

A comprehensive study on the Technology Transfer Ecosystem

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List of Abbreviations

ATP: Alliance of Technology Transfer Professionals
 AUTM: Association of University Technology Managers
 BIGG: Individual Young Initiative
 CGF: Credit Guarantee Fund
 COST: European Cooperation in Science and Technology
 EEN: Enterprise Europe Network
 EIS: European Innovation Scoreboard
 EIUI: Entrepreneurial and Innovative University Index
 EPO: European Patent Office
 EU: European Union
 EUA: European University Association
 FDI: Foreign Direct Investment
 GDP: Gross Domestic Product
 GI: Geographical Indication
 HEIs: Higher Education Institutions
 HRST: High-Rise Skilled Technicians
 ICT: Information and Communication Technologies
 ICTA: Information and Communication Technologies Authority
 IPL: Intellectual Property Law
 IPRs: Intellectual Property Rights
 IRC: Inovent Research Commercialization
 ISIF: International Invention Fair
 ISO: International Organization for Standardization
 ITU: Istanbul Technical University
 KOSGEB: The Small and Medium Enterprises Development Organization
 KTU: Karadeniz Technical University
 LPC: Law No. 4054 on the Protection of Competition
 METU: Middle East Technical University
 MoIT: Ministry of Industry and Technology
 MÜSİAD: The Independent Industrialists' and Businessmen's Association
 NATO: North Atlantic Treaty Organization
 NGOs: Non-Governmental Organizations
 OECD: Organisation for Economic Co-operation and Development
 OIZs: Organized Industrial Zones
 P&D: Product Development
 PATLIB: Patent Library
 PCT: Patent Cooperation Treaty
 PUIC: Public-University-Industry Cooperation
 R&D: Research and development

RDAs: Regional Development Agencies
 RTPs: Registered Technology Professionals
 SCST: Supreme Council for Science and Technology
 SMEs: Small and medium-sized enterprises
 STEM: Science, Technology, Engineering and Mathematics
 TAI: Türkiye Aerospace Industry
 TDZs: Technology Development Zones
 TEKMER: Technology Development Centre
 TIM: Türkiye Exporters Assembly
 TOBB: The Union of Chambers and Commodity Exchanges of Türkiye
 TRL: technology readiness level
 TSE: Türkiye Standards Institute
 TT: Technology Transfer
 TTGV: Technology Development Foundation of Türkiye
 TTO: Technology Transfer Office
 TTOs: Technology Transfer Offices
 TTP: Technology Transfer Professionals
 TUSEB: Health Institutes of Türkiye
 TÜBA: Türkiye Academy of Sciences
 TÜBİTAK: The Scientific and Technological Research Council of Türkiye
 TÜBİTAK 1004: TÜBİTAK 1004 Center of Excellence Support Program
 TÜBİTAK 1513: TÜBİTAK 1513 Technology Transfer Offices Support Program
 TÜBİTAK 1601: TÜBİTAK 1601 Providing and Implementing Preparation, Initiation, and Capacity Building for Technology Transfer Offices Support Program
 TÜBİTAK 1702: Patent Based Technology Transfer Support Program
 TÜBİTAK MAM: TÜBİTAK Marmara Research Center
 TÜRKPATENT: Türkiye Patent and Trademark Office
 TÜRKSMĐ: Türkiye Industrial Property Valuation, Engineering and Consultancy Services Inc.
 UAV: Unmanned Aerial Vehicle
 UIC: University-Industry Cooperation
 WIPO: World Intellectual Property Organization
 VQA: Vocational Qualifications Authority
 YÖK: Council of Higher Education
 ÜSAMP: University-Industry Joint Research Centers Program
 ÜSİMP: University-Industry Collaboration Centers Platform of Türkiye
 İŞKUR: The Employment Agency

1. Introduction

Türkiye's technology transfer (TT) ecosystem is a structure where many actors come together in the process of transferring scientific and technological knowledge from the source to industry and the market. The cornerstones of this ecosystem are the public sector, academia and industry, and through the interactions between these parties, technological innovations are transformed into economic value. The cooperation of these three main actors in TT process is critical for the sustainability of innovation and increasing competitiveness. Türkiye's strategic goals in this area are to develop indigenous technologies, increase international competitiveness and strengthen the Research and development (R&D) ecosystem.

Main Actors in Türkiye's TT Ecosystem

- Main Actors on the Public Side

The regulation and support of TT processes in Türkiye is largely the responsibility of public institutions. The public sector establishes legal regulations on TT and R&D activities and provides incentives and support mechanisms. In particular, public institutions such as the Ministry of Industry and Technology (MoIT) and the Scientific and Technological Research Council of Türkiye (TÜBİTAK) play a critical role in accelerating TT.

While the MoIT plays a key role in determining Türkiye's R&D and innovation policies, TÜBİTAK provides important incentive programs and grant support for TT. TÜBİTAK 1513 Technology Transfer Offices Support Program and TÜBİTAK 1601 Providing and Implementing Preparation, Initiation, and Capacity Building for Technology Transfer Offices Support Program constitute an important source of support for the establishment and institutional capacity building of TTOs at universities. In addition, regulations such as Law No. 5746¹ on Supporting R&D and Design Activities, Law No. 4691² on Technology Development Zones (TDZs) and Corporate Tax Law No. 5520³ are among the main legislations that form the legal framework for TT processes in terms of tax incentives and researcher assignments. These laws provide tax reductions for R&D and innovation activities, support for personnel employment and various incentives for firms operating in TDZs.

- Main Actors on the Academy Side

In the TT ecosystem, academia plays an important role in the production and commercialization of scientific knowledge. In Türkiye, universities, research centers and TDZs are the main sources of innovation activities. In particular, TTOs established within universities act as a bridge in the process of patenting, licensing and transferring the knowledge obtained from R&D projects to industry.

TTOs are interface units that enable the transfer and commercialization of knowledge produced at universities to industry. These offices enable the commercialization of academic research by strengthening UIC. Thanks to the TÜBİTAK 1513, TTOs have been established in many universities in Türkiye and a significant increase in the number of patents has been achieved through these offices. At the same time, these offices contribute to the development of the entrepreneurship ecosystem and enable the establishment of start-ups and spin-offs.

Universities also contribute to TT through R&D projects, patent applications and licensing processes. The 2017 TTO Regulation encouraged universities to participate more actively in R&D and innovation activities. This regulation enables the commercialization of R&D projects of universities and supports the transfer of academic discoveries to industry.

- Main Actors on the Industry Side

As the ultimate recipient of TT, industrial actors are critical actors that commercialize technologies produced by academia and the public sector and transform them into economic value. Industrial

enterprises in Türkiye invest in R&D activities to develop innovative products and services. Tax reductions, incentives and supports provided to industrial enterprises have increased investments in R&D activities.

Industry actors also play an important role in bringing technologies developed at universities to the market by taking an active role in UIC projects. R&D centers and design centers established in Türkiye are important infrastructures provided to industry in the process of TT. In particular, large industrial organizations develop new technologies in cooperation with universities and integrate them into their production processes.

Legal Framework and Support Mechanisms

Legal regulations and incentives for the development of the TT ecosystem in Türkiye have been adopted by both public institutions and the private sector. While the MoIT plays a key role in determining Türkiye's R&D and innovation policies, TÜBİTAK provides important incentive programs and grant support for TT.

Regulations such as Law No. 5746¹ on Supporting R&D and Design Activities, Law No. 4691² on TDZs and Corporate Tax Law No. 5520³ are among the main legislations that form the legal framework for TT processes in terms of tax incentives and researcher assignments. These laws provide tax reductions for R&D and innovation activities, support for personnel employment and various incentives for firms operating in TDZs.

TÜBİTAK's 1513 and 1601 Support Programs constitute an important source of support for the establishment and institutional capacity building of TTOs at universities.

Challenges, Opportunities and Risks

Although the TT ecosystem in Türkiye is developing rapidly, it still faces some structural problems and risks. These problems include insufficient budget allocation for R&D activities, the existence of bureaucratic obstacles in TT processes, and the lack of experience of TT professionals. In addition, the lack of strong university-industry cooperation (UIC) and the limited number of industrial organizations investing in R&D is another obstacle to TT.

