UNIVERSITIES' CONTRIBUTION TO THE NATIONAL TECHNOLOGY INITIATIVE

Prof. Dr. İsmail KOYUNCU
Prof. Dr. Hacı Ali MANTAR
Prof. Dr. Şule Itır SATOĞLU
Prof. Dr. Altan ÇAKIR
Assoc. Prof. Mustafa Evren ERŞAHIN
Assist. Prof. Dr. Tankut AKGÜL

DOI: 10.53478/TUBA.978-625-8352-17-7.ch09

UNIVERSITIES' CONTRIBUTION TO THE NATIONAL TECHNOLOGY INITIATIVE

Prof. Dr. İsmail KOYUNCU[i]
Istanbul Technical University

Prof. Dr. Hacı Ali MANTAR[ii]
Gebze Technical University

Prof. Dr. Şule Itır SATOĞLU[iii]
Istanbul Technical University

Prof. Dr. Altan ÇAKIR[iv]
Istanbul Technical University

Assoc. Prof. Dr. Mustafa Evren ERŞAHİN[v]
Istanbul Technical University

Assist. Prof. Dr. Tankut AKGÜL[vi]
Istanbul Technical University

Abstract

The National Technology Initiative has been put forward in the last fifteen years as a step towards the technology and innovation competitiveness needed by our country, which has been defined in order to ensure Türkiye's economic and technological independence. The building blocks of the National Technology Initiative consist of five basic components and are carried out together with our higher education institutions to revive the competitiveness needed according to the principles of "High Technology and Innovation", "Digital Transformation and Industry Initiative", "Entrepreneurship", "Human Capital" and "Infrastructure". Within the scope of an effective and efficient program, a structure that leads the private sector and works in coordination with on-site R&D, subject-oriented development and productization studies and the production of new technologies has been established. The National Technology Initiative is defined as a national struggle, and a comprehensive study is carried out, especially in research universities, in order to make our country a global actor in the field of technology and industry. Developing critical technologies locally and nationally, providing competitive research, development, products and services in high-tech fields, increasing our share in global value chains with original and innovative production are among the main objectives of the National Technology Initiative. It is the beginning of a long-term mobilization process in order to increase the use of trained manpower and infrastructure, expand the entrepreneurial ecosystem, and make the existence of interdisciplinary participatory stakeholders in this ecosystem independent of technology and welfare. The fact that Türkiye can be a pioneer in the international arena, R&D infrastructure, trained manpower, innovative business models, products and services depends on having a strong higher education and entrepreneurship ecosystem. In this manner, thanks to our researchers and entrepreneurs, who can read the global economy well and will enable Türkiye to open up to international markets. Türkiye will achieve a stronger structure in the future through its strong universities, with the initiative of national technology.

Keywords

National technology, University, R&D, Innovation, Entrepreneurship

[i] koyuncu[at]itu.edu.tr | ORCID: 0000-0001-8354-1889
[ii] hamantar[at]itu.edu.tr | ORCID: 0000-0002-1066-9942
[iii] onbaslis[at]itu.edu.tr | ORCID: 0000-0003-2768-4038
[iv] altan.cakir[at]itu.edu.tr | ORCID: 0000-0002-8627-7689
[v] ersahin[at]itu.edu.tr | ORCID: 0000-0003-1607-0524
[vi] akgult[at]itu.edu.tr | ORCID: 0000-0002-2368-4041

1. National Technology Initiative

According to Schumpeter, the engine of economic growth is technological advancements (Aksu, 2014). In this context, technological innovations replace former technologies and thus lead to a transformation in society. The effect that the three industrial revolutions having taken place in the last three centuries have had on the lifestyle of societies, with the invention of first steam engines, then electrical machines, and finally computers and robots, is the most significant proof to this.

As of this century, we are now going through the fourth industrial revolution. Digital technologies developing with this revolution have started to touch upon every aspect of our lives while competencies in information technologies have begun to be considered basic literacy competencies. We can remotely control the things in our house, communicate in a language which we do not know thanks to artificial intelligence, and perform a number of financial and corporate transactions without leaving our homes with the help of digital financial technologies and applications like e-government via the internet.

Nevertheless, the negative aspects of industrial revolutions cannot be overlooked. For example, it has been observed that although the industrial revolutions throughout history have increased the welfare of some people, they also have lowered the standards of living of some others such as the working class (Küçükkalay, 1997). In the fourth industrial revolution, negative effects such as the concentration of the global capital in some parts, increase in income inequality, control of personal data and environmental pollution come to the forefront with the monopolization of certain technology companies. For this reason, countries follow some strategies and policies in line with their own needs and interests against the destructive character of the fourth industrial revolution. Germany's "Industry 4.0", Japan's "Society 5.0" and China's "Made in China 2025" initiatives can be given as examples of these strategies.

In this process, Türkiye has also put its own strategy into effect with the "National Technology Initiative". The main goal of the National Technology Initiative, consisting of 5 main components which are "High Technology and Innovation", "Digital Transformation and Industry Move", "Entrepreneurship", "Human Capital" and "Infrastructure", is to increase Türkiye's global competitive capacity. In a case where such a course of action does not pan out, it will not be possible to talk about Türkiye's total independence in the near future in terms of economy and technology (Ministry of Industry and Technology, 2019).

The infrastructure required for the National Technology Initiative to be successful has been established to a great extent in the last 18 years. According to 2020 TUIK data, research and development expenditure increased to 54 billion 957 million TRY in 2020. It is seen that 44,7% of the R&D expenditure of 20 billion 333 million TRY in the manufacturing industry in 2020 was made by enterprises in high technology actions. Türkiye has a strong infrastructure and manpower needed to develop innovative products in an ecosystem of universities and private sector enterprises with 209 universities, 1244 R&D centers, 323 Design Centers, 92 Technology Development Regions, and 199000 R&D personnel (TUIK, 2021; Ministry of Industry and Technology, 2022).

However, we see that some steps that will increase Türkiye's global competitive capacity and enable it to have a say in the world in an economic sense were also taken in the first years of the Republic, but they could not completely succeed. Cement, sugar, and iron and steel factories that opened as a result of the industrialization policies are examples of these.

Nevertheless, there have been some changes in industry and technology policies after the Second World War (Uğural, 2016). With these changes, Türkiye has been steered in the direction of a country that does not produce technology, but imports it from abroad. For example, the attempts of Nuri Demirağ and Vecihi Hürkuş in order to manufacture aircraft and train pilots, which have been made with local resources, have failed because of this policy (Aydoğan, 2020). Another example is the Devrim automobile, which was designed and manufactured in Türkiye (Güneş, 2012). The reason why Devrim automobile could not go into mass production is not the inadequacy of engineering skills, (on the other hand, the project was completed in a short time like 4-5 months with limited resources) but the lack of self-confidence that arose in society as a result of the policies implemented.

For this reason, the success of the National Technology Initiative is only possible if this goal is adopted by large masses. From this point of view, one of the most important investments of the National Technology Initiative is the investment in people. Making every part of society productive, open to innovations, questioning things, and doing research is the primary goal of the National Technology Initiative. Established in 81 provinces in Türkiye within the scope of the National Technology Initiative with this goal, "Deneyap" Technology Workshops provide the basic level of education to young people starting from secondary school in priority areas from electronics to software, nanotechnology to cybersecurity, and raise technological awareness. In addition, TEKNOFEST Aviation, Space and Technology Festival, which is held every year with a similar purpose enables young people to take an active role in many areas and develop projects with competitions in a number of categories such as autonomous vehicles, agricultural technologies, rockets, model satellites, chip design, artificial intelligence, and unmanned aerial vehicles. At the same time, scientists who have carried out successful scientific and technological studies in their fields of expertise are encouraged to continue their studies in universities and industry institutions and organizations in Türkiye through the International Leading Researchers Program (Ministry of Industry and Technology, 2019).

It catches the attention that most of the companies with a net worth exceeding 1 billion dollars in the last 20 years in developed countries are not structures operating in the fields of oil, energy and infrastructure built with serious investments as it was 100 years ago, but structures built with brain power. (CB Insights,2022). For this reason, considering the goal of the National Technology Initiative to create human capital accordingly, the importance of universities is better understood. An efficient output-financial feed cycle to be created between industry and university will make a considerable contribution to the high technology production of our country, as is the case in its examples in the world. Besides, ensuring this cycle will pave the way for our academics to be directly involved in the high-tech production process. Our universities will not only be a part of the process of getting a profession but will also have a structure that constantly feeds the entrepreneurial ecosystem with human resources. This process will also enable associate, undergraduate, graduate and doctoral students to be productive in technology in their student life and to be involved in the entrepreneurship ecosystem through activities such as technology clubs, industry-supported projects, training and internship programs within the university.

For development, it is important to direct strategic human capital to the fields of basic sciences and engineering as a country. Furthermore, the number of graduates with doctorate degrees should be increased. When we look into the example of Germany, which is the most developed country in Europe and to which we are similar in terms of population and surface area, inferences that can be regarded as input for the National Technology

Initiative have been made. In this examination, only undergraduate and graduate programs have been taken into consideration since there are no associate degrees in Germany. As a result, although we have a similar number of graduates with Germany, it has been established that German undergraduate students have more graduate and doctorate degrees compared to Turkish students. It is seen that there is a relatively lower number of graduates in Türkiye in the fields of motor vehicles, ships and aircraft compared to Germany whereas there are more graduates in Türkiye in the fields of architecture and construction than there are in Germany. We can state that this strategic situation coincides with the current national economy. The number of students graduating from interdisciplinary engineering programs in Germany is proportionally high. It is believed that this approach will bring unique solutions to problems in every engineering field. In order for students to go into depth in one area, they need to be informed in other areas as well (German Academic Exchange Service; German Research Institution).

The high R&D intensity that has helped Türkiye become a global leader in information and communication technologies has emerged from a system of innovation parallel to world norms that encourage "close cooperation between the public, industry and the academic community in the nation-building process". Besides the fact that investments in R&D continue to support programs to increase scientific, engineering and administrative expertise, the weight of these investments has begun to take shape in a design that specializes primarily in the defense industry sector in search of patents and profits. The change, supported by R&D tax incentives and foreign technology imports, has led to the implementation of important formations regarding the National Technology Initiative.

