned:** | ○ KTI provides assistance and services broadly to the whole society by promoting a culture shift in professionalism and openness when it comes to R&D. Industry stakeholders have found it useful to have one point of contact to find research expertise and access ideas and technology created by public research performing organisations. |
| **Further information:** | https://www.knowledgetransferireland.com/ |

## SFI (IE): Industry RD&I Fellowship Programme

| KT Area: | Knowledge sharing |
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| **Description of activity:** | Industry RD&I Fellowship Programme funds academic researchers at Irish research institutes, at any level from Postdoctoral Researcher to Professor, to spend up to one-year full time in any company worldwide. The companies can be of any size, and any location. During the fellowship the researcher joins the company as a researcher and SFI covers the salary expenses. The programme does not entail any responsibilities after the one-year time. The criteria for selection for the fellowship are that the researcher is currently employed at an Irish research institute, and that the work tasks at the company focus on research. |
| **Objectives:** | The fellowship programme is inherently about capacity building, skills development, and networking, and the program has several objectives. First, the fellowship programme aims to attract people in academia to consider career in industry. Second, the programme aims to give researcher in academia an opportunity to experience industry research to build capacity on industry knowledge. Third, from a broader perspective the programme aims to enhance industry capacities to absorb research, especially at the SMEs and micro company level. Fourth, the programme aims to create networks between non-Irish companies and Ireland. |
| **Sector(s):** | Multisectoral |
| **Time span:** | The fellowships last for maximum one year. |
| **Resources (person years/budget):** | 100 fellowships per year each approx. €100,000 - €150,000. |
| **Management/ coordination:** | The programme is managed by SFI staff. There is a LinkedIn page for companies and researchers to post their profiles and SFI also organises matchmaking events. Applications are straightforward and internationally peer reviewed. |
| **Support activities:** | SFI organise career workshops for postdocs at which Industry Fellowship one to one matchmaking events are held with industry plus SFI promote the programme widely. |
| **Results/impact (measurable):** | The programme success can be measured through popularity of the programme (i.e. number of participants), number of jobs offers participants receive from fellowship companies, and the number of part-taking companies who seek to span operations to Ireland. Yearly the programme facilitates 100 researchers' fellowships. 100% of participants receive a job offer either from the company where they did the fellowship or from a competitor. Almost 50% accept the job offer. From the second half who declines the offer, 30% establish own company, 25% join another SME or micro company. Around 1-2 persons return to academia. |
| **Success factors and drivers:** | ○ Simple application process, high success rate, no post award restructure conditions. |
| **Barriers:** | ○ Sufficient SFI budget to fund the increasing number of applications. |
| **Opportunities:** | ○ The fellowship programme is important for the development of industry ecosystem in Ireland. It attracts researchers to industry and creates linkages between industry and academia. It also attracts new foreign companies to Ireland. Moreover, the programme is important for internal skills development and industry knowledge. |
| **Further information:** | https://www.sfi.ie/funding/funding-calls/sfi-industry-fellowship-programme/ |

## SFI (IE): SFI Research Centres

| KT Area: | Knowledge co-creation |
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| **Description of activity:** | The SFI Research Centres were established to deliver significant scientific, economic, and societal impact for Ireland. The Research Centres facilitates networking of scientists, academia, and industry across fields. In total 16 centres operate under the SFI framework. The centres operate within universities, which ensures excellence in research. The aim of the centres is to bring best practitioners in academia, technical research, and industry together in areas which are strategically attractant to industry and to Irish national priorities. The centres lay foundations for an effective and productive academic and industrial partnership. |
| **Objectives:** | Objective of the centres is to :<br>• provide major economic impact for Ireland through increasing the level of industrial and commercial investment into R&D, and to transfer technology and expertise to Irish-based multinational companies and SMEs.<br>• spin out new, high-technology start-up companies that have the potential to raise external angel or venture funding<br>• inspire the future generation of STEM students and train and educate a cohort of engineers and scientists at MSc/MEng, PhD and post-doctoral level that will take up high-value employment in MNCs and SMEs based in Ireland<br>• engage the general public and equip them with the tools to confidently understand and debate science, technology and engineering research in Ireland |
| **Sector(s):** | Multisectoral |
| **Time span:** | The SFI Research Centres Programme was launched in 2012. Centres are funded initially for a 6-year term. At year 4, they can apply through a closed competition for a further 6 year term of funding. Selection is based on an assessment by an international panel of expert reviewers of a centre's performance from a scientific and impact perspective, including assessment of performance against a core set of KPIs.<br>SFI is currently considering plans for future phases of funding. As the programme is still relatively young, our most mature centres are only early into their second terms of funding. |
| **Resources (person years/budget):** | Establishment of the centres is divided into 6-year phases. Phase 1 concentrates on setting up the centre and putting together the operations team. Here SFI funds 70% of all activity and the centre is required to find 30% industry funding. A maximum SFI budget of €30M direct costs applies at Phase 1. In the 2nd phase the centres funding consists of SFI funding 33% (no maximum budget) with a requirement to leverage 67% of the budget from industrial and non-exchequer, non-commercial (NENC) sources (minimum of 20% industry and 20% NENC) . Phase 3 plans are in development. |
| **Management/ coordination:** | All SFI Research Centres have governance structures which consists of an executive committee, governance committee, scientific advisory committee, and industry advisory committee. Centres also have a core operational team which consists of Centre manager or Executive Director, business development manager, EU funding manager, commercialisation manager and financial manager. |
| **Support activities:** | The SFI, in the first 6 years of the centre's establishment, funds the centre 70%. The host university support is critically important for the centre. |
| **Results/impact (measurable):** | Centres' performance is measured by a dual approach, i.e. through a series of key performance indicators which assess the academic and commercialization outputs and through a qualitative reviews every two years. The qualitative review is conducted by an international peer-review panel (2-3 day onsite assessment). So far, quantitative results indicate a strong increase in private sector funding. Since the establishment of the centres, private sector funding for universities was in total 8 million per year, whereas today it is about 300 million euros per year. The centres have also created 36 companies, 222 licences and agreements, and 1174 MSc and PhD students have been financed and in total 8303 publications have been published through the centres. |
| **Success factors and drivers:** | The aim of the centres is to conduct globally interesting and relevant projects. For this it has been important that each centre director can operate flexibly and make relatively autonomous decisions based on their internal academic and business understanding. Maintaining high scientific quality and hosting several researchers drives industry engagement. High scientific success is understood as an important branding strategy as well as an attractant for industry interest.<br>Leadership, management, and strong operations team play a crucial role in the centre's success. The Centre manager along with other top managers usually have a strong scientific background from the field where the centre operates. This enables the centre to have relevant and in-depth understanding of the fields academic and business environments. It is also important and useful that the business development manager comes from the industry itself, as they will be able to bring contacts and expertise from the industry to the centre. This helps in networking as well as designing meaningful collaborations.<br>Leverage funding model ensures centres aim to secure autonomous and sustainable funding base, and it directs centres to collaborate with industries actively. This boosts private co-funding of R&D and knowledge transfer across sectors<br>Evaluation after the first four years of their first six-year funding is crucial for enabling a smooth transition from phase 1 to phase 2. Here the international panel evaluates the centre's success and progress with a decision on Phase 2 funding announced prior to year 6 of Phase 1. This allows Centres to maintain momentum from both a scientific and industrial collaboration perspective.<br>Centres also have a mandate to have an impact from economic and societal perspective. This boosts centre's drive for societal impact and can create linkages and spill-overs across regions and sectors. For the societal impact, some centres |