However, there are also significant opportunities for TT in Türkiye. In particular, the young population, the growth of the entrepreneurship ecosystem and the increase in start-ups can contribute to accelerating TT processes. Moreover, R&D incentives and tax breaks provided by the government encourage industry to invest more in R&D activities. Türkiye's geographical location and potential in strategic sectors also offer significant opportunities for TT.

However, risks should not be ignored in the TT ecosystem. In particular, factors such as the sustainability of R&D activities, financial difficulties encountered in TT processes and the inability of universities to cooperate sufficiently with industry are among the risks that limit the development of the ecosystem.

This study will analyse in detail the main components of the Türkiye TT ecosystem. It will focus on the roles of public, academic and industrial actors, as well as the interactions and cooperation between these actors. It will also discuss the legal regulations and incentive mechanisms that support TT, assess the challenges, opportunities and risks faced by the ecosystem, and analyze the sources of funding in the TT ecosystem. In this context, this study will be an important source of data for strategies, policy recommendations, training and curriculum studies that will increase the effectiveness of TT processes in Türkiye.

1.1 Work Methodology

The methodology of the work includes a literature review, TT and R&D reports published in Türkiye and one-on-one interviews. The judgmental sampling method, also known as purposive sampling method, was used as the interview method. In purposive sampling, the researcher selects a sample from a smaller group that is a member of the main population based on his/her knowledge, expertise and the relationship of the group to the main population [1,2]. In this method, it is assumed that the selected group will be

suitable for the purpose of the study and will provide the goal that the study wants to achieve [3]. If the main mass is homogeneously distributed and the researcher dominates the main mass, the selected samples will yield good results [4]. The fact that the group conducting the research consists of TT experts has an important effect on the choice of this method. Since the experts work in the TT ecosystem, it was easy to select the parties to be interviewed one-on-one. The parties reached were closely interested in the project activities and volunteered to participate. Some of the industry experts and institutions that were interviewed one-on-one were the parties that provided letters of support during the project writing phase. This had a positive impact on the interviews.

2. Background/Environment

As the contribution of technology to the economy and society has come to the forefront, R&D investments have increased in Türkiye. In addition, the importance attached to TT for the production and transfer of technology has also increased from past to present. Policies and legal regulations have been put in place to improve the TT ecosystem. At the same time, TT-based collaborations between many institutions have been established and are currently developing.

When we look at the parties involved in the TT ecosystem in Türkiye, these are: Technology producers and developers, capital providers and intermediaries, TT requesters and TT intermediaries. Technology developers are universities, academics, entrepreneurs, inventors, technopark and other companies, R&D Centers, incubation centers. Fund and capital suppliers are public institutions, venture capital, angel investors, incubation centers, investor businesspeople and banks. Intermediaries are TTOs and TT platforms, as well as consultants, lawyers and innovation professionals. In the current situation in Türkiye, efforts are being made to create a suitable environment for these parties to realize TT.

The laws in Türkiye provide a favorable environment for the development of the ecosystem. In general, R&D incentives, tax incentives, establishment of R&D centers and technoparks for technology production, support for the employment of qualified personnel and personnel mobility (university - industry) can be listed. Law No. 5746¹ on Supporting Research, Development and Design Activities and Corporate Tax Law No. 5520³ provide tax advantages to companies on R&D-based issues. In addition, R&D incentives, tax exemptions and discounts are also applied to companies located in technoparks established by the Ministry of Industry and Technology. Technoparks are important centers for the commercialization of knowledge. Academics who produce technology at universities are legally entitled to establish companies in technoparks. This has been an important facilitator in the commercialization of academic studies. R&D Law No. 5746¹ also gives academics the right to work in R&D and Design Centers. The income they have earned as a result of their activities in these centers has also been subject to tax deduction.

On May 18, 2018, an omnibus law introduced an incentive scheme for entrepreneurs aged 18-29. This support aims to ease the tax burden of young entrepreneurs and enable them to focus on their own business. In this context, the income of young entrepreneurs between the ages of 18-29 is exempt from tax for 3 years up to a specified amount. In addition, the compulsory insurance to be paid by company owners is exempt from tax for 1 year up to a specified amount. The Employment Agency (İŞKUR) brings qualified personnel and companies together and part of the employment costs can be provided by İŞKUR.

Organized Industrial Zones (OIZs) were established in Türkiye to support the orderly development of industry, ensure environmental sustainability and provide appropriate infrastructure services to industrialists. In addition to the infrastructure services they provide, OIZs enable industrial enterprises to operate efficiently by providing social facilities, education and health services. TT is one of the main

components of OIZs and they encourage UIC by collaborating with technoparks, TTOs and R&D centers. Law No. 4562⁴ on OIZs regulates the establishment, management and supervision of OIZs. Stakeholders in OIZs include industrialists, local governments, universities, chambers of commerce and industry, TTOs and relevant public institutions. OIZs are one of the key dynamics of the Türkiye economy and contribute to the national economy through their production activities, employment creation and export potential. OIZs are constantly evolving to adapt to changes in Türkiye's industrial policy and global trends.

The Union of Chambers and Commodity Exchanges of Türkiye (TOBB) is an important organization contributing to TT in Türkiye. TOBB has a wide network of 365 chambers and stock exchanges across Türkiye, representing more than 1.5 million members. Within the scope of TT, it establishes collaborations between industry, universities and the public by promoting R&D and innovation. TOBB helps commercialize innovative projects by collaborating with TTO and universities. It also develops policies that encourage entrepreneurship and digital transformation strategies. TOBB carries out various programs for technology-oriented entrepreneurship and industry to increase Türkiye's competitiveness. TOBB's training and capacity building activities contribute to raising awareness and competence in TT through trainings and seminars organized for its members.

As an important stakeholder in TT, the Türkiye Exporters Assembly (TIM) works to develop exports and promote innovation. TIM offers various projects, initiatives and training programs aimed at increasing Türkiye's export volume and supporting technological transformation. In particular, it encourages innovation, R&D and the use of technology to enhance the global competitiveness of exporting companies. In this context, it takes steps to assess the maturity of the TT environment.

The Independent Industrialists' and Businessmen's Association (MÜSİAD) is an important non-governmental organization that promotes TT in Türkiye's business world. In the process of TT, it guides its members in innovation, R&D and digital transformation. Aiming to increase the competitiveness of industrialists in the global market, MÜSİAD offers technological solutions to SMEs and supports entrepreneurship. It also strengthens technology-based collaborations by establishing international connections.

The costs of R&D and TT activities (contract costs, patent application costs, etc.) can be an obstacle to successful TT. At this point, there are many funding sources in Türkiye. The Scientific and Technological Research Council of Türkiye (TÜBİTAK), the Small and Medium Enterprises Development Organization (KOSGEB), Ministry Supports, local government supports (fair support, etc.) provide non-refundable and/or refundable funding sources for the production and dissemination of technology. Again, for the interfaces (TTOs) operating to bring the knowledge produced here together with those who demand the knowledge, TÜBİTAK provides non-refundable support and mentorships through TÜBİTAK 1601, TÜBİTAK coded programs. Within these calls, there may be separate calls for staff employment. For technology demanding parties, calls under TÜBİTAK Technology and Innovation Support Programs Directorate (TEYDEB) and KOSGEB programs provide opportunities to cover the costs of TT. In addition to these publicly supported supports that accelerate TT, TT mechanisms are also widely used in the private sector. Angel investment and venture capital funds, pre-incubation, incubation and accelerator programs, technology competitions, crowdfunding platforms, innovation and entrepreneurship programs run by private companies, contract-based TT agreements are among the frequently used instruments in Türkiye. In addition, mergers and acquisitions of startups are also among the instruments used in TT. These processes and support mechanisms are determined and maintained in line with Türkiye's development goals. **Türkiye's future development plans are published in the "Development Plan" document prepared by the Strategy and Budget Directorate of the Presidency of the Republic of Türkiye.**

First Five-Year Development Plan (1963-1967): This plan represents the first systematic effort towards Türkiye's science and technology policies. Emphasizing the importance of basic scientific research, the plan set targets for improving the research environment and training research personnel. However, these objectives were not fully realized. The Plan led to the establishment of TÜBİTAK [5].