2. Universities and Their History

Higher education institutions have functioned in different categories - academy in Ancient Greece, madrasah in the Islamic world, cathedral and monastery in the Christian world – by training scholars or Muslim judges since the early ages (Çetinsaya, 2014). The aim of the madrasahs in the Islamic civilization was to reach "science", learn "the truth, knowledge and skill" regardless of their geographical origin, and "to produce something unique to them" (Kenan, 2015). It is reported that the oldest madrasahs in the records started education in Transoxiana and Khorasan in 907, and the real development of the madrasahs took place with the establishment of the Nizamiye Madrasah in 1067 in Baghdad with the Great Seljuks. Afterwards, the Ottomans continued their madrasah education by developing it and built multi-program madrasahs in the fields of theology, law, medicine and astronomy from intermediate to high levels in many places such as Iznik, Bursa, Edirne and Istanbul (Kenan, 2015).

When we describe university as an autonomous community formed by the gathering of teachers and students to implement teaching activities at a high level in certain disciplines, it can be accepted that the oldest university in the world is the University of Bologna, which was founded in 1088. The word "universitas", which is the origin of the word "university", also means "community, guild, one body". When we address the word in this sense, it can be said that this basic quality of university has reached the present day. However, the changes experienced in societies over the centuries have caused universities to constantly change, transform and undertake new missions. In medieval universities, the liberal arts (eg, grammar, logic, arithmetic, and astronomy), theology, and law and medicine which are more practical sciences, being the most advanced knowledge a free man could claim to possess were taught. The main purpose of the educators of the period was to preserve, interpret and convey the philosophy and wisdom of the ancient knowledge. Research was not known yet at the time. These first-generation universities used to meet the human resource needs of organizations with the increasing rate of urbanization.

Seven centuries after the first-generation universities were established; these universities went through a transformation and started to be research institutions as well as carrying out educational activities. Therefore, the concept of the second-generation university was born. In this period, the factor that triggered the new generation university revolution can be said to have been Berlin Technical University, which was founded by Wilhelm vonHumboldt in 1810 and later renamed Berlin Humbolt University (Wissema, 2009). The founding principles of Berlin Technical University, which is the first example of second-generation universities, are the conduct of education and research together as a common mission, freedom of learning and teaching, and institutional autonomy. Humboldt's model, which supports the unity of research and teaching, has started to be applied by spreading to many countries from Germany to all of Europe and then from the United States of America to Japan. Istanbul Technical University was also established during this period. It was established in 1773 with the name "Mühendishane-i Bahri Hümayun" in order to work over the navy and bring it to a modern position as a result of the great defeat of the Ottoman Navy in Çeşme in 1770.

Second-generation universities focused on exploring nature through research activities supported by systematic experiments. However, research carried out for this purpose has generally focused on a single discipline. In this period, interdisciplinary research in which more than one scientist with expertise in different fields collaborated is not common.

Towards the end of the 20th century, countries that were advanced in industry and technology began to transform Humboldt's university model into a different one that also met the needs of the society. Thus, the concept of the third-generation university emerged. Third-generation universities are expected to transform the knowledge that produce into commercial products by establishing technology-oriented initiatives and implementing projects with the industry. At the same time, it is aimed to disseminate the produced knowledge to the society with the cooperation of industry and non-governmental organizations. With this additional mission they undertake, third-generation universities should contribute to economic growth and social development in addition to producing and disseminating knowledge (Çalıkoğlu et al., 2013).

Another feature that distinguishes third-generation universities from second-generation universities is that they aim to produce multi-disciplinary solutions and add value (Alan, 2016). The mechatronics branch that appears in today's engineering departments can be given as an example of this. The aim of this new branch, which has emerged by combining machine science with electronic science and computer science even, is to contribute quickly and effectively to developing technologies. It is able to isolate the necessary information and related hardware/software components as needed and bring together the expertise of all three departments in practice for a common purpose. Another example of a multi-disciplinary approach is biomedical engineering. The aim of this engineering branch is to increase the quality and efficiency of health services and it covers many professional fields such as engineering, medicine, biology, computers and statistics (Polat and Karahan, 2009).

One of the most important factors in the development of countries is highly qualified manpower. The most important element that generates this power is graduates of higher education. Today, associate and undergraduate programs alone are not considered adequate to train high-qualified manpower with the developing technology and increasing knowledge, and postgraduate education is needed. For this reason, creating a strategic situational awareness about higher education graduates is of high importance for the development of our country (Yücel and Erol, 2022). Nevertheless, in order to contribute to the National Technology Initiative, it has become even more important to conduct scientific research in both the private and public sectors with highly qualified manpower (TUBITAK, 2020).

3. Fourth-Generation University (Entrepreneurial University)

It is seen that the mission of third-generation universities to benefit society has started to focus on finding answers to important problems such as environmental pollution, climate change, and epidemic diseases that threaten humanity today. At this point, we observe that universities are going through a new transformation in order to find solutions to regional and global problems and to provide a sustainable future. This has called forth the concept of the fourth-generation university (Erdem, 2016).

Whereas third-generation universities are expected to produce innovative and high-value-added outputs, fourth-generation universities are supposed to set strategic goals, play a transformative role in society, and be the driving force of the local economy (Lukovics & Zuti, 2015). Another important difference is that fourth-generation universities are mostly thematic universities (Erdem, 2016). The concept of the thematic university can be defined as implementing effective teaching and research activities in a particular field. Social Sciences Universities, Technical Universities, Health Universities, Education Universities, and Science Universities can be given as examples of this.

With the fourth-generation universities positioning themselves thematically, it can be predicted that holistic approaches based on education, research and entrepreneurship may go to the point of divergence again. Hence, within the scope of the “Mission Differentiation and Specialization Project for Our Universities Focused on Regional Development”, prepared with the cooperation of the Higher Education Institution (YÖK) and the Ministry of Development, it is aspired in recent years that some universities specialize in education, some universities specialize in research, and some universities specialize in entrepreneurship (Saklı, 2017). Time will tell how the economic, cultural, political and social changes experienced around the world will lead to a transformation in universities.

The basic strategy of research universities in Türkiye is to build each university upon distinctive specialization qualifications. Research universities aim to contribute to the Local and National Product Development Activities through areas with research priority given below, and things that can be done for this purpose are listed as follows (YÖK; TÜBİTAK, 2021).

- Community-based research arising from real relationships, where research is developed with internal and external partners to develop research groups,
- Research to train undergraduate researchers and enable them to continue their postgraduate studies by providing a wide range of available opportunities for undergraduate students to gain research experience and contribute to research,
- Interdisciplinary research based on a shared intellectual culture (not tactical partnerships) where new questions arise and different perspectives can be addressed,

- Studies aimed at employing, training and providing visiting faculty members on university pedagogy and curriculum based on the important studies of research units on new, innovative and excellent teaching,
- Public research concentrating on social and environmental justice, including peacebuilding and advocacy for vulnerable and disadvantaged populations.

All these matters make our universities one of the most important stakeholders in the "National Technology Initiative " project. Information on what our universities have done and can do in this context is given below.

4. What Have Been Done and What Needs to Be Done at Our Universities to Contribute to Local and National Product Development

4.1 Local and National Technological Product Development Processes and Strategy to be Followed

Technology development is problem-oriented, and it aims to find and improve the technology needed. Since technology development aims at the potential commercial product outputs of the future, it is necessary to act depending on long-term strategies regardless of whether it is successful or not at the end of the process. These are processes where technical uncertainties and unknown factors are high, and commercial expectations are not very clear (Sökmen, 2016).

Product-oriented development, on the other hand, ensures that experiences gained over research and practice lead to the production of equipment, tools and machines that will realize strategic goals in the long term and the establishment of new systems. Product development defines processes that it goes through such as design, engineering, and testing from the idea stage to step where it reaches the ultimate consumer. Product development consists of routine and repeatable steps (Sökmen, 2016). The developed product can be one that is developed with technological or routine methods which do not require excessively high technology. In the process of developing a technological product, all the possible real problems that can be encountered in practice are tested on prototype in suitable ambient conditions. All functional tests are tested with different scenarios in real environment. After that, mass production starts.

The strategy to be followed depending on the Technology Readiness Levels (TRL) while developing technological products is given in Figure1. Technology Readiness Levels is an index developed in the 1970s by NASA researchers to measure the maturity of a study which is being developed. TRL ranges from 1 to 9. We can say that a project at TRL 6 level is in the prototype stage that will enable it to be tested in an environment similar to the real one. Technology readiness levels and product development processes are given in Figure 1 (TUBITAK BTYPDB, 2017).

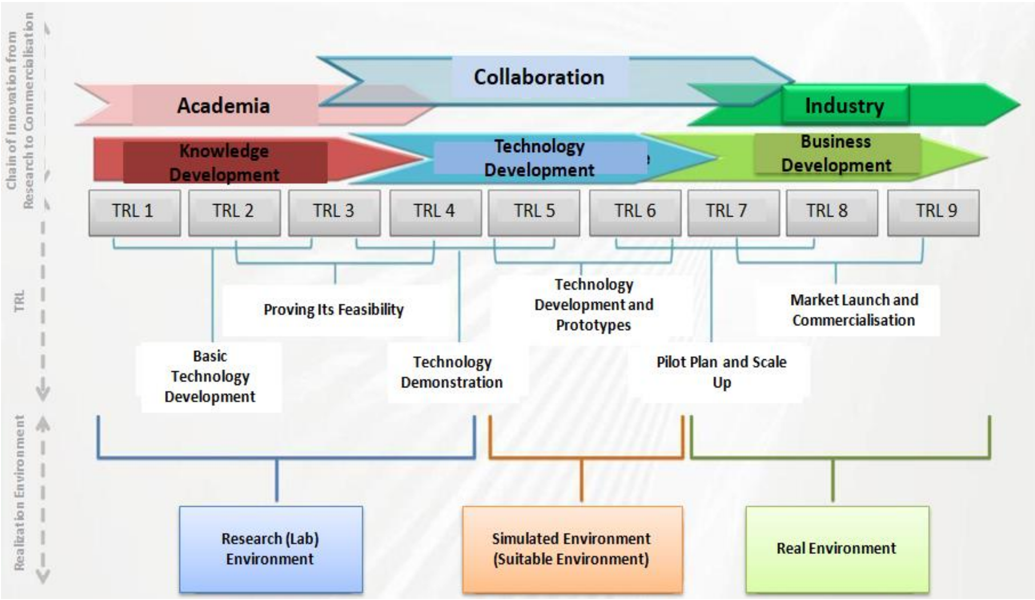


Figure 1. *Technology readiness levels and product development processes (TUBITAK BTYPDB, 2017)*

Decreasing the current deficit is one of the significant steps regarding Türkiye's aim to achieve full economic independence and become one of the 10 largest economies in the world, which is in its 2023 vision. Supplying the inputs from domestic manufacturers instead of importing them will make great contributions to the development of the domestic manufacturing industry as well as provide added value to the national economy. For this purpose, support programs that will encourage the domestic production of strategic products whose import amounts are high should be organized, the technological production capabilities of companies must be improved, and dissemination of technology must be facilitated (KOSGEB, 2019). Therefore, localization and nationalization of high technology products with a need for import, increasing the gross national income per capita and thus allocating more shares for R&D will be possible.

local and national technological product development processes can be brought to better levels by applying and experiencing the developed technology in relevant areas. It is not possible to develop a globally needed product by focusing on technology with no need for use. Thus, developed products should first be used by the private and public sectors in our country, problems encountered should be solved retrospectively and the production of technological products with much better quality should be made possible. Export of the products that complete their development process properly in our country will come to the fore and in this way; more contributions will be made to decrease the current deficit.

