UNIVERSITIES OF THE FUTURE

COLLABORATIVE DIGITAL SHIFT TOWARDS A NEW FRAMEWORK FOR INDUSTRY AND EDUCATION

Handbook for HEIs

(Higher Education Institutions)

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Introduction

1 Introduction

The fourth industrial revolution is bringing significant changes in working life and private companies' operations. Universities must adapt to the ongoing changes and take up the resulting challenges. First, they should educate specialists in emerging professions who understand new technologies and know-how to use information strategically. These specialists should not only have high competencies in their specializations but also understand the problems of other specialties and be able to contribute to them using their skills and knowledge (T-shape).

However, it is often not known what the labor market will look like in a few years, so universities should place great emphasis on educating in soft skills, such as the ability to work in interdisciplinary teams, the ability to quickly learn and search for relevant information online.

Higher education institutions can support companies in taking their challenges on, providing a skilled workforce and constant training. Moreover, not only is the cooperation is mutually beneficial, as the industry can deliver market insights. It is also providing support, innovation, and economic development for local societies through social programs.

The handbook was created to briefly present Industry 4.0 and its potential benefits and threats for HEIs – higher education institutions. Opportunities for development and changes brought about by changes in the organization of work resulting from the onset of the fourth industrial revolution will be presented, as well as threats resulting from the insufficient speed of adapting to the market needs. Moreover, it promotes sincere cooperation between the industry and Higher Education Institutions. The recipients of this publication are executives in companies that want to be a conscious subject of Industry 4.0 revolution

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Education of the future

2 Education of the future

The world and the reality in which we live are constantly changing. Only a few dozen years ago, an employee graduating from school had a job guaranteed until the end of his life. However, the rapid development of technology, and thus also of everyday life, brings us constant changes. The short life span and continuous development of technology mean that what was a technical novelty at the beginning of studies, is after graduation often a dying and outdated technology. This entails the need for continuous learning, training, and often changing the profession, even several times in a lifetime. This results in the need to supplement the teaching paradigm, from a one-time and long process of acquiring knowledge and skills, to short forms of life-long learning and short training courses. Besides, technological changes bring us new opportunities for the development of education. One of the outstanding ones is Massive Open Online Courses (MOOCs), which allow you to expand your knowledge and skills with a specific fragment. International education is another important aspect facilitated by the constantly evolving ICT technologies. Thanks to instant messaging, cloud technologies, and tools for managing the learning process, constant cooperation, meetings, and development are possible. Some examples of this are as follows: the International Joint Post-graduation in Industry 4.0 – Digital Innovation and Transformation, carried out in cooperation with Portugal, Poland, and Finland at the turn of 2020/2021, the result of the Universities of the Future project; the ME310 course, organized by the international SUGAR network; and the SQUAD course, organized by three universities belonging to the Design Factory Global Network (DFGN)- Porto Polytechnics, Warsaw University of Technology, Pace University.

2.1 Post-pandemic situation

The aftermath of the SARS-CoV-2 virus spread around the world resulted in changes that few had foreseen – a complete change in the organization of work, education, health care, the collapse of enterprises, the emergence of new business models, and much more. The rapid response of universities and schools to lockdown resulted in extremely rapid changes in education, online learning was organized, and many teachers took advantage of educational support tools such as virtual whiteboards and classrooms, gamification solutions, video recordings, and many others. After the COVID-19 pandemic, will these changes be abandoned? According to the author of this handbook, no. On the contrary, it will be an impulse for further development of online education. One can only hope that the advantages of on-site education will be balanced with those of online education.

2.2 Education 4.0

Education 4.0 is a term associated with Industry 4.0 which refers to the changes in education caused by industrial transformation. So, we can say that the fourth industrial revolution will affect the roles for which we are preparing today's students. From HEIs, this will require an effort to prepare new employees to work in an era of technological transformation. Besides, it will also require existing employees to upgrade their skills and knowledge to fit the newly created job roles.

To this end, a revolution in education is needed to enable people all over the world to take advantage of the opportunities created by the advent of these technologies (Education 4.0, 2019).

2.3 Competences of the future

During the work on the "Universities of the Future" project, the work skills for Industry 4.0 were identified (see Fig. 1). These are divided into two main categories: domain-specific and transferable skills. Domain-specific skills are engineering, business and management, and design and innovation. Distinguishing between these three skills is of great importance and shows what the work of an engineer of the future will look like. They should have the knowledge and engineering skills, they should be able to design innovative products, and finally be able to sell the results of their work.