Second Five-Year Development Plan (1968-1972): In this plan, science and research were addressed under a separate heading, but the objectives were largely compatible with the first plan. The second plan also aimed at increasing R&D expenditures and training qualified manpower. The establishment of the TÜBİTAK Marmara Research Center (TÜBİTAK MAM) and the Construction Research Center are among the concrete steps taken in this period. [6].

Third Five-Year Development Plan (1973-1977): This plan is the first plan in Türkiye to include technology policies. It contains detailed provisions on technological development, manpower and investment policies. The plan aimed to utilize technology in line with the needs of the country and to support domestic technology production [7].

Fourth Five-Year Development Plan (1979-1983): The fourth plan emphasizes problems such as the insufficiency of domestic technology production and the low level of R&D expenditures. The tendency of the industry to outsource technology was criticized and it was aimed to transform the industrial sector into a structure that produces its own technology. TÜBİTAK's inability to establish a relationship between development plans and science and technology is one of the important points criticized [8].

Fifth Five-Year Development Plan (1985-1989): This plan criticizes the lack of emphasis on TT and R&D in industrial policies and emphasizes the need for a dynamic structure in R&D activities. In addition, the necessity of strengthening UIC and the establishment of a national quality control system were emphasized [9].

Sixth Five-Year Development Plan (1990-1994): This plan sets more specific targets for R&D and emphasizes that priority should be given to areas such as biotechnology, information technology and microelectronics. Moreover, doubling the number of researchers and the establishment of the Türkiye Patent and Trademark Office (TÜRKPATENT) are important steps in this plan [10].

Seventh Five Year Development Plan (1996-2000): The seventh plan includes structural change projects necessary for the transition to an information society. Comprehensive decisions on science and technology policies were taken and the share of R&D expenditures in gross domestic product (GDP) was targeted to increase to 1.5%. The development of a national defense industry and the enhancement of UIC are also cited as prominent elements of this plan [11].

Eighth Five Year Development Plan (2001-2005): The eighth plan identifies that most of the science and technology targets envisaged in the seventh plan have not been realized and attributes this to the lack of a systematic approach. This plan identifies strategies for priority areas such as information and communication technologies and proposes legal arrangements for the establishment of technoparks [12].

Ninth Development Plan (2007-2013): This plan sets the objectives of increasing Türkiye's science and technology capacity and improving its global competitiveness through innovation. Issues such as the dissemination of information and communication technologies and the consolidation of e-government services under a single roof also have an important place in the plan [13].

Tenth Development Plan (2014-2018): The Tenth Plan emphasizes that knowledge-based production has become one of the cornerstones of economic growth and calls for greater emphasis on R&D investments. The plan states that large-scale educational technology initiatives such as the Fatih Project should be expanded and domestic technology should be supported in public procurement [14].

Eleventh Development Plan (2019-2023): This plan presents a comprehensive strategy to strengthen Türkiye's R&D and innovation ecosystem. It is planned to focus the R&D support system to cover all processes from research to commercialization and to transform it into a structure suitable for the needs of sectors. Targets such as increasing the number and quality of researcher manpower in the private sector and encouraging the employment of PhD researchers in industry emphasize the importance of UIC. Furthermore, steps will be taken to analyze the effectiveness of TTOs and disseminate good practices, provide financial support to innovative projects and ensure integration with the EU Research and

Innovation Framework Programs. In the field of space, the National Space Program will be implemented and the capacity of the Türkiye Space Agency will be enhanced [15].

Twelfth Development Plan (2024-2028): This plan presents a comprehensive strategy to increase Türkiye's global competitiveness in science, industry and technology. R&D and innovation activities will be focused on priority sectors and critical technology areas, and performance-based support practices will be expanded. Platform-based national initiatives will be launched especially in the areas of green transformation and domestic technology development, and support models covering the process from basic research to the final product will be developed by strengthening cooperation between industry and universities. In addition, competent academicians from abroad will be attracted to Türkiye and pioneering R&D infrastructures will be supported. R&D capabilities will be increased in strategic areas such as space technologies, health technologies, chip production and polar research, and necessary infrastructures will be established for advanced technologies such as artificial intelligence, cyber security and biotechnology within the scope of the "National Technology Initiative". These targets will serve to achieve Türkiye's 2053 net zero emission target and strengthen its strategic position in the international arena [16].

When TT and R&D activities in Türkiye are analyzed in terms of investment:

Türkiye published its **Foreign Direct Investment (FDI) Strategy** for the period 2024-2028. This strategy aims to strengthen Türkiye's position on the global investment map and reduce the barriers faced by investors in Türkiye. The strategy includes policies under the themes of "Investment Climate Competitiveness", "Green Transformation", "Digital Transformation", "Global Supply Chain", "Skilled Human Resources" and "Communication and Promotion".

Under the Investment Climate Competitiveness theme, it is aimed to incentivize investors and develop mechanisms for resolving investment disputes. Under the Green Transformation theme, it is aimed to increase renewable energy production, promote climate and environmentally friendly technologies and facilitate investors' access to green energy. Under the Digital Transformation theme, it is planned to realize international standards, data policies and legal regulations to support the digital transformation process. The Global Supply Chain theme includes strengthening integration into global value chains and improving logistics capabilities. Under the theme of Qualified Human Resources, it is aimed to ensure the development of the required qualified human capital and to carry out legislative work in line with the professions of the future. Under the Communication and Promotion theme, it was planned to actively promote Türkiye's investment environment and convey effective messages to target audiences.

As stated in the relevant document, despite the stagnation in global FDI flows, investments in Türkiye's region are on the rise. "High value-added service sector investments" in Türkiye's region are on the rise. The concepts of "green transformation" and "sustainability" have become the most important determinants of global FDI flows. Global value chains are being reshaped with "close sourcing" and "sourcing from friendly countries" approaches and affect FDI flows. Digitalization is one of the most important phenomena transforming global FDI flows. "Protectionism" rising with trade and technology wars has an impact on FDI flows. The share of mega projects in FDI flows is increasing. Türkiye's region is one of the leading destinations for these investments. Türkiye is one of the economies attracting the most FDI in its region. It is the leading country in the region, especially in "food-agriculture" and "manufacturing" projects and "expansion" type investments. International investors operating in the country play a critical role in making Türkiye a competent production and export base. Investments in technology ventures have become an important component of global FDI flows.

Türkiye is geographically located at the intersection of Central and Eastern Europe, the Middle East and North Africa (the wider region). Thanks to its strategic location, Türkiye is one of the leading destinations for global FDI flows. International investors often compare Türkiye with one or more of the countries in this wider region in their assessments of new investment projects in different sectors and activities. Therefore, the analysis of regional FDI flows is based on these country groups. The share of global FDI flows in this broad region entered a rapid downward trend after the 2008 Financial Crisis. However, despite the contraction trend observed in global FDI in the period starting in 2016, investments in the wider region

started to gain momentum. While FDI inflows to the region amounted to \$67.4 billion in 2015, they doubled 2.6 times to \$178.3 billion in 2023. Türkiye, which has attracted \$261 billion in FDI over the last 20 years (2004-2023), is the second largest investment attractor in the region with a market share of 9.8%. In the 2014-2023 period, compared to the previous 10-year period, Türkiye increased its share in greenfield investments and became one of the top 3 countries attracting greenfield investments in the region. Türkiye is the region's 2nd largest attractor of mergers and acquisitions type investments. Türkiye is among the leading countries in the region in expansion type investments.

In early-stage investments, Türkiye's startup ecosystem, which attracted \$74 million in investments through an annual average of 104 transactions between 2010 and 2020, reached its historical peaks between 2021 and 2023, attracting \$1.33 billion in investments through an annual average of 338 transactions. Between 2020 and 2023, Türkiye's startup ecosystem reached unicorn status (startups valued at more than \$1 billion) with 5 startups and decacorn status (startups valued at more than \$10 billion) with 2 startups. In 2022, Türkiye was one of the 10 countries in Europe with the highest number of tech startup investments [17].