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| | are very active in informing policy. This is also seen as a way for the centres to impact shaping of national research priorities, which is beneficial for the centres' core operations.<br>Companies may also want to pay as little as possible to R&D activities. Companies may start out with small scale collaborations but over time SFI has observed that they engage in larger scale collaborations with Centres, in some cases becoming strategic partners of a centre. |
| **Barriers:** | In general, companies usually seek to avoid extra costs and as such they want to pay as little as possible for R&D activities. This is a factor that can sometimes hinder companies' willingness to participate. Moreover, the establishment of networks and industry engagement takes time. Recruitment of qualified staff for the operational team is key for success. For this, brain drain can pose challenges in recruitment of qualified staff. |
| **Opportunities:** | The division of centre's establishment into phases enables effective setting up the centres as well as encourages the centres to increase networking and matching of research institutes and companies. Defining of key collaborators in the first years of centres operations is an important opportunity as this enables any subsequent partnership to be based on strong relationships.<br>Aligning the centres thematic topics with national priorities, as well as on open call proposals enables the centres on the one hand support realization of national scientific agenda and focus on areas where Ireland has strong advantage, but also opening up to new unexplored areas and sectors.<br>Moreover, management team's strong background in science and industry is an opportunity to increase output of relevant research which increases likelihood of positive scientific, societal, and economic impact.<br>Expanding the centre model to new geographical areas, especially to regions where there exists strong expertise in certain scientific areas, is considered an opportunity to boost R&D&I and co-creation activities to new geographical areas, scientific fields, and economic sectors. |
| **Threats:** | The centres are multi institutional, so their daily work consists of a large network, and a lot of focus is placed on engaging with the network. This requires a lot of reporting and constant engagement with companies. Centres also need to be able to look at the scientific developments within the centre's thematic topic, as well as to monitor what is not only suitable for a collaboration with the company, but also suitable for new spin off companies. This is important, as companies often want to pay as little as possible.<br>Shifting from one phase to another entails risks in terms of the funding of the centres. If the centre has not been able to secure funding from industries nor create enough contacts, continued funding might not be possible.<br>Decreasing central funding for networks drastically may decrease quality of scientific excellency in centres if the centres need to look for funding elsewhere. Also, the network coherency might start to fall apart if central coordination is dissolved and centres work autonomously. This may harm the reputation, brand, and overall functioning of the research network. |
| **Lessons learned:** | Centres need to have autonomy and decision-making power to decide on the projects which they think are useful and worthy of proceeding. Evaluation of project proposals by industries is based on centres' managements academic and industrial understanding. Quantitative and qualitative evaluations are needed to measure centres success. Key for success is a well-functioning operations team and strong scientific leadership. |
| **Further information (web page etc.):** | https://www.sfi.ie/sfi-research-centres/ |

# Best practices from INESC TEC (Portugal)

## INESC TEC (PT): LET-In

| KT Area: | Knowledge Valorisation |
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| **Description of activity:** | LET-In (Laboratório de Empresas de Base Tecnológica) is INESC TEC's proof of concept innovation lab (pre-incubation services), which provides a range of services to technology-based projects with high innovation profile. These services range from organization of workshops for new product development, business model ideation and prototyping, to coaching and mentoring, technological and business consultancy or advanced training for entrepreneurial capacity building. LET-In acts as INESC TEC's umbrella for a series of projects involving relevant regional, national and international stakeholders in the fields of technology valorisation and technology-based entrepreneurship. Although LET-In was initially created to support internal entrepreneurs and researchers, it was later made available also for external promoters. LET-In contributes to the following knowledge transfer activities:<br>o Development and implementation of acceleration programmes supported by new methodologies and tools to foster the development of technological entrepreneurial projects.<br>o Development of tools and provision of direct support to researchers in the process of turning knowledge and technologies into business (technological development, IP, business model, investment roadmap).<br>o Support for proof of concept, including development of attractive investment project proposals for external investors.<br>o Development of open innovation campaigns (Call for Challenges & Call for Solutions) to facilitate knowledge and technology exploitation and interactions between companies and researchers.<br>o Provision of personalised mentorship for potential INESC TEC spin-off projects (Intellectual property management, data management and protection, legal services, product and service design, business model design, implementation roadmap, investment strategies, partnerships, etc.). |
| **Objectives:** | The main objective of LET-In is to leverage research outputs for marketplace and society benefit, develop entrepreneurial skills among research community and organizations, and support the development of science-based entrepreneurship projects with an aim of maximizing the value perceived by the market and investors (thus creating economic return for INESC TEC and its researchers). |
| **Sector(s):** | Multisectoral. |
| **Time span:** | LET-In was launched in 2007. Phase 1 (2007-2009): creation of the organization and pilot projects. Phase 2 (2009-2015): cooperation with ecosystem actors and the launch of several accelerator programmes at national level. Phase 3 (since 2015): exploitation of intellectual property generated in INESC TEC and launch of open innovation campaigns at national and European levels. |
| **Resources (person years/budget):** | Let-In services are carried out by a team of three people. |
| **Management/ coordination:** | LET-In is coordinated by the Center for Innovation Technology and Entrepreneurship (one of the sixteen INESC TEC Centres), in a close cooperation with INESC TEC Licensing Office. There is also a strong commitment and support from the INESC TEC Board of Directors to LET-In. |
| **Support activities:** | LET-In mobilizes other INESC TEC researchers and experts for specific tasks depending on the technologies, application sector, support services, etc. LET-In also has a network of mentors that supports in business collaboration. |
| **Results/impact (measurable):** | Since 2007, more than two-hundred technology-driven entrepreneurial projects have been mentored and fifty-nine technological spin-off companies have been launched in connection to LET-In activities. Sixty spin-offs have been supported for fundraising and sixteen INESC TEC spin-offs have been launched (internal IP and/or promoters). |
| **Success factors:** | o Creating a sustainable service is challenging and this was achieved with the development and implementation of a business model for the operation. Specific methodologies and tools were developed or adapted to maximize the complementarities between the LET-In team and the existing knowledge, experience and partnerships across the entire organization of INESC TEC.<br>o The multiple INESC TEC partnerships with companies in different sectors were particularly relevant to facilitate access to the market intelligence and support the "proof of concept" activities.<br>o INESC TEC's capability to invest its own resources in the development of minimum viable product (MVP) and proof of concept activities proved to be an important attracting factor.<br>o INESC TEC's multidisciplinary centres and supporting services were a driver for knowledge transfer activities.<br>o Industry is more open to co-create and test emerging technologies, which facilitate the development of the proof-of-concept phase, while researchers are more aware about knowledge valorisation and entrepreneurship.<br>o The increase of specialized seed funds nationally and at the European level is a positive transformation (e.g., EIC pillar of Horizon Europe Programme). |