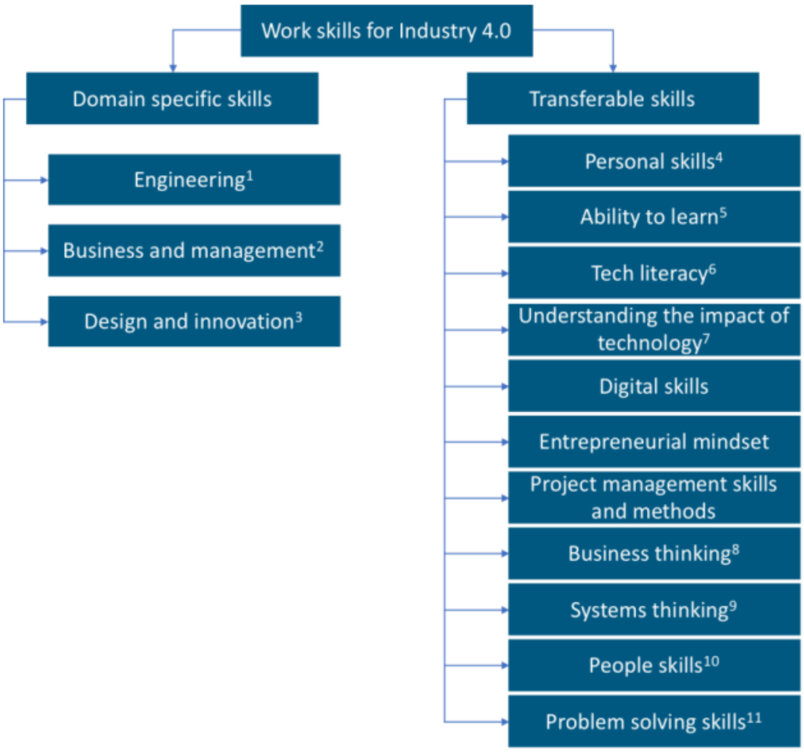


Figure 1 Skills for Industry 4.0 (Based on State-of-maturity report, PKA focus group, enabling event Finland)

[1] **Engineering**: data science (advanced big data analytics, etc.), novel human-machine interfaces, digital to physical transfer technologies, advanced simulation (virtual plant modeling, etc.), automated production management systems (for product and process quality control, inventory, logistics), AI; robotics, automation, programming, IT (data communication, networks, etc.), mechatronics, cybersecurity, AR and VR

[2] **Business and management**: Change management and strategy, talent management (strategies and tech tools), organisational structures, managers learning to become facilitators, business analysis (using forecasting data and planning metrics)

[3] **Design and innovation**: Human-robot interaction and user interfaces, tech-enabled product and service design

[4] **Personal skills**: self-management, self-knowledge, self-motivation, self-confidence, work attitude, professional and ethical responsibility, (State-of the Art report) curiosity, risk-taking and resilience, flexibility, growth mindset

[5] **Ability to learn**: Lifelong learning, self-learning, learning how to learn

[6] **Tech Literacy**: basic science and tech including mathematics, understanding of tech

[7] **Understanding impact of tech**: Social impact and industrial impact, such as use cases

[8] **Business thinking**: service orientation, LEAN, basic business principles, etc.

[9] **Systems thinking**: understanding ethical issues, futures literacy, ability to create new business models

[10] **People skills**: Empathy, emotional intelligence, communication (written, oral, and use of communication tech, persuasion, negotiation), teamwork (multidisciplinary, international), leadership

[11] **Problem-solving skills**: , gathering, analysing and managing information, knowledge management, creative thinking, critical thinking, analytical thinking, experimentation, judgement or decision making.

In turn, the selection of transferrable skills shows us the importance of soft, personal, and people skills, as well as the importance of lifelong learning. Future education should provide sufficient technology literacy skills for workers to be able to self-upskill. It is crucial for people to understand the impact of technology and to have strong digital skills. The worker of the future should be able to think on the global level and to see details without losing the whole view. They should be able to solve complex problems and to see the solutions as well as the commercialization opportunities.

University of the Future

3 University of the Future

We are referring to the concept of the project title, University of the Future, as we believe our goal is to provide guidance for HEIs to such a University of the Future.

3.1 University of the Future in 20 years

During one of the Ignition Events, held on January 28th, 2019, a wide group of representatives of state institutions, company managers, university employees, and students reflected on, among other things, what the university of the future should look like in 20 years. Writing this material two years later, a year after COVID-19 entered Europe, many of these seemingly futuristic statements are now the norm or at least a vital need.

Online learning and access. Firstly, distance learning, which has been the norm for almost a year for higher and lower levels of education should be accessible to everyone. This is also related to access to resources (laboratories, equipment), not only without entering the university but also without leaving your home.

Practical, contemporary, real problems. A continuous need is to teach students by having them solve real problems. This method is used in many courses, for example during the Universities of the Future joint post-graduation course, the international Product Development Project courses, ME310, and many others. However, this approach is more difficult for teachers, as they have to constantly track and obtain such problems for resolution. A similar aspect is the flexibility of the programs that should be implemented according to market needs. This requires the constant evolution of the curricula. An interesting conclusion from the event is the idea that the professor should have extensive experience, not only theoretical but also practical in his field.

