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Transfer of the Best Applications through Structural Dialog in Capacity Increase in Digitalization, Industry-University Collaboration and Internalization

University - Industry Collaboration Framework Report

İSTANBUL SANAYİ ODASI

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CIVIL SOCIETY SECTOR

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University-Industry Cooperation has not reached the desired level for many years in many countries around the world. It is a known fact that this situation is very clearly related to many factors such as financial, technological, legal and social.

In order to provide a holistic perspective to the University – Industry Cooperation, knowledge and technology exchange processes are elaborated in a systematic manner.

Report aims to provide point of view to eliminate the short falls of practical implementation of theoretical studies of academic literature, and explain approaches to enable new collaborations.
In addition, this Report is of particular importance in terms of focusing equally on both university and industry perspectives.

CONTENTS

What is University - Industry Collaboration (UIC)?

UIC means the interaction aiming to encourage the information and technology-based transformation of the industry;

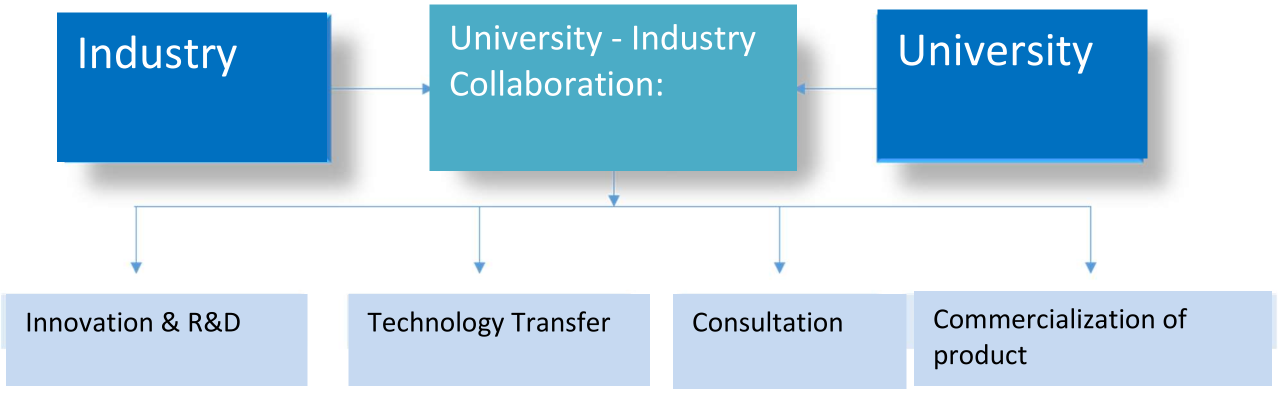
Briefly, it is any kind of interaction between the Higher Education System (HES) and industry.

Knowledge Transfer: It is the process of reciprocal knowledge and technology transfer to perform the university or company operations within the collaboration.

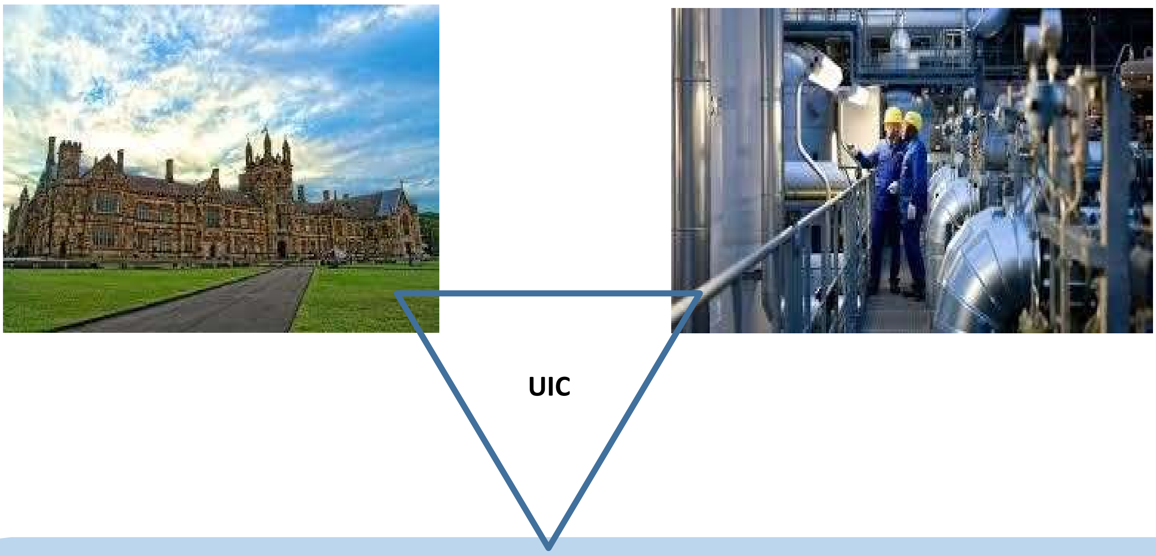
Academic Engagement: It is the collaboration process of scientists and researches for knowledge transfer with industrial companies.

Commercialization: The process of patenting, licensing academic inventions and researches and/or resulting in academic entrepreneurship.

University- Industry Collaboration has a long history as a tool for establishing the knowledge stock of organizations. UIC has been on the significant rise in many countries including USA, Japan, Singapore and European Union countries. This rise is resulted from the combination of pressures on the industry and universities. For the industry, the pressures include rapid technological change that is radically transforming the current competition environment for most companies, includes shorter product life cycles and intense global competition. For the universities, the pressures include growth in knowledge and increasing costs and difficulties of funding problems. In addition to being accepted as the engine of economic growth in universities and increasing social pressures to perform more comprehensive social services that they had in the past (in other words, education and knowledge generation). Such pressures on both sides have created an increasing stimulus for the development of UIC aiming to increase innovation and economic competitiveness in corporate levels through knowledge exchange between the academic and commercial fields (for example, countries and sectors). Besides, UIC is deemed as a promising tool generally in order to increase the organizational capacity in open innovations in the points where an organization uses external networks in innovation and knowledge development as a supplementary option for traditional internal R&D.



Key Role



University - Industry Collaboration plays a key role in providing economic development through commercialization of the knowledge not only in terms of reciprocal knowledge transfer. It has shown that approximately 10% of new products and technologies developed would not emerge without university and industry collaboration.

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Historical Development Process of University-Industry Cooperation

The first application of university - industry collaboration was observed in England in early-17th century. Even though several university - industry collaborations were observed in 18th century in the Europe and 19th century in USA, the second half of 20th century when ‘research’ and ‘contribution to economic and social development’ were included into “education”, the primary mission of universities was the period when university-industry collaboration was one of the most effective actors of the national innovation systems.

A German pharmaceutical company, Bayer, started collaborative research with universities in the late 19^{th} century. During World War I, the American National Research Council brought together universities to work in collaboration with industrial institutions in order to find solutions to the problems caused by the war.

Mutual collaboration established between MIT and Standard Oil Company before 1940 enabled the development of chemical engineering discipline and resulted in a registered patent for Standard Oil. Research Corporation was established after World War I in order to conduct and manage the patenting and licensing activities centrally.

The last quarter of 20th century witnessed a technological competition between Japan and USA. While Japan focused on collaboration with industrial research programs in particular sectors such as microelectronic in post-Cold War period, USA increased its collaboration investments for defense purposes in post-World War II period.

Bayh-Dole law entered into force in 1980 enabled licensing and patenting activities to increase, and universities like Stanford, Columbia, University of California to become the main licensor of technology and holder of intellectual property rights.

The beginning of 1980s are the years when Japan gained superiority against USA in the global competition with university-industry collaboration-based R&D activities. As the result, USA made the university-industry collaboration the primary factor of federal technology policy for the development of national competition. Bayh-Dole law which saved the economy in USA became a role model for many countries in terms of intellectual rights.

Pressures Driving University-Industry Collaboration

Industry-Driven

- Fast technological transformation
- Shortening life cycles
- Global competition
- Finance and human resource need

University-Driven

- Increase in scientific knowledge
- Increasing research costs
- Difficulty in finding fund and financial support
- Difficulty in supplying resource
- Requirement of commercializing information

Social-Driven

- Perception that universities should be the source of economic development
- Instead of social-societal results of researches, economic consequences are perceived more important

Organizational Forms of the University - Industry Collaboration

In academic studies, there is a view that it is extremely difficult to create a typology that shows all prospective connections between the university and the industry. The forms of university-industry cooperation; takes the form of joint ventures, networks, consortia and alliances; However, as these forms cover the UIC relationship, various broader forms have been defined. Relationship styles are also classified according to duration and technology flow. And also; research support (endowment/ trust fund), cooperative research (institutional agreements, group arrangements, institutional facilities, informal intentions), knowledge transfer (hiring of recent graduates, personal interactions, institutional programs, cooperative education) and technology transfer (product development and commercialization activities through university research centers). Expanded organizational forms to reflect additional information obtained from systematic reviews are included in Table 1 (Ankrah and Omar, 2012: 390).

Table 1: Organizational Forms of University - Industry Collaboration (Ankrah and Omar, 2015:391)

Personal Informal Relationships	• Academic spin-offs • Individual consultancy (paid for or free) • Information exchange forums • Collegial interchange, conference, and publications • Joint or individual lectures • Personal contact with university academic staff or industrial staff • Co-locational arrangement

Personal Formal Relationships	• Students’ involvement in industrial projects • Scholarships, Studentships, Fellowships and postgraduate linkages • Joint supervision of PhDs and Masters theses • Exchange programmes (e.g. secondment) • Sabbaticals periods for professors • Hiring of graduate students • Employment of relevant scientists by industry • Use of university or industrial facility (e.g., lab, database, etc.)
Third Party	• Institutional consultancy (university companies including Faculty Consulting) • Liaison offices (in universities or industry) • General Assistance Units (including technology transfer organizations) • Government Agencies (including regional technology transfer networks) • Industrial associations (functioning as brokers) • Technological Brokerage Companies
Formal Targeted Agreements	• Contract research (including technical services contract) • Patenting and Licensing Agreements (licensing of intellectual property rights) • Cooperative research projects • Equity holding in companies by universities or faculty members • Exchange of research materials or Joint curriculum development: • Joint research programmes (including Joint venture research -project with a university as a research partner or Joint venture research -project with a university as a subcontractor) • Training Programmes for employees
Formal Non-Targeted Agreements	• Broad agreements for U-I collaborations • Endowed Chairs and Advisory Boards • Funding of university posts • Industrially sponsored R&D in university departments • Research grant, gifts, endowment, trusts donations (financial or equipment), general or directed to specific departments or academics

Focused Structures	• Association contracts • Innovation/incubation centers • Research, science and technology parks • University—Industry Consortia • University—Industry research cooperative research centers • Subsidiary ownerships • Mergers

Motivations for University - Industry Collaboration

Universities and industrial companies establish their relations with each other with different motivations. Motivation factors that have an impact on university-industry cooperation are examined in six dimensions which can be considered as the primary bases for organizations to interact with each other. Each factor is enough to establish a relation on its own; however, these factors might interact at the same time when decided to establish an interorganizational relation.