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| **Barriers:** | ○ The lack of entrepreneurial education and training of researchers is a significant barrier, calling for a significant effort both from their side and also from INESC TEC services.<br>○ Since INESC TEC does not have an investment fund, its funding capabilities are limited and depend of national and European public programmes and/or private investors.<br>○ The significant increase of employment rate in the fields of emerging technologies (particularly digital ones) is reducing the number of candidates for entrepreneurship.<br>○ The average value of seed investment per project is still low in Europe.<br>○ The proliferation of acceleration initiatives, entrepreneurship programmes, etc., causes some times promoters to become dispersed, losing focus on project and business development. |
| **Lessons learned:** | ○ The vast majority of investment programmes and funds (both public and private) have difficulties and limitations to properly value science-based innovation, particularly when entrepreneurs are looking for seed capital for start-ups. A proof of concept stage can significantly contribute to reduce this gap and increase the value of the proposal for the evaluators/investors.<br>○ To execute the proof of concept stage (moving from ideas to business model), a set of specialized skills is needed. It is necessary to combine the specific scientific and technological knowledge with skills on marketing, science-based start-ups, IPR management, etc. To do this effectively, organizations need to master and integrate these skills, or otherwise the process becomes too long and expensive. Physical proximity between team members is also very important at this stage. The time and resources needed to cover this stage depend heavily on the area. |
| **Further information:** | https://letin.inesctec.pt/ |

## INESC TEC (PT): Innovation Ecosystem

| KT Area: | Knowledge co-creation |
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| **Description of activity:** | While basic science is more often developed by academia and scientific organizations, and (incremental) innovation by companies, science-based innovation calls for a "link" between these two types of players, in many cases ensured by the so-called intermediary or interface organizations, such as RTOs, technology centres, incubators, etc. The completeness and working models of these innovation eco-systems strongly influences their performance. Complementary to this, particularly when addressing low/mid tech sectors or SME's, collaboration is also fundamental to gain critical mass and, at the same time, reduce costs and risks of individual companies.<br>This context justifies INESC TEC's strategic option of actively promoting and supporting the creation and operation of innovation eco-systems, aiming at facilitating and maximizing the success of science-based innovation activities (its main goal). These eco-systems are particularly relevant for collaborative research and innovation activities, including: roadmaping; applied research; dissemination, demonstration and pilot lines; cross fertilization and further exploitation, internationalization and synergies with EU programmes, among others.<br>Important instruments to materialize these eco-systems are clusters and platforms. |
| **Objectives:** | The main objective is to promote the creation of and/or to actively participate in innovation eco-systems related with INESC TEC's the main application areas/markets, aiming at: 1- developing and implementing collective research and innovation agendas, namely via collaborative research projects and other activities; 2- gathering all relevant stakeholders to cover the entire innovation cycle, from research to market uptake, including education and training; 3- mobilizing the necessary funding sources, including private and public, regional, national and international (namely, European); 4- developing and implementing collective research and innovation agendas, namely via collaborative research projects and other activities. |
| **Sector(s):** | Although INESC TEC competences and most of its activities are quite cross sectorial, the organization has a stronger presence in specific application areas/markets, such as Energy, Industry, Health, Sea and Agro-food and Forestry. Other sectors are also being addressed, namely Construction, Finance, Transports, Aeronautics, Space and Defence. |
| **Time span:** | In a more formal way, these activities started at national level, in the 90's, in the framework of a strategic collaboration established with the Shoe sector, involving the most relevant sectorial organizations, several shoe producers, technology providers for the sector (machine manufacturers, software houses, etc.) and other RTOs.<br>Later, this activity was significantly developed by the National Clusters Programme, launched by the Portuguese Government in 2008.<br>INESC TEC also participated in similar dynamics developed at European level, with the creation of the European Technology Platforms (since 2003) and PPPs (since 2009). |
| **Resources (person years/budget):** | Until 2019, most of this work was developed by the interested INESC TEC centres, but in 2019 a new organization structure was created to coordinate the organization's intervention in the most relevant markets/value chains, called "TEC4". In 2020, 5 "TEC4" were created (TEC4ENERGY, TEC4INDUSTRY, TEC4HEALTH, TEC4SEA and TEC4AGROFOOD), each one of them counting with a coordinator and a business developer. Complementary, a group of 3 more people ensure similar functions to the other markets covered by INESC TEC (mentioned above). The annual budget for this structure is around 0,75M€.<br>Currently, INESC TEC is an active member of 11 clusters at national level and 15 other similar initiatives (platforms, PPPs, etc.) at European level, involving an annual investment of more than 0,2 M€ only in fees. |
| **Management/ coordination** | As mentioned before, the new TEC4 structure coordinates the participation strategy in the different initiatives, at national and international level, for the related sectors or value chains, and also ensures several of the development activities, all this in close articulation with the interested INESC TEC Centres. |
| **Support activities:** | The growth of INESC TEC activities at European level led the organization to create an office in Brussels (https://hub.inesc.pt/), in collaboration with the other institutes of the INESC Group. This Hub supports INESC TEC researchers and management teams in all relevant activities in Brussels, namely the relation with the EC and with other partners also with offices there. |
| **Results/impact (measurable):** | This type of collective initiatives has a critical role in the creation and dynamization of innovation eco-systems. The active and relevant role that INESC TEC has in the creation phase and/or in the development of their activities gives the organization the possibility to: 1- have access to a broader audience of relevant and interested stakeholders and create new research and innovation dynamics; 2- influence the research and innovation strategy and roadmaps; 3- to establish solid and successful project proposals and consortia; 4- maximize results and impact (covering the entire innovation cycle, promote further exploitation and cross fertilization, boost dissemination and demonstration, etc.); 5- have easier and more successful access to funding programmes and instruments.<br>In 2020, INESC TEC had more than 100 collaborative research projects running, supported by national and European programmes, representing more than 6M€ of revenues.<br>This capability of acting at the different levels (European, national, regional) allows the organization to align research and innovation strategies and agendas and also the multiple supporting programmes and funding instruments, paving the way for an integrated approach to the entire innovation cycle and to take full advantages of the complementarities and synergies between the work developed at the different levels.<br>A good example to illustrate the results and impact of this strategy is INESC TEC intervention in the manufacturing area. The work done since 2003, both at European level (first, in the MANUFUTURE ETP, later in EFFRA and, |