Türkiye's situation in innovation, R&D and R&D expenditures, which are the basis of TT, was evaluated from the Global Innovation Index report published by the World Intellectual Property Organization (WIPO). Accordingly, Türkiye ranked **39th** among 132 economies in the Global Innovation Index published in 2023. This ranking shows the progress Türkiye has achieved in the field of innovation in recent years. For example, while Türkiye was ranked 51st in 2020, it rose to 41st in 2021 and as high as 37th in 2022. However, in 2023, it showed a slight decline to 39th place [18].

Türkiye performed better in innovation outputs than in innovation inputs. In 2023, Türkiye **ranked 52nd** in innovation inputs and **32nd** in innovation outputs. Although the ranking in innovation inputs is lower than last year, the ranking in innovation outputs is higher than last year.

When Türkiye's situation is analyzed in detail in the WIPO report:

Regional and Income Group Comparisons: By 2023, Türkiye ranks **4th** among upper-middle-income economies and **4th** among 18 economies in the North Africa and West Asia region. These data show that Türkiye ranks high both regionally and by income group.

Türkiye's Strengths and Weaknesses: Among Türkiye's greatest strengths in innovation, higher education enrollment rate (% gross) **ranked 2nd**, domestic industrial diversity **ranked 4th**, and industrial designs (per billion PPP\$ GDP) **ranked 4th**. These indicators show that Türkiye performs strongly in areas such as education and industrial diversity.

However, some weaknesses in Türkiye's innovation system are also noteworthy. Environmental performance **ranked 127th**, business policies **114th** and the proportion of science and engineering graduates **100th**, indicating that Türkiye needs improvement in these areas.

Türkiye's R&D expenditure per GDP reached 1.13% by 2021, placing Türkiye **35th** in the global ranking. Moreover, the share of high-tech manufacturing in Türkiye's total manufacturing output was 30.03%, **ranking Türkiye 36th** [18].

When Türkiye's overall innovation performance is assessed in the light of various indicators, it is seen that Türkiye has a strong performance especially in innovation outputs but has room for further improvement in innovation inputs and some institutional weaknesses. Türkiye's position in regional and global rankings reveals that the country needs to take strategic steps to further develop its innovation potential.

The Doing Business Index, which has been prepared regularly by the World Bank every year since 2004, analyzes business regulations affecting the investment climate in member countries. The analysis based on Türkiye's data in the 2020 **Doing Business** report reveals the country's global position in terms of ease of doing business. According to the report, Türkiye ranks 33rd out of 190 countries, indicating that the country is in the upper-middle range in terms of ease of doing business. Türkiye's overall score is 76.8 out

of 100. Türkiye ranks 77th in terms of ease of starting a business and scores 88.8 in this area. The process of starting a business consists of 7 procedures and takes 7 days on average. The cost of this process is calculated as 6% per revenue. On access to credit, Türkiye ranks 37th and scores 75.0 points. In the area of protection of minority investors, Türkiye ranks 21st and scores 76.0. This indicator focuses on the protection of minority shareholders' rights. In terms of ease of tax payment, Türkiye ranks 26th and scores 86.6. On average, 10 tax payments are made per year and the time spent on these payments is 170 hours. In the area of cross-border trade, Türkiye ranks 44th and scores 91.6. Export documents take an average of 4 hours and transactions at the border take 10 hours. In terms of contract enforcement, Türkiye ranked 24th and scored 71.4 points. It takes 623 days to resolve a trade dispute. Türkiye's weakest area is insolvency resolution. In this area, Türkiye ranks 120th and scores 38.5 points. It takes approximately 5 years to resolve a bankruptcy and the recovery rate is 10.5%.

While these data show that Türkiye is in a strong position in some areas in terms of ease of doing business, they reveal that significant improvements are needed, especially in areas where it is weak, such as insolvency resolution.

When R&D expenditures in Türkiye are analyzed, Türkiye's total R&D expenditure increased by 96 billion 932 million in 2022 compared to the previous year, reaching 198 billion 670 million. In the last 21 years, R&D expenditure has increased 10-fold, from \$1.2 billion in 2002 to \$12 billion in 2022. The share of R&D expenditure in GDP was 1.32%. In 2022, the private sector continued to be the main driver of R&D spending with a share of 61.4%. The share of the private sector in R&D expenditures was followed by higher education with 33.8%. The share of public R&D expenditures in total R&D expenditures was 4.8%. The private sector also ranked first in R&D financing with 50.2%. Of the 122 billion 28 million R&D expenditures made by the private sector in 2022, 54.4% was made in R&D centers. Of the 72 billion 311 million R&D expenditures in the manufacturing industry, 49.1% was realized by enterprises engaged in high technology activities [19].

2.1 EIS in Türkiye

European Innovation Scoreboard

The European Innovation Scoreboard (EIS) is an important analysis tool published annually by the European Union (EU) that systematically assesses the innovation performance of European countries. The EIS allows for comparisons between EU member states and other European countries by examining the innovation capacity and performance of countries on various criteria. This assessment takes into account many factors that constitute the key components of innovation and divides countries into four main categories according to their innovation performance:

1. Those whose performance is above 125% of the EU average: **Innovation Leaders,**
2. Those whose performance is between 100% and 125% of the EU average: **Strong Innovators,**
3. Those whose performance is between 70% and 100% of the EU average: **Moderate Innovators,**
4. Those whose performance is below 70% of the EU average: **Emerging Innovators.**

The EIS uses a set of indicators to identify the strengths and weaknesses of each country's innovation ecosystem. These indicators are grouped into different areas such as human resources, attractive research systems, digitalization, firm investments, intellectual assets, innovation activities, financing and support mechanisms. For example, "human resources" includes indicators such as PhD graduates and population with tertiary education, while "research systems" includes criteria such as international scientific co-publications and most cited publications. This comprehensive analysis reveals the innovation performance of countries compared to the EU average and guides the development of innovation policies [20].

2.1.1 Türkiye's Performance and Related Indicators

According to the EIS 2024 assessment, Türkiye is in the "Emerging Innovator" category. The country's innovation performance is 51.7% of the EU average, which is above the average of the Emerging Innovators

group (48%). This shows that Türkiye is making progress in innovation, but with a significant gap with the EU average. Although Türkiye has recorded a 6.1% increase in its innovation performance since 2017, this increase lags behind the EU's overall rate of increase (10%). This suggests that Türkiye has made some progress in improving its innovation performance but needs to do more to close the gap with the EU.

2.1.1.1 Human Resources

Türkiye's performance in human resources is 60.3% of the EU average. This indicator has three main components: **New PhD graduates, population with tertiary education and population participating in lifelong learning.**

Türkiye performs particularly poorly in terms of PhD graduates, remaining at 34.5% of the EU average. This low rate shows that Türkiye has a serious need for improvement in terms of training highly qualified researchers. Türkiye's performance in lifelong learning is 23.6% of the EU average. This low rate indicates that the participation of adults in continuing education and skills development activities is insufficient in Türkiye. However, in terms of the proportion of the population with tertiary education, Türkiye performed at 92.4% of the EU average. This ratio shows that Türkiye performs well in higher education.

2.1.1.2 Attractive Research Systems

In terms of attractive research systems, Türkiye's performance is 49.3% of the EU average. This indicator has three main components: **International scientific co-publications, scientific publications ranked among the top 10% most cited, and foreign PhD students as a percentage of all PhD students.**

In terms of international scientific co-publications, Türkiye performs very poorly, with only 14.3% of the EU average. This shows that Türkiye researchers need to be encouraged more in international collaborations. However, in terms of the most cited publications, Türkiye has a more positive outlook in this area, reaching 76.1% of the EU average. While this sends positive signals about the quality of research in Türkiye, it does not change the fact that international collaborations need to be increased. In terms of foreign PhD students as a percentage of all PhD students, Türkiye is 39.5% of the EU average.

2.1.1.3 Finance and Support

Türkiye's performance in the area of financing and support is 62.4% of the EU average. This indicator has three main components: **R&D expenditures in the public sector, venture capital expenditures and direct and indirect government support to R&D activities of enterprises.**

Türkiye performs strongly in terms of direct and indirect government support to business, with 124% of the EU average. This shows that Türkiye is using public resources effectively to promote innovation. However, venture capital expenditure is only 11.9% of the EU average, revealing significant room for improvement. As venture capital plays a critical role in the development of innovative start-ups and Small and medium-sized enterprises (SMEs) in particular, underperformance in this area poses a significant risk to the sustainability of the innovation ecosystem. R&D spending in the public sector is 63.9% of the EU average.