Table 2: Motivations for Universities and Industry: A Comparison (Ankrah and Omar, 2015:392)

	University	Industry
Necessity	• Responsiveness to government policy • Strategic institutional policy	• Responsiveness to government initiatives/policy • Strategic Institutional policy
Reciprocity	• Access complementary expertise, state-of-the-art equipment and facilities • Employment opportunities for university graduates	• Access to students for summer internship or hiring • Hiring of faculty members
Efficiency	• Access funding for research (Government grant for research & Industrial funding for research assistance, lab equipment, etc.) • Business opportunity, e.g. exploitation of research capabilities and results or deployment of IPR to obtain patents • Personal financial gain for academics	• Commercialize university-based technologies for financial gain • Benefit financially from serendipitous research results • Cost savings (easier and cheaper than to obtain a license to exploit foreign technology) • National incentives for developing such relations such as tax exemptions and grants • Enhance the technological capacity and economic competitiveness of firms • Shortening product life cycle • Human capital development
Stability	• Shift in knowledge based economy (growth in new knowledge) • Discover new knowledge/test application of theory • Obtain better insights into curricula development • Expose students and faculty to practical problems/applied technologies • Publication of papers	• Shift in knowledge based economy (growth in new knowledge) • Business growth • Access new knowledge, cutting-edge technology, state-of-the art expertise/research facilities and • complementary know-how • Multidisciplinary character of leading edge technologies • Access to research networks or pre-cursor to other collaborations • Solutions to specific problems • Subcontract R&D (for example due to lack of inhouse R&D) • Risk reduction or sharing
Legitimacy	• Societal pressure • Service to the industrial community/society • Promote innovation (through technology exchange) • Contribute to regional or national economy • Academics' quest for recognition or achieve eminence	• Enhancement of corporate image
Asymmetry	• N/A	• Maintain control over proprietary technology

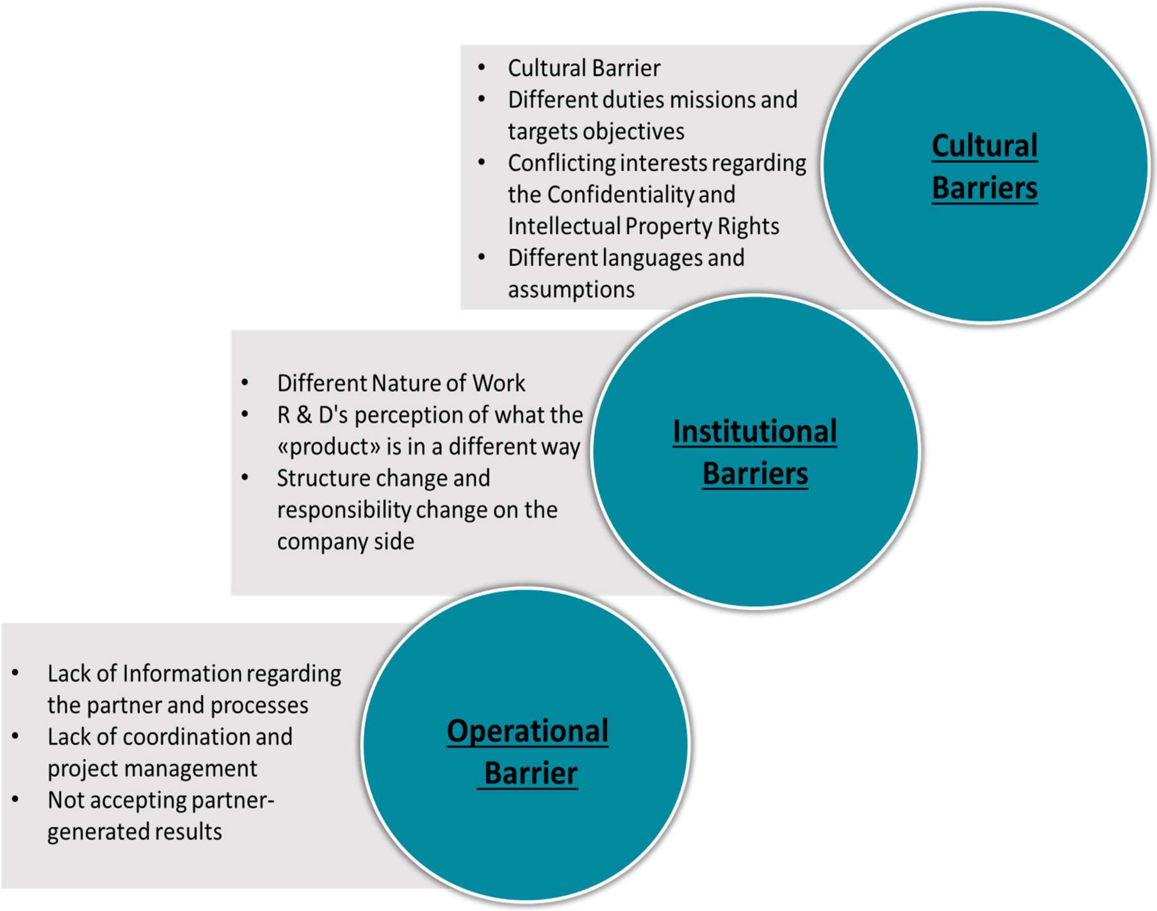
Transfer Channels for University - Industry Collaboration

- Scientific publications
- Reports of universities for industry
- Patent texts
- Informal communication channels
- Employment of people graduated from university or with academic career in the industry
- Joint research projects
- Contractual researches
- Financially supporting doctorate students and their projects

- Joint use of facilities such as laboratories and equipment by both universities and companies
- Employees working simultaneously in universities and industry
- University spin-offs
- License, patent and know-how patents
- Consultancy
- University technology transfer offices
- University centers

Barriers to the University - Industry Collaboration

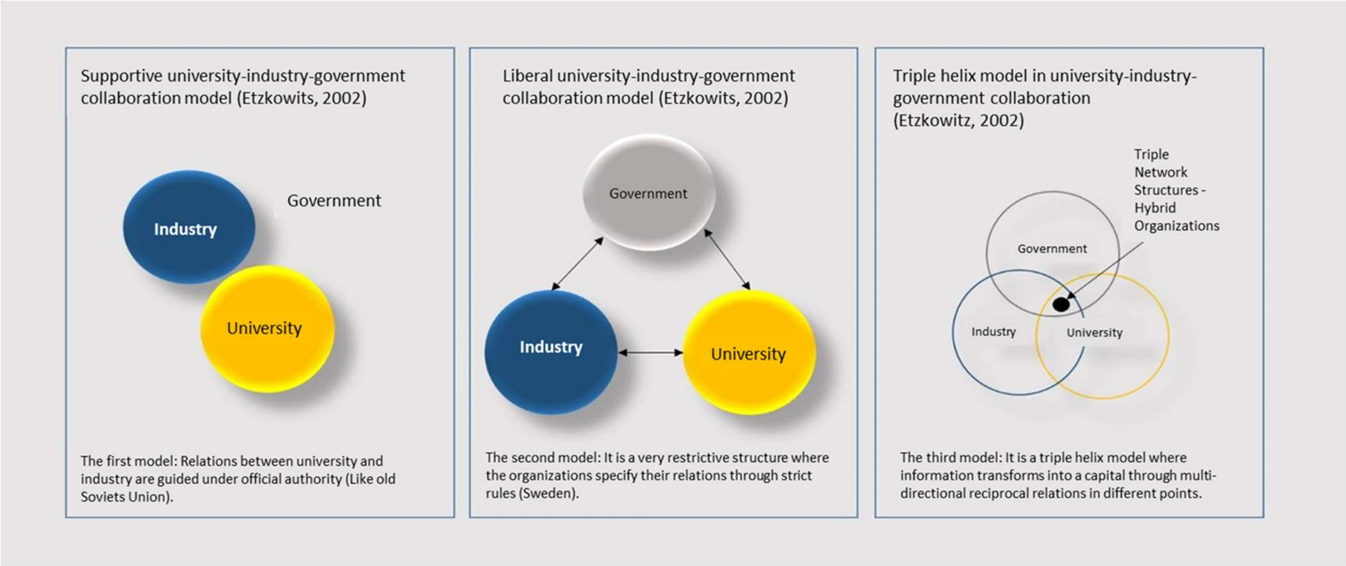
Even though the advantages and potential of UIC collaborations are well defined, many barriers and challenges that might lead to failure are confronted.



Institutionalization Approaches of the University - Industry Collaboration Models

University-industry collaboration is one of the most critical elements of national innovation system since it has a determinative role in industry's transforming findings obtained as the result of scientific and technological studies into marketable product or service, new or developed manufacturing method or new social service method; in other words, in gaining competency in innovation and having a say in the world market (Goker, 2002). When the state is included into the collaboration structure, three main elements of the national innovation system are formed. Etzkowitz (2002) defines the relations of university-industry-government collaboration in three models.

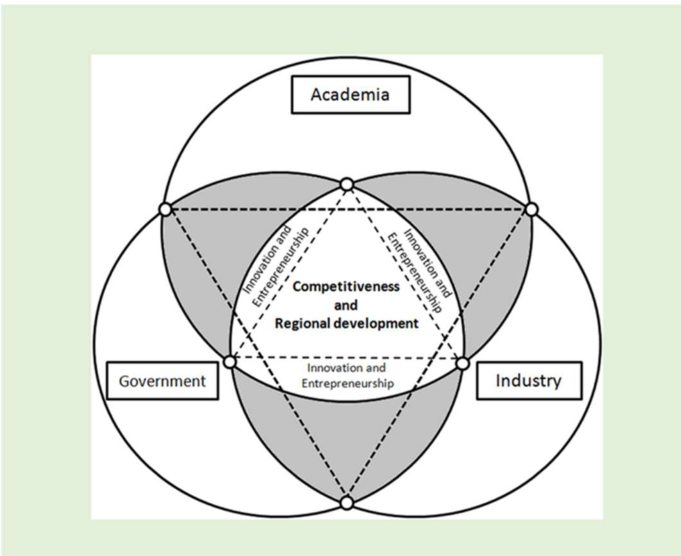
The triple helix is a helix innovation model in which the information process is transformed into capital through multi-directional mutual relations at different points. The first phase of the model consists of internal changes such as improvement of economic development by bilateral relations and universities between the firms through strategic collaborations in each three branch. The second phase is to create an impact of a helix on another. The three and last phase is the birth of triple networks and creative organizations from the three branches of the helix through new opinions and forms for the advanced technological development. In the triple helix, university-industry-government relations are defined as organizational fields that are attached to each other and in a constant interaction where one organization can replace the other. The university takes an educational role for firm founders, industry and universities through incubators while the government has a role providing risk capital with minor-scaled innovation researches and other programs (Etzkowitz, 2002).



Triangulation of the Triple Helix Model

This model represents the organizational relations towards the innovation between the public, private sector and academic arena through triple helix structure, and plans such relations in different levels of the structure and then tries to explain the use of information as capital. It has developed many applications in compliance with this model practically.

It has focused on innovation and enterprise as critical factors in university-industry collaboration; the main aim is to create employment upon the regional competitiveness and development thanks to the capacities of encouraging new investments; and accordingly to direct the economies to meet new competitiveness standards.



(Farinha ve Ferreira, 2013)

Old and New Approaches in University - Industry Collaboration

"Mode 1” refers to the university-based knowledge production mode. Mode 1 is also compatible with the linear innovation model. Linear innovation model claims that that there is basic research in the university context: The university research will spread to society and the economy slowly but gradually. They are the economics and companies that collect university research lines and transform the knowledge that they have gained in this way into practice and innovation in order to obtain economic and commercial success in markets outside the higher education system. Within the framework of linear innovation, there is a sequential "before-after" relationship between fundamental research (production of knowledge) and innovation (application of knowledge).

Understanding of Mode 1-based knowledge generation was challenged by “Mode 2”, the concept of new knowledge generation. Mode 2 underlines the application of knowledge and knowledge-based problem solving: "Knowledge generated in the context of practice", "interdisciplinary", "heterogeneity and organizational diversity", "social accountability and reflection" and "quality control". Here, the key is to focus on knowledge generation within the context of practice.

Mode 2 refers to the clear emphasis on innovation itself and innovation models. The linear innovation model has not been only challenged in the initial stage of fundamental research and innovation but also been challenged by nonlinear innovation models that are concerned with establishing more direct links between the production of knowledge and the application of knowledge which are brought together. Besides, Mode 2 seems to be in compliance with the nonlinear innovation and its impacts.

The Triple Helix that was introduced and developed by Henry Etzkowitz and Loet Leydesdorff (2000) is a model of knowledge, innovation and university-industry-government relations and by which a national innovation system is created intertwiningly. The triple helix is defined by the systems and sectors: academia (universities), industry (commerce) and state (government). In existing innovation discourses, the "Triple Helix" model refers to a phenomenon such as "standard model" of innovation.

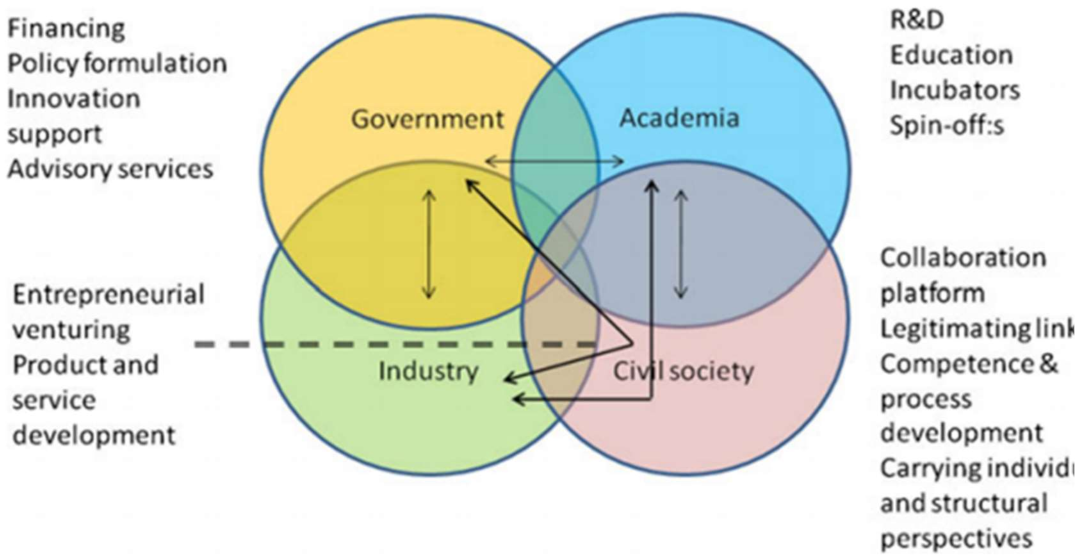
The "Mode 3” refers an organization or system that that seeks creative ways to combine and integrate different knowledge production and knowledge application principles (e.g. Mode 1 and Mode 2) such as university, higher education institution or higher education system, and which encourages diversity and heterogeneity and creates creative and innovative organizational contexts for research and innovation accordingly. Mode 3 encourages the creation of “creative knowledge environments”. “Mode 3 universities, higher education institutions and systems are ready to conduct “fundamental research in the context of practice”. It has also the characteristics of nonlinear innovation.