The interdisciplinarity of programs, subjects, majors. Completion of the course should take place through the implementation of an interdisciplinary project, and not only through memorization. An important aspect of this is the concept of the T-shape skills of the professors, i.e. specialization in a specific field complemented with a wide horizon and understanding of others.

Passion, openness of the administration, students, teachers.

Good organization of the teaching process, partnership, and **continuous dialogue** of student-lecturer-administration. There is often a situation where students do not provide their comments on the work of teachers, do not report that the course is inadequately conducted, when the administration does not understand the educational process and thus creates (often unconsciously) problems for both the teacher and the student.

Verification of the university by its clients: employers who hire graduates for work and graduates whose usefulness is assessed after leaving the university walls. The labor market should verify the quality and brand of studies.

Internationalization of the university and entering into partnerships, as well as creating networks with others. This will increase the mobility of both physical and virtual staff and students. Thanks to internationalization, students will be able to gain education and experience in different places around the world, and teachers and professors will be able to conduct research together with various partners. This will lead to effective learning in different universities as the student will have the opportunity to obtain learning outcomes by choosing courses from different universities. Learning foreign languages is also an important aspect.

This is closely related to the creation of various **networks of universities** (and other institutions) (e.g. Global Design Factory Network, SUGAR, European University Network), at various levels, such as education, science, and entrepreneurship.

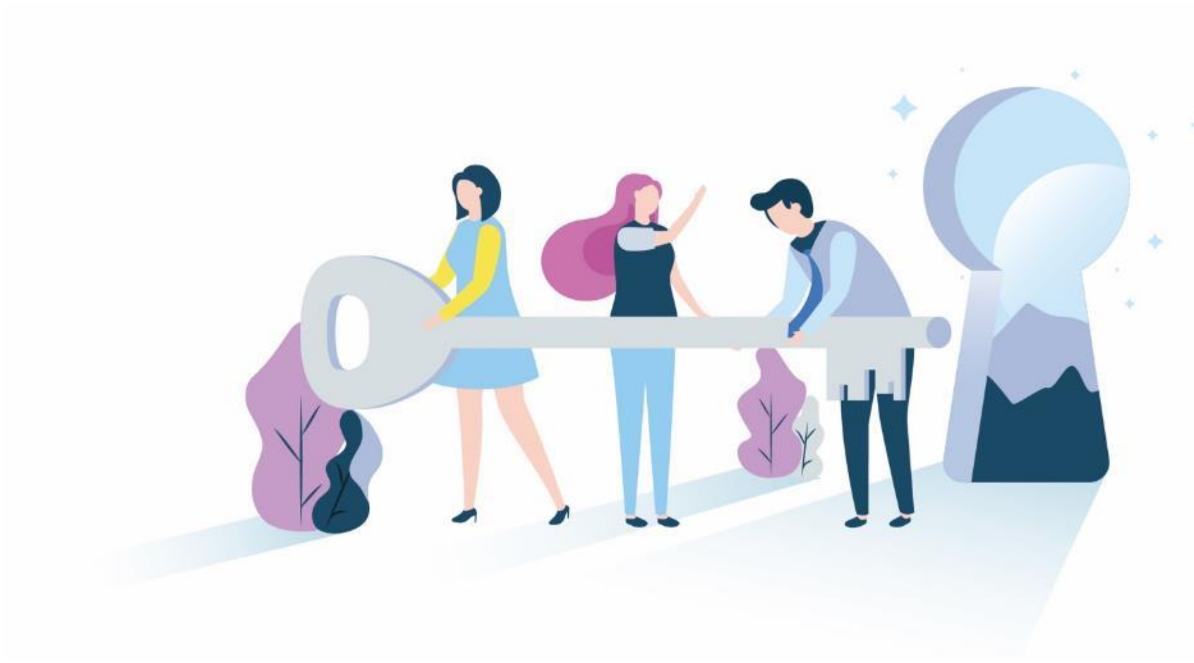
In the era of Industry 4.0, **technology** is one aspect you cannot overlook. Process automation will mean that more and more emphasis should be placed on learning soft skills that will increase staff productivity and enable creative problem-solving. Moreover, one should focus on the use of technological tools for education, and put emphasis on learning to use ICT tools. In the era of assistants (e.g. google assistant, Alexa), the emphasis should be on learning to ask the right questions and critically evaluate the information provided from different sources.