There are two benefits to reducing the current account deficit by developing local and national products. These are ceasing the import of the developed product and also exporting it abroad. Furthermore, local and national product development and domestic unit costs of products will decrease. This will decrease the entry costs of the foreign equivalents of the same product into our country, and thus, another two-way benefit will be provided.

4.2. Local and National Product Development Activities at Our Universities

There are a number of reasons why universities have a pioneering role due to their contributions to technological developments and activities within the scope of research, development and training processes. In a general sense, if these processes are defined as a set of skills, competencies and other qualities that increase productivity, they are personal assignments that develop value chains of economies or activities that help improve lean manufacturing processes in order to increase the efficiency as a critical component of the human capital of our country. Human capital comes to the forefront as the most distinctive feature of the economic system. Thus, it is known that it improves the effect of education on research and productivity increase by studying more. Therefore, there are three main factors that affect the local and national product development efficiency of a country within the scope of universities. The first one is increasing the collective capacity of the interdisciplinary workforce in order to fulfill the existing duties. The second one is facilitating the information transfer related to new information, products and technologies which have been produced in different categories with continuity in secondary and higher education. The last one is producing new information and thus increasing the capacity for developing products and technologies (World Economic Forum, 2016).

In the past century, rapid information flow and accelerating technological developments have made the economy and social environments very complex and competitive. It can be concluded that technological advances have brought about major changes in the way industries emerge, coalesce, degrade and evolve over time. Global-scale technological competition and trained manpower pose an important managerial challenge for companies or organizations, especially in technology-oriented industries. The fundamental and absolute question is how research institutions and companies can strategically manage their product studies, value chain system, product strategies and technology, competencies and capabilities in a complex changing business and technological environment (World Economic Forum, 2016).

The work environment for organizations is considered to be complex and constantly changing, and technology plays a crucial role in managing this environment for better productivity, innovation and business model development. In parallel with companies, higher education institutions are in the process of transformation in order to strive, adapt to new technological trends and meet the new opportunities in the market. For this reason, the basic need for all public institutions, universities, research institutes and companies is to have the ability to form strategies in business and technology levels and manage this side-by-side to achieve sustainable competition and value creation. Structures that manage and optimize a single function of the relevant institution at a time are now aware of the need to strategically manage multiple functions. Thus, institutions as a whole need to have critical strategic management capabilities in order to obtain high returns on project support and government funds and to gain continuity (Figure 2) (Sahlman, 2020).

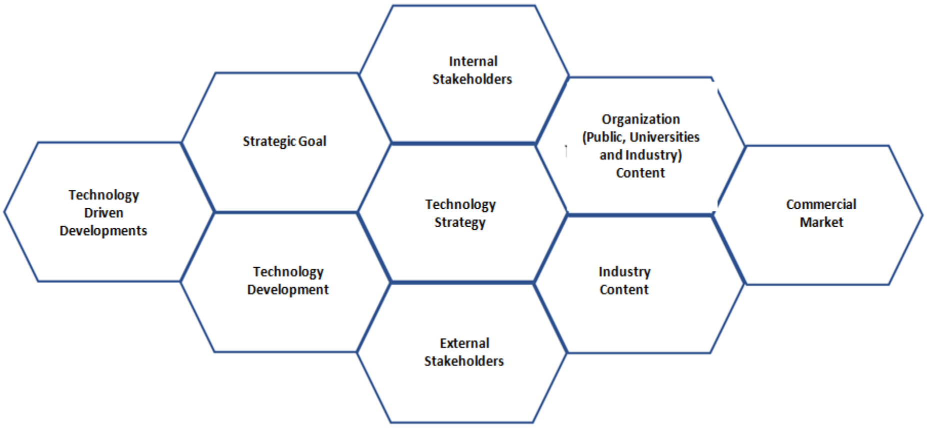


Figure 2. *Local and national technology development determinants (Sahlman, 2010)*

Strategic technology management is expected to provide tools or ways to manage the complexity, uncertainty and dynamic nature of business caused by technology. Within the scope local and national product development activities, the term ‘strategic’ in relation to technology management emphasizes the connection of strategic management with technology management and sustainability. Local and national focused strategic perspective and management is a single-color organizational chart of strategic technology development and a contribution that should be considered for various stakeholders in this regard (Figure 3). In addition, technology management and research activities refer to elements such as innovative approaches surrounding technology activities and R&D management separate from other managements as a whole. For this reason, sense of management for the strategic technology-driven local and national products is positioned separately from other management types and all universities, public and industrial organizations are evaluated as a whole.

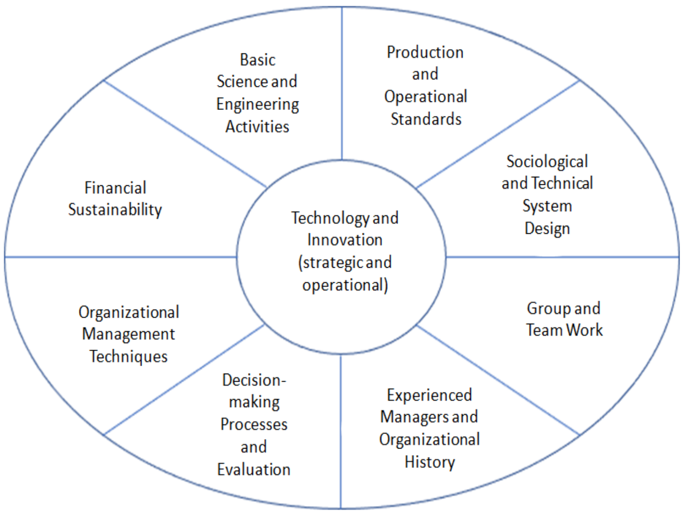


Figure 3. *Organizational strategic and operational management chart of technology and innovation management in local and national technology (Margaret and Garry, 2007)*

When the contributions made from the central administration budget for research and development activities in Türkiye are classified according to socioeconomic targets, the highest R&D funding was made to universities for general knowledge development with 48.8% in 2020. These goals are followed by the defense industry with 13.4%, industrial production and technology expenditures with 10.2%, transportation with 6.7%, and education with 5.9% in the scope of telecommunication and other infrastructures (Figure 4) (TÜİK, 2021b). When considered from this point of view, universities play an important role in the National Technology Initiative and important resources are transferred to them.

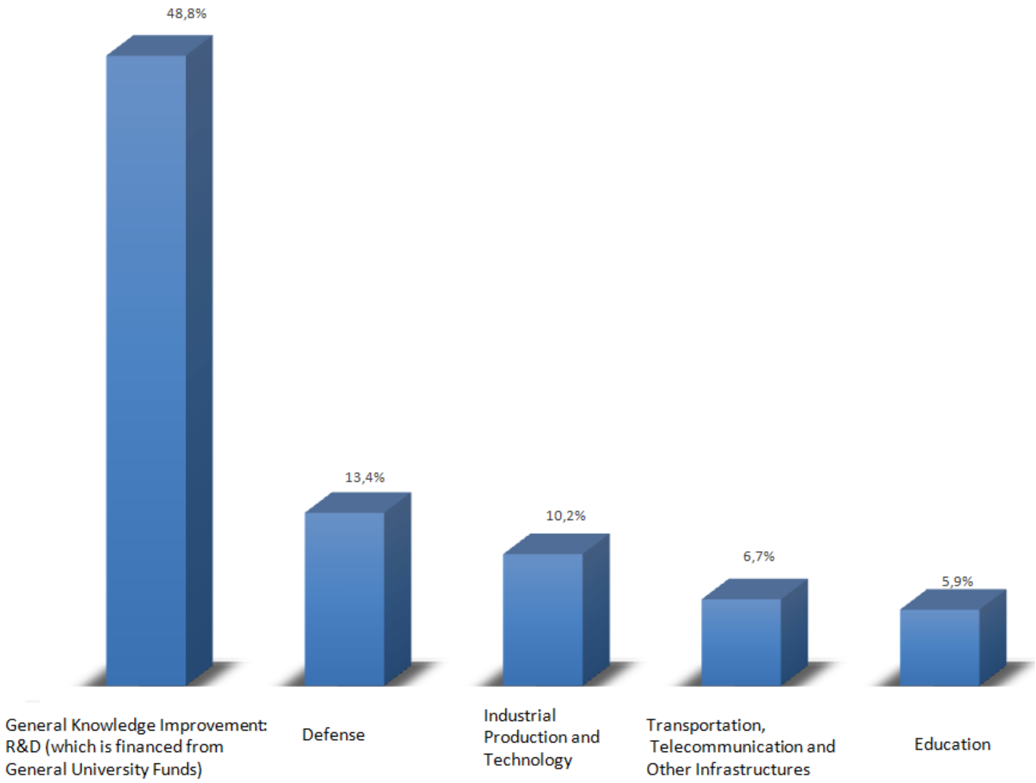


Figure 4. *Top five target headings with the most expenditure in 2020 (TÜİK, 2021b)*

While the ratio of gross domestic R&D expenditures in GDP was 1.06% in 2019, its ratio in GDP of 5 trillion 46 billion 883 million TL increased to 1.09% in 2020 (Figure 5) (TUIK, 2021). Financial and non-financial companies had the largest share in R&D expenditures with 64.8%, followed by higher education institutions with a share of 28.4%. While 57.2% of R&D expenditures were financed by financial and non-financial companies in 2020, general government financed 28.4%, higher education financed 12.3%, foreign resources financed 2.0% and other domestic resources financed 0.1% of R&D expenditures (Figure 6). In 2020, a total of 199371 people worked as R&D personnel. Looking at its distribution by sectors, 65.3% of the R&D personnel were in financial and non-financial companies, 29.9% in higher education and 4.7% in the general government sector, which also includes non-profit organizations. When the R&D personnel are analyzed according to their education level, it is seen that 33.1% of the R&D personnel have a bachelor's degree. This is followed by doctorate or an equivalent degree with 32.1%, master's degree with 24.6%, vocational school with 5.1%, and high school and lower categories with 5.1% (TUIK, 2021).