Mode 1 and Mode 2 can be defined as “knowledge paradigms” underlying the production of knowledge by the higher education institutions and university systems. According to Mode 1, success or quality can be defined as academic excellence which is a comprehensive definition of the world (and society) based on fundamental principles or initial principles that are evaluated by the societies acting as knowledge producers. According to Mode 2, success and quality can be defined as a problem solution method which is beneficial (efficient, effective) for the world (and society) as evaluated by the knowledge producer and user. The "Mode 3” refers t an organization or system that that seeks creative ways to combine and integrate different knowledge production and knowledge application principles (e.g. Mode 1 and Mode 2) such as university, higher education institution or higher education system, and which Mode 3 encourages the creation of “creative knowledge environments”. “Mode 3 universities, higher education institutions and systems are ready to conduct “fundamental research in the context of practice” (Carayannis ve Campbell, 2019).

The Quadruple Helix Innovation System) understanding emphasizes that sustainable development, knowledge economy, knowledge society and knowledge democracy should develop all together. Quadruple Helix promotes the perspectives of knowledge society and knowledge democracy to support, encourage and further advance the knowledge production (research) and knowledge application (innovation).

For developing economy, competition and long-term sustainable growth, quadruple helix model which is based on stakeholder theory is a model for co-creation with stakeholders using the innovation developed for other stakeholders in the society. In quadruple helix model, stakeholders and users of the innovation especially included are not passive; instead, active and participatory in the innovation developed within the scope of collaboration. It directs its collaboration focuses as in awareness of social needs and problems. Involvement of the users into the process activates the feedback mechanism and enables the developed innovation as an open innovation. In quadruple helix model, the collaboration of the parties is supported with the process of co-creation. For the success of this model, the stakeholders should fully comprehend their priorities and skills and then establish a harmonized co-creation relations.

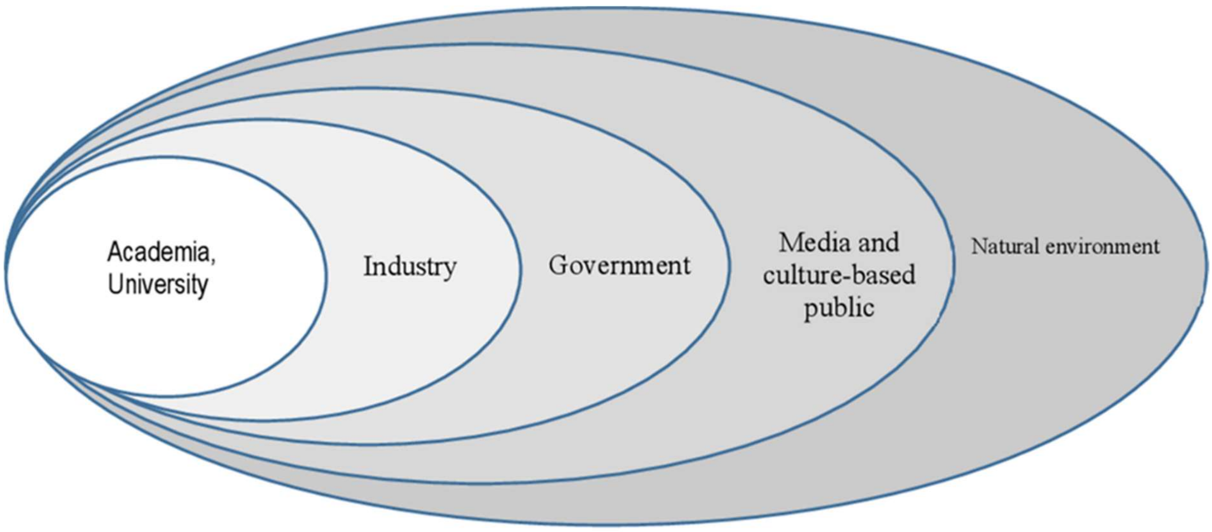
The Quadruple Helix covers the structures and processes of the global Knowledge Economy and Society as specified by Carayannis and Campbell (2009). Innovation systems creates a knowledge democracy which has an interdisciplinary, nonlinear and hybrid and shared nature. To illustrate, Yawson (2009) states that advances in biotechnology, ICT, and nano-technology encourage innovation and convergence while revealing the importance of the adequate number of regulations and requiring the public awareness as well. "Civil Society" has become an important helix of innovation systems. The quadruple helix model developed addresses to the four helixes of innovation economics: Academy and Technological Infrastructures (university laboratories and industrial R&D facilities), Firms, Government and Civil Society are equally important to have a smart, inclusive and sustainable economic growth (Afonso et al., 2012).



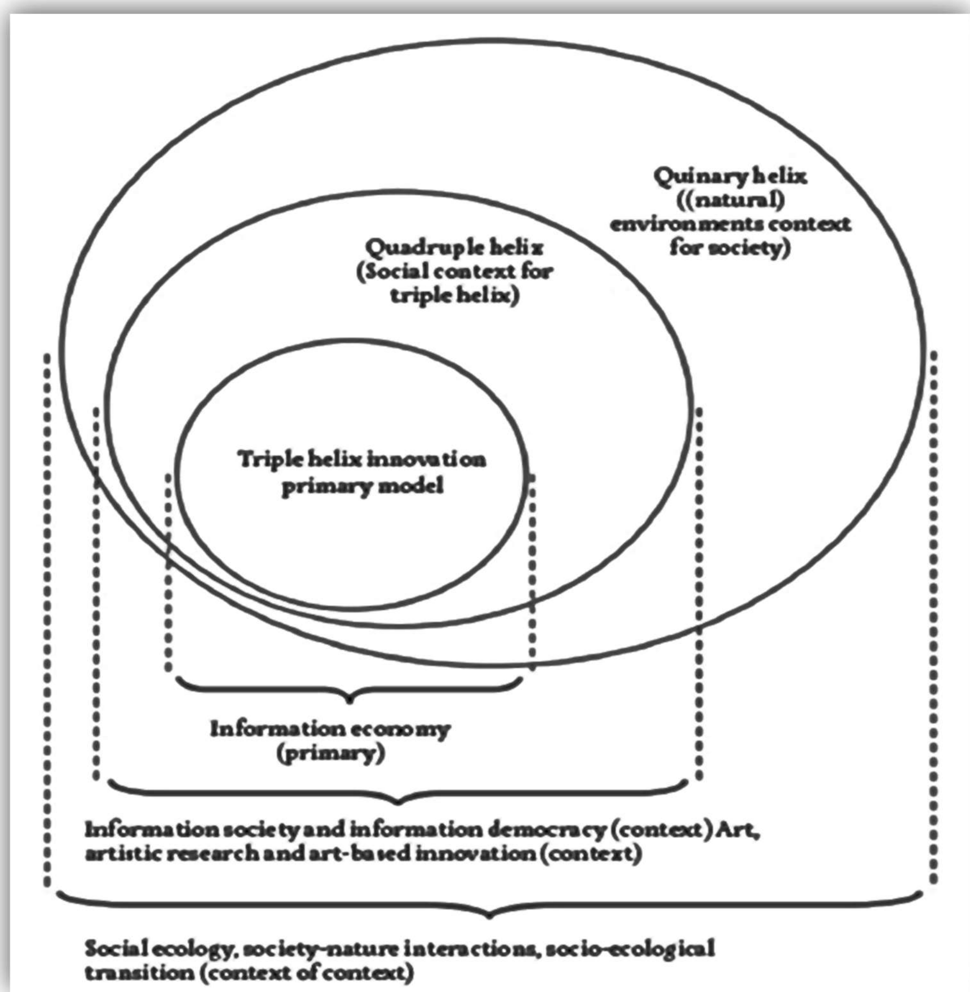
Quadruple helix innovation system: (Lindberg et al., 2012)

The Quinary Helix refers to the socio-ecologic transition of the society, economy and democracy, and therefore, Quinary Helix Innovation System is ecologically sensitive. The quinary helix bases its understanding of knowledge production (research) and knowledge application (innovation) on social ecology.

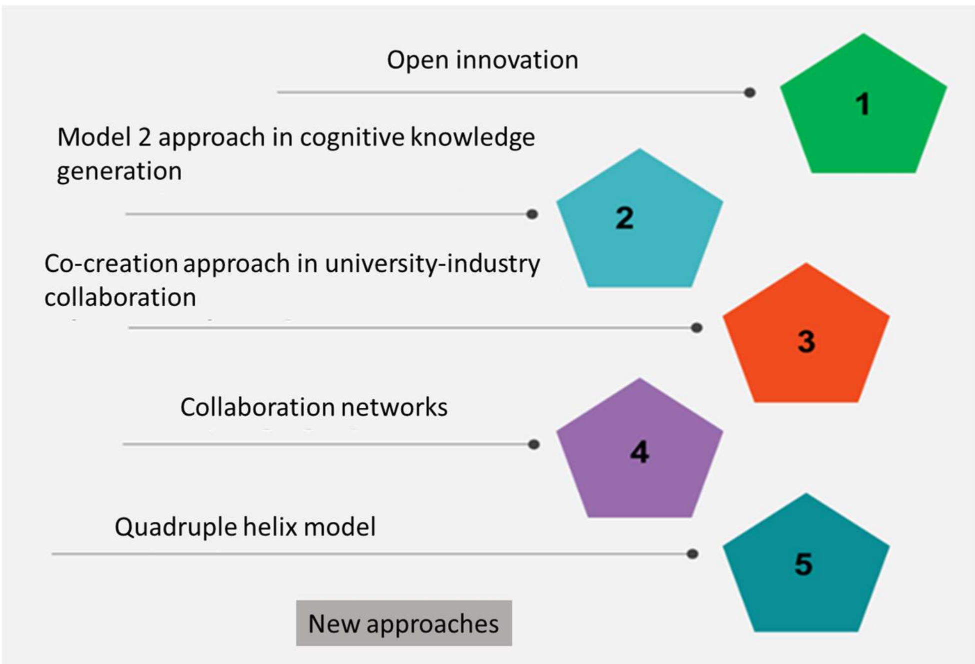
Environmental matters (like global warming), causes concern and represents the survival matters for the humanity. However, quinary helix defines the environmentally and ecologically concerning matters as possible driving factors for future knowledge production and innovation in potential opportunities as well. Consequently, it defines the opportunities for knowledge economy as well; quinary helix supports the creation of win-win situation between ecology, information and innovativeness here and creates a synergy between the society and democracy (Carayannis ve Campbell, 2019).



Subsystems of Quinary Helix Model (Etzkowitz & Leydesdorff, 2000; Carayannis & Campbell, 2012)



Quadruple and Quinary Helix Innovation Systems regarding Society, Economy, Democracy and Social Ecology (Carayannis & Campbell, 2019:46)



University - Industry Collaboration: Role of the Government

University-industry-government strategical collaborations provide an organization structure where different skills, competencies, traditions, expectations and intellectual capital are integrated. Functions of the government are to operate the personal research laboratory, fund the universities, provide the science and knowledge infrastructure, provide support and guarantee for public research projects. It provides the legal and regulatory structure on the standardization and security of private technologies, research ethics and intellectual property for the production and use of knowledge. The government encourages business sector to make enterprises in suitable levels in the development, use and training of the technology. Configuration of the transformation system for reciprocal learning is one of the main functions of the government.

Briefly, the government connects the university and local industries to provide a sustainable communication and information change between the government, university and industry; feeds, raise and adjust the industry-science collaboration for the regulative collaboration of higher education institutions. It promotes the public-private sector collaboration to support innovation. Therefore, it establishes an organizational structure in line with the demands and priorities all actors. It provides financial conveniences for scientific and technological investments of private sector like tax exemption, support, etc. It puts forward more flexible working principles. What is more important that it informs the society about the university-industry-government collaboration (Koç and Mente: 2007).