2.1.1.4 Firm Investments

Türkiye's performance in the area of business investment is 48.1% of the EU average. This indicator has three main components: **R&D expenditure in the business sector, non-R&D innovation expenditure and innovation expenditure per employed person.**

R&D spending in the business sector is 53.5% of the EU average and has increased by 24.8% since 2017. While this increase is seen as a positive development, it indicates that Türkiye still lags behind the EU average in terms of firm investment. Non-R&D innovation expenditures are 51.1% of the EU average. In terms of innovation expenditures per employed person, it is 39.4% of the EU average.

2.1.1.5 Innovators

Türkiye's performance on the innovation activities indicator is 72.6% of the EU average. This indicator has two main components: **SMEs introducing product innovations** and **SMEs innovating in business processes**.

Among SMEs, product innovators perform at 67.7% of the EU average, while business process innovators are at 76.5%. However, since 2017, these indicators have declined by 66.6% and 56.6% respectively. These declines indicate a marked decline in SMEs' innovation activity and a need to strengthen supportive policies in this area.

2.1.1.6 Intellectual Assets

Türkiye's performance on the intellectual asset's indicator remains at 30.7% of the EU average. This indicator has three main components: Patent Cooperation Treaty (**PCT**) **patent applications**, **trademark applications** and **design applications**.

In terms of PCT patent applications, Türkiye reached 57.1% of the EU average but performed poorly in trademark applications at 18.9% and design applications at only 1.8%. These indicators reveal that Türkiye has serious room for improvement in intellectual property rights (IPRs), particularly in the area of design. Protecting intellectual assets and increasing applications in this area would be a critical step towards boosting Türkiye's innovation capacity.

2.1.1.7 Digitalization

Digitalization is considered a driver of innovation in modern economies. Türkiye performs poorly on the digitalization indicator, remaining at 38.6% of the EU average. This indicator has two main components: **Broadband penetration** and **individuals with general digital skills above basic**.

The broadband penetration sub-indicator reveals that Türkiye performs at 46.1% of the EU average. In terms of individuals with above-basic general digital skills, Türkiye performs poorly at 28.3% of the EU average. According to the indicators, there is a need for improvement especially in areas such as digital infrastructure, digital skills and digital transformation in business processes. The low level of digitalization suggests that Türkiye may face challenges in adapting to the digital economy and increasing its competitiveness. This implies that both the private and public sectors need to increase their investments in digitalization. In order to close the gap with the EU average in this area, Türkiye needs to implement digitalization strategies more effectively and promote digital literacy.

2.1.1.8 Use of Information Technologies

Türkiye's performance in the area of IT Usage is 50.3% of the EU average. This indicator has two main components: Information and Communication Technologies (ICT) **professionals employed** and **ICT usage by enterprises**.

In terms of employed ICT experts, Türkiye performs quite poorly, remaining at only 2.9% of the EU average. This low rate indicates that ICT experts are not sufficiently included in the workforce and that the country is lagging behind in the digitalization process. In particular, a greater presence of ICT experts in the workforce is a critical need for accelerating digitalization processes and increasing innovation capacities. The ICT use by enterprises sub-indicator reveals that Türkiye's performance is 50.3% of the EU average. This shows that digital technologies have not fully spread among enterprises and digitalization processes are not progressing at the expected pace. Supporting the digitalization processes of SMEs in particular is important for increasing innovation and competitiveness. In light of these data, in order to accelerate Türkiye's digitalization process and strengthen the innovation ecosystem, it is necessary to develop programs to increase the employment of ICT experts and implement policies to encourage the use of ICT by enterprises.

2.1.1.9 Linkages

The linkages indicator assesses countries' capacity for international cooperation and networking. Türkiye is 77% of the EU average on the linkage's indicator. This indicator has three main components: **Innovative SMEs collaborating with other companies, public-private co-publications** and **High-Rise Skilled Technicians (HRST) job-to-job mobility**.

International cooperation and linkages play a critical role, especially in scientific research and TT. Türkiye's low linkages score indicates that it is not sufficiently integrated into international collaborations and is unable to fully capitalize on opportunities in this area. This suggests that Türkiye needs to strengthen international partnerships and collaborations to play a more effective role in the global innovation ecosystem.

2.1.1.10 Employment Impacts

The employment impacts indicator measures the impact of innovation on employment. Türkiye's performance in this area remains at 30.4% of the EU average. This indicates that Türkiye's capacity of innovation activities to generate employment is below the EU average. This indicator has two main components: **Employment in knowledge-intensive activities** and **employment in innovative enterprises**.

The potential for employment creation, especially in high-tech sectors, is limited. In order to increase the impact of innovation on employment, it may be beneficial for Türkiye to train more labor force in R&D and innovation fields and develop policies to support employment in innovative sectors.

2.1.1.11 Sales Impacts

The sales impact indicator assesses the impact of innovation on sales. Türkiye's performance on the sales impact indicator is 68% of the EU average. This indicator has three main components: **Exports of medium and high technology products, exports of knowledge-intensive services** and **sales of new-to-market and new-to-firm innovations**.

The rate of commercialization of innovation activities is lower than the EU average. This shows that Türkiye faces challenges in commercializing innovation and increasing market share. Bringing innovative products and services to the market and supporting these processes are critical to boost Türkiye's competitiveness. In this context, incentives for commercialization of innovation can be increased and companies can be encouraged to develop innovative solutions.

2.1.1.12 Environmental Sustainability

The environmental sustainability indicator measures the environmental impact of innovation and its orientation towards green technology. Türkiye's performance on environmental sustainability is 43.3% of the EU average. This indicator has three main components: **Resource efficiency, air emissions from fine particles** and **environmentally relevant technologies**.

Türkiye lags behind EU countries in environmental sustainability. Increasing investments in green technology and encouraging environmentally friendly innovations can improve Türkiye's performance in this area. Environmental sustainability has become an important element of global competitiveness and long-term economic growth. Therefore, Türkiye needs to adopt a more proactive approach to environmental sustainability and increase its innovation activities in this area.

2.1.2 Relative Strengths and Weaknesses

According to the EIS 2024 analysis, Türkiye's strengths in certain areas stand out. These include new product sales to new market and firm (124.1% of the EU average), direct and indirect government support to business (124% of the EU average), job-to-job mobility of HRST (106.2% of the EU average), proportion

of population with tertiary education (92.4% of the EU average) and most cited publications (76.1% of the EU average). These areas reveal Türkiye's strengths in the innovation ecosystem.

On the other hand, Türkiye performs poorly in certain areas. Design applications (1.8% of the EU average), ICT experts employed (2.9% of the EU average), employment in knowledge-intensive activities (9% of the EU average), international scientific co-publications (14.3% of the EU average) and venture capital expenditures (11.9% of the EU average) are among the weaknesses that negatively affect Türkiye's innovation performance.

2.1.3 Framework Conditions

Türkiye faces challenges in the areas of human resources, research system and digitalization. There are significant shortcomings in international scientific co-publications (14.3% of the EU average) and in attracting foreign PhD students (39.5% of the EU average). There are also weaknesses in the quality of scientific output, with the proportion of most cited publications at 76.1% of the EU average. However, the rate of higher education graduates is 41.7%, which is close to the EU average. The proportion of recent graduates in Science, Technology, Engineering and Mathematics (STEM) fields is only 34.5% of the EU average.

In terms of digitalization, broadband penetration lags behind the EU, with the share of companies with the fastest fixed internet connection limited to 36.2%. The share of the workforce with digital skills is also 28.3% of the EU average.

On the positive side, improvements were recorded in all these areas in the 2017-2024 period. Particularly noteworthy are the 33.2% increase in broadband penetration, 29.3% increase in most cited publications and 23.2% increase in new STEM graduates.