3.2 Competences of the University of the Future

The constitution of knowledge-based economies, coupled with dynamic, digital, and unstable contexts, has led to a greater appreciation of a mixed-match between highly technological hard skills, and soft skills, combined with the student's behavior and mental, emotional, and social skills. It is, therefore, possible to list the following four main dominant skills acquired by the Universities of the future: engineering, which is the application of technical and scientific knowledge with the purpose of inventing, designing, building, and improving the structures, machines, and pieces of equipment, systems and processes and materials from several fields of economic activity; business and management, concerning the set of skills that pertain to a company's management, coordination and administration, for which organization, planning, target-setting, problem-solving and the monitoring of the work stages are crucial; and design and innovation, which are intimately connected, referring to the innovation process guided by design, close to the connectors, which takes advantage of its ability to understand and influence the way people can ascribe meaning to things since people purchase meanings, narratives and not things. Regarding soft skills, design thinking in business deserves to be highlighted as a process that builds trust and confidence with the business partners, empowering designers to do a great job, and tech literacy, which is the ability to use, manage and assess technology. Technological literacy is related to digital literacy in that when an individual is proficient in using computers and other digital devices to access the Internet, digital literacy gives them the ability to use the Internet to discover, review, evaluate, create, and use information via various digital platforms. Furthermore, it is important to reflect in an integrated and systemic way, from an analytical, creative, communicative, and data-decision-oriented standpoint.

3.3 University of the Future structure

Theories on entrepreneurship have expanded and been enhanced in the last few decades. In parallel, universities have also fostered an upgrade to their roles to become more futuristic and innovative, thus serving the society they belong to and becoming accessible to everyone. Entrepreneurship and education are two opportunities that need to be leveraged and interconnected in order to develop the necessary human capital to build the societies of the future since entrepreneurship is the engine that fuels innovation, the creation of qualified jobs, and economic growth. The phrase “entrepreneurial university” was first used by Clark (1998), in his study *Creating entrepreneurial universities: an organizational path of transformation*, which defines it as the university that operates changes in its structure and organizational culture and strengthens its management core, namely through curricula, programs, and funding sources. The entrepreneurial university is thus more social as well evolutive and constantly seeks to be innovative, becoming more proactive, flexible, and dynamic in managing its relations with the economy and society, even if taking risks. Gibb, Haskins, and Robertson (2013, p. 25) assert that universities face enormous challenges as well as new opportunities in the creation of an entrepreneurial culture, since the massification of education, limited (and decreasing) public funding, and global competitiveness make Higher Education institutions more sensitive to environmental development and, consequently, to entrepreneurial activities. Although it was initially conceived as a transmitter of knowledge, the university later embraced the task of creating knowledge, developing a “second mission”. More recently, universities were assigned a “third mission”, that of contributing to society and to socioeconomic development in a more direct way, in order to become an entrepreneurial university. Broadening the focus of traditional universities – based on teaching and researching is currently the great challenge of many universities, considering that the entrepreneurial university can be a global public agent by fostering the development of the local, regional, national and international communities, through the creation of public value.



HEI Industry collaboration

4 HEI Industry collaboration

4.1 University-industry collaboration and their determining factors

Networks play a crucial role in the innovation processes (Powell & Grodal, 2005; Chesbrough, 2003). They allow the companies to access external sources of knowledge and they are regarded as key success factors in core conceptual models (such as the Kline Rosenberg model, 1986) and world-renowned measuring structures (OECD & Eurostat, 2005).

A growing number of studies provide empirical evidence regarding the increasing importance of networks and pinpoint different collaboration patterns in accordance with the innovation strategies that the companies adopt (Badillo & Moreno, 2016; Dachs et al., 2008; Srholec, 2016; Veugelers & Cassiman, 2005). In this regard, a fundamental role is played by the companies' various partners, and their institutionalized knowledge (universities, R&D organizations) (Kaufmann & Tödtling, 2001; Lee, 2000; Perkmann & Walsh, 2007; Schartinger et al., 2002). Through these collaborations, companies strive to complement their technical and scientific knowledge, as well as their qualified equipment and employees, whilst educational institutions gain access to additional research funding, empirical data, and training opportunities. These collaborations are also actively supported by political decision-makers and public policy analysts, as they exploit commercial opportunities that concern Science and Technology (OCDE, 2016).

Research concerning organizational innovation has for long been used to study the determinants and the motives that lead to cooperative activities between innovation partners (Aschoff & Schmidt, 2008; Badillo & Moreno, 2016; Dachs et al., 2008; Lööf e Broström, 2008; Maietta, 2015; Srholec, 2016).

Studies conducted within the context of emerging markets suggest that the efficiency of R&D collaboration strategies may be significantly harmed by deficiencies in the national innovation systems (Hayter et al., 2018; Parilli e Heras, 2016; Wright, 2014). Moreover, the absorptive capacity of these countries' companies is greatly undermined, since they are lacking the necessary skills (Wang & Han, 2011; Zahra e George, 2002). Many companies have limited access to financial means, thus constraining their collaborative potential, as well as their empirical studies, which are reduced to models that do not capture the complexity of the innovation processes, as they take into consideration a narrow range of determinants (Aristei et al., 2016; Eom & Lee, 2010).