We can summarize the role of the government as follows:

- R&D funds, incentives and tax reductions
- Innovation support credits

• Performance-centered premium and incentive system for the researchers

• Incentive criteria recommended by OECD to measure the university performance: R&D funds transferred from the private sector, consultation revenues, revenues earned from patent licenses, spin-off and start-up activities

• Intellectual Property Rights Adjustment and Technology Transfer Offices

• Science Parks, spin-offs and incubation centers

• Educational and development activities for the industry

Proposed Actions to Encourage Universities for Collaboration

Maintaining Environmental Balance: Legal regulators should create a balanced financial and legal environment which is free from volatility and uncertainty in order to establish long-term strategic partnerships.

To provide the universities with the autonomy by which they can conduct the scientific researches and establish partnership: The best actor to decide on the strategy of a university its own management staff and academic personnel. It is not possible for universities which cannot act free to establish right and successful partnerships.

To award active and collaborative universities: Strong collaborations should be supported and promoted through correct legal regulations and governmental programs.

To support universities to fight for success: Universities are in search of establishing partnership with the best stakeholders all the time, therefore, the researches of successful universities should be supported that collaborations leading to higher employment rate can be established.

Proposed Actions to Encourage Industry for Collaboration

- To conduct a research that the industry cannot be successful on its own.
- To develop long-term but flexible research collaborations in line with the industry's goals.
- To develop a shared vision and commons strategy.
- To enable to contact with right people and authorize the right people.
- To allow the opinions to cross-grow, create and strengthen communication channels.
- To focus on the quality of the research instead of focusing on the intellectual property rights.
- To be open for the interaction of different disciplines and provide interdisciplinary solutions for the industry.

University – Industry Collaborations
Country Examples

COUNTRIES

Japan

England

Singapore

Israel

Canada

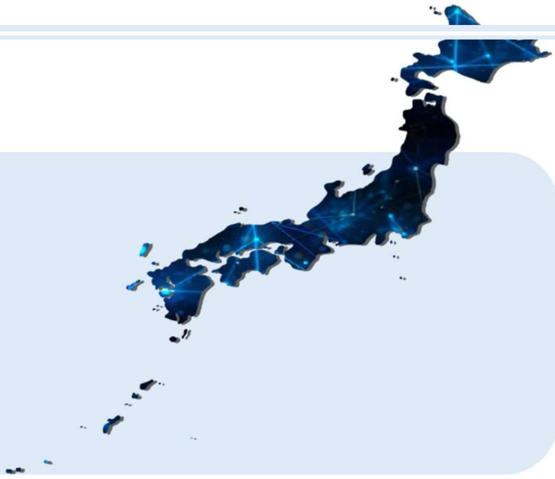
South Korea

France

Germany

USA

Japan



Japan has the most developed university-industry cooperation (USI) system among all East Asian countries. Japan has managed to realize several policies by which it aimed to create an entrepreneurial infrastructure and to facilitate close relations between universities and the private sector since early-1960s (Japan Science and Technology Agency):

- joint research centers
- joint patent applications
- joint financing opportunities

Besides, it started to enforce the Law on Development of Technology Transfer from Universities to the Private Industry in 1998 by which numerous joint research project and patent applications have been made. Japan has specifically focused on expanding academic research for its followers and meeting industry-public needs. It started to provide fund for university TTMs deemed to be suitable within the scope of the program by an application in 1998 out of public resources as to be limited to 300.000 USD in the amount of 2/3 of operational expenses not exceeding 5 years. At the end of the fifth year, TTMs were expected to perform their own operations with their own incomes. A new support program was put into effect for centers that could not succeed after the fifth year.

Independence was provided to all national universities and the opportunity to become partners in TTMs was provided by a law enacted in 2004. Profit-oriented companies to support TTMs were established in some Japanese universities, and by which several startup companies were established to commercialize university R&D outputs and faculty members were encouraged to purchase shares of such companies. In Japan, the term "Technology Licensing

Office (TLO)" is used to point out to the license or technology transfer institution of a university or research institution. This term covers not only the technology licensing operations but also business incubators, university-industry joint research projects and knowledge dissemination. The main objective of such offices is to commercialize the outputs of public research.

In the latest science and technology primary plan, the importance of the academy which works with the society in the promotion of the technology which might provide assistance in the discovery of new resources and overcoming the country-specific issues including improving the quality of life for the elderly, preventing damage in major disasters.

Article 7 of the Basic Education Law in 2006 explains that the primary activities of all national universities are 'advanced knowledge ...' that they contribute to the development of the society by disseminating the outputs of their operations and researches. Universities should also comply with the promotional strategies:

-social and public concerns,

-global competition in science and technology and

-key technologies of national importance such as supercomputers and space transport.

At the beginning, the policy of Japan to support the technology transfer had been based on USA model that was created by Bayh-Dole Law which the universities were allowed to protect their title and copyrights for the inventions resulted from the researches funded by the government. On the other hand, most of the biggest research universities in Japan was accepted as public institutions in 2004 and thus not allowed to continue their collaboration with the industry; the transfer of this policy between the countries could not be aligned completely. In today's world, the Japan Science and Technology Agency (JST) audits the Center for Intellectual Property Strategies (CIPS); however, only provide policy recommendations to universities and public research institutions (Japan Science and Technology Agency n.d.). Problems arising from UIC, Intellectual Property laws in Japan not only for industrial rights in common ownership, but also censorship on publications, industrial rights. It is not exceedingly rare Japan to reject to announce the findings of UIC research and even academicians to perform self-censorship. UIC laws show an attitude to be aware of the many university collaborations that involve private sector obligations that develop discoveries beyond initial patent applications.

The Japanese government that is aware of the reluctance of the academic community to engage with the industry for the best ideas continues to force the universities to compete for joint research projects as an income source and reduce the corporate funds. Despite of the relative success in creating partnerships between the universities and the industry, final attitudes of Japan on innovation were prevented because of the differences between the objectives of the university and industry. Generally, they could not establish and develop collaborations since the industry can make use of owning various scientific and technological patents regardless of their commercialized or no commercialized nature However, Japanese universities have successfully started negotiating about the contracts with private industries that formally accept their private licensing rights for a limited time only and return to the university during the recent term. National and private universities do have exclusive intellectual property policies and based on the framework of this policy; the outputs of the collaborating firms might differ.

The government encouraged alliances and mergers with alliances consisting of 65 universities between 2001 and 2008. Also, Japan demonstrates that its efforts to create a successful UIC environment finalized with a low number of enterprises when compared to the other industrialized countries so far. Numerous changes and reform policies are entered into force, such as encouraging the creation of software and services to provide increase in the mobility of human resources beyond the sectoral boundaries, to develop more cyber technology and obtain more financing resources for potential doctorate students. Furthermore, Science, Technology and Innovation Council (CSTO) plans to shift UIC to implementation and commercialization within the scope of the new plan. Also, a new tax incentive is among the expectations which will entirely allow R&D research institutes to reduce their taxable income by 20% to encourage innovation.

Key points of transferability include the following issues:

- Nationally dictated areas of research can prevent UICs
- Changes in the Intellectual Property policies can restrict innovation
- If the industry does not continue to develop, UIC contracts should be returned to the universit

England

England focused on improving university-industry collaboration in the early 1990s. In 1999 Higher Education Funding Council of England (HEFCE) created a special fund in England to provide assistance for the networks between universities and industry which is still a relatively well funded initiative. HEFCE provided a fund for £5.1 billion from Business, Innovation and Talents Department (BIS) to support UIC and target workforce development and traced various UIC indicators in England and recorded significant growth in 2013-2014. England established the 'Science and Innovation Investment Framework', which supported the technology transfers between university and industry in a more intense manner between the years of 2004 and 2014. The government finances UK research efforts with additional support from charities (particularly the Wellcome Trust that donates £700 million annually for biomedical research), some international sources (such as the EU), and the private sector. Also, most of the governmental funds provided for research in higher education institutions (HEIs) are provided through non-departmental public bodies such as Research Councils or through HEFCE and similar funding agencies in other countries of England.

Most of the universities in England have their own TT units. When the corporate structures of the units are taken into consideration, it is seen that TT offices of different universities are structured in different ways. Several university units provide service as affiliates. But there are a few independent structures. England which is closer to the USA rather than Europe in terms of systems, applications and TT culture can be deemed as taking part among the rapidly advancing countries in terms of R&D expenditures and research outputs. When the subjects of patent and scientific articles are examined, it is seen that the key technologies such as information and communication technologies (ICT), biological sciences, nanotechnology, environmental technologies and their derivatives and pharmaceutical, defense and motor vehicles are focused on. So, despite of the relatively low share of R&D among OECD countries, it is reported that its activities are mostly centered in advanced technology fields. Important developments are observed in risk capital deemed as the main funding source and an important indicator of entrepreneurship and innovation for the new technology based firms which are one of the significant factors of TT operations.

Facilitation Centers serve as a central mechanism to support UIC. The National Innovation Agency is a non-profit organization that specialized in a different technological field by the Technology Strategy Board that connects the industry with the research and academic community, each of which is working collaboratively on commercial products and services.

All of the Facilitation Centers are not located in universities and operate as independent organizations; however, all of them have close connections with the universities. They have been established to fill the gap in transferring researches from universities to the industry and their commercial results are 1/3, 1/3, 1/3 funding model; 1/3 is used as commercial fund agreement, 1/3 as basic public investment and 1/3 as collaborative R&D.

Data on their success in using the UIC is very completed; however, it is claimed that the contribution of universities is necessary for the outputs since their establishment. Universities provide the necessary expertise, infrastructure, and connections to innovate. University - Industry Collaboration supported by the Facilitation Centers are not only performed in official methods like collaboration contracts but also unofficial methods like information exchange and networks. There were seven Facilitation Centers by February 2014 and the government provided an additional innovation fund for £185 million to enable England to be more innovative in 2015-2016. Facilitation Centers consist of totally local business specialists and Facilitation program showed indications to enter into the international arena. A cell therapy center was established through an alliance with the Canadian Regenerative Medicine Commercialization Center in 2013.

Although the UIC system in England is relatively well developed, obstacles before the growing UIC still maintain their existence. To illustrate, it is stated that personal characteristics are of crucial importance when predicting their professional status, reputation and pre-industrial funding histories and likelihood of dealing with the industry, in addition to the disciplinary fields. Besides, there may be a 'misalignment' between institutional-level goals and priorities, national-level policies, and individual initiatives for UIC participation because the corporate support does not announce the UIC difference between the organizations.

Key points of transferability include the following issues:

- Government approval of the Agency for UIC funding
- It operates non-university business centers as a beneficial model to increase formal collaboration.

Singapore

Despite of its small size, Singapore takes a high place among countries in terms of research efficiency and university-industry collaboration. Comprehensive R&D of Singapore originates from decades of government activity including the National Science and Technology (S&T) plans setting guidelines to increase scientific funds and efforts. Therefore, it has created an exceptionally talented and innovative workforce (Singapore Ministry of Commerce and Industry 2006) by experiencing an increase from 28/10.000 in 1990 to 87/10.000 in 2004 in Singapore scientific community. On the other hand, it is possible that future innovation will be limited as continuous employment of the entrepreneurial mindset is not a requirement for economic stability which is caused by Singapore's highly skilled workforce and prosperous economic situation.

Singapore consists of university-industry collaboration support programs and grants. The Ministry of Education (MOE) offers special funding opportunities such as the R&D and Innovation Fund which supports Polytechnic partnerships with industry, and the Academic Research Fund (AcRF) which finances projects in the value of $500,000 to $1 million within three years. It complies with the interests of Singapore and has the potential to attract international researchers to Singapore. Singapore also host the Agency for Science, Technology and Research (A * STAR), an exceptional bridging agency. A * STAR, the leading public institution collaborates with both the public and private sector to create economic growth and employment in Singapore. The A * STAR group covers various science, engineering and health councils, graduate academy for scholarships, joint use of laboratory resources and business incubation all of which aim to promote the commercial application in Singapore. Technology transfer and intellectual property structure of Singapore has a uniform and supported nature. Singapore has tried to provide professional intellectual property training to aid technology transfer since 2003. The government established National Research Agency to further support the research and innovation in addition to the implementation of systematic processes for R&D in 2006. The agency enables 50% of the inventor(s) to earn a net profit, while 30% is allocated to a specific department and 20% to the university. Besides, copyright fees are calculated over the total amount produced and 75% of the first $500.000 is allocated to inventors while the rest is allocated to the university. Efficient intellectual property policies of Singapore have further enhanced its competency to attract foreign investment and highly skilled workforce.

Furthermore, Singapore adopted the principle of “52 days” which requires academicians to spend 52 days for researches annually and 1 day in a week in order to prevent the university to be kept away from its primary educational obligations. Faculty management departments and technology transfer offices will need more additional education and specialty to be able to engage in complicated and multi-disciplinary projects as the technology and innovation continue to grow in Singapore.