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| | more recently in the EIT MANUFACTURING KIC), and at national level, with the creation, in 2008, of the PRODUTECH – Production Technologies Cluster, boosted the level of activity (number of projects, partners and revenues) and its national and international recognition as one of the main players in this field (supported by the fact that INESC TEC and its researchers have relevant positions in all these organizations).<br>It's also important to highlight that these dynamics didn't benefit only INESC TEC but also several other organizations. This can be illustrated with the significant increase in the participation in H2020 calls: Portuguese partners captured around 4% of PPP Factories of the Future related calls budget, when the national average is approximately 1,6%, and industrial companies, namely SMEs, got almost 50% of that value.<br>INESC TEC has similar examples in other areas, such as Energy, Sea and Agro-Food. |
| **Success factors and drivers:** | The need to address the diversification and speeding of technological development and to ensure return of the related investments is pushing stakeholders to work closer together and to implement more effective and efficient frameworks.<br>The growing recognition of importance of eco-systems as a key component for successful implementation of science-based innovation is a strong driver.<br>The existence of specific programmes or special conditions in the regular ones that promote and incentivize collaborative work (Roadmaping, R&D, education and training, etc.) is also a major driver.<br>INESC TEC positioning, as an intermediary organization between academia and business, potentiates and facilitates its role as promoter, facilitator and/or orchestrator of this type of initiatives.<br>INESC TEC accumulated experience and expertise, resulting from working at the different levels (European, national and regional) and with different types of sectors and companies (from low to high tech; from large corporations to SME's) provides the basis for a solid understating of the multiple dynamics that can be generated and also of the specific organizational models and supporting methodologies and tools that need to be customized to promote and support them. |
| **Barriers:** | Setting-up and operate sustainable innovation eco-systems is a mid to long term activity that calls for patience, persistence and significant investments (mainly in human resources) before it starts to generate benefits and impact.<br>Complementary, it's important to refer that several of the related costs are not eligible for support by public programmes, meaning that they need to be supported by the organizations.<br>In many areas, the number of existing organization and initiatives is very high, making the respective landscape difficult to understand, address and manage. |
| **Opportunities:** | The new European Research and Innovation and Industrial policies, where eco-systems (namely industrial eco-systems) are a key element.<br>The new European research and innovation partnerships, namely the new Missions, calling for the mobilization and active involvement of a large and diversified number of stakeholders and also a stronger articulation and complementarity between the European level and the national/regional level (synergies).<br>The growing importance and visibility given to Clusters, namely as orchestrators of innovation eco-systems, both at European level and also at national/regional level. |
| **Threats:** | Changes in policies are a major threat to the sustainability of innovation eco-systems. Unfortunately, this is quite frequent, causing difficulties to the initiatives. |
| **Lessons learned:** | The existence of solid innovation eco-systems is a key factor for the successful implementation of science-based innovation.<br>RTOs can play a relevant role, both as promoters of these initiatives and also in the dynamization of several of the related activities.<br>Well formulated and (particularly) stable policies and supporting instruments are also crucial. |
| **Further information (web page etc.):** | The following link contains several examples of results of collaborative projects and strategic partnerships established with companies and sectors:<br>Please access the link below and watch the videos numbered 31-61 which have English subtitles.<br>https://goo.gl/2xAYts |

## INESC TEC (PT): INESC TEC Higher Education Networking strategy

| KT Area: | Knowledge sharing |
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| **Description of activity:** | "The best way to transfer knowledge is through people". This concept is implemented at INESC TEC via the combination of advanced education (Master, PhD and Pos-doc programmes) with collaborative R&D projects with companies. Young researchers, supported by INESC TEC own grant programme or by public programmes, are involved in the execution of collaborative R&D projects with companies. This allows them to progress in their studies (towards an academic degree) and to have a first contact with the market and its reality. At the same time, they are a first level of already trained human resources to further develop and scale-up the new technologies, either in existing companies or through the creation of new start-ups. In many cases, these young researchers are contracted by the companies involved in the collaborative projects, thus benefiting from their skills and knowledge and allowing them to real incorporate the new knowledge. For INESC TEC, this also boost new opportunities for collaboration with those companies. |
| **Objectives:** | The main objectives of this activities are: 1 - to attract young students and researchers to our projects, providing them and interesting mix of advance education, contact with relevant companies and a good job perspective; 2 – to provide our customers and partners with new technologies and solutions but also with highly skilled people that they can hire; 3 – to develop new contacts and "entry points" in new companies via our former researchers. |
| **Sector(s):** | Multisectoral |
| **Time span:** | INESC TEC has been doing these activities almost since its creation but they were significantly increased with the creation of our own grant programme, in 2001. Complementary, the 2008 international economic crisis led several sectors and companies to invest more in research and innovation, thus needing more highly skilled human resources, namely in the areas of engineering and particularly in digital technologies. |
| **Resources (person years/budget):** | In 2020, grant holders represented around 40% of our researchers. Due to its nature, this activity involves all our research centres and also several of our supporting services (human resources, communication, etc.). Since 2010, our grant programme supported more than 1000 grants, mostly for Master and PhD, representing and investment higher than 12M€. Complementary, INESC TEC acts as an hosting organization for grant holders supported by national and international programmes. |
| **Management/ coordination:** | The advanced training programme has a dual coordination: the scientific component is managed by the coordinators of each INESC TEC centre (responsible for the selection of the research areas), in line also with the scientific strategy of the organization. The human resource department is responsible for all the supporting activities. |
| **Support activities:** | It's important to refer that the Master and PhD programmes and degrees are managed by the Universities and Polytechnic Schools, not by INESC TEC. Thus, it's very important to this programme the close relation INESC TEC has with those organizations and its academic staff. |
| **Results/impact (measurable):** | Every year, more than 200 young researchers leave INESC TEC and go to the market, approximately 75% with Master degree and 25% with PhD. This is, by far, our biggest contribution to knowledge spreading and sharing, and also to the economic and social development.<br>Considering that the organization has around 850 researchers in total, this gives an idea of the dimension of the staff rotation and also of the organization effort linked with this activity.<br>It's also important to refer that these young researchers come from many different countries and go to work also in many countries and types of organizations. Our alumni is a window to this level of impact. |
| **Success factors and drivers:** | Companies need highly skilled human resources, capable of developing and/or absorb new knowledge and use it to develop innovative solutions (science-based innovation).<br>The acceleration of technological development processes demands for a reduction of the time window between knowledge creation and market exploitation. It also calls for a better combination and alignment between technology development and education and training (particularly, advanced training).<br>The close collaboration between INESC TEC and Universities and Polytechnic Schools, particularly the involvement of academic teachers and researchers in collaborative R&D projects with companies, create the right framework to attract students and to involve them in those projects.<br>On the other end, the development of strategic partnerships with individual companies or sectorial organizations (such as technology centres or clusters) allows for a better understanding or joint development of technological roadmaps, setting the scene for mid/long term integrated research and education action plans. This is critical to identify and attract the right students for these activities. |
| **Barriers:** | In several cases, it's still difficult to support R&D and education and training activities in the same project (for example, it implies to use different funding instruments). |
| **Opportunities:** | More and more companies are investing in science-based innovation and this demands for highly skilled human resources. There is also a growing understanding of the importance of combining technological development with education and training activities. The current situation in the digital transformation area is a good example of that need: many companies refer that the main barrier for a faster implementation of digital technologies and solutions is the lack of qualified human resources.<br>This corresponds to a bigger effort and companies must play an active role there (they can't depend only on the "traditional" education system). But they can't do it also alone: collaborative actions, involving several companies and also education and training organizations is the right combination. RTO's are particularly well positioned to promote and implement this type of initiatives. |
| **Threats:** | Currently, the biggest threat to this type of activities is the pressure from the market for human resources. Students are attracted by companies even before they finished their studies, thus reducing the number of students wiling to enter in advanced training programmes. This is particularly serious in some domains, namely in engineering areas (including digital technologies). |