It is assumed that the inclusion of other factors, such as logistics management, product design, innovative process/service, or strategic orientation could have a similarly large influence on any economic activities, in addition to the R&D expense and the hiring of highly qualified human resources.

The determinants that lead to R&D cooperation (with the purpose of reaching R&D results that generate innovation) and to consulting cooperation (aiming at the purchase of C&T services) are not the same and must therefore be identified. The factors that determine the mode of cooperation with the knowledge producers should thus be clarified, as well as the main obstacles that stand in the way of successful cooperation, highlighting the role of universities and business organizations.

Innovative companies that seek technological advances, radical innovation, and the introduction of new products are fairly dependent on connections with academic partners in order to obtain scientific knowledge (De Faria et al., 2010; Kaufmann e Tödtling, 2001). Access to academic knowledge and the results of research driven by problems and solutions add to the creation of business ideas (Schmidt e Salomo, 2007), technology development, and disruptive innovation (Cohen et al., 2002; Lee, 2000; Mansfield, 1998). Scientific knowledge is a fundamental input to production processes, namely in the initial stages when the search for innovation results is still relatively low (Jensen et al., 2003).

In addition to knowledge exchange, industry-science interactions bring economic benefits (such as access to additional funding, equipment, and facilities), learning opportunities (for instance by means of R&D projects consortia or personal mobility), and reputation gains for the actors involved, especially for the universities.

However, the considerable information asymmetries between partners and significant differences in the standards that regulate scientific and commercial activities inhibit science-based technology transfer.

Companies strive to conceal research novelty and to capture valuable knowledge, whereas researchers endeavor to disseminate their most recent scientific results (Bruneel et al., 2010; Fiaz e Naiding, 2012). In this regard, several factors influence the process of translating academic research knowledge into development and technology innovation and explain the multitude of interaction modes between the industry and science and technology transfer. These factors include types of transferred knowledge, characteristics of the knowledge senders and receivers (including geographical proximity), the companies' innovation strategies, and the intensity of personal contacts (Bekkers e Bodas Freites, 2008; De Fuentes e Dutrénit, 2012; Fischer et al ., 2017; Perkmann e Walsch, 2007; Schartinger et al., 2002).

The external macro-environment surrounding the enterprise is just as important. Companies with underdeveloped innovation systems usually lack a knowledge infrastructure that functions well, which hinders the dissemination of cooperative behavior (Cohen et al., 2002; Fischer et al., 2017; Rapini et al., 2009). This raises the question of whether the State, as an actor, can provide support to innovation activities and produce a political, legal, and institutional environment that is favorable to cooperative activities (Tornatzky et al. 2002). In many emerging economies, such as Portugal, Poland, and Finland, the State is a core economic actor.

Because of this, the list of classifications of science-industry cooperation modes that can be found in the literature is long. The forms of interaction range from the acquisition of R&D results, including R&D joint and contract agreements, to staff mobility and informal contracts. R&D

cooperation (in other words, R&D collaboration agreements) is defined by intense interaction between partners and is focused on the conversion of R&D results into commercial applications. Consulting cooperation (for instance, academic consulting) with knowledge producers aims at the acquisition of C&T services that do not directly imply R&D (Perkmann e Walsch, 2007; Schartinger et al., 2002).

Given the relevance of science-industry cooperation as an important form of sharing knowledge (Cohen et al., 2002), there is an intense debate regarding the motivations and factors that affect the companies' propensity to cooperate with universities and other R&D organizations. The literature discusses a wide range of determinants, including the company's features, market structure, it's capacity to successfully conduct R&D and develop innovations, intellectual and industrial property management, and public support (financial and tax) availability.

Six determinant factors for the cooperation between universities and R&D organizations can thus be identified:

- **General firm specificity**: Scholars point to the size of the company as one of the most influential determinants for innovation activities. Most large companies, therefore, become multiproduct companies and attain higher yields from the resources applied to R&D projects, benefitting from economies of scale.
- **Absorptive capacity**: One of the most relevant measures is the quality of the human capital, signified by the ratio of the number of graduates to the total number of the company's employees. Attention must also be paid to the concept of "open innovation", which identifies a set of new proxies, particularly the specificity of the internal flows of scientific and technological knowledge.
- **Public support**: Governments provide support to the companies that need external partnerships, but that face problems with resources, especially financial and network ones. Most empirical studies show that public support increases the likelihood of science-industry cooperation, even though the most efficient and stimulating policy instruments of this phenomenon are not acknowledged.
- **Level of competition**: According to Schumpeter, the innovation phenomenon is linked to a process of creative destruction, since it generates profit for the innovator, but decreases the profit of the non-innovator. Regarding this process, it is interesting to analyze the competition between companies that are already established in a certain sector, as well as the prospective competition between already-existing companies – the incumbents – and possible newcomers. Arrow (1962) argues that the incentives to invest in collaborative R&D decrease as market power increases or, in other words, that organizations in less concentrated industries receive a higher incentive for innovation. From this perspective, the absence of profit of companies in the perfect competition encourages them to innovate and thereby, even if only for a short period of time, to attain positive revenues, both through cost reduction and through price increase due to differentiation. Over time, other

companies gain access to the innovation, which dissolves this advantage and takes the innovative company back to zero profit (the inverted U-shaped relationship).