Key points of transferability include the following issues:

- Policy sustainability focus on attracting a highly skilled workforce
- Uniform long-term intellectual property right policy from which the inventor(s) benefits in the short term
- Transfer offices and wide range of organizations to provide assistance

Israel

Israel is one of the world's leading science and technology centers with its population of around 8.5 million. Israel that competes within its own territory attaches importance to both military and civilian innovation. It allocates large amounts of resources to R&D development. The ratio of R&D expenses of Israel to GDP doubled the OECD average in 2009 (Israel ranked highest in the OECD in 2012) The government played a role in the success of UIC. The government has encouraged collaborative R&D and commercialization since the late 1960s. The government played a significant role including supporting 'gap filling' programs in order to provide fund for the technologies in need of extra support for commercialization in addition to allowing universities to decide their own regulations independently. The government has also encouraged universities to build science parks since the early-1970s and the four campuses were created to develop the deeper university industry at the beginning.

The Office of the Chief Scientist-OCS helps to provide R&D grants to technology incubators, university-industry transfer units and other R&D collaboration agreements. OCS is also effective for tax exemptions, tax reductions and cash grants specifically. Incentives might only be used by companies with technological competencies that will conduct research in Israel and meet a high standard of technological innovation.

Weizman Institute which is a research-based university hosted the first private technology transfer office (TTO) in 1957 and is still one of the most successful technology transfer office of the world. One of the unprecedented characteristics in Israel is that TTO has the Institute fully. Because of this ownership, university transfer offices can switch from one to another so they can find the best structure for commercialization. Business leaders are employed to guide the office successes of office specialists in the board of directors of TTOs generally. Besides, the university provides most of the funds that are needed by the transfer office to implement, acquire, and maintain Intellectual Property for all innovations. That is why universities in Israel are extremely strict in the commercialization of their technologies and innovations outside of the private transfer offices since such offices act as important income producers. More than 15 new companies are established on annual basis in Israel because of UIC collaborations. TTOs in Israel are not intervened by the government which is a distinctive feature of them compared to the other countries; and which means that all projects are selected for potential revenue returns to the private sector, not in response to a national need. All Israeli universities already have their own TTOs and they are affiliated with the Israel Technology Transfer Organization (ITTN).

Israel has launched the Technology Incubator Program (TIP) since 1990s. Incubator programs, that had originally been adapted from the United States, were structured in Israel at the beginning. Thus, all stakeholders which are the industry, private investors, universities, and government parties are expected to finance the project. Investment budgets for incubator programs can vary from $ 500,000 to $ 1,000,000. Great majority of the incubators are privately owned and managed by private ownership; however, incubation programs are partially government funded, and which means that the commercialization of the incubator project usually takes place at the earliest possible stage, thus the most important developments might be realized outside of the intellectual property authorizations of the universities. Every incubation center in Israel might receive hundreds of applications for startup ideas led by individual entrepreneurs. Although there are only 7 universities in Israel today, there are 35 incubation centers. Projects are changing in areas such as medical devices, biotechnology and pharmaceutical products, clean technologies, and electronics.

Key points of transferability include the following issues:

- Government policies to facilitate an active and highly motivated UIC environment
- High-tech technology transfer offices and incubators buildings
- High government and private sector expenditures on R&D

Canada

Environmental factors of Canada are unique among the sample countries. Canada has a strong resource-based economy, and much of public R&D research is financed by industry (OECD 2012). To illustrate, R&D of Canada in 2014 cost 30,6 billion CAD half of which was contributed by the industry itself (Statistics Canada 2014). On the other hand, R&D expenditures of businesses in Canada are still below the OECD average, and the top 500 corporate R&D investors are below the OECD average (OECD 2012) as well. Canada supports UIC results through higher public R&D expenditures and tax subsidies (patents, entrepreneurship, and trademarks (above the OECD average)) (OECD 2012). To illustrate, Scientific Research and Experimental Development Tax Incentive Program of Canada can reduce tax up to 35% of the industrial R&D (Canada Revenue Agency 2015). Incentive program includes quality research, basic research, applied research, and experimental research (Canada Revenue Agency 2015).

Also, Canada provides assistance for UIC financing through several network program within the scope of Networks of Excellence Centers (NCE).

Three programs are operated through the NCE Secretariat:

1. Networks of Excellence Centers
2. Commercialization and Research Excellence Centers (CECR)
3. Business-Oriented Networks of Excellence Centers (BL-NCE)

Such programs are initiated to create academic networks, train future researchers, and accelerate knowledge creation. An assessment that puts forward the effectiveness of the NCE program in enhancing relationships between disciplines and sectors, facilitates the knowledge required by researchers and partners to transmit research results, and helps thousands of

graduate students gain experience and training through networked research projects was published in 2013. Also, the report underlined a fund insufficiency which proved to cause obstacles before the activity and efficiency of the program.
Directed research funding of Canada also has a strong influence on the managerial dimension. Commercialization and Research Excellence Centers (CECR) of Canada has included a grant program competition since 2007. Grants are provided to the non-profitable organizations in a competitive way by the universities, colleges, research organizations, companies or other non-governmental organizations that are not already financed in each year. The ultimate goal is for the centers to be independent and self-sustaining in order to establish internationally accepted commercialization and research centers in four priority fields (health, energy / natural resources, ICT, environment). The results obtained in the assessment of the program in 2014 showed that the progress of the program was well and the program required to continue for a long time before the assessment of the results and the program will benefit from the adjustment of the expectations.

The program fills an important gap in funding innovative research programs in Canada, but some obstacles defined which are before its success: Competition to attract world-class researchers, misunderstandings about the definition of cooperation, limited numbers of centers apart from host organizations and need to revise the CERC performance measurement strategy.

Canadian NCEs started Mitacs with specialization in mathematics with a special focus on training the next generation of the workforce that realizes the reduction of postgraduate student enrollments and the importance of retaining knowledgeable researchers in late-1990s. The multi-component program organizes internship program based on university-industry collaboration and has established joint institutes with similar organizations in the USA and Mexico and provides assistance for postgraduate students of Canada in professional competencies.

The "Facilitation Program", an especially extraordinary program, has already created 10,000 internship opportunities and aims to provide 10,000 internships on annual basis for graduate students by 2020. The Facilitation Program has owned an investment for $24 million and enabled to increase R&D investments in employability of graduates, retention of talented graduates, R&D investments in collaboration between university and industry stakeholders with the strong support of both state administration and local industry (Mitacs Corporate Plan 2015–16, 2015). Key points of transferability include the following issues:

. Government tax reductions to encourage innovation and UIC

. Target programs for UIC grants and networking

. Emphasis on industry internships for interested graduate students

South Korea

In South Korea (Korea), the UIC had been in very limited number until the 1990s, and the universities had not been known for their research and the main focus was on teaching until 90s. Industry leaders tried to establish collaboration with foreign firms believed to have more innovative technology than universities or other domestic industries. However, Cooperation, Research and Development Promotion Act started to focus on comprehensive national R&D policies and the need for UIC in the early-1990s.

Most of the UIC projects in Korea was firstly initiated through personal connections instead of directed policies, which Resulted in misidentification of many relations and projects which were inadequate in terms of professional applications within the scope of intellectual property rights specifically. Korea struggled with the management of UIC projects and patents until it designed intellectual property policies which were similar to those seen in Singapore. The government responded to R&D-related matters by combining two separate ministries which are the Ministry of Education, Science and Technology (MEST) and the Ministry of Information Economy (MKE). It revised the name of the ministry as The Ministry of Science, BIT and Future Planning in 2013. It is aimed to better improve the understanding between the university, industry and government and encourage the innovative capacities throughout the country. Korea does not share most of its industrial sector technology, patents, and publications with the academic community for now. Even though the government have made great efforts to create organizations that will help transfer technologies smoothly, still deficiencies in a single basic organization that can facilitate R&D in university-industry areas are seen. Revenues of only 8.5% of private universities originate from commercial or industry collaborations.

The most prominent UIC project in Korea is Brain Korea 21 (BK21). The project is designed for the PhD students or young graduates capable of creating innovative technologies or scientific discoveries to be published in leading academic journals. Besides, by this project, it is aimed to enhance the status of Korean universities, receive more doctoral education abroad, encourage cooperation with industry and adopt an innovative knowledge economy. The project has managed to strengthen its UIC bond since each Korean university does have laboratories and/or equipment funded by the industry. Selected institutions that have been provided with funds under the project have become the most famous research centers in Korea.

Key points of transferability include the following issues:

- Direct connection between the development of domestic industry and the trend of UIC
- Nationally approved program to provide training and support to graduate students and young researchers, Failure in having comprehensive intellectual property rights and trust in personal networks are still obstacles

France

France is the sixth major R&D country among the world countries in terms of its expenditure on R&D to its gross domestic product. Also, enterprise-based R&D intensity is relatively low in France compared to other R&D intensive countries since France has a relatively smaller share in medium and high technological manufacturing industries. However, while the R&D expenses in the business world tended to decrease in most countries after the global financial crisis, it has increased in France. Research of the European Council shows that this is partly due to the 2008 extension of R&D tax incentives (EC 2014). Furthermore, while the R&D expenses funded by public is high, that are funded by the enterprises are low; and most of the public-private research relations are subsidized by the government.

France has the French National Center for Scientific Research (CRNS), a fairly stable administrative system operating since 1939. Some attempts to operate 10 research institutes, support programs that provide interdisciplinary research and research education, analyze the scientific environment, and promote the dissemination of research have been realized within the scope of CRNS. The budget of CRNS in 2014 was 3.24 billion Euro. CRNS consists of decentralized direct laboratory management and 18 regional offices that support 1025 research units (95% joint research laboratories with universities and industry) in addition to 10 research institutes. So, it vastly different from traditional departmental structures as it includes research centers that are part of the organization. In terms of 25 agreements between major international industry groups, more than 4000 patents and more than 700 companies established with CNRS since 2000, its success if of crucial importance (CRNS 2015). The center has independent but associated departments for evaluating institutes, programs and scientists known as AERES.

In France, TTMs have focused on bilateral cooperation agreements rather than licensing intellectual property. Licensing and commercializing the output of the research started to be on the agenda mostly after the document "Innovation Law" dated 12 July 1999 in France and "Recommendations on FSMH Policies" published by the Ministry of Research in 2001. The autonomous structure of universities in France allows them to establish TTM as they see fit.

The Innovation Act allows public sector employees to retain their civil servant status for up to six years if they prefer to take place in in a startup. With its central tax incentive, CIR finances the contract and patent application process to promote innovation among successful applicants since France has a relatively low level of patent production.

Key points of transferability include the following issues:

- Tax incentives have been extended even during the austerity periods
- Extensive National Research Center with different institutes and units has been coordinated and evaluated
- An innovation law has been enacted to help academics work part-time in the industry

Germany

Science and research have been characterized by an excellent infrastructure, a wide range of disciplines, well-equipped research facilities and competent staff in Germany. Research is an international activity in Germany and conducted in cooperation with European or international stakeholders generally.

The German higher education system is built with a close link between learning, teaching and research. Germany hosts around 400 higher education institutions thar provide all academic disciplines, and which includes 110 universities totally (Universitäten) and more than 230 universities of applied sciences (Fachhochschulen / Hochschulen für angewandte Wissenschaften). Also, it provides students with a practical academic education by emphasizing on applied research.

Germany is one of the most attractive research and higher education countries in the world. About 320,000 international students are enrolled in German higher education institutions. Nearly 26,000 international doctoral students are enrolled in German universities, and more than 38,000 international academicians work in German higher education institutions now.

According to the results of the country reports realized with 28 member countries and 5 associated countries within the scope of the European University-Business Cooperation Project, German professors carry out consulting activities privately (Steinbeis model1) while the management and evaluation activities are not carried out by more than half of German academics in Germany. The higher is the volume of the work, the higher is the possibility to collaborate with a German academician. 57% of academicians with whom collaboration relationship has been established in Germany are significantly involved in major-scaled businesses. This collaboration has been reduced to 54% for medium-sized businesses, 42% for small and micro-sized businesses, and 20% for entrepreneurs in the business development process.

Major-scaled enterprises in Germany are more likely to work on challenging R&D technology-focused projects while the SMEs often tend to work on strategic market-oriented projects. Such two kinds of enterprises engage in collaborative operations in different levels and on different times because of different reasons. Even if the fund insufficiency is deemed as a crucial obstacle before the collaboration, in case of the non-availability of the perceived motivation tools enough (academicians underlines the personal motivations, such as gaining new insights and practical implementation of results), the availability of funds is not sufficient for cooperation to take place. The collaboration is initiated by the motivations.