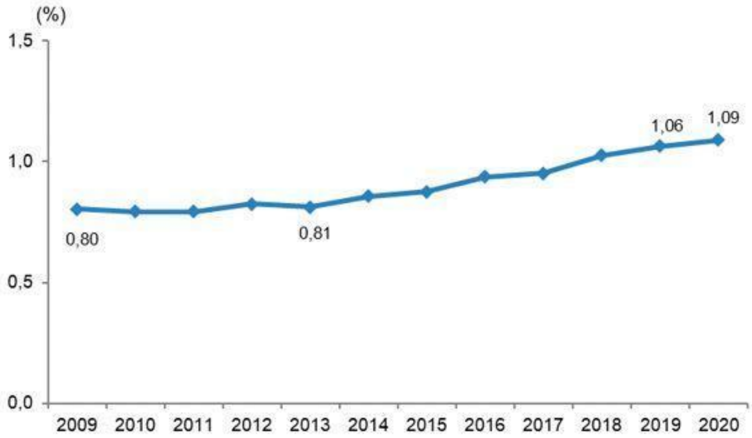


Figure 5. *R&D expenditure share in GDP, 2009-2020 (TUIK, 2021)*

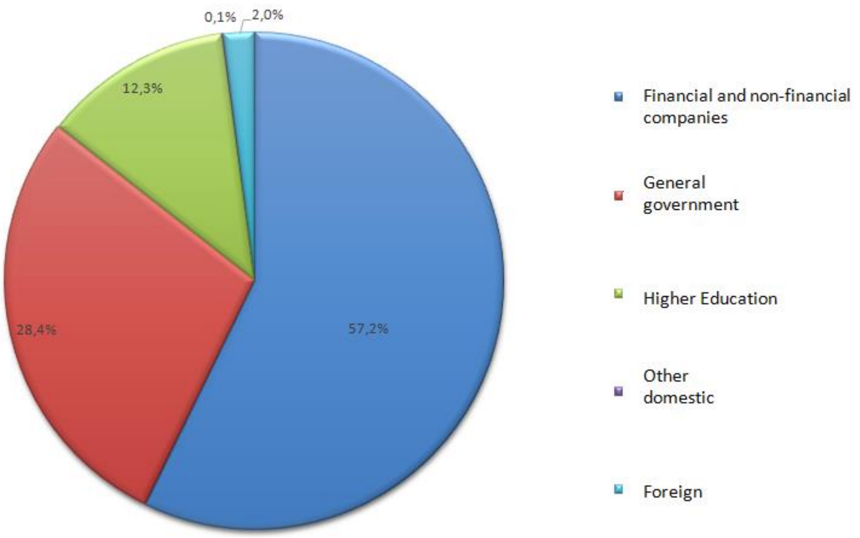


Figure 6. *Distribution of financial resources by sectors (TUIK, 2021)*

While directing technological studies in our universities, the use of patent intelligence will be innovative. When the technologies with the highest number of patents compared to 2020 are examined, the 5 areas shown are indeed the 5 areas that Türkiye should focus on. In particular, we must continue to increase our human and technological capital in the field of quantum computing and artificial intelligence (Figure 7). In Figure 8, the status of the continents in the field of patents all over the world is demonstrated. A large increase is seen in the Middle East and Africa, but 87% of this increase belongs to Israel alone (Clarivate).

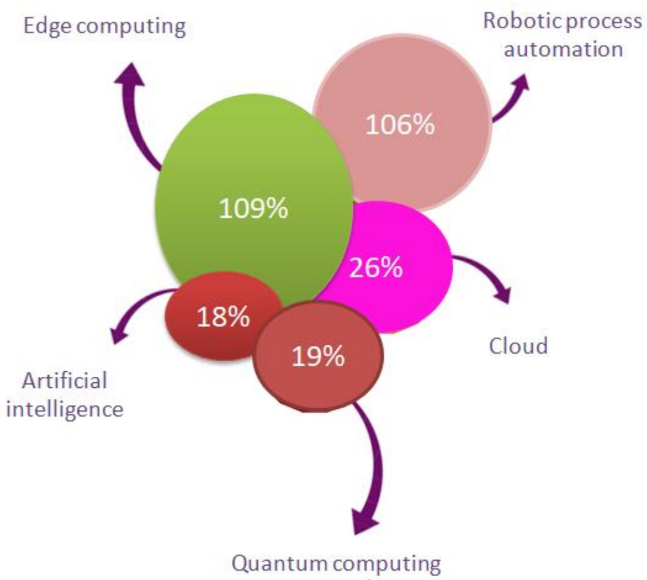


Figure 7. *2021 patent analysis report review of Global Data (Clarivate)*

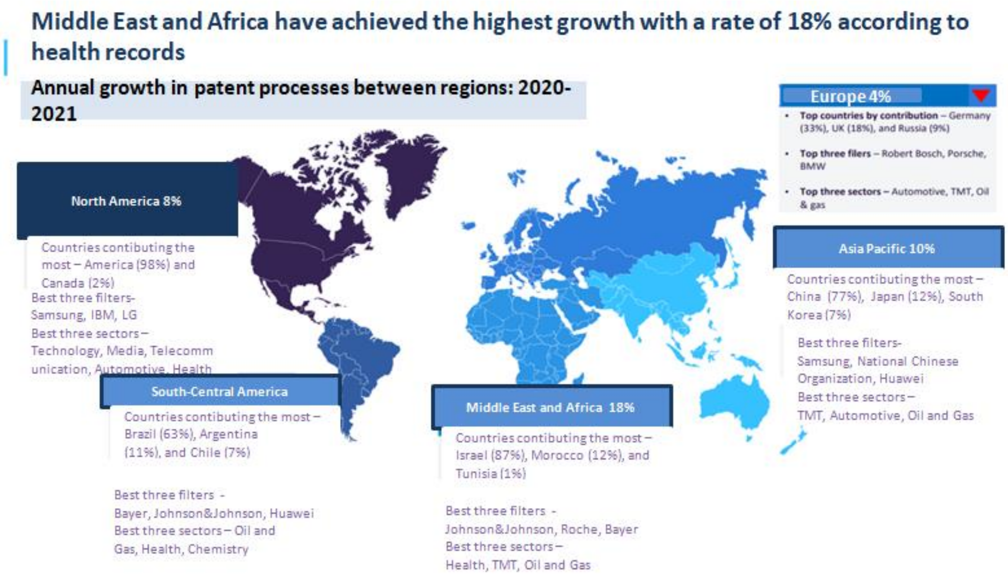


Figure 8. *Conditions of continents in the world in the field of patents (Clarivate)*

Besides, when the leading companies in patent applications are examined, there is only one American company. South Korea, Japan and China are shifting their technology center of gravity to Asia (Figure 9.) In particular, when universities in the world are examined, the fact that the 10 universities that made the most patent applications in 2021 are in China which should be evaluated in detail from a strategic point of view (Figure 10) (Clarivate).