- **Technological opportunities**: technological opportunities refer to the companies' capacity to exploit the emergence and diffusion of new technological paradigms, which influence their innovation intensity and their productivity growth. The level of technological opportunities directly affects the probability of innovation for the external resources that are currently in existence and that can be exploited. The results of empirical studies show that high levels of technological opportunities facilitate the absorption of external knowledge, enabling R&D partnerships to flourish.
- **Appropriability conditions**: Connections between science and industry are associated with risky, expensive, and long-term activities, as well as with high political expectations. It is presumed that the propensity to innovate and cooperate is stronger when companies can efficiently control the flow of valuable information and protect research results from violation or copy (Cohen e Levinthal, 1989). Empirical studies show that better appropriability conditions encourage the participation of companies in cooperation projects with knowledge producers.

In light of the above, one can argue that the motivation to cooperate with universities and R&D organizations largely surpasses the mere tertiarization of R&D processes. This confirms that the context of industry-science cooperation cannot be confined to collaborative R&D. The acquisition of C&T services (that do not directly entail R&D) is common practice for companies, especially ones with high and medium-technology intensity.

Along with the discussion of different strategies of interaction between industry and science, it is shown that large (and older) enterprises are more prone to getting involved in knowledge-intensive partnerships, resulting in radical innovations. Emphasis should be placed on the size and age of business organizations as key determinants of collaborative innovation activities (Aristei et al., 2016; Srholec, 2016).

As innovation partners, universities seem more open to public enterprises, whereas R&D organizations are linked to the acquisition of relevant knowledge as a way to access the global markets.

Regarding risks, the effort to innovate on a business level is primarily contingent upon the country's degree of technological opportunities. In turn, this influences the companies' overall propensity for innovation strategies based on collaborative R&D. On the other hand, the likelihood of establishing a lasting connection with academic partners is increasingly determined by the absorptive capacity (for instance, the culture of innovation management) and by the sector of the economic activity (higher for more knowledge-intensive industries).

Cooperative practices flourish if companies work on strengthening their intellectual property strategies (regardless of the chosen appropriability mechanisms). The main obstacle to successful cooperation is the widespread belief that the academy is inadequate to produce applicable results.

It is worth noting that several empirical studies demonstrate that only policy instruments specifically promoted to foster cooperation have a significant impact on the emergence of new industrial-scale attachments.

4.2 Key-actors and main mechanisms to science-industry cooperation

University-Industry collaboration is becoming an increasingly broad phenomenon, which encompasses a vast array of strategic interactions. It is embodied in collaborations, including research partnerships, contract research, research consortia, consulting, and funding of cooperative research centers, through the sharing of their knowledge and skills, as well as of their personnel and R&D facilities (Perkmann et al., 2013).

Technology cooperation comprises different kinds of transactions between research entities and companies, which may occur sequentially and simultaneously to strengthen the process, specifically by building a reciprocal relationship, favorable to the interests of both parties (Hudson & Fraley, 2014). This phenomenon is carried out through different channels, both formal and informal. The formal channels include training and education, hiring of students and academic researchers, licenses, sharing of equipment, instruments, and external consulting and extension services of universities and research centers (Lockett et al., 2003; Bercovitz and Feldman, 2006). In addition to these, there are also informal transaction mechanisms, such as publications, conferences, and exchanges between scientists, researchers, and entrepreneurs (Zuniga and Correa, 2013). These transactions are important facilitators and promoters of the innovation process and entrepreneurship (O'Kane et al., 2014; Cunningham et al., 2017).

It should be emphasized that technology transfer and commercialization do not evolve naturally and linearly from research and scientific breakthroughs. The adverse economic conditions and the inadequate supply of complementary services often pose obstacles to their completion, considering that it is a process with multiple actors and different stages, in which chance might also play a fundamental part.

Yet, the benefits for companies adopting the technology transfer paradigm are undeniable (West et al., 2014). The company does not interrupt its internal process of R&D, since it is reliant on its partner, which allows it to obtain intellectual property from one partner and a spin-off from the other (Harmon et al., 1997). Hence, more partners mean more innovative ideas for new products, methods, or processes. The gains from accessing the partner's intellectual property are evident since the company does not take as many risks or face as much uncertainty (Geuna and Rossi, 2011). The constant interactions between research entities and companies throughout the innovation process demand a wide range of technological abilities, as well as of transaction and communication channels, which ensure a reciprocate and voluntary knowledge transfer from scientists and engineers to entrepreneurs (Conceição et al., 2012).