The five biggest obstacles before the UIC for German academicians are as follows: 1) Bureaucracy related to UIC, 2) Insufficient working time of academicians for UIC activities (allocated by the university), 3) Limited resources of SMEs, 4) Lack of business finance for UIC, and 5) UIC's conflict with teaching and research responsibilities.

Bureaucracy with UBC stands as the most important obstacle to collaboration for academicians, both cooperating and non-cooperative. This result is based on the on the number of regulations, policies and laws in the German context. Because of being created by different government officials and different levels (federal, state, and local), they can even be non-compliance with each other. It is a challenging fact for university stakeholders and business representatives. It is one of the biggest challenges for regulations to find the correct way in this complicated situation for the UICs in Germany. Besides, the insufficiency in the working time allocated for the academicians by the university is seen as a big UIC challenge for both groups. Academicians should always compete against their other roles and responsibilities when it comes to UIC. While the academicians in collaboration are restricted by the resource and finance-related factors, for the non-collaborative academicians, barriers to cultural issues may be more important including different motivations and time horizons between the two organizations.

The main factors that facilitate UIC for German academics and university representatives are as follows: focusing on the importance of mutual trust, interdependence, and shared goal. German organizations deem trust as a key element in UIC. If trust is established, the collaboration is more likely to be successful. In case of non-existence of trust, the projects are more likely to fail. Business interest in accessing scientific information is considered a driving force. It is important for academicians to have funding to collaborate; however, university representatives see the previous relationship with the business partner as another important facilitator.

The five most important motivation factors for university representatives are as follows: 1) To obtain finance / financial resources, 2) To increase the reputation of the university, 3) To increase the employability of the graduates, 4) To use the researches of the university in practice and 5) To obtain new information for research

It is seen that German universities mostly use joint collaboration programs and contract-based research projects methods as technology transfer channels to the industry. The leading factor in Germany’s technology development power is the research institutes with public or semi-public nature. These structures also serve as an effective bridge in R&D activities between universities and industry. Several important organizations with their various missions, different research field focuses and technology transfer setups within this scope; Fraunhofer (Fraunhofer Gesellschaft (FhG)), Helmholtz Centers, Leibnitz Association (WGL), Max Planck Innovation, Germany Steinbeis Foundation Transfer Centers. It is observed that interfaces for corporate technology transfer and especially TTOs started to be established after 1980 in Germany.

One of the important results of the "Knowledge Creates a Market" initiative launched by the German government in 2001 is that right ownership of research conducted at universities regarding intellectual property rights through a law amendment similar to Bayh-Dole was given to the universities and that an obligation was imposed on academicians to notify the university regarding their studies. The university can have the intellectual rights that will arise from the research as a result of its evaluation. It is stated that Patent Marketing Agencies (PMA) were established in 2002 so that TTAs that were started to be established in the universities increasingly to be more functional and to provide support in the commercialization process of academic research results. It is underlined that such agencies are involved in all processes (patentability, filling inventions, commercialization potential research, patent applications, bargaining with third parties, contracts, etc.) and in all relevant areas for the commercialization of research outputs in collaboration with the universities. It is reported that a significant increase has been obtained in the number of inventions and rates of commercialization thanks to this system. It is seen that PMAs are also involved in the previously established technology cooperation network that consists of 200 scientific institutions and 100,000 researchers. This system which is known as German Patent Marketing and Technology Transfer Agencies Network is funded by German Ministry of Economy and Technology (BMWi).

USA

Organized pursuit of R&D in research university and industry in the United States was born nearly 125 years ago and grew throughout the 20th century as parallel. Upon the adoption and enforcement of the Bayh-Dole Act by the US Congress in 1980, universities and small enterprises were enabled to become patent holders for research with federal sponsorship, which changed the relation between academy and industry deeply. The legislation allowed universities to license their patents to sectors or exclusively to a sector. The copyrights acquired by universities for this type of licensing have been used to award the inventor(s) in addition to promoting further research and education. The law of Bayh-Dole is deemed as a milestone since it has a great impact on the development of TTOs and is in the nature of an example for almost all developed countries.

The long and rich history of US university collaboration has been resulted from several unusual structural features of the US higher education system. When compared to Japan, Germany, France and United Kingdom, US higher education system has always been in a higher level throughout the century. Almost every international comparative analysis puts forward that the number of students and the number of institutions are much higher than such industrial economies. US system is also characterized by various institutions including research universities, liberal arts colleges, and public and private institutions. Such institutions are not governed nationally or centrally; instead, they compete with each other in fierce way only for prestige, students, faculty, and resources gains, which is a very distinctive structure compared to the most of other industrial economies.

Engineering research centers (ERCs) of the National Science Foundation (NCF) are one of the major policy innovations of the US government in the 1980s to develop advanced university-industry R&D collaboration. ERCs are coming to the forefront among other university-industry R&D programs for the wideness of targets in changing the method of performing academic engineering research and education and underlying the pre-competition generic researches. ERCs are designed to conduct a research on next-generation technology at the intersection of disciplines which will be beneficial for the industry without fousing on the results closely and accordingly to fill a specific gap in the American national innovation system.

USA's discovering the importance of university-industry collaboration and developing its collaboration processes and implementations by its applications and legal regulations are of crucial importance in the current technological development status of USA.

The USA has taken successful steps in innovation ecosystems. To illustrate, even though the Silicon Valley in the 1960s was not very compatible with the entrepreneurship than it is today, successful innovation ecosystems have made great progress by adapting to changing conditions in the extensive business and regulatory environment. It provided the integrity with its university-industry cooperation offices, incubation centers, technology licensing and commercialization offices and local funding institutions in the ecosystem that it has created.

Silicon Valley, Cambridge-Boston-Route 128 Ecosystem, Raleigh and Research Triangle Ecosystem, and Austin Ecosystem are important ecosystems for both the United States and the world. Silicon Valley that was set forth by USA through the successful national innovation system design policies implemented has a privileged position. Most of the money that has entered into the US Finance comes from Silicon Valley where nearly 60% of advanced technological innovations and inventions are exhibited.

Boston Route 128 is the leading ecosystem of the world with more than fifty educational institutions such as MIT and Harvard. When it comes to the regional economies, in the west, Silicon Valley and on the east, Boston Route 128 ecosystem are the most important structures in the world that serve as a model for other countries.

Elements of the Boston Route 128 Ecosystem are as follows:

-Educational Institutions (such as Harvard, MIT, Boston, Tuft, Bason)

-Corporate R&D Laboratories (such as Microsoft, Google, Mitsubishi, Novartis, Pfizer)

-Central and Local Public Initiatives (such as Life Sciences Cluster, Robotics Cluster)

-Entrepreneur Support Organizations (128 Innovation Capital Group, Boston Entrepreneurs Network), Investors (Venture Capital, Business Angels, Corporate Investor Groups), Regional

Trade Associations, Regional Publications, Service Providers.

-MIT Organizations (Deshpande Center for Technological Deployment, Entrepreneur Mentor Service, MIT Entrepreneurship Center, MIT company Forum, MIT Entrepreneurship Club.

-Modular Offices / Services (Cambridge Settlement Center, One Kendall Square, Regus), competitions for dynamism.

Almost every university in the USA has created its own technology transfer policy and established the necessary infrastructure for technology transfer and licensing. University - industry collaboration is set by means of technology transfer offices. To illustrate, MIT-Industry Liaison Office is an office established to bring researchers and students at the university together with the industry. It interacts with major-scaled and international companies. The key point in university-industry collaboration in USA is the belief and trust that the collaboration will benefit both sides in time.

Case Studies

Case Study 1:
Vienna University of Technology
(TUW，Austria)

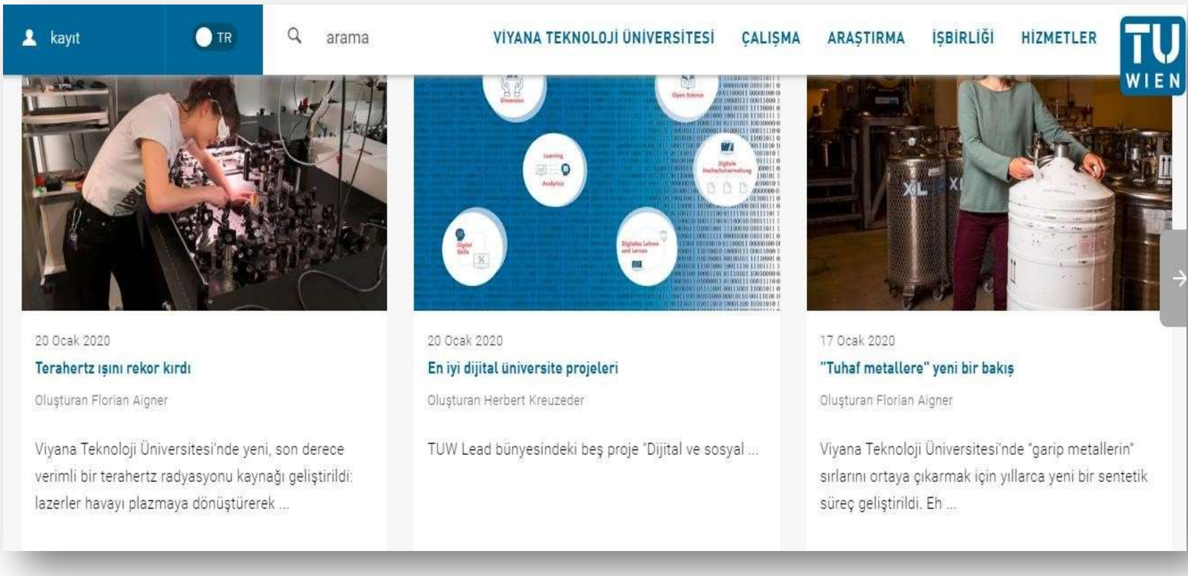
The case study presented by Vienna University of Technology has focused on excellence centers initiated by Forschungszentrum Telekommunikation Wien (FTW).

The excellence centers of the university are inter-faculty infrastructure designed to have a critical audience in various specialties. The excellence centers are flexible and have various duration and financing resources. They are practical corporate response to meet the needs of the collaboration stakeholders.

The FTW center which was established in 1998 witnessed that its partner and governance structure rapidly changed as the number of projects increased due to the capacity of the center to meet the customer needs. FTW is a research center in the field of communication technology and its activities consist of three types of projects:

1. Strategic research
2. Application-oriented projects
3. Product services and development

Vienna University of Technology: “FTW is a nationally leading and internationally renowned Research Center that develops and implements its specialty in communication technology. Industrial and academic members of the FTW acts in line with a common objective to drive research and innovation in the field of communication technologies towards the application of Internet Protocol-based technologies that are used in the development of distributed infrastructures and environments that are smartly usable and smartly managed. The general strategic research program of the center focuses on the progress of generic technologies that are the key supporter for smart infrastructure innovation and value chain creation in telecommunications, transport and energy.”



https://www.tuwien.at/

In the European Union's funding programs, the Vienna University of Technology in Austria has a project budget of 83.66 million Euros and a project budget of 97.49 million Euros, participating in the VII. European Union research, technological development, and implementation framework program (2007-2013) with a total of 217 research projects. It is the most successful organization with a financial contribution of the European Union. Preliminary evaluations show that the Vienna University of Technology has made a remarkably successful start in the new European Union framework program (2014-2020) in research and innovation Horizon 2020 (H2020) and has achieved success above the European Union average.

Case Study 2:

Katholieke Universiteit Leuven (KU Leuven, Belgium)

In the case study presented by KU Leuven, different levels of university-industry collaboration is discussed. The case study which is based on this collaboration has brought KU Leuven and Samsonite together and focused on the development of a brand-new composite material; and accordingly, it has developed a light but strong suitcase.

KU Leuven: "The project was carried out in cooperation with Samsonite and the self-reinforcing PP material supplier. As well as other types of honeycomb material, a new technology research institute called as SLG which is a joint enterprise of Sirris and KU Leuven: research institute established Composite Application Laboratory at a later stage of the process. The sector and the application were supported; and further, the project led to a successful FP7 NMP project involving 8 multinational industrial partners."

http://www.slc-lab.be/references/samsonite/samsonite

Leuven University's research project in collaboration with Samsonite resulted in the world's best-selling suitcase series. Samsonite, a leading suitcase manufacturer was intended to develop a lightweight, strong suitcase using a synthetic composite material called Curv®. Professor Ignaas Verpoest from the Department of Metallurgical and Materials Engineering (MTM) of KU Leuven adapted the material for the manufacture of luggage together with Samsonite. The team developed a layered design where a top layer of material protected against scratches while the additional medium layers enhanced the impact resistance. First prototypes of the suitcases was made in collaboration with Professor Vandepitte or the Department of Machine Engineering in Leuven. Samsonite launched the Cosmolite suitcase series based on KU Leuven technology or produced over 2 million in 2009.

https://www.leuvenmindgate.be/infopanelen-eng/suitcases

Case Study 3:
Aalborg University (AAU, Denmark)

The case study of Aalborg University which is a role model focused on a collaboration resulted from a particular research project. A student at Aalborg University developed a project in the BML scientific field, more specifically on cardiology. The invention as the outcome of this project resulted in a patent where the rights of the university were protected. This project resulted in the creation of a PhD position for the student, and several companies met with the university to form a consortium and further develop the product.