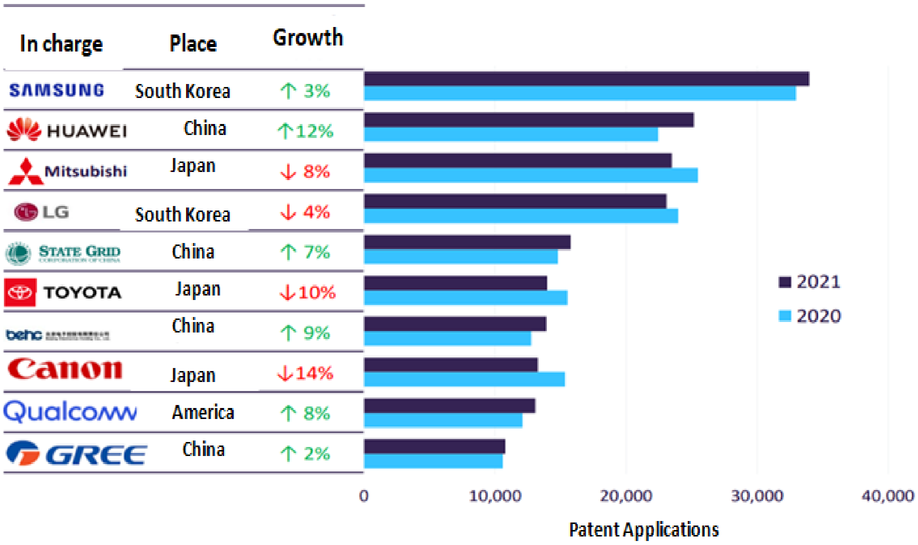


Figure 9. *Leading companies in patent applications (Clarivate)*

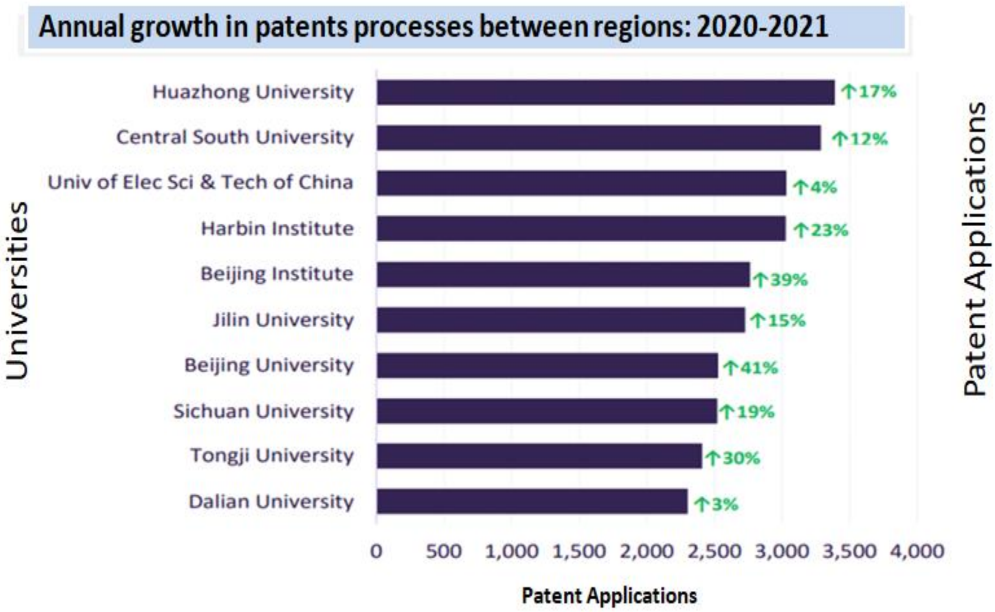


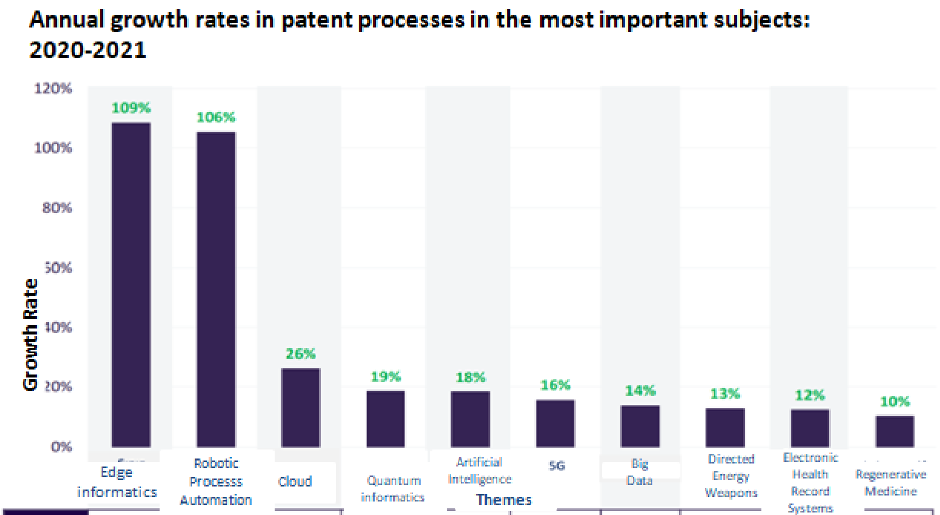
Figure 10. *Top 10 universities with the most patent applications in 2021 (Clarivate)*

When we study the 10 technologies with the most patent applications, we see energy weapons that are pointed directly toward defense. What needs to be done here is to study the patent ecosystem of patents in this field by using patent intelligence in the National Technology Initiative, and a similar ecosystem should be tried to be created in Türkiye in the same way.

Besides, edge informatics, robotic operation automation, cloud informatics, quantum computing, artificial intelligence, big data and 5G Technologies are all data-oriented technologies; therefore, they can be evaluated within the scope of data analytics and science

(Figure 11). When considered more specifically, they can be evaluated as a technology ecosystem under the umbrella of artificial intelligence. These technologies will also prepare humanity for the metaverse, the internet medium of the future. This situation should be separately evaluated in the scope of the National Technology Initiative. In the light of this data, it can be seen that the strategic human capital should be prepared based on artificial intelligence and analytics.

The contributions of the top 10 technologies, which are significant in terms of defense technologies, to the existing national defense and even national security system should be evaluated separately because the ecosystem related to defense technologies is the most developed ecosystem due to the level of existing human capital in the process of transforming it into products compared to other fields, and the reflections of defense technologies on other field technologies. Developing the strategic human capital of this ecosystem is of utmost importance.



	Edge informatics	Robotic Process Automation	Cloud	Quantum informatics	Artificial Intelligence	5G	Big Data	Directed Energy Weapons	Electronic Health Record Systems	Regenerative Medicine
2020	1,450	163	22,878	2,573	116,086	13,180	45,996	1,681	11,130	10,168
2021	3,024	335	28,861	3,052	137,487	15,242	52,315	1,896	12,508	11,217

Figure 11. *Top 10 technology fields with the most patent applications (Clarivate).*

Making all these developments in universities is addressed with the structural scheme within the university (Figure 12). Here, units that are primarily concerned with technology production, faculties, research and graduate education institutes, thematic application and research centers (UYGAR), Scientific Research Projects (BAP) unit, technology transfer offices, floating capitals, student clubs and project teams, technopoles are incubation centers. Brief information about each unit is given below.

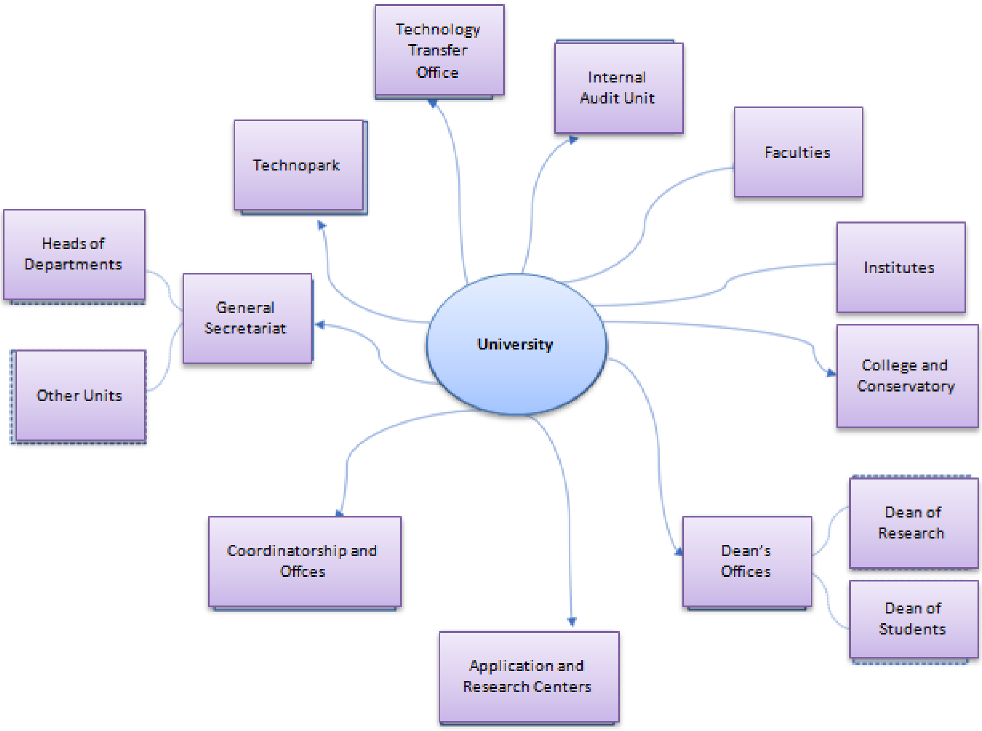


Figure 12. *General Organization Structure at Universities (İTÜ)*

4.2.1. Graduate Schools (The Need for Training Ph.D. Researchers)

Postgraduate education in universities is carried out in graduate schools or in the Institute for Graduate Studies in Science/Social Science/Education/Health. Being the combined form of all, graduate schools have recently become more prominent in the country.

The demand for doctoral graduates in Türkiye comes from two different places. The first of these is the demand from universities to meet the need for faculty members, while the second demand is issued by the R&D centers of public or private sector. If Türkiye increases its R&D expenditures to 3% of GDP in line with the trends of developed countries, many more Ph.D. researchers will be needed in domestic research centers. Considering all these needs, it is expected to reach 300,000 full-time researchers in the upcoming years.

The number of doctoral graduates in Türkiye for 2021 amounted to 8275. While it was 4617 in 2011, it increased to 8069 in 2019 but decreased to 7598 in 2020, considering the pandemic effect. As of 2020, the total number of doctoral graduates in Türkiye is approximately 54,000. When compared to developed countries, this number is low and needs to be increased. The number of graduate students is targeted as 600,000 in Türkiye for the year 2025. In order for the number of graduate students, which is around 210,000 as of 2019-2020 academic year, to reach this target, a rapid increase in capacity is required. In addition, the number of faculty members, which is approximately 89,000 today, is expected to reach 150,000 by 2025. In order to meet both demands, the number of doctoral graduates must increase significantly in the upcoming period (YÖK, 2007).

The target of increasing the number of doctoral students, which amounts to 106,148 as of 2021 with an increase of approximately 10% compared to the previous year, is of utmost importance in terms of local and national technological targets (Figure 13). From 2011 to 2021, the number of research assistants increased from 37,217 to 51,548, the number of lecturers increased from 28,626 to 38,289, and the number of instructors (assistant professor, associate professor, and professor) increased from 49,955 to 89,848. While the total number of teaching staff was 115,798 in 2011, this number reached 185,702 in 2022 (Data Source; Higher Education Information Management System).

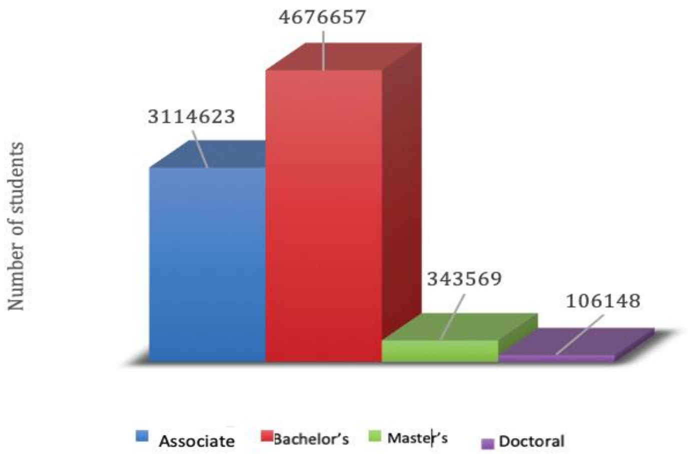


Figure 13. *The number of students with an associate, bachelor's, master's, and doctoral degree*

4.2.2. Research Institutes

Research institutes are organizations responsible for conducting research on a wide variety of topics. They are research centers that have the competence to direct applied research with the aim of specializing in basic research. For this reason, there are many research institutes that carry out research activities in the fields of social sciences such as sociology and history, although they mostly operate in basic science research. Besides mostly being established independently of institutions, research institutes are sometimes established under names such as "research center" or "research and application center" within universities or ministries, too. Focal research areas in these institutes are defined as scientific research conducted within these institutes under the main subjects of health, basic science, informatics, history, and culture. The results of these studies offer suggestions for establishing connections among the studies regarding the past and the future and determining future research directions, as well as ensuring progress in the related field. Thus, the results of such studies are published in scientific and academic journals and support the academic activities and competencies of the institutions they are affiliated with. They also provide a good basis for progress by acting as a source of new research within the scope of the findings obtained on the studied areas. The trainings given in research institutes are designed with the aim of contributing to the lifelong learning processes of individuals. These institutes are basically defined as interdisciplinary organizations that enable individuals to access research and application-oriented postgraduate education in the field they wish, and undertake important tasks in local and national technology-oriented developments (Yurdakul et al., 2021). Figure 14 demonstrates the role of research institutes in local and national technological product development.