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| **Lessons learned:** | Companies need new knowledge / new technologies to feed their science-based innovation processes. But they also need the human resources with the right skills, necessary to develop and scale-up the new solutions.<br>The organizations that are able to provide them the two "components" have a solid competitive advantage.<br>RTOs are particularly well positioned to implement this type of approach. |

# Appendix 4: On Polish Stakeholders Engagement

## Short profile of Łukasiewicz Institutes

| Name | Profile |
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| Łukasiewicz - Instytut Logistyki i Magazynowania (Institute of Logistics and Warehousing) (Łukasiewicz-ILIM) | The Łukasiewicz-Institute of Logistics and Warehousing is widely acknowledged as Poland's centre of competence in logistics and a strategic partner of GS1 Poland. It is an interdisciplinary, state-owned R&D unit where logistics is perceived as both a subject of research as well as the field of practical application.<br>The Institute's main areas of competence embrace logistics including optimisation and designing of logistics processes, transport systems, distribution networks, hubs and warehouses. |
| Łukasiewicz - Instytut Lotnictwa (Institute of Aviation) (Łukasiewicz-ILOT) | The activities of the facility focus on the provision of design, engineering and research services in the field of aviation and aerospace. The Institute conducts international cooperation with the European Union and transatlantic countries in the field (primarily with General Electric as part of the Engineering Design Center): aircraft engines, aerodynamics, aircraft structures and material testing. The Łukasiewicz- Institute of Aviation also cooperates with Boeing, Airbus and Pratt & Whitney, and conducts research for other sectors of the economy. |
| Łukasiewicz-Instytut Technik Innowacyjnych EMAG (Institute of Innovative Technologies EMAG) (Łukasiewicz-EMAG) | It is a network institute specialising in applied computer science, technical information technology and information technologies. The Institute deals with, among others broadly understood cybersecurity, artificial intelligence, data analysis (decision support systems), IoT (Industry 4.0, Smart Cities), digital public services and laboratory research. The unit carries out tasks affecting the computerization and IT security of the country. Participates in creating the National Scheme for Assessing and Certifying the Security and Privacy of IT Products and Systems in accordance with Common Criteria.<br>Strong relationships with the industry, especially mining and energy, allowed to build a strong potential with experience, knowledge, implementation facilities, and a laboratory infrastructure in the field of testing equipment, systems and machines. |
| Łukasiewicz-Krakowski Instytut Technologiczny (Krakow Institute of Technology) (Łukasiewicz-KIT) | The Łukasiewicz – Krakow Institute of Technology conducts interdisciplinary research covering both classical and modern technologies of material production and processing. The Institute will develop 3D printing technologies based on metals, plastics and ceramics, and will also produce materials and tools for the advanced technology industry, e.g. space. Other research areas of the Institute will include: design and manufacture of materials for electromobility and fuel cells, production and processing of composite and nanocomposite materials for special applications, and development in the field of robotization and automation of processes in line with industry 4.0. |
| Łukasiewicz-PORT Polski Ośrodek Rozwoju Technologii (PORT Polish Center for Technology Development) (Łukasiewicz-PORT) | PORT Polish Center for Technology Development is a research and development organization focused on the development of new technologies by conducting research for the needs and in cooperation with the industry. PORT is a network of specialized scientific-research and technological laboratories as well as measurement and specialist laboratories, which are clustered in 6 research areas: biobank, biotechnology, nanobioengineering, special materials, photonics and electronics, analytics. Each of the areas brings together several specialized laboratories, all of them equipped with the highest-class research equipment that allows conducting application research maintaining the highest quality standards. |
| Łukasiewicz-Instytut Spawalnictwa (Institute of Welding) (Łukasiewicz-IS) | It is a leading and key welding research and development organisation in Poland. In its long-standing activity Institute of Welding has been solving problems in welding technology, coordinated numerous R&D projects and strengthened close links with the Polish industry and foreign centres Institute of Welding is the only organisation of its type in Poland, has the status of the Centre of Excellence. |

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| Łukasiewicz-Instytut Chemii Przemysłowej im prof. Ignacego Mościckiego (Industrial Chemistry Institute) (Łukasiewicz-ICHP) | The Pharmaceutical Research Institute and the Institute of Biotechnology and Antibiotics, belonging to The Łukasiewicz Network, have been incorporated into the Łukasiewicz – Industrial Chemistry Institute form June 1st, 2020.<br>The main tasks of the Institute are: scientific research focusing on applications, development, design and industrial application activities in the field of chemistry. The Institute offers licenses and know-how for modern chemical processes. Basic and applied research works are conducted and development works, implementation and design works related to chemical processes are carried out. |
| Łukasiewicz-Instytut Metalurgii Żelaza im St. Staszica (Stanisław Staszic Institute for Ferrous Metallurgy) (Łukasiewicz-IMZ) | Rendering scientific research, consulting and training services for steel producers, steel users and institutions involved in the steel business. |
| Łukasiewicz-Instytut Włókiennictwa (Textile Research Institute) (Łukasiewicz-IW) | The Institute carries out interdisciplinary research, development and implementation works in the field of technical sciences in the field of: material engineering, chemistry, polymer processing technology, environmental protection, nanotechnology, industrial biotechnology.<br>The Textile Research Institute is currently conducting scientific research and development and implementation works in the field of: textile materials that improve safety and quality of life, functionalization of textile and composite materials, textronic products – SmartWear, innovative 3D structures for technical and medical applications, bioeconomy in the field of textiles, circular economies, recycling textile waste, decorative replacement fabrics for revitalizing historic buildings – ReviTex, anthropometric research, among others for uniformed services, sustainable development. |
| Łukasiewicz-Instytut Obróbki Plastycznej (Metal Forming Institute) (Łukasiewicz-INOP) | The objective of the Institute's activity is scientific research and development works in the field of technical science disciplines of: construction and exploitation of machines, material engineering, mechanics, automatics and robotics, biotechnology, biocybernetics and biomedical engineering, as well as implementation of the obtained results to the industrial practice. The Institute is the leading scientific entity in the scope of technology and design of machines, devices and tools for non-metallurgical metal forming.<br>The Institute's mission is to improve the competitiveness of enterprises, especially small and medium ones, by implementing advanced, innovative and effective technologies, in order to build economy based on knowledge and cooperation. |
| Łukasiewicz-Instytut Tele- i Radiotechniczny (Tele and Radio Research Institute) (Łukasiewicz-ITR) | The Tele and Radio Research Institute is a first class research institute pursuing comprehensive and multidisciplinary research and development works over highly developed technologies and innovations having viable prospects for implementation in many business sectors.<br>The line of business of the Institute involves research and development works and adaptation of results of these works to practical applications. The works are carried out by specialised Research and Innovative Centres assigned to priority directions of the Institute's operations.<br>The Institute's mission is being realised by conducting scientific and research work and by applying such works and preparing them for implementation at the industrial scale. These efforts are carried out by specialised Centres. |
| Łukasiewicz-Instytut Elektrotechniki (Institute of Electrical Engineering) (Łukasiewicz-IEL) | Łukasiewicz Research Network - Electrotechnical Institute - research institute conducts research and development, unit and small-lot production, experimental production, product certification as well as publishing and standardization works in the field of electrical engineering.<br>The Institute consists of research and development departments, branch offices, an experimental facility, research and calibration laboratories, and a team for certification of electrotechnical products.<br><br>The Łukasiewicz Research Network - Electrotechnical Institute is the organizer and co-organizer of many national and international scientific conferences, where the latest problems and issues related to electrical engineering are presented and discussed. It publishes "The Works of the Electrotechnical Institute" - a non-periodical publication that has been published since 1951. It contains original articles based on theoretical and experimental research carried out at the Institute, as well as habilitation theses and shortened doctoral dissertations. |