Aalborg University: "The student made an invention in collaboration with the consultant during the project. The invention was announced to the Technology Transfer Office and the rights were granted to the university and patented. The student was provided with a university-funded doctoral position to continue the research because of the innovation and highly scientific aspects of the technology. The technology was marketed in the press and scientific environments, and the university pursued different strategies for commercialization.

Major-scaled companies in Denmark with ideas on how to commercialize the invention held talks with the University during the doctoral study. They stated that it was necessary to establish a consortium and the parties should apply for funding to the Danish National Foundation for Advanced Technology so that the technology concept could be further developed while the project could be proven.

The application was accepted and nearly 800.000 £ was provided for the project while the amount was matched with a private financing in the same amount. During the project funded by the Danish National Foundation for Advanced Technology, the parties decided to establish a separate company for product development and sales. The university transferred its rights to this company and other parties contributed to the investments. Besides, the risk capital was invested successfully. The spin-out is working on the product to further improve and aims to market the product."

Case Study 4:
Tampere University of Technology (TUT, Finland)

The case study presented by Tampere University of Technology addressed mainly the institutional level. It does not serve as a specific example of the university's collaborative research project, but it has focused on the general approach of the university to collaborative research. The case study describes the recent changes operating at the University as a private foundation since 2010. Establishing partnership with the industry is one of the cornerstones of the university's strategy.

Tampere University of Technology: "Tampere University of Technology (TUT) was commissioned as a private foundation (TUT Foundation) on the date of January 1st, 2010. Tampere University of Technology is often called "Finland's industrial university" because of its strong collaboration researches conducted with non-academic partners. Tampere University of Technology tries to motivate the researchers and students to benefit from the outputs of the researches and inventions in an active way. The service is based on the collaboration between the TUT and regional and national-scaled partners.”

Case Study 5:
Leuphana University of Lüneburg (Germany)

Leuphana University of Lüneburg focused on the example of Sustainability Sciences Incentive that is its case studies. This initiative combines the natural and social sciences with an interdisciplinary approach. At the time the case study was presented, Leuphana University of Lüneburg made a strong emphasis both on the collaboration with public and private stakeholders; and developed a new corporate strategy based on the principle of determining priorities for the regional research and education strategies. The strategic approach of the university involves the recruitment of new staff in order to provide faculty/department integration that will result in interdisciplinary research approaches.

Leuphana University of Lüneburg: “The Leuphana case study in the EUIMA project discusses the collaborative research aspects at the program level: The following data is based on the efforts that is based on the exemplary collaboration of Sustainability Sciences Incentive collaboratively integrated into the Faculty Sustainability of Leuphana newly established. Four major science initiatives were created as part of Leuphana's modernization process: Educational Sciences, Management and Entrepreneurship, Cultural Sciences and Sustainability Sciences characterized by a combination of natural and social sciences in an interdisciplinary approach, which Is represented by the composition of the new faculty and the curriculum of the Graduate, Postgraduate and Doctorate degrees.”

Case Study 6:

Münster University of Applied Sciences
Münster UAS, Germany

The case study presented by Münster University of Applied Sciences (Münster UAS) put forward the Science to Business Marketing Research Center (S2BMRC) focused on different research fields such as entrepreneurship, partnership, knowledge, and technology transfer.

Münster UAS: "The element that is integrated into Münster UAS and has contributed to significant information regarding the methods to acquire third party financing by conducting comprehensive researches on how to develop commercial collaboration for the university is the Science to Business Marketing Research Center (S2BMRC). The research center focuses its research on university-collaboration and examines key factors for the successful commercialization of research competencies, capacities, and results. It develops, confirms, and presents new models and instruments in order to provide support for the research on research and technology commercialization and the realization of market-oriented university-business partnerships. Knowledge and Technology Transfer and Commercialization, Technology Evaluation and Innovation Management / Marketing."

Case Study 7:
University of Paderborn (Germany)

University of Paderborn presented two case studies as C-Lab (case study 7a) and S-Lab (case study 7b).

Case Study 7a: C-Lab

C-Lab case study brought the collaboration between the University of Paderborn and Atos together. C-Lab research collaboration has been operating successfully for over 25 years and focused on new innovations put forward by the Information and Communication Technologies application within the framework of a collaboration agreement instead of an official legal entity. In this project, each stakeholder enables their personnel and resources to adapt into project collaborations that have been agreed during the periods specified within the framework of long-term relation. The collaboration has spread to other research disciplines/fields where the interdisciplinary perspectives are required to be developed such as business management and psychology to take into consideration the market opinions and human behavioral factors.

C-Lab -University of Paderborn: "C-LAB" is not a classical technology transfer organization; instead, it is a special and real collaboration that provides mutual benefit for both parties. Therefore, R&D is conducted by hybrid teams consisting of the employees of both partners jointly. Results can be used (scientifically and commercially) by each partner. If commercialized by one partner, a compensation to be negotiated must be agreed with the other partner on a case-by-case basis. Not forming a legal entity is the main principle of this collaboration, which means that the employees of C-LAB are the personnel of Atos or the university. It results in a closer integration C-LAB into two main organizations when compared to a legal entity with a joint ownership. C-LAB is closely linked to local R&D networks despite of the close integration with only two organizations. Furthermore, it is connected with the related national and international academic and industrial organizations as active in national and European funded collaboration projects"

Case Study 7b: S-Lab

S-Lab was created on a strong individual basis as a collaborative research institute bringing the faculties of computer science, electrical engineering and mathematics together. S-Lab University of Paderborn: "S-Lab was established as a joint research institute by five professors in the department of computer sciences of the faculties of computer science, electrical engineering and mathematics in 2005. S-Lab was inspired from the existing individual collaboration research connections, a transfer and transformation culture between the university and companies through various network creation activities and a joint, interdisciplinary and collaborative research tradition created by organizations such as Heinz Nixdorf Institute (interdisciplinary research institute established in 1989) or C-LAB. S-lab cooperates with the University administration and the law and transfer offices of the University. On the other hand, it has its own management, management office and personnel to acquire, manage and control the research projects through different types of financing programs."

Case Study 8:
Ruhr Universität, Bochum (Germany)

Ruhr University Bochum (RUB) has deemed the collaboration with non-university research institutions as an important priority in its strategy to increase research capacity. The collaborations were in the form of joint postgraduate schools, joint assignments, and frame agreements. By the RUB case study, the Center of Electrochemistry Sciences (CES) was created as an example on how ThyssenKrupp Steel Europe and SMEs are combined in order to carry out a series of collaboration projects on an integrated inter-institutional basis of public and private financing in electrochemistry. Ruhr University Bochum: "CES is a direct answer for industrial need that addresses numerous electrochemical issues varying from material sciences to biotechnology. Especially the industry sectors require knowledge and expertise in electrochemistry in terms of energy, basic chemicals, polymers, surface treatment, micro system technologies, diagnostics and environmental monitoring, product or process development. Therefore, CES hosts for a modern electrochemistry laboratory to solve the complicated challenges assigned by both academic and industrial partners. Also, it coordinates collaborative research projects of its members, establishes new collaborations with external partners from industry and other research institutions, funds the research activities of various young researcher groups and encourages the new researchers who are at the beginning step of their career paths, and provides different levels of electrochemistry training courses for different audiences within and outside the university. ”

Case Study 9:
TuTech Innovation (Germany)

TuTech Innovation presented two case studies, one focusing on industrial biotechnology, Bio Catalysis 2021 (case study 9a), and another focusing on climate change adaptation strategies, Klimzug Nord (case study 9b).

Case Study 9a: TuTech Innovation - Bio Catalysis 2021

Within the TuTech Innovation - Bio Catalysis 2021 cluster, TuTech, Hamburg Technology University includes the industrial partners and Hamburg State Authorities. The main focus of the cluster is the biocatalysis application for industrial processes. The enterprise is the output of the IBN network (Industrial Biotechnology North) that aims to intensify its existing expertise in industrial biotechnology, leverage synergies and create visibility into biotech applications in northern Germany. TuTech Innovation - Bio Catalysis 2021 cluster will be financed with € 20 million over five years and its coordination is under the responsibility of TuTech Innovation.

TuTech Innovation - Bio Catalysis 2021: “The aim of BIOCATALYSIS 2021 Cluster:

To use the potential of industrial biotechnology to develop new products and production processes. Its special focus is the application of biocatalysts for industrial processes.

The administrative management of the BIOCATALYSIS 2021 cluster is conducted by TuTech. It integrates multidimensional concepts, objects, and program management because of the leadership requirements of the cluster. The aim is to optimize the management of joint R&D projects of major-scaled enterprises, SMEs, academic institutions and non-university institutions."

Case Study 9b: TuTech Innovation - Klimzug Nord

The TuTech Innovation – Klimzug Nord cluster deals with climate change adaptation strategies in northern Germany. This collaboration brings together public authorities, industry and several academic institutions in the region. The project focuses on the impacts of climate change, particularly in the areas of estuary river management, integrated urban development and sustainable cultivated environment. The project also aims to develop an action plan for the metropolitan area of Hamburg.

TuTech Innovation - Klimzug Nord: "KLIMZUG-NORD partners will research the results of climate change in urban areas on Hamburg metropolitan zone, agricultural sites and tidal riverbed of Elbe. Several action plans will be recommended by taking into consideration the research data, environmental planning, city law and economic plans.

The aim requires a coordinated action plan for urban regions including a master plan by 2050. The collaboration is based on a collaboration agreement and a common objective: The aim of the project is to combine scientific, technical, and financial efforts. Political, administrative, scientific, and economic interest groups come together to determine the effects of climate change and to create an action plan. They are determined to produce realistic priorities and solutions for the metropolitan area within a framework by 2050 together. The network aims to create a master plan for climate change management in the Hamburg metropolitan area for up to one year. Three (main) subjects for 2050: estuary river management, integrated urban development and sustainable cultivated environment."

Case Study 10:
Politecnico di Torino (Italy)

Politecnico di Torino presented two case studies one of which is in a corporate level (Polito corporational; case study 10a) while the other discusses the collaboration between the university and General Motors PowerTrain Europe (Polito GM; case study 10b).

Case Study 10a: Polito presents an overall perspective on the establishment and sustainability strategy with the business sector of the following university regarding the corporate Case study.

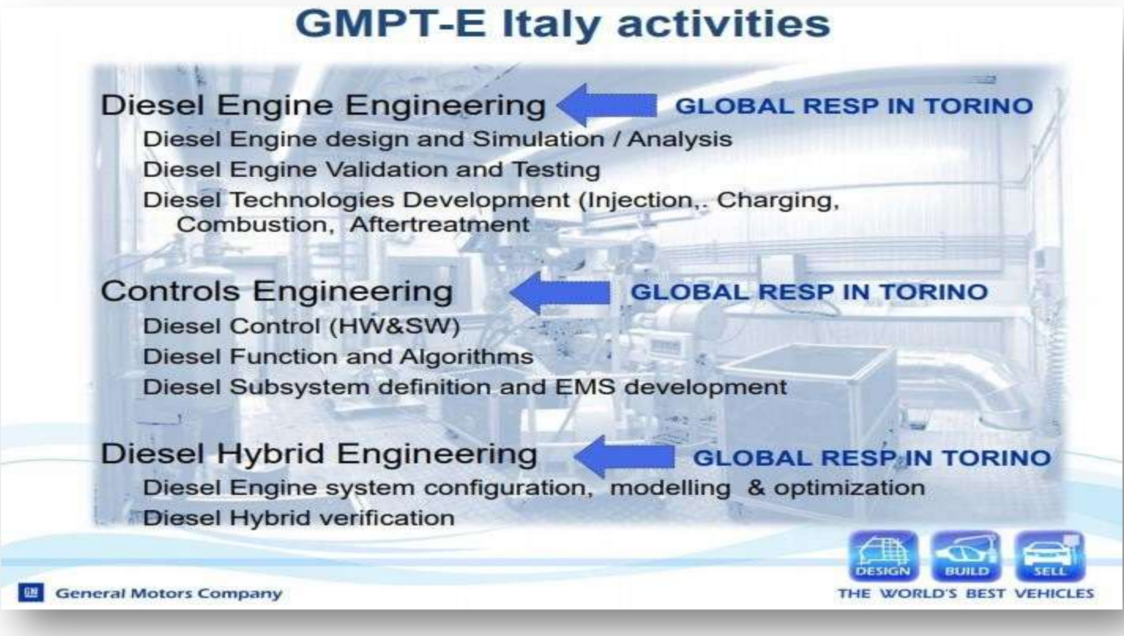
Politecnico di Torino has adopted a new model which uses a partnership agreement based on a new legal and contract in the relations with medium and major-scaled business facilities since 2006. This model which is the main subject of the best application that we want to emphasize in the relation between the university and business facility is based on the assumption of a permanent and configured relation like a collaboration in the higher education curriculum and national/international research projects following the professional integration in an organization in terms of ordering, financing industrial doctorates, joint patents in many integrated area as its direct results. This collaboration is possible to be established in a common field or a physical area where academic information is put into force like a kind of “technology transfer laboratory” in special or more effective situations. (Citadel Polytechnic-Polytechnic Campus)”

This special case study has focused on the Research Support and Technology Transfer Area (SARTT), which deals with the organizational model of the university to support the research, EU fundraising, structural and national fundraising and research contracts, and technology transfer. Also, the central administrative services within the research subject is a part of SARTT.