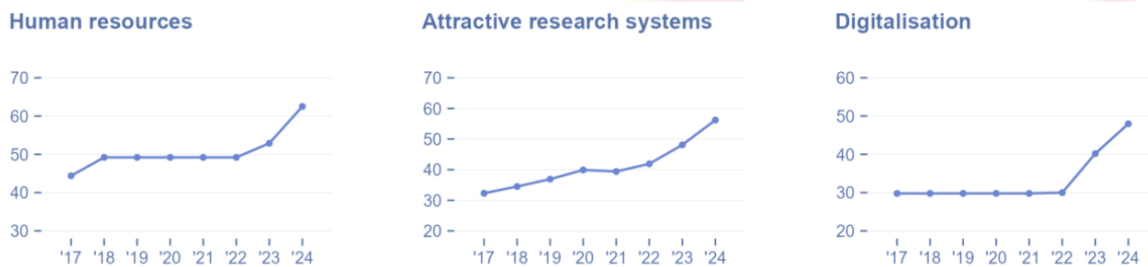


Figure 1. Framework Conditions Analysis for Türkiye

2.1.4 Investments

R&D expenditures in Türkiye are well below the EU average. Public sector R&D spending is 0.5% of GDP, while private sector R&D spending is 0.8% of GDP. Venture capital investments are also very low. However, there is a 3.2% point increase in public sector R&D spending and a 24.8% point increase in private sector R&D spending over the 2017-2024 period.

On the other hand, Türkiye's direct government funding for business and tax incentives for R&D are above the EU average of 124% and have increased by an impressive 97.7% since 2017.

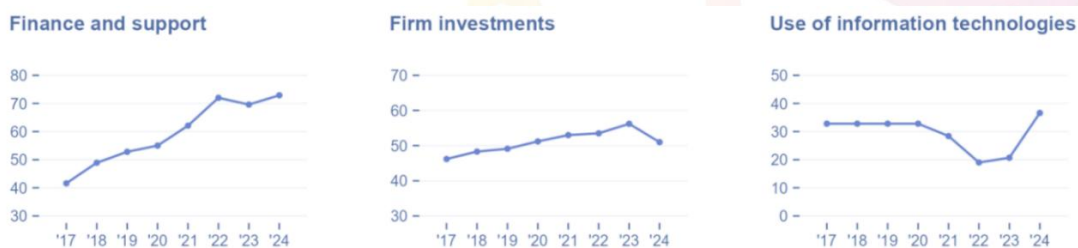


Figure 2. Investment Analysis for Türkiye

2.1.5 Innovation Activities

The proportion of product innovating SMEs (67.7% of the EU average) and business process innovating SMEs (76.5% of the EU average) in Türkiye is below the EU average. The rate of collaboration and public-private co-publications by innovative SMEs is also low. Intellectual property indicators (PCT patent applications, trademarks and design applications) also lag behind the EU average.

As a positive indicator, the job mobility of science and technology human resources is above the EU average, but there has been a 41.2% point decrease since 2017.



Figure 3. Innovation Activities Analysis for Türkiye

2.1.6 Impacts

The employment rate in knowledge-intensive activities is only 9% of the EU average and has increased by 4.8% points since 2017. The employment rate in innovative enterprises is also low (48.4% of the EU average) and has decreased by 41.8% points since 2017.

In terms of exports, Türkiye lags behind the EU both in exports of medium and high-tech products and in exports of knowledge-intensive services. However, sales of new-to-market and new-to-business innovations are above the EU average.

In environmental indicators, while there has been an improvement in resource efficiency and air emissions, the development of environment-related technologies is well below the EU average and has been declining since 2017.

Overall, Türkiye's innovation performance is generally below the EU average, but it has made progress in some areas. Particular focus is needed in areas such as increasing R&D investments, improving digital skills, strengthening public-private partnerships and increasing high-tech exports. It is important that Türkiye tackles these challenges and build on its strengths to improve its innovation ecosystem.



Figure 4. Impact Analysis for Türkiye

2.1.7 Structural differences

2.1.7.1. Performance and Structure of the Economy

According to the 2023 Economic Review by the Organisation for Economic Co-operation and Development (OECD), Türkiye stands out as a fast-growing economy with an average annual growth rate of

6% between 2000 and 2021. The share of manufacturing in Türkiye's employment distribution is 19.9%, which is higher than the EU average of 15.8%. However, the share of employment in high and medium-high technology sectors is 20.4%, which is well below the EU average of 37.9%. This suggests that Türkiye is strong in the manufacturing sector but needs to develop in technology-intensive areas.

2.1.7.2 Business and Entrepreneurship

Türkiye's entrepreneurial ecosystem appears to be dynamic. The business start-up rate is 2.8% and the Total Entrepreneurial Activity rate is 15.7%, well above the EU averages of 0.8% and 6.8% respectively. This shows that the propensity to start new businesses and the entrepreneurial spirit are strong in Türkiye. However, net FDI inflows are 1.4%, below the EU average of 1.9%, indicating that the country needs to improve in attracting foreign investment.

The most striking difference is seen in the share of enterprises with the highest R&D expenditure. While this rate is only 0.2% in Türkiye, it is 8.4% in the EU. This large difference clearly demonstrates that the private sector in Türkiye needs to increase its R&D investments.

2.1.7.3 Innovation Profiles

Türkiye's innovation profile presents a mixed picture. The proportion of in-house product innovators who engage in market innovation is 11.3%, close to the EU average of 11.7%. However, the proportion of in-house product innovators who do not engage in market innovation is 7.6% and the proportion of in-house business process innovators is 11.1%, below the EU averages of 13.7% and 17.6%, respectively. This suggests that Türkiye firms are doing relatively well in developing innovative products but lag behind in innovating internal processes.

The proportion of innovators who do not develop innovations themselves is 6.1% in the EU, while it is 0.9% in Türkiye, which is very low compared to the EU. This suggests that Türkiye firms tend to develop innovations more internally.

The proportion of non-innovative firms with innovation potential in Türkiye is 22.6%, which is higher than in the EU, which is 17.8%. This suggests that there is significant potential for innovation growth in the future. However, the high proportion of non-innovative firms with no propensity to innovate (39.3% compared to 30.6% in the EU) suggests that many enterprises are still resistant to adopting new technologies or processes.

2.1.7.4 Governance and Policy Framework

The Corruption Perception Index and Rule of Law indicators show significant challenges for Türkiye. Türkiye's corruption perception index score is 36, while the EU average is 64. This suggests that Türkiye needs to strengthen its anti-corruption strategy and establish an independent anti-corruption institution.

For basic school entrepreneurship education and training, assessed on a scale from 1 to 5, Türkiye's score is 2.1 and the EU score is 2.6. Türkiye is below the EU score. This indicates that Türkiye needs to further integrate entrepreneurship education into the basic education curriculum.

In terms of public procurement of advanced technology products, Türkiye is slightly better with a score of 3.5 compared to the EU score of 3.4. This shows that Türkiye is proactive in using public procurement as a tool to support innovative firms.

2.1.7.5 Climate Change and Demography

The Greenhouse Gas emissions intensity of Türkiye's energy consumption 88.8 is slightly higher than the EU average 82.8. This suggests that Türkiye needs to improve energy efficiency and move towards renewable energy sources.

In demographic terms, Türkiye's population growth rate 1% is significantly higher than the EU average 0.3%. This shows that Türkiye has a young and dynamic population but needs to do more to develop the skills of this population and create jobs.

2.1.8 Conclusions and Recommendations:

According to the EIS 2024, Türkiye's innovation performance still lags behind the EU average, although progress has been made in certain areas. Strengths include new product sales, government support and the proportion of the population with tertiary education, while significant improvements are needed in areas such as design applications, employment of ICT experts and employment in knowledge-intensive activities.

Overall, Türkiye's innovation performance presents a mixed picture. It has strengths such as an entrepreneurial spirit and a dynamic economy but needs to improve in areas such as R&D investments, high-tech employment and innovative business processes. Türkiye needs to focus on these areas, improve its education system and fight corruption to strengthen its innovation ecosystem. It is also important to take steps to tackle climate change and sustainable development [20].