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| Łukasiewicz-Instytut Napędów i Maszyn Elektrycznych KOMEL (Łukasiewicz-Institute of Electrical Drives and Machines KOMEL) | KOMEL Institute is a leading company in the field of electrical machines and drives issues such as testing, development, design, operation and diagnostics.<br>Current scientific research and development work conducted in the Institute includes: permanent magnet generators used in renewable energy sources, energy-saving drives and motors with permanent magnets, used mostly in electric vehicles drives, high- and low-power energy-saving electrical motors, explosion-proof motors used in mining and pump houses in oil and gas industry, special purpose electrical motors (e.g. aircrafts, machine-tool industry, ship industry, electric traction, military uses etc.). KOMEL Institute also offers diverse services related to electrical machines and drives such as: diagnostic tests of operating electrical machines, expert opinions on machine and drive failures, repair, reconstruction and modernization of motors and high-power machines in particular, reduction of noise and losses in older types of electrical motors, lab tests of models and prototypes of rotating electrical machines. |
| Łukasiewicz-Przemysłowy Instytut Maszyn Rolniczych (Industrial Institute of Agricultural Engineering) (Łukasiewicz-PIMR) | Łukasiewicz - Industrial Institute of Agricultural Engineering actively participates in the Network's initiatives, implementing a number of projects in the field of modern techniques for agriculture and the food industry - automation, robotization, use of digital solutions in agrotechnical works, environmental protection, renewable energy sources, precision agriculture.<br>The priority directions of the Institute's work include research on reducing energy consumption in the operation of machines, limiting the impact of machines and devices on the devastation of the natural environment and health hazards, satellite technology for the needs of precise agriculture, computer analysis of structures, as well as on the development of computer systems for designing and diagnosing machines. The basic product offered by the Institute for machinery industry enterprises are innovative machine constructions and specialized research and design services. |
| Łukasiewicz-Instytut Przemysłu Organicznego (Institute of Industrial Organic Chemistry) (Łukasiewicz-IPO) | Łukasiewicz Research Network - Institute of Industrial Organic Chemistry (IPO) is a leading research and development center of more than 60-year- long tradition. It carries out research concerning national defence, state services, chemical and manufacturing process safety as well as work for the agriculture including: production technology for plant protection agents, elaboration of effective and safe application of plant protection agents in arviculture and pomiculture. IPO elaborates and implements preparations for insect control in animal farming and sanitary hygiene, auxiliary products for pharmacy, household chemistry, paper and tanning industry. |
| Łukasiewicz-Instytut Technologii Drewna (Wood Technology Institute) (Łukasiewicz-ITD) | Łukasiewicz Research Network - Wood Technology Institute is the only research institution in Poland which deals in a comprehensive manner with theoretical and practical issues of wood processing, its application and creation of new composites based on woods<br><br>The Institute's mission is to conduct research aimed at production of modern materials and improvement of production technologies and processing techniques, which leads to harmonious and sustainable development of the wood industry and to achievement of high international competitiveness of the Polish wood sector.<br><br>Through implementation of research results in the form of innovative, energy-saving and hygienic materials using both wood raw material and wood waste, which help to improve the quality of life, have positive influence on the environment and health, and increase the share of renewable energy carriers in the national energy balance, the Institute strives to create modern wood sector which meets the requirements of the 21st century society. |
| Łukasiewicz-Instytut Inżynierii Materiałów Polimerowych i Barwników (Institute for Engineering of Polymer Materials and Dyes) (Łukasiewicz-IMPiB) | Łukasiewicz – IMPiB offers effective solutions in the field of engineering of polymer materials, elastomers and rubber, paints and varnishes, as well as the design and construction of machinery and equipment for processing polymer materials in modern forms of cooperation with the industry.<br>The Institute participates in international scientific events, we organize cyclical international conferences of the paints, plastics and elastomers industry, the main goal of which is to transfer the latest achievements in these areas to Poland, making it an information center for Central and Eastern Europe. |
| Łukasiewicz-Instytut Technologii Eksploatacji (Institute for Sustainable Technologies) | Łukasiewicz– The Institute for Sustainable Technologies for nearly 30 years already has been specialising in building up innovation performance in the areas of machine construction and maintenance, and technical and environmental safety. Additional areas of the Institute's activity include model solutions in the field of technology transfer and |

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| (Łukasiewicz-ITEE) | continuing vocational education, which are the foundation of the EU strategy – "Europe 2020." The focus on the EU and Poland's priority research areas enabled the Institute to undertake novel, cost-effective and socially required basic and applied research. |
| Instytut Mechaniki Precyzyjnej (The Institute of Precision Mechanics) -Łukasiewicz IMP) | The Institute of Precision Mechanics (IMP) conducts high-quality research, development and implementation activities relating to surface treatment of metallic products and improvement of mechanical properties, durability and corrosion resistance of tools, machine parts and structures. The primary goal of the Institute is to transfer the developed technologies – including the equipment required to use them, measuring and testing instruments and know-how – into all branches of the industry and also to provide services. During the many years of its activity, the Institute has become a recognisable brand, and the effects of its research are in common use. |

## Short profile of interviewed Polish Stakeholders

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| **Ministerstwo Rozwoju i Technologii**<br><br>Ministry of Economic Development and Technology | The Ministry is an office of government administration providing services to the Minister of Economic Development, Labour and Technology. The areas of the activity of the Ministry are: economy, work, construction, planning and spatial development and housing, as well as tourism. The strategic goal of the institution is to modernize Polish economy in terms of technology and ecology. |
| **Ministerstwo Edukacji i Nauki**<br><br>Ministry of Science and Education | The Ministry of Education and Science was established on January 1, 2021. It provides services in the field of education and upbringing, as well as higher education and science. It aims at improvement of the quality of Polish science and higher education and creates the best possible working conditions for students, academic teachers and researchers. The Ministry focusses on cooperation between science and the economic environment. |
| **Porozumienie Akademickich Centrów Transferów Technologii (PACTT)**<br><br>Polish Association of Centers for Technology Transfer | PACTT is an association of major universities in Poland, including technology and medical universities. It gathers together representatives of technology transfer offices (TTOs) responsible for protection, management and commercialization of Intellectual Property (IP).<br><br>PACTT plays an important role as a platform connecting science and business. As PACTT, we facilitate communication, cooperation and research by implementing a model of one-stop shop. We support business through brokers acting as dedicated coordinators who review and select relevant inventions and research teams from more than 70 Polish universities. This way you can easily access research potential in academia across Poland. |
| **Wrocławskie Centrum Transferu Technologii (WCTT) Politechniki Wrocławskiej**<br><br>The Wroclaw Centre for Technology Transfer (WCTT) of Wroclaw University of Science and Technology | WCTT is one of the national leaders in the commercialization of research results, ensuring effective transfer of knowledge and technology to an innovative economy. From the very beginning, the Center has treated the transfer and commercialization of technology as one of the main areas of its activity. The Wroclaw Center for Technology Transfer is the initiator and one of the founders of the nationwide Alliance of Academic Technology Transfer Centers (PACTT), currently grouping over 60 centers from public universities. |
| **Polska Izba Gospodarcza Zaawansowanych Technologii**<br><br>Polish Chamber of Commerce for High Technology | The Chamber stimulates the development of knowledge-based entrepreneurship and to provide comprehensive assistance to its members in achieving commercial success of their innovative projects in the field of advanced technologies.<br>Chamber's fields of activity: |