It should be added that technology transfer occurs through the support and active participation of a number of actors and organizations, which play the role of aggregating value to the process, functioning as the "us" in the system. Notwithstanding the variety of contexts and institutional settings, the actors involved in the process carry out activities that involve the production of technological knowledge, the provision of pivotal support services, training, market studies, and intermediation.

The main roles of the actors involved in university-industry collaboration:

- **Scientists and engineers**: their tasks are to create knowledge and sustain the continuous supply of innovative ideas that might become commercially viable; they also play an active role in developing prototypes and demonstrators.
- **Research labs**: instrumental in several stages of the science-industry cooperation process, owing to the variety of activities they carry out, through their contribution in terms of basic research, their support of business innovation and technological development, and their involvement in patenting and licensing activities in knowledge markets.
- **Intermediaries**: brokers involved in arbitrating information, are responsible for connecting the different economic sectors and market segments and liking entrepreneurial networks.
- **Universities and polytechnic institutions**: their interest in bringing their empirical studies closer to the new technologies introduced in the market has led them to become the main technology transfer office host.

4.3 Culture of HEI-Industry collaboration

In the project, we look into what the role of the universities will be and how they can address society's educational needs. Furthermore, we would like to highlight that societies are going through an inevitable change in the industry and the economy. Countries are addressing this by developing public policies and innovation strategies to direct the changes, to support the industry, and to establish the role that universities will have in this transformation so that educational opportunities are available to everyone.

The information gathered for this report is the result of 30 interviews with industry representatives and researchers, 56 interviews with educational forerunners, and additional focus group events and workshops for industry representatives, university representatives, and students.

One of the main challenges is the lack of skilled labor, particularly in the STEM field. Industry reports at least 50,000 positions that will remain vacant due to lack of qualified graduates. So as to improve the situation, companies hire abroad, offer free training, and hire self-taught workers. **One of the big issues identified is the large gender imbalance when it comes to women interested in pursuing a career in STEM. It is important to address this, starting from basic education, in order to single out the factors that might discourage girls from studying science and engineering.** Additionally, an interest in science, problem-solving, and mathematics can be encouraged from a young age to motivate more people to enter these fields.

On the other hand, the current educational and social systems require that we anticipate changes and adapt to them. In order to achieve this, we have to change the way we approach upcoming challenges. The government, industry, and university representatives who were interviewed generally described universities as slow to react and added that increasing the flexibility of the educational offering and making it more student-focused were central approaches to meet these challenges.

Fear of the unknown and the uncertainty of how new systems would work were some of the reasons given to explain the rigidity and the resistance to changes in the education systems (PKA focus group). This rigidity extends to the reluctance to introduce changes in structures.

Resistance to change and rigid systems also result in a lack of collaboration between sectors. Collaboration between and across disciplines, stakeholders, and national borders is seen as an absolute necessity to improve education. However, collaboration was also highlighted as one of the key challenges. **Different stakeholders and people in different fields have their assumptions and ways of working, so how can they understand each other's mutual value, organize the collaboration, work together, ensure continuity?** This challenge requires constant communication and understanding between different sectors, identifying mutual interests and objectives, and the willingness to commit to the initiatives to the end. For that purpose, it is recommendable for users to be aware of the different objectives and values of each stakeholder, in order to make the collaboration more successful.