Case Study 10b: Polito GM

The university and GM established a joint center of the Automotive Research Institute located on the university campus. The collaboration covers the research and education activities and includes internship, master, and doctorate programs as well as 600 office spaces, 12 laboratories and more. The seven departments of the university participated in the collaboration and work in different and specific research stages varying from basic research to product development. The duration of the agreement between the university and GM is 30 years and is revised every five years. Partnership agreements have been negotiated beforehand (each new agreement includes principles and references that have already been determined, and thus the negotiation processes of the new agreements are facilitated.)

Polito GM: “One of the most successful examples of new Politecnico incentive model is its partnership with General Motors Powertrain Europea and Politecnico di Torino. GM is not only close in Europe but also it is the first automobile manufacturer to decide to establish a facility inside a university building. Within the framework of academic partnership research agreement and academic partnership agreement on education and training signed in March 2006, GM established a research center on diesel engines for the development of small automotive diesel engines of the GM world. In the campus of Politecnico di Torino, Politecnico and GM initiated various joint research projects aiming to develop educational activities such as Master as well as the innovative, efficient and environmentally friendly power transmission technologies for automotive application. “GM Powertrain has not only established a new model in terms of the content but also laid the foundation of a new path on comprehending the means of managing the relation between the business world and the universities.”



https://didattica.polito.it/zxd/cms_data/attachment/6/GM_2014.pdf

Case Study 11: Norwegian University of Science and Technology (NTNU, Norway)

The joint study presented by NTNU includes the collaboration with the DNV company (Det Norske Veritas). The case study is a role model demonstrating a strong focus in corporate level since it discusses a long-term collaboration with corporate strategic targets. Additionally, the university has developed and performed general policies and processes for joint research activities. DNV that develops operations in marine, oil and pipeline industries has various partnerships with the universities in Europe, North America and Asia. The main focus areas are polar climate engineering, clean renewable energy and integrated operations in terms of its collaboration with NTNU. The collaboration between NTNU and DNV includes a five-year frame agreement and the covers various operations related to research, education, and training. Even if the SET (Biotechnology, Medical and Life Sciences) is the main component regarding the scientific focusing areas of this collaboration, the research operations varies up to ESSH (Economic, Social Sciences and Humanities).

NTNU: “The collaboration between NTNU Norway and DNV included a framework agreement between 2008-2013 with a commitment of € 1.5 million from the company on annual basis. The aim of the collaboration is not only to focus on scientific and technological development, but also strengthen the education and learning of the future’s researchers and possible new employees. The study was mostly prevailed by the engineering sciences; however, it is emphasized to support the social science researches on international legal and regulatory regimes and policies.”

Case Study 12: Autonomous University of Madrid Madrid, UAM, Spain)

The case study of Universidad Autónoma de Madrid focused on the project basically. UAM has established several university-company rostrums in different scientific fields. Such rostrums consist the first step in a collaboration project and based on a three-year agreement with the companies. This case study has demonstrated the collaboration between UAM and Accenture and focused on the scientific field of SUY. Accenture is a consulting and technology outsourcing company that provides consultation for its clients in business management and strategic development. Accenture has supported the rostrums in economy and innovation management fields. In this specific case study, it has focused on researches on collaboration between UAM and Accenture, innovation policy and recommendations on innovation policy.

UAM: “UAM - Accenture Rostrums/Chairs in the fields of economics and social sciences and humanities have been an integral part of an excellent research environment for collaboration including important partnerships for long time. UAM was mostly established with major-scaled companies and was the first step towards a private project collaboration. 29 rostrums/chairs have been created so far - 19 in BML, 3 in SET and 7 in SUY. Rostrums were established through a 3-year-agreement by being funded for 50.000 € on annual basis.

Case Study 13: Rovira i Virgili University

This case study focused on the university's long-term collaboration with REPSOL. This partnership has brought forward many research contracts since its inception in 1999. It has also extended beyond the research project level with the involvement of the company in teaching and funding.

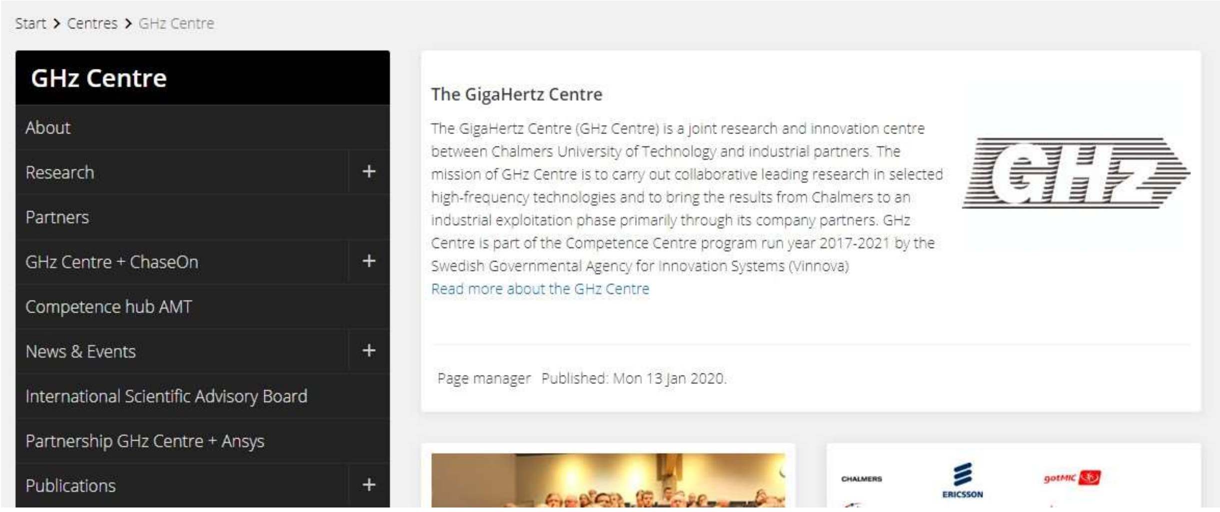
Rovira i Virgili University: "REPSOL approached to us for the first time in 1999; because we successfully developed the database of ministries Homogeneous Catalysis projects. Thanks to our participation in the conferences and symposiums, REPSOL got information about this specialty. REPSOL and CTQC (Technology Transfer Office) have been partners in projects related to sustainable chemistry conducted in CTQC since 2009. The roots of the research agreements being developed in CTQC for the time being is the previous collaboration performed through TecaT, the innovation center and FURV between REPSOL and research group (1999-2009). An ITN offer was provided in the call of the latest FP7 within this scope. This network offer was resulted from specialty acquired from a long term collaboration and infrastructure. Thanks to the industrial applications which are the output of the research studies developed in collaboration with REPSOL on the catalytic systems and good understanding maintained during the collaboration, we managed to deal with the education of new young generation with competencies on innovative and sustainable processes. "

https://www.repsol.com/en/index.cshtml

Case Study 14: Chalmers University of Technology (Sweden)

In the case study presented by Chalmers University of Technology, a report was presented on GigaHertz Center (GHz Center). This collaborative research center specializes in microwave technology and is a part of the institution’s Department of Micro Technology and Nanoscience (MC2). GHz Center has three kinds of collaboration: advisory consultancy, contract research and joint ventures.

Chalmers University of Technology: “The GigaHertz Center (GHz Center) which is the example situation in this report is one of the few collaboration projects with industry at MC2. It is by far the largest in the MC2 with a turnover of around € 1.6 million a year over ten years. GHz Center has three extensive collaboration types each of which holds different collaboration degrees: advisory consultancy, contract research and joint ventures. A general management idea for effective collaboration is to have a mix of companies and to avoid from bilateral setups. The ideal mix is often two large companies that have complementary needs (i.e, company and system setup for us) and a SME or company that wants to emphasize more innovative opinions for major-scaled companies in the project as well. ”

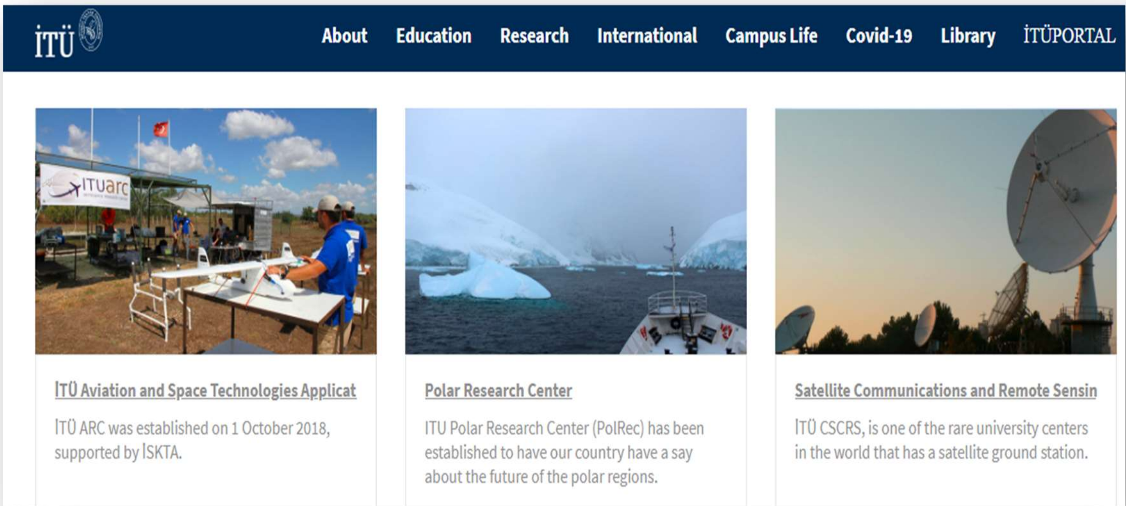


https://www.chalmers.se/en/centres/ghz/Pages/default.aspx

Case Study 15: Istanbul Technical University (ITU,Turkey)

Istanbul Technical University reported a case study with a strong focus on the institutional level. It has focused on Rotorcraft Center of Excellence (ROTAM) which is a research center working on the design and development of manned and unmanned helicopters. ROTAM has national and international partners and its organisational structure is composed of academics from different disciplines across the university.

Istanbul Technical University: "Rotorcraft Center of Excellence (ROTAM) is a unique National Rotorcraft Centre of Excellence in Turkey, which aims to promote education, academic and industrial collaboration in the field of rotorcraft design and manufacturing. ROTAM has created an academic and research environment to develop rotorcraft design and manufacturing methodologies in collaboration with national and international partners, since 2003 […] Main research activities of ROTAM: Detailed design and development of manned (particularly Light Commercial Helicopter) and unmanned rotorcraft configurations, aerodynamic and structural analysis, control systems development, manufacturing drawings preparation, auxiliary systems and system integration.”



https://www.itu.edu.tr/en/research

Case Study 16: Newcastle University (England)

The case study presented by the Newcastle University had a strong focus on the institutional level and it also addressed the programme level. The case was based on NewRail which is a research center developing its operations in various fields in rail industry. The research center has participated in many EU projects successfully and has strong connections with companies and other institutions on international scale.

Newcastle University: “The case study of Newcastle University is based on NewRail research; and the successful participation of the center and EU in the FP6 and FP7 collaboration programs. NewRail is a private rail research center that has a wide range of specialty in different fields of the rail industry. The aim of the research center is to develop and maintain the highest international standards of excellence in railway related research. NewRail has a wide range of experience in applied researches focusing on the development and strategic application of innovative technologies for railroads, and it is connected with the organizations and final users in addition to the important international actors in the sector. ”

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