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| | • promotion of high-tech entrepreneurship, achievements of the Chamber's members and creators of advanced technologies,<br>• undertaking activities to expand the cooperation of entrepreneurs with research and development and scientific units as well as technology transfer |
| **Agencja Rozwoju Przemysłu (ARP)**<br><br>Industrial Development Agency (IDA) | The IDA supports business enterprises in operation and development of business activity, as well as in the implementation of restructuring processes, and plays a major role in increasing competitiveness of Polish industry.<br>The IDA finances enterprises from various industries; however, it specialises in financing industrial enterprises as well as enterprises providing services for industry. |
| **Narodowe Centrum Badań i Rozwoju (NCBR)**<br><br>National Centre for Research and Development | The National Centre for Research and Development (NCBR) is an executive agency as it is understood according to the Act on Public Finance of 27 August 2009, established to carry out tasks within the state policies on science, innovation, as well as science and technology. NCBR is a centre for supporting and developing innovative technological and social solutions, creating an ecosystem of knowledge of, and information about, innovation. It organises and implements undertakings contributing to the civilization growth of the country. Since 2011, the Centre has also been an intermediate body for priorities within the area of supporting higher education and the R&D sector. |

# Appendix 4: On the Project Team

## VTT Team

**Rafael Popper** (PhD) (Technical & Scientific Leader) is Founder and Director of Futures Diamond Ltd and Director of Executive Education in 'Foresight and Sustainable Futures', 'Foresight in Action', 'Foresight Methods', and 'SMART Foresight' at the Manchester Institute of Innovation Research (MIOIR) of the University of Manchester in the UK. In 2018 he was appointed Professor of Foresight and Science, Technology and Innovation (STI) Governance at the National Research University Higher School of Economics (HSE) in Russia and he has been Principal Scientist in Business, Innovation and Foresight at VTT Technical Research Centre of Finland Ltd (2016-2021). He has over twenty years of experience working as foresight and innovation policy consultant for several international organizations including the European Commission, Economic Commission for Latin America and the Caribbean (ECLAC), United Nations Industrial Development Organization (UNIDO), United Nations Development Programme (UNDP), World Bank, as well as for several government and business organisations in Europe, Latin America, Africa, Asia and Australia.

**Riina Bhatia** (MSSc) is a Research Scientist in Future-Proof Societies at VTT Technical Research Center of Finland. She holds a MSSc in Peace, Conflict and Mediation research and is currently pursuing a MSc in Environment, Politics and Development as SOAS, University of London. She has previously worked at the European External Action Service in New Delhi, European Migration Network, Economic Development Office of Finland and as a gender equality consultant at a Nordic research consortium. Her interest and expertise lie in political economy, development and sustainability, gender equality, migration and energy transitions.

**Janne Lehenkari** (PhD) is Research team leader at VTT Technical Research Centre of Finland. He has over 20 years of experience in innovation research, impact assessment and policy work. Currently, Lehenkari is project manager of a large-scale impact assessment of H2020 projects funded by Societal Challenge 5 (EC, DG RTD). In 2018-2019, Lehenkari was expert in a feasibility study for Technical Expertise on Best Practices from Other Countries in the Context of Upcoming Establishment of the New Polish Łukasiewicz Research Network (EC, SRSP).

**Asta Bäck** works as Principal scientist at VTT Quantitative science and technology studies team. Since 1983, she has held various positions at VTT, such as team leader and research scientist. She has been a project manager in national and European projects. Her expertise and research interests include media technology and media innovations, use of social media to support innovation processes, as well as natural language processing and social network analysis methods for analyzing various kinds of textual data. Her research has been published in the Journal of Innovation Management, the Journal of Future Studies, Strategic Thinking and Policy, and the International Journal of Social and Humanistic Computing, among others

**Jouko Myllyoja** (M. Sc. Marketing, M. Sc. Environmental engineering, BA) works as a senior scientist in Future-proof societies -team in VTT. Jouko shares particular interest towards methodological development of foresight - futures knowledge creation through participatory activities and actions in particular. His responsibilities have covered conducting foresight projects in various substance areas. His thematic fields of interests concern e.g. innovation ecosystems, organizational development and futures

of work. His international assignments have covered projects such as Cybersecurity Awareness and Knowledge Systemic Highlevel Application (Horizon 2020), Policy instruments and Incentives for Circular Economy (EIT) and ICT for Health in South Africa (Ministry for Foreign Affairs of Finland).

## ISI Fraunhofer Team

**Thomas Stahlecker** (PhD) studied economic geography, international technical and economic cooperation and business administration at the Technical University of Aachen (RWTH Aachen). In 1998 he received his master's degree, in 2005 his doctoral degree. Between 1999 and 2000 he was employed as a researcher at the Center of Technology Assessment in Baden-Wuerttemberg. Since May 2000 he has been working at the Fraunhofer Institute for Systems and Innovation Research ISI in Karlsruhe as a senior researcher and project manager in the Competence Center 'Policy – Industry – Innovation'. Since 2007 he is the coordinator of the business area 'Regional Innovation Systems'. His current fields of interest are regional economic theory, regional technology oriented development, regional innovation and technology indicators, evaluation of policy programmes, innovation and technology policy.

**Andrea Zenker** (PhD) worked as trainee and technical assistant at the Lower Saxony Forest Tree Breeding Station in Staufenberg-Escherode, before she studied Geography and Modern Languages at the University of Gießen and the Université de Besançon. In 1996, she received her diploma in Geography from the University of Gießen. She then worked as consultant for Desktop Mapping at GRIT in Werne. In 1997, she joined the Fraunhofer Institute for Systems and Innovation Research ISI Karlsruhe where she works as researcher and project manager in the Competence Center 'Policy – Industry – Innovation'. In 2007 she was awarded her doctoral degree in Geography from the Université de Strasbourg (then Université Louis Pasteur). Her research interests are in regional innovation, methodological questions in innovation research, knowledge, creativity and innovation, and comparative aspects of innovation in France and in Germany.