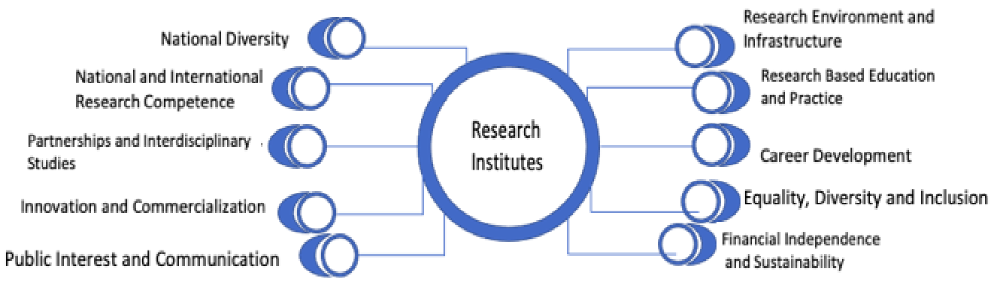


Figure 14. *The role of research institutes in local and national technological product development (Yurdakul et al., 2021)*

4.2.3. Thematic Research Centers

Thematic research centers play a crucial role in the development of local and national technological products and in the transformation of this technology into a product. Figure 15 shows the role and importance of thematic research centers in local and national technological product development as a horizontal and vertical flow chart.

Research universities attach particular importance to strengthening their technological assets that will meet their goals, as they are innovative and meet various societal needs. In these higher education institutions, there are training and research laboratories that will enable students, young researchers, and academics to conduct scientific work. These laboratories, which encourage scientific research on many different topics, also create an important workspace for interdisciplinary studies. In these research environments where studies and development activities are carried out, numerous tests, analyses and experiments make it possible to produce prototypes that are needed. These prototypes can be turned into products with very different mechanisms, as shown in Figure 15. Therefore, it would not be wrong to state that local and national product development studies can be conducted in these higher education institutions.

Figure 15. *The role and importance of thematic research centers in local and national technological product development*

4.2.4. Entrepreneurship Activities for Students (Student Clubs, Student Project Teams)

Student clubs, which were established to strengthen the cultural and social aspects of the universities they are affiliated with, provide students with a rich cultural environment where activities are carried out for different fields and interests through a perspective based on the direct participation of students. These clubs contribute to the training of qualified and trained human resources needed by our country in accordance with the main objective of TEKNOFEST and similar technology competitions.

According to some studies conducted in our country, which have aimed to determine the entrepreneurial tendencies of Business students, only 8.7% of them have been found to prefer being an entrepreneur to working at a high paying job in the first five years of their careers, although nearly 40.5% of them have aspired to start their own business in the future (İşcan & Kaygın, 2012). Considering the general tendencies of other departments, it may be asserted that the interest in entrepreneurship among Business students results from the Entrepreneurship course they take in their department. Similarly, it is observed that entrepreneurship activities for students in universities support the formation of similar interests, start-up projects, and unique patent/work processes. Entrepreneurial students must be innovative and develop unique ideas, solutions, products, and services (Caliendo-Alexander, 2008; Döm, 2008). These assets are of great importance for students to develop their careers and establish successful enterprises. For this reason, student club activities which are conducted within the scope of universities and supported by them are considered as a significant starting point for the National Technology Initiative.

4.2.5. Technopark Activities

Technoparks are innovation and technology ecosystems in which universities/research institutions and industrial organizations carry out research and development activities in the same space by transferring knowledge and technology between them. In this regard, technoparks undertake important tasks in the academia-industry cooperation, which acts as a part of the National Technology Initiative program.

Also known as technology parks, technoparks provide services such as consultancy to facilitate technology transfer between academia and industry through the Technology Transfer Office (TTO), as well as offering physical environments such as modern offices and research laboratories for the joint development of academic units and businesses (Kiper et al., 2019). Prior to the beginning of the "TÜBİTAK 1513 Technology Transfer Offices Support Program" in 2013, activities conducted by technology transfer offices of universities were uncommon. Since the program was launched, over 100 Technology Transfer Offices have been opened at universities.

Technology Transfer Offices might be in the form of:

- A unit within the Rectorate,
- A company or unit in partnership with the Teknokent Management Company,
- A corporation.

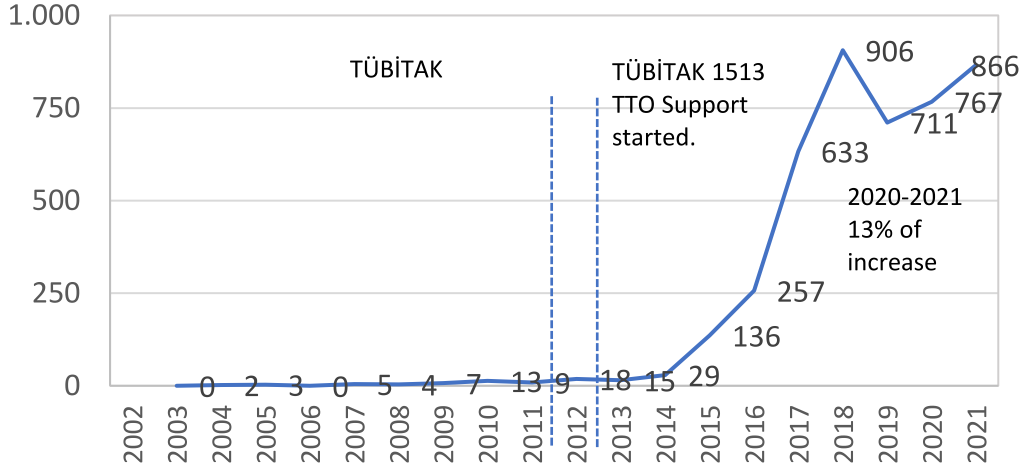
Countries aspiring to hold power in the world economy and maintain a sustainable competitive power invest in R&D activities. Thus, technoparks, where such R&D activities are carried out, have gained importance in recent years. Technoparks facilitate the commercialization of innovative products and services developed through TTOs and the growth of innovative companies by engaging in the entrepreneurial ecosystem with their incubation centers (Ministry of Industry and Technology, 2021).

According to the report published by the Strategic Research and Efficiency General Directorate of the Ministry of Industry and Technology in 2021, TTOs mainly aim to create contracted R&D projects with industry, write and conduct projects to reach national and international funds and support, and provide entrepreneurs with pre-incubation services, research and project partnerships, and coordination services (Ministry of Industry and Technology, 2021).

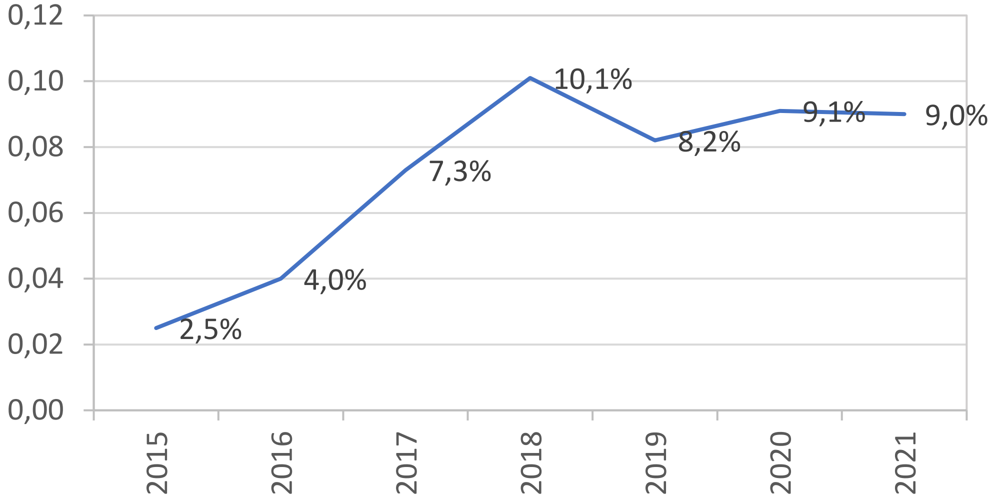
According to the same report, the least requested services are patent mapping processes, collection and management of invention statements, and the collection of new business ideas from students and researchers. Although it is stated in the report that TTOs contribute to universities in many ways, the first five of these contributions are listed as follows:

- Increase in the number of projects conducted in collaboration with industries,
- Increase in the innovative entrepreneurship index,
- Increase in the number of academics and young entrepreneurs,
- Increase in the number of national and international projects,
- Establishment of effective data collection systems.

In addition to the information mentioned above, the report states that TTO activities have increased the Intellectual and Industrial Property Rights (IPR) and entrepreneurship awareness of academics and students by over 85% (Ministry of Industry and Technology, 2021). Another indicator of the performance of TTOs is their impact on the increase in university patent applications. In the years following 2013, when TÜBİTAK 1513 support started to be given, there was a significant increase in the number of university patents (Figure 16).



a) Total number of patent applications



b) The ratio of university patent applications to total patent applications

Figure 16. *Total patent applications and the role of TTOs (TPR, 2021)*

4.2.6. Incubation Centers

Incubation centers (named after the 'incubator') provide initiatives with the guidance service needed at the initial stage. They can be established for profit or to support economic development.

For-profit incubators are usually established by private investors. The majority of non-profit incubation centers, on the other hand, may be established in technoparks through academic or university support.

Opportunities offered to entrepreneurs by an incubation center can often change in line with the purpose of the center (Telif Hakları Genel Müdürlüğü, 2021). Incubation centers provide initiatives with a physical environment (coworking spaces), mentoring (academic-industrial-commercial), training programs, social opportunities for networking, bridging entrepreneurs and investors, management and marketing support and other professional support (Telif Hakları Genel Müdürlüğü, 2021). These benefits provided by incubation centers are of vital importance for entrepreneurs and the National Technology Initiative, in the process where investors generally find early-stage venture companies risky.