2.2. Legislative Frameworks

R&D activities are important in order to produce new technology and to provide competitive advantage with this technology. In today's highly competitive world, R&D is among the essential activities of businesses. R&D expenditures are increasing day by day. Companies that want to get ahead in competition attach importance to R&D activities in the process of transition from labor-intensive capital to technology-intensive capital [21].

In Türkiye, R&D was first brought to the agenda with the "Law on the Organization and Duties of the Ministry of Industry and Trade" numbered 3143⁵ published in the Official Gazette dated 18.01.1985 and numbered 18639. With this law, the General Directorate of Industrial R&D was established under the Ministry of Industry and Trade. Article 10 of the Law lists the duties of the Directorate as follows; "In order to follow and encourage technological developments in the industrial field, to carry out programs that will ensure the active participation of industrial enterprises in Türkiye in technological R&D in cooperation with higher education institutions (HEIs) and foundation universities, to support real and legal persons in patenting, investing and marketing the technological product resulting from R&D projects and to prepare procedures and principles and regulations regarding the implementation of these programs, and to cooperate with public and private institutions for the development of industry, to provide investment and business loans and to meet the needs of industrial enterprises" [22].

TT agreements have a special importance within the framework of the Law No. 4054⁶ on the Protection of Competition (LPC) published in 1994. Although these agreements may contain anticompetitive elements, they may be exempted under certain conditions.

Article 4 of the LPC prohibits agreements that prevent, distort or restrict competition. However, a special assessment is made for TT agreements within the framework of the Group Exemption Communiqué No. 2008/2 on TT Agreements. This assessment aims to strike a balance between the protection of IPRs and the functioning of the free market economy.

TT agreements may be evaluated within the scope of group exemption or individual exemption. Group exemption is granted to agreements that meet the conditions set forth in Communiqué No. 2008/2. On the other hand, individual exemption, may be granted by the Competition Board to agreements that meet the conditions set forth in Article 5 of the LPC.

As a result of the amendment made by Law No. 7246⁷, it is now possible for undertakings to conduct "self-assessments". This amendment aims to increase the legal certainty of the exemption regime. However, undertakings can still apply to the Competition Authority on a voluntary basis.

The exemption applies until IPRs in the licensed technology expires, becomes obsolete or is declared invalid. Where know-how is involved, the exemption continues for as long as the know-how remains confidential. As a result, TT agreements have a special position in competition law and exemption applications seek to strike a balance between the economic benefits of these agreements and their potential adverse effects on competition.

Another important step taken within the scope of R&D was the decision to adopt the "International Science, Technology and Innovation Strategy 2007-2010" at the High Council for Science and Technology held in 2006. It was decided to initiate the preparation of the 2007-2010 International Science, Technology and Innovation Strategy under the coordination of TÜBİTAK with the participation of relevant organizations. TÜBİTAK was assigned the task of implementing and monitoring the Implementation Plan prepared according to this decision. The importance of science, technology and innovation policies among the economic policies implemented after 2005 has increased [23]. Due to changing conditions both at the domestic and global level, R&D policies continue to be updated from time to time.

With the adoption of Law No. 3143⁵, Türkiye has experienced significant developments within the scope of R&D activities. Supporting R&D activities was supported by the following laws [22]. These laws are as follows;

- Law No. 4691² dated 20.06.2001 on TDZs.
- Law No. 5228⁸ dated 31.07.2004 amended the Income and Corporate Tax Laws and introduced the R&D deduction.
- Law No. 5746¹ dated 28.02.2008 on Supporting Research, Development and Design Activities.

With these laws, arrangements have been made to support R&D activities.

According to the National Innovation System targets for 2023 published by TÜBİTAK in 2011, Türkiye's share of R&D expenditures in GDP is envisaged to be 3% and the number of full-time equivalent researchers to be 300,000 [24]. To achieve these targets, R&D activities are supported in various fields through MoIT, KOSGEB, TÜBİTAK, Development Agencies and the Technology Development Foundation of Türkiye (TTGV) [25]. In 2023, according to the data published by Türkiye Statistical Institute, the ratio of R&D expenditures to Gross National Product in 2022 was realized as 1.32% and the number of full-time equivalent researchers was realized as 272,638.

In Türkiye, the National Science and Technology Policies 2003-2023 Strategy Document (Vision 2023) was prepared in 2003 (Tübitak, 2004). The aim of this policy is to prioritize technology and scientific studies, increase the use and efficiency of existing technologies, and create economic and social impact by developing new technologies [26].

At the Information and Communication Technologies Authority (ICTA) meetings, Türkiye's main policy decisions on R&D and innovation are taken at the policy level. The aim of these meetings is to strengthen R&D capacity [27]. In 2015, the Supreme Council for Science and Technology (SCST) steered Türkiye's R&D ecosystem by taking important decisions such as strengthening universities' R&D efforts, training qualified human resources and supporting international incubation centers. In 2016, the ICTA took new decisions to accelerate the commercialization of R&D projects. These decisions made it easier for prototypes and products, which are the outputs of R&D, to meet with investors and reach markets [22].

In Türkiye, the leading institutions in the distribution of research funding are the MoIT and TÜBİTAK, which is a ministry-affiliated institution. In addition, various ministries and public institutions also play an active role in the allocation of research funds, either directly or indirectly. These institutions include the Ministry of Trade, KOSGEB, the Ministry of Energy and Natural Resources, the Ministry of Treasury and Finance, the Ministry of National Defense, the Ministry of Transport and Infrastructure, the Ministry of Health, the Ministry of Agriculture and Forestry, and the Türkiye Energy, Nuclear and Mining Research Council [22].

Among these institutions, TÜBİTAK has the widest range of support. TÜBİTAK's support can be categorized under six main categories: Academia, business, public institutions, entrepreneurship, scientific activities

and science and society. At the center of the innovation ecosystem, TÜBİTAK plays critical roles in many areas. These include promoting experimentation and learning, knowledge generation and dissemination, guiding research and selection processes, contributing to market formation and efficient use of resources. In addition to R&D and innovation networks, TÜBİTAK also provides grants for science and society projects. In addition to encouraging experimentation and learning, these grants also aim to improve the development and efficient use of resources.

TT supports provided by TÜBİTAK are summarized below [28]:

TÜBİTAK runs various programs to support TT in Türkiye. Among these programs, the Individual Young Initiative (BiGG) Program, the TTOs Support Program, the Call for TTPs and Patent Commercialization Support stand out.

1612 - BiGG Program: Provides support for entrepreneurs to transform their technology and innovation-oriented business ideas into products and services with high commercial value. The program covers the processes from the idea stage to the market. With this call, implementing organizations are authorized to run the BiGG program and provide free accelerator support to entrepreneurs.

1513 - Technology Transfer Offices Support Program: Supports the commercialization of knowledge and technologies produced in universities and TDZs. The program aims to improve the institutional capacity of TTOs and ensure their target-oriented growth.

1613 - Call for Technology Transfer Professionals: Supports the recruitment of competent Technology Transfer Professionals (TTP) to improve the performance of TTOs.

1607 - BiGG+ SME Mentor Interface: Supports the creation of mentoring mechanisms to increase the business development and innovation capacity of SMEs.

1702 - Patent Based Technology Transfer Support Call: Aims to transfer patented technologies developed in universities, research institutions and TDZs to industry.

1602 - TÜBİTAK Patent Support Program: Aims to increase the number of national and international patent applications.

*Supports provided are selected from the active supports as of 2024.

These programs support TT in various ways. For example, they accelerate TT by helping entrepreneurs commercialize their ideas, strengthening UIC, increasing the capacity of TTOs, providing mentoring to SMEs and encouraging the licensing of patented technologies. Furthermore, these programs strengthen the ecosystem by supporting the employment of TTPs and encouraging patent applications.

In conclusion, TÜBİTAK's TT supports aim to strengthen Türkiye's innovation ecosystem and accelerate the conversion of knowledge generated at universities into economic value. These programs aim to contribute to the country's technological development and competitiveness by supporting a wide range of actors, from entrepreneurs to SMEs, universities to industrial enterprises.