**Ewa J. Dönitz** (PhD) has been a senior researcher in the Competence Centre Foresight at the Fraunhofer Institute for Systems and Innovation Research ISI since 2009. She is Coordinator of th e Business Unit Foresight for Strategy Development. She is an expert in scenario development and supports colleagues across the Institute in developing scenarios in various thematic areas and leads national and European Foresight projects. Her research is focussing on the whole range of Foresight methods in particular scenarios, visions and roadmaps and its application for underpinning strategy building and innovation processes. Since June 2013, she has been a coordinator of the Business Unit Foresight for Strategy Development. She teaches innovation and project management at the Femtec Berlin. Since 2011 she has been a lecturer for the futures research methodology at the University of Kassel and Karlsruhe Institute of Technology. After having studied economics at the Oskar Lange Economics Academy in Wrocław (Poland) and economics at the University of Bremen, she worked as a research associate at the Institute for Project Management and Innovation (IPMI) at the University of Bremen and received her PhD with a thesis on advancing the scenario methodology.

**Hendrik Hansmeier** studied geography at the University of Marburg, where he received his Bachelor's degree in 2016, and economic geography at the University of Hanover and the Jagiellonian University of Kraków, finishing with a Master's degree in 2018. During his master's studies, he was employed at the German Centre for Higher Education Research and Science Studies as a research assistant, in the research area 'Educational Careers and Graduate Employment'. In February 2019, he joined the Fraunhofer Institute for Systems and Innovation Research ISI in Karlsruhe and since that time has been working as a

researcher in the Competence Center Policy and Society, in the Business Unit Regional Innovation Systems. His current research interests include analyses of the emergence, diffusion and impact of knowledge and innovation on the regional level, the design and implementation of regional innovation and technology policies, as well as methodological aspects of regional innovation research.

## EPRD Team

**Małgorzata Olesiak**, Director of EPRD Research and Evaluation Department, participated in numerous research projects as EPRD Project Director (since 2005) and expert/ evaluator (since 2007). She has extensive experience in analysis, including evaluation and data collection (conducting interviews, surveys, elaboration of case studies) in the field of innovation, R&D and technology transfer ("Analysis of knowledge-intensive sectors in the region of Mazowsze in the context of smart specialization", "Cooperative relations between companies with foreign capital shares and domestic companies - a result of the diffusion of knowledge and innovation (spillover effects)", "Legal support in implementation activities for ERDF R&D projects in Poland"). Małgorzata has been Country Team Leader in the project "Mainstreaming Climate Change into CSF-Funds 2014-2020". She coordinated and conducted quality control activities in a number of projects in the area of innovation funded by the Ministry for Foreign Affairs of Finland. Ms Olesiak possesses good analytical and report writing skills. Recently she has been engaged as Project Director in the DG Research and Innovation "Study on fostering industrial talents in research at European level".

**Tadeusz Peczek** holds a master's degree in Agriculture and Agricultural Mechanisation. He is the owner and President of the Board of EPRD and acts as a senior adviser in the area of regional development, partnership building, R&D, knowledge transfer, agri-products market structures, and SME development. During the last 20 years, by performing the post of the Project Director, he has been responsible for the management and monitoring of over 50 projects financed by the EU and other international agencies in Poland and abroad. As the founder of EPRD, from 1995 he supervised the company activities aimed at supporting regional and local development, with particular focus on assisting self-governments in obtaining external funds for investments, elaborating local development plans and establishing their spatial policy. From 2000 he was involved in the preparation and implementation of projects financed under structural funds (in Poland) and pre-accession funds. Mr. Pęczek has in-depth knowledge of EU Cohesion Policy issues, structural funds and EU pre-accession instruments, particularly PHARE and SAPARD procedures as well as an extensive experience in the area of rural and urban development. He has a proven knowledge and experience in creation of cooperation platforms linking business and science and providing assistance to research institutions in knowledge transfer, including conclusion of the cooperation agreement between EPRD and Center for Pre-Clinical and Technological Research (CePT), the largest biomedical and biotechnological initiative in Central and Eastern Europe.

**Anna Gajek** holds a master's degree in environmental protection. He is the coowner and Vice President of the Board of EPRD and acts as a senior adviser in the area of regional development and environmental issues in relation to investment and infrastructure projects. She has knowledge with large infrastructure projects for public and private clients realized at municipal, regional and national level. From 2000 she was involved in the preparation and implementation of projects financed under pre-accession funds and structural funds (in Poland). She was responsible for the management of team of experts in preparation of application to national and international funds (Structural and Cohesion Funds, EEA Grants, Norway Grants, Swiss Contribution). She was responsible for the management of team of expert in preparation

Environmental Impact Assessments (EIA). She has experience with multi-functional development of the regions and environmental protection at local and regional level, preparation of regional and local studies on spatial planning, preparation of socio – economic development strategies. Her expertise includes the partnership building, creation and development of small and medium enterprises. She has knowledge in the field of innovation and technology transfer. Anna has proven knowledge and experience in creation of cooperation platforms linking business and science and providing assistance to research institutions in knowledge transfer, including relevant support provided to the Institute of Environmental Protection and the New Chemical Syntheses Institute.

**Monika Mańkowska** holds master's degree in Romance Philology (French and Italian) at Maria Curie-Sklodowska University and a Post-Graduate at the UNESCO Chair for Translation Studies and Intercultural Communication at Jagiellonian University (French and Italian). Monika is an efficient senior manager with over 6-year experience in managing EU and other international donors assistance projects and more than 10 years of working experience in the areas of marketing and communication. She has a solid track record of supervising projects and supporting the events organisation as well as event management (workshops, conferences, clusters and hubs, fairs). As examples of the projects successfully managed by Monika we can give TA - DEAR for EU members states and multinational framework contract - Joint Programming, where she coordinated the work of event organiser and involved herself as event coordinator. She has been in charge of quality assurance in our backstopping services for projects in Europe but also in Africa. Through these experiences she has gained in-depth knowledge about the EU approach and regulations governing the logistics of EC events. Moreover, the preparation of events being closely related to the communication strategy and marketing materials requires excellent knowledge of the Communication and Visibility Manual prepared by the EC.

**Agnieszka Naudeer** holds master's degree in sociology and law at John Paul II University. Agnieszka works as an assistant with over 3 years of experience in supporting management of international projects and over 3 years' experience in the areas of education management. Before joining EPRD she worked in the education sector. She has a track record of supervising projects and supporting the events organisation as well as event management (live webinars, workshops, fairs). She is a co-founder of a Saturday school in England where she was responsible for the legal issues as well as the School Improvement Plan. Since she joined EPRD, she has been working as an evaluation assistant.

## AARC Team

**Nicholas Holmes** is an Associate Director at AARC. He holds a 1st class honours Postgraduate Diploma in Management Practice from the Smurfit Graduate Business School, a MSc. in Business and Entrepreneurship, and a Bachelors' in Engineering from Trinity College Dublin. Nicholas is primarily involved in the quality assurance and management of a range European Union projects focused on Digitalization, Research & Innovation, and the EU Green Deal. He is an experienced project manager, having worked on a wide range of projects across the EU and internationally since 2009.

# Appendix 5: Acknowledgments

We are grateful for those organizations and their experts who took the time to share us their experiences and insights regarding their respective organizations' knowledge transfer strategies. Thank you TECNALIA, Science Foundation Ireland, TNO, INSEC TEC, VTT, AIT and ISI Fraunhofer.