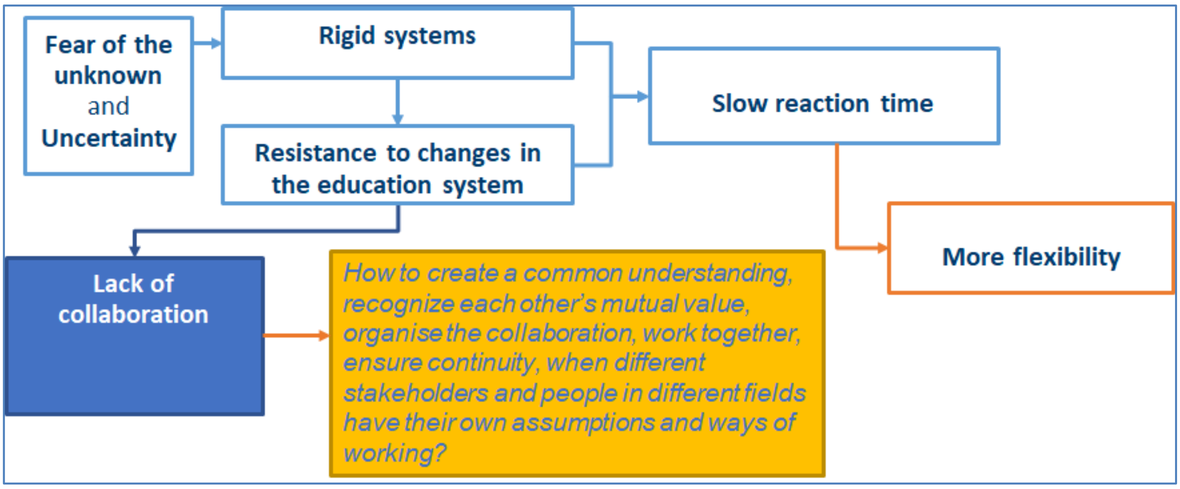


Figure 2 Challenges in creating a culture of collaboration

As regards new types of effective education initiatives, scaling up and replication can be challenging. The reason for this is that local job markets, laws, and the economy at least partially dictate how well initiatives function, so it can be difficult to implement something similar in a different location. At the same time, it can be difficult to find a balance between quality and scalability, and scaling can also be dependent on the size of the ecosystem.

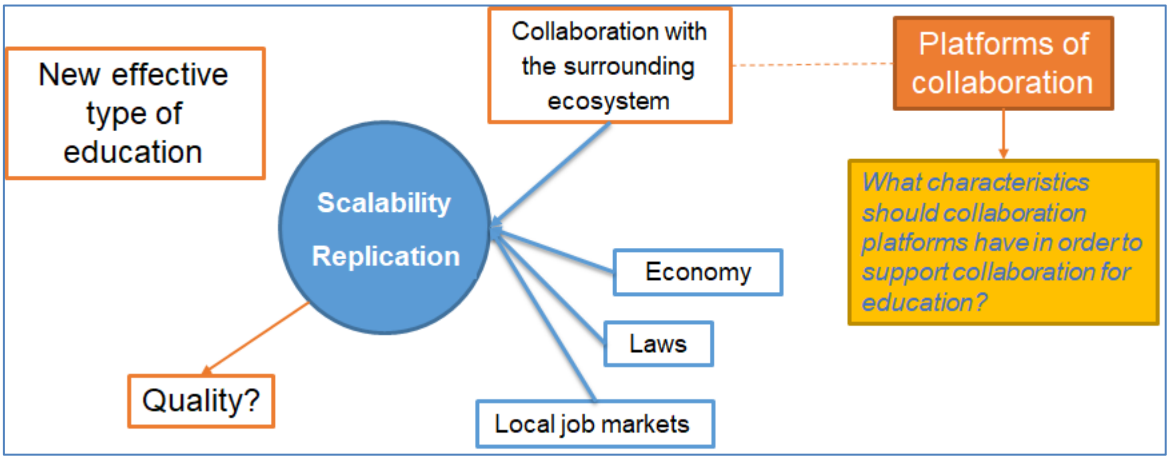


Figure 3 Scalability and replication issues in education initiatives

Collaboration with the surrounding ecosystem was perceived to be effective, and platforms have been raised as a potential solution to achieve collaboration between sectors, or amongst different actors in education. **Our third challenge is, what characteristics should platforms have in order to support collaboration in education? The following is a list of topics to consider when developing the platform:**

- it should enable communication between organizations:
    - for collaboration,
    - for sharing industry projects,
    - for research,
    - for updating curriculum,
- it should follow security protocols,
- it should enable user authentication,
- ownership must be established in order to moderate content and ensure quality,
- it should be a space where people can come together to work in projects and find skilled people,
- it should enable knowledge exchange between disciplines,
- the benefits for industry, HEIs, students, and society should be highlighted and communicated clearly,
- multidisciplinary collaboration should be encouraged and supported.

5 Recommendations

The industrial revolution is both an opportunity and a threat. To take advantage of opportunities, you must identify them correctly. You should also understand and be aware of potential risks.

New fields of study should be created, or the existing ones should be modified, adapting them to the requirements of the labor market, and the European Qualification Framework, but looking at them from a perspective, ensuring an appropriate level of education. A good example is a new field of study created at the Warsaw University of Technology in 2020, strongly related to Industry 4.0, "IoT Engineering". This field not only offers modern content, but also provides new forms of education, as it is based on Problem Based Learning, using Double Diamond methodology, and teamwork – a big project each semester. Another example is the modification of the existing field of study "Computer Science" at the Warsaw University of Technology. The field of study has been implemented since 2019. The changes went towards Artificial Intelligence, which is also an important element of Industry 4.0. Also, in this case, great emphasis was placed on innovative education (Problem Based Learning), teamwork, and the development of students' entrepreneurial skills.

There is also a need to ensure continuous cooperation and dialogue between universities and industry. This cooperation should be multidimensional: research partnerships, contract research, research consortia, consulting, and funding of cooperative research centers, through the sharing of their knowledge and skills, as well as of their personnel and R&D facilities. Furthermore, the model where the companies, university staff, students co-creates common projects, curricula are needed. To ensure such cooperation, the culture of HEI-Industry collaboration should be fostered.

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