4.3. Restructuring Education in Universities According to the Concept of Local and National Technological Product Development: Research Based Education

21st-century skills can be defined as the competencies, learning attitudes, knowledge and skills required to be successful in the business world and society of the century we live in. These skills can be divided into three main groups: learning and innovation skills, knowledge, media and technology skills, and life and career skills (Yalçın, 2018). Thanks to the education and training given in our universities, it is necessary to train individuals who can particularly adopt the concept of local and national technological product development. Accordingly, there is a need to equip young people with these skills through both the contents and works included in the lesson plans and the activities to be implemented outside the lesson plan. For this purpose, learning and training activities need to be redesigned through a research-oriented education perspective.

Research based education is a learning/teaching style in which learning, and research are integrated and students' learning experiences are designed and realized in the form of learning by doing and practicing (Camacho-Rivadeneira et al., 2017). In this framework, a more autonomous learning environment is created by designing activities such as experiments, projects, workshops, and competitions. Students are very active throughout the learning process and although they are responsible for their learning, academics or advisors take the role of a guide during the entire process. In other words, the teaching style of "knowledge transfer", which simply means lecturing in the classroom, must now be transformed into a method where students are actively involved in the learning process and take responsibility for their own learning. In this process, the role of the academic is to convey the basic information in the lessons, introduce the real-life applications of the transferred information to the students through projects, experiments, and so on, or guide students in the organization and implementation of these activities.

In addition, interdisciplinary and product-oriented project teams which are established through student initiatives are considered as an innovative example for research-based learning. Today, the development of high-tech products is made possible through the integrated use of the knowledge gained from many engineering disciplines. Therefore, there is a need for people in many engineering fields to work in collaboration during the product design phase. Besides benefiting from the knowledge of engineering, project teams should also include members from social sciences in order to consider the usability, aesthetic properties and consumer behaviors of product designs and find sponsors to meet the costs. In other words, work conducted by project teams can be regarded as a simulation of the way large companies work in real life, aiming at the design of high-tech products in universities. Moreover, students also improve such social skills as teamwork, problem solving and conflict management thanks to these activities. Research based experience that university students gain by participating in project teams enables them to have higher self-confidence in their career path and to be employed by companies.

Furthermore, having undergraduate and graduate students work as researchers in scientific research projects may be thought as a method to be followed in investigating the parameters that play a key role in new product development and product design. TÜBİTAK and higher education institutions allow undergraduate and graduate students to be assigned to projects as scholarship holders, thus enhancing the research-based learning experience at both levels.

Research based education is natural among the studies that are carried out at the graduate level since it is aimed to bring innovation in different ways such as an innovative method, product development, or the application of a method to a different field for the first time. In this respect, the added value of postgraduate research in high-tech product development studies is expected to be high. The registration of the product or process designed as a result of many doctoral theses with patents is also an indication that high-tech products and processes can be obtained as a result of postgraduate studies.

Considering the life and career skills of the 21st century skills, problem solving, critical thinking, communication, cooperation (teamwork) and self-management are of significant importance in business life (Yalçın, 2018). In addition to knowledge-based competencies, such social skills may be needed especially in interdisciplinary projects. Extracurricular activities such as social and sportive club activities carried out in universities help students gain some life skills like teamwork, communication and problem solving. These social skills may prevent the occurrence of problems that are likely to be experienced in large teams where high-tech products are developed.

As explained above, the widespread application of research-based education at undergraduate and graduate levels in universities has gained utmost importance for the development of local and national high-tech products. An education model that encourages learning by research rather than transferring knowledge in universities and the development of social skills through extracurricular activities will be beneficial for the realization of the National Technology Initiative.

5. Overall Evaluation

In these days when we are going through a rapidly changing technological age with digital transformation, we are aware of the fact that our country has a strong young population born as digital natives. With this young population who are prone to digitalization, the only means of transforming these changes into opportunities and advantages is primarily realized through learning and constantly keeping oneself up to date. When our young people have to stay up to date with the competencies of today's world, universities play an important role in the local and national Technology Initiative with their interdisciplinary research institutes, faculties and centers. As data become the raw material of technology, sustainable and data-oriented thinking, and research and productization studies are carried out in every field from materials engineering to mechanical engineering, from computer engineering to electrical and electronics engineering, from basic sciences to social sciences. These, in turn, result in the emergence of invaluable initiatives.

In today's world, where new generation professions are emerging through a process of change, our universities offer the education processes and research infrastructures of the most sought-after professions. Hence, young people should have the skills to make a difference and should receive a research-development oriented education. There is a strong Türkiye that works to create a world where young individuals who can follow the world and developments will take the lead in change and become useful individuals, first for themselves and then for the society and their country. Furthermore, in order for these talents to have a greater impact on the country, entrepreneurial ecosystems should be expanded, and collaborations between academia and industry should be increased and strengthened with these young talents. In the future, no matter what profession, specialty, or sector our young people choose, there will be a Türkiye with individuals who are productive, innovative, self-developing, inquisitive, and strong and who are looking to the future with an entrepreneurial mindset.

To conclude,

- Studies on high-qualified manpower should be accelerated. The number of graduates with master's and especially doctorate degrees should be increased. Particular attention should be paid to interdisciplinary programs in engineering fields.
- Courses in universities should be developed to support the National Technology Initiative.
- Research based training should be included in our curricula.
- Extracurricular activities that develop students' technical and social skills should be encouraged and when necessary, credited without affecting average grade of students.

References

Aksu, L. (2014). İktisat ekollerinin iktisadî büyüme konusundaki düşünceleri ve modellerinin analizi. *Türk Dünyası Araştırmaları*, 106(208), 351-392.

Alan, G.A.E. (2016). Türkiye'de yeni nesil üniversiteler. *Maltepe Üniversitesi İletişim Fakültesi Dergisi*, 3(2), 105-118.

Aydoğan, A. (2020). Atatürk dönemi Türk havacılık faaliyetleri ve havacılık faaliyetlerinin gelişim süreci. *Uluslararası Tarih Araştırmaları Dergisi*, 4(2), 69-81.

Caliendo-Alexander, Marco (2008). "Is Entrepreneurial Success Predictable? An Ex-Ante Analysis of the Character-Based Approach". *Kyklos*, 61(2), 2008, s.194.

Camacho Rivadeneira, M. H., Valcke, M. ve Chiluiza, K. (2017). Research based learning in higher education: a review of literature. In 11th International Technology, Education and Development Conference, INTED2017 (pp. 4188-4197). *International Academy of Technology, Education and Development (IATED)*.

CB Insights (2022). The Complete List Of Unicorn Companies. https://www.cbinsights.com/research-unicorn-companies

Clarivate. https://clarivate.com/products/ip-intelligence/patent-intelligence-software/innography

Çalıkoğlu, M., Alabay, M. ve Aygün, A. (2013). Üçüncü Nesil Üniversitelerin Yeniden Konumlandırılması: Bağımsız bir Fonksiyon olarak Sosyal Etkinin Doğuşu. *International Conference on Quality in Higher Education*, 978-992.

Çetinsaya, G. (2014). Büyüme, kalite, uluslararasılaşma: Türkiye Yükseköğretimi için bir yol haritası. *Yükseköğretim Kurumu*, Ankara.

Döm, S. (2008). Girişimcilik ve Küçük İşletme Yöneticiliği (Vol. 2.) *Detay yayıncılık*, Ankara.

Erdem, A.R. (2016). Üniversite anlayışındaki değişim: Birinci nesil üniversiteden dördüncü nesil üniversiteye. *TYB Akademi: Dil, Edebiyat ve Sosyal Bilimler Dergisi*, 16(6), 21-52.

German Academic Exchange Service. https://www.daad.de/deutschland/promotion/phd/de/13306-phdgermany-datenbank/

German Research Institution. https://www.gerit.org/de/

Güneş, S. (2012). Türk toplumu ve otomobil. *Süleyman Demirel Üniversitesi Fen-Edebiyat Fakültesi Sosyal Bilimler Dergisi,* 2012(25), 213-230.

İşcan, Ö. F. ve Kaygın, E. (2012). Üniversite Öğrencilerinin Girişimcilik Eğilimlerini Belirlemeye Yönelik Bir Araştırma. *Atatürk Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, 15 (2), 443-462.

İTÜ. Organizasyon Şeması. https://www.itu.edu.tr/docs/librariesprovider2/default-document-library/organızasyon_seması_ıtu.pdf?sfvrsn=c49b4439_4

Kenan, S. (2015). Modern üniversitenin oluşum süreci. *Osmanlı Araştırmaları/The Journal of Ottoman Studies*, 45(45), 333-367.

Kiper, M., Taş, R. ve Ünlü, S. (2019). Teknoloji Transfer Ofisleri. *Anadolu Üniversitesi Yayınları*.

KOSGEB. (2019). KOSGEB Stratejik Ürün Destek Programı.

Küçükkalay, A. (1997). Endüstri devrimi ve ekonomik sonuçlarının analizi. *Süleyman Demirel Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, 2(2).

Lukovics, M. ve Zuti, B. (2015). New functions of universities in century XXI towards “fourth generation” universities, *Transition Studies Review*, 22(2), 33-48.

Margaret, A.W. ve Garry, D.B. (2007). The Management of Technology and Innovation: A Strategic Approach.

Polat, M. ve Karahan, A. (2009). Multidisipliner yeni bir bilim dalı: Biyoinformatik ve tıpta uygulamaları. *Süleyman Demirel Üniversitesi Tıp Fakültesi Dergisi*, 16(3), 41-50.

Sahlman, K. (2010). Elements of Strategic Technology Management. *Faculty of Technology, Department of Industrial Engineering and Management, University of Oulu.*

Saklı, A.R. (2017). Recep Tayyip Erdoğan üniversitesi öğrenci ve akademisyenleri ile Rize halkının karşılıklı algı ve beklentileri, *Recep Tayyip Erdoğan Üniversitesi Yayınları*, 369-379.

Sanayi ve Teknoloji Bakanlığı. (2019). Sanayi ve Teknoloji Stratejisi. Ankara.

Sanayi ve Teknoloji Bakanlığı. (2021). Teknoloji Transfer Ofislerinin Etkinliğinin Değerlendirilmesi. Ankara.

Sanayi ve Teknoloji Bakanlığı. (2022). Ar-Ge, Tasarım Merkezleri ve Teknoloji Geliştirme Bölgeleri (TGB). https://www.sanayi.gov.tr/arge-tasarim-merkezleri-ve-tgb

Sökmen, N. (2016). Teknoloji geliştirmede bütünleştirici yaklaşımlar. *MSB Birinci Savunma Teknolojileri Günü Savunma Sanayi ARGE ve Teknoloji Yönetimi Paneli*.

Telif Hakları Genel Müdürlüğü. (2021). https://www.telifhaklari.gov.tr/resources/uploads/2021/06/09/YARATICI-KULTUR-ENDUSTRILERI-KULUCKA-MERKEZLERI-RAPORU-2021.pdf

TÜBİTAK. (2020). 2020 Yılı Performans Programı, Ankara.

TÜBİTAK. (2021). Üniversitelerin Alan Bazında Yetkinlik Analizi. Ankara. https://www.tubitak.gov.tr/sites/default/files/Guncel_Universitelerin_Alan_Bazli_Yetkinlik_Analizi.pdf

TÜBİTAK BTYPDB. (2017). TÜBİTAK Bilim, Teknoloji ve Yenilik Politikaları Daire Başkanlığı Teknoloji Hazırlık Seviyesi (THS) Bilgilendirme Notları.

TÜİK. (2021a). Araştırma-Geliştirme Faaliyetleri Araştırması, 2020. https://data.tuik.gov.tr/Bulten/Index?p=Arastirma-Gelistirme-Faaliyetleri-Arastirmasi-2020-37439

TÜİK. (2021b). Merkezi Yönetim Bütçesinden AR-GE Faaliyetleri İçin Ayrılan Ödenek ve Harcamalar, 2021. https://data.tuik.gov.tr/Bulten/Index?p=Merkezi-Yonetim-Butcesinden-AR-GE-Faaliyetleri-Icin-Ayrilan-Odenek-ve-Harcamalar-2021-37448

Türkiye’nin Patent Raporu 2020. (TPR 2021). Patent Effect, 2021.

Uğural, C. (2016). Cumhuriyet’in bilim ve teknoloji politikası (1923-1950). *Dört Öge*, (10), 113-132.

Yalçın, S. (2018). 21. Yüzyıl Becerileri ve bu becerilerin ölçülmesinde kullanılan araçlar ve yaklaşımlar. *Ankara Üniversitesi Eğitim Bilimleri Fakültesi*, 51(1), 183-201.

YÖK. (2007). Türkiye'nin yükseköğretim stratejisi, Ankara.

YÖK. https://www.yok.gov.tr/Sayfalar/Universiteler/arastirma-universiteleri.aspx

Yurdakul, S., Yıldırım, B. ve Şahin, S. A. (2021). Yükseköğretime Bakış: İzleme ve Değerlendirme Raporu. https://www.ebs.org.tr/ebs_files/files/yayinlarimiz2021/YuksekOgretimeBakis2021.pdf

Yücel, E. ve Erol, S. (2022). 2015-2019 yılları yükseköğretim mezunlarının eğitim ve öğretim alanlarına göre değerlendirilmesi. *Yükseköğretim ve Bilim Dergisi*, 12(1), 88-101.

Yükseköğretim Bilgi Yönetim Sistemi. https://istatistik.yok.gov.tr

Veri Kaynağı. https://www.verikaynagi.com/konu-basligi/yuksek-ogretim-kurumu-istatistikleri/

Wissema, J. G. (2009). Üçüncü kuşak üniversitelere doğru: Geçiş döneminde üniversiteleri yönetmek, Özyeğin Üniversitesi Yayını, 2b, İstanbul.

World Economic Forum. (2016). The Global Competitiveness Report 2016–2017. https://www3.weforum.org/docs/GCR2016-2017/05FullReport/TheGlobalCompetitivenessReport2016-2017_FINAL.pdf

Telif Hakları Genel Müdürlüğü. (2021). https://www.telifhaklari.gov.tr/resources/uploads/2021/06/09/YARATICI-KULTUR-ENDUSTRILERI-KULUCKA-MERKEZLERI-RAPORU-2021.pdf

About Authors

Prof. Dr. İsmail KOYUNCU | Istanbul Technical University | koyuncu[at]itu.edu.tr | ORCID: 0000-0001-8354-1889

He was born in 1974 and graduated from Antalya high school in 1990. He had a B.Sc., M.S. and Ph.D degrees in Environmental Engineering Environmental Engineering Department of Istanbul Technical University, in 1995, 1997 and 2002, respectively. He has completed a-year-post doctorate studies at Rice University, USA in 2003 and 2-months-post doctorate studies in Belgium. He also worked as a visiting professor at Rice University for one year in 2004. He worked as a Research Assistant in Istanbul Technical University between 1996-2004 and is currently working as a Professor in Environmental Engineering Department of Istanbul Technical University. He has also been an adjunct faculty at Michigan State University Civil and Environmental Engineering Department since 2019. He worked as a Dean of graduate school, Senate and Board Member of Istanbul Technical University between 2012-2018. Now, he is the president of Istanbul Technical University and Director of National Research Center on Membrane Technologies. He is also member of Turkish Academy of Sciences since 2012. He was awarded with The Scientific and Technological Research Council of Türkiye (TUBITAK) Young Scientist Award (2008) and Economic Cooperation Organization (ECO) International Award 2009 (in the field of Environment). Research areas are water and wastewater treatment and reuse, advanced water treatment technologies, membrane technologies, environmental nanotechnology, environmental effects of nanoparticles, hydraulics of water and wastewater treatment plants. He has more than 200 journal papers and 300 conference presentations. He is married with 3 children.

Prof. Dr. Hacı Ali MANTAR | Gebze Technical University | hamantar[at]itu.edu.tr | ORCID: 0000-0002-1066-9942

He graduated from Istanbul Technical University, Electronics and Communication Engineering Department in 1993. He completed his master's degree in 1998 and his doctorate in 2003 at the USA College of Engineering and Computer Science, Syracuse University. Mantar served as the Head of TÜBİTAK Informatics and Information Security Advanced Technologies Research Center (BİLGEM) between 2015-2020. He served as the Chairman of HAVELSAN's Board of Directors between 2018-2020. He still serves as the Chairman of HAVELSAN's Board of Directors. He worked at Gebze Technical University Computer Engineering between 2006-2021. He is working as the Rector of the Gebze Technical University.

Prof. Dr. Şule Itır SATOĞLU | Istanbul Technical University | onbaslis[at]itu.edu.tr | ORCID: 0000-0003-2768-4038

Prof. Sule Itir Satoglu graduated from Yildiz Technical University Mechanical Engineering Department and started to work as a research assistant at Istanbul Technical University Industrial Engineering Department in 200. She received her master's degree in Engineering Management from Istanbul Technical University in 2002. In 2004, she carried out research studies related to the subject of his doctoral thesis at the State University of New York, Buffalo, School of Management. Then, in 2008, she received her PhD in Industrial Engineering from Istanbul Technical University. She supervised a total of four PhD and 13 master's theses on subjects such as Lean Manufacturing Systems, Sustainable Supply Chain Management, Humanitarian Aid Logistics in Disasters, and served as principal investigator of Tübitak projects and University supported Research Projects. She contributed to the education of many undergraduate students, and held administrative positions at Istanbul Technical University, such as department vice-chair, vice-director of the Institute, and vice-dean. She conducts research on sustainable development, sustainable supply chain management and humanitarian logistics in disasters.

Prof. Dr. Altan ÇAKIR | Istanbul Technical University | altan.cakir[at]itu.edu.tr | ORCID: 0000-0002-8627-7689

Prof. Dr. Altan Cakir received his M.Sc. degree in theoretical particle physics from Izmir Institute of Technology in 2006 and then went to graduate school at the Karlsruhe Institute of Technology, Germany. During his Ph.D., he was responsible for a scientific research based on new physics searches in the CMS detector at the Large Hadron Collider (LHC) at CERN. Thereafter he was granted as a post-doctoral research fellow at Deutsches Elektronen-Synchotron (DESY), a national nuclear research center in Hamburg, Germany, where he spent 5 years, and then recently got his present a full professor position at Istanbul Technical University (ITU), Istanbul, Türkiye. Currently, Altan Cakir is a group leader of ITU-CMS group at CERN and leading a data analysis group at the CMS detector. Furthermore, he was a visiting faculty at Fermi National Accelerator Laboratory (Fermilab), Illinois, USA in 2017. His group's expertise is focused on machine learning techniques in large scale data analysis. However, their research is very much interdisciplinary, with expertise in the group ranging from science, detector development R&D and big data synthesis to economy and industrial applications. Today, he is consulting various companies worldwide, and sharing his expertise in big data application areas, strategies, skills and competencies based on the real-world scenarios.

Assoc. Prof. | Mustafa Evren ERŞAHİN | Istanbul Technical University | ersahin[at]itu.edu.tr | ORCID: 0000-0003-1607-0524

Assoc. Prof. Mustafa Evren Ersahin graduated as an environmental engineer from the Environmental Engineering Department of Trakya University in Türkiye holding the first rank both in the department and faculty in 2003. He received his MSc degree from Environmental Engineering Department at Istanbul Technical University. In 2010, he has joined the Sanitary Engineering Section of the Water management Department at TU Delft as a PhD researcher. He obtained two PhD degree from both Istanbul Technical University and Delft University of Technology in 2015. He was involved in many research and development projects in the field of energy efficiency in wastewater treatment, resource recovery, dynamic membrane technology, innovative wastewater treatment processes, anaerobic biotechnology, membrane bioreactors, renewable energy recovery and biosystem modelling. Assoc. Prof. Ersahin has been awarded nine different awards, four of which are international, for his contributions to science. He got TUBITAK Incentive Award, and Scientist of the Year Award in 2020.

Assist. Prof. Tankut AKGÜL | Istanbul Technical University | akgult[at]itu.edu.tr | ORCID: 0000-0002-2368-4041

Dr. Akgül completed his undergraduate education at Boğaziçi University, Department of Electrical and Electronics Engineering in 1999. He received his master's and doctorate degrees from the Georgia Institute of Technology, Department of Electrical and Computer Engineering in 2001 and 2004, respectively. Until 2018, he was a Technical Leader with the Service Provider Video Technology Group, Cisco Systems, where he worked on IPTV and cable networks. From 2018 to 2019, he was a Technical Leader with Synamedia, where he worked on multimedia content distribution systems. He is currently an Assistant Professor with the Electronics and Communication Engineering Department, Istanbul Technical University. He is also a member of the Board of Trustees and the Board of Directors of the Turkish Technology Team Foundation. His research interests are embedded software design, video compression, transport protocols, and multimedia streaming, and he has various patents in these areas.