The coordination of policies in the field of science, technology and innovation in Türkiye is the responsibility of MoIT. The main tasks of the MoIT include the development, implementation and coordination of policies in these areas, as well as the promotion of R&D and innovation projects, activities and investments. At the political level, SCST is Türkiye's top science, technology and innovation policy-making body. The Ministry of Treasury and Finance provides tax breaks and various incentives for R&D activities. The High Planning Council, the highest level body responsible for the preparation and implementation of national development plans, incorporates science and technology policy actions into these plans. To promote R&D and innovation at the regional level, 26 Regional Development Agencies (RDAs) have been established under the Ministry of Development at the NUTS II level of the *Nomenclature of Territorial Units for Statistics (NUTS)*. The Ministry of National Education and the Council of Higher Education (YÖK) play an active role in designing and implementing education policies. The Türkiye

Academy of Sciences (TÜBA) is involved in identifying and proposing scientific priority areas. KOSGEB and TTGV are other important institutions implementing industrial R&D support mechanisms. Each of these institutions plays a specific role in Türkiye's science, technology and innovation ecosystem, contributing to the country's development in these areas [22].

According to the latest report published by the TURKSTAT in 2023, gross domestic R&D expenditure increased by 96 billion 932 million in 2022 compared to the previous year, reaching 198 billion 670 million. While the ratio of gross domestic R&D expenditure in GDP was 1.40% in 2021, its ratio in GDP was 1.32% in 2022, amounting to 15 trillion 11 billion 776 million [19].

Indirect support for R&D activities includes tax incentives and exemptions provided under various legal regulations. In this context, Law No. 5746¹, which entered into force in 2008, was an important milestone. With this law, companies were able to deduct all of their annual R&D expenditures from corporate tax. Prior to 2008, this rate was 40%.

Data from the Survey of Allocations and Expenditures Allocated for R&D Activities from the Central Government Budget, which examines the distribution of public resources for R&D activities in Türkiye, does not allow for a clear distinction between private and public sector R&D financing.

Indirect R&D subsidies reported by the TURKSTAT include tax exemptions and deductions provided under four main laws. These laws are Income Tax Law (No. 193⁹), Corporate Tax Law (No. 5520³), TDZs Law (No. 4691²) and R&D Activities Support Law (No. 5746¹). Within the scope of these legal regulations, the state provides indirect R&D financing through various mechanisms. These include tax incentives such as R&D tax credits, R&D allowances, discounts on wage taxes and social security premiums of R&D personnel, and accelerated depreciation practices for R&D investments [22]. These indirect support mechanisms are designed to encourage R&D activities in Türkiye and increase private sector investments in this field. In this way, they aim to contribute to the country's technological development and increase its innovation capacity.

The ability of universities to become partners in technoparks is regulated by the Law No. 4691² on TDZs. According to this law, universities, public research centers and institutes can be direct partners in the establishment and management of technoparks. By being among the founding partners of technoparks, universities play a critical role in the commercialization of scientific knowledge and technological innovation. This legal framework makes it possible for universities to take part in the activities of technoparks and have a say in their management. Thus, the integration of academic knowledge with industry is encouraged and Türkiye's national innovation capacity is enhanced.

The assignment of academics to technoparks is also secured by Law No. 4691. According to this law, universities can assign their faculty members to R&D projects in technoparks. The ability of academics to work in technoparks enables universities to bring their research activities together with industry. In addition, the ability of academics to work in companies in technoparks enables them to transfer their knowledge and experience directly to industry. This process contributes both to the implementation of academic studies and to the development of innovative solutions needed by the industry.

The Regulation on TTO of HEIs entered into force after being published in the Official Gazette dated December 7, 2017 and numbered 30263. This regulation introduces regulations on the establishment, structure and functioning of TTOs.

According to this regulation, TTOs can be established in the following ways:

1. **Directly Under University Management:** TTOs can be established directly within the university with the decision of the university board of directors. In this case, the TTO operates as a unit of the university.
2. **As a Separate Company:** Universities can establish a company or become a partner of an established company to carry out TT activities. In this case, TTO is structured as a capital company in which the university has a shareholding.

3. Within the Existing TDZ: TTO can also be established within the TDZ management company operating within the scope of the TDZs Law No. 4691².

This regulation aims to increase the TT capacities of universities and thus strengthen the country's innovation ecosystem by enabling TTOs to operate in a more flexible and effective structure.

In Türkiye, the ability of universities to become partners in technoparks, to assign academics to these zones and to establish TTOs as companies is based on legal regulations developed to strengthen the country's R&D and innovation ecosystem. These regulations enable universities to take an active role in the processes of commercializing research results and integrating them with industry. In line with Türkiye's science and technology policies, this legal framework aims to increase the country's international competitiveness.

The effective realization of TT depends on the availability of qualified human resources and the proper guidance of these resources. In this context, the qualified personnel support offered by the İŞKUR stands out as one of the important elements supporting TT. By acting as a bridge between universities, technoparks and industrial organizations, İŞKUR encourages the employment of qualified personnel who can participate in TT processes.

Until 2017, inventions made by academics at universities in Türkiye were considered as free inventions. Due to this gap in the law, there were problems in the commercialization of inventions made by universities. In order to solve this problem, the Intellectual Property Law (IPL) No. 6769¹⁰ entered into force on January 10, 2017. With this law, the law on inventions realized with the know-how of universities states: "The sharing of the income from the invention between the higher education institution and the inventor is determined in such a way that at least one third of the income is given to the inventor". In addition, in applications made by academics at universities, the applicant is the university and the inventor is the academician who made the invention. This law has closed the gap on IPRs in TT activities.

3. Strategy for TT

It is very important to reveal where the technology is developed, where it comes from and how it is transferred, in short, what its source and distribution methods are in order to reveal strategies in the TT process. TT from university to industry and from company to company can be carried out in many different ways such as contracts, support programs, government incentives, foreign capital investments, import of machinery-equipment, employment of foreign experts, international subcontracting. In Türkiye, laws and regulations on TT are generally regulated within the scope of IPRs, R&D activities, UIC and innovation policies. The main strategies in Türkiye on these issues are presented below.

- Development Plans

In order to change the technological structure of Türkiye's production, many policies are carried out by the state. In 1923, with the legal declaration of the Republic, many regulations were made to improve the economy in Türkiye. In the 1923 Izmir Economic Congress, decisions were taken for industrialization and economic development, and in this direction, the Law on Incentive Industry was enacted in 1927. In the 1950s, industrial production increased and foreign capital was encouraged. In the 1960s, industrialization policies based on import substitution started to be implemented, and mandatory practices for the public sector and incentive practices for the private sector were planned. As of 1963, the first Development Plan was prepared and a certain pace of development was achieved. The First Five-Year Development Plan envisaged that problems related to industrialization could be solved through basic and applied research. Increasing research activities in universities, sending students abroad for doctoral education, increasing the number of researchers and increasing the share of R&D expenditures in GDP were included in the first plan and TÜBİTAK was established to achieve these targets. The Second Five-Year Development Plan

included the title "Science and Research" and emphasized that TÜBİTAK, State Planning Organization and universities should work in coordination, while the Third Development Plan emphasized technological development, TT and transition to modern technology. Until the 2000s, many activities such as directing R&D activities towards solving technological problems, tax incentives, increasing the number of technoparks and strengthening the technology infrastructure were included in the plans. In the early 2000s, the "TDZs Law" numbered 4691², referred to as the Technopark Law, was put into effect. Also in these years, the "Vision 2023" national development project, which includes strategic plans that Türkiye aims to realize until 2023, was put into practice. This project aimed for Türkiye to make significant progress in the economic, social, scientific and technological fields until 2023, the 100th anniversary of the Republic. Similar targets have been set in the plans published to date.

In the 12th Development Plan covering the years 2024-2028, it is stated that the adoption, development and dissemination of sustainable production and green transformation technologies and R&D activities that enable TT from other sectors, especially the defense industry, to the medical device sector will be supported. In addition, support mechanisms will be implemented to increase knowledge and TT through collaborations between universities, research infrastructures and the private sector, and the institutional capacities of interface structures will be improved and their effectiveness will be increased [16].

- **MoIT Strategic Plans**

The strategic planning process for public institutions in Türkiye was made mandatory by the Public Financial Management and Control Law No. 5018¹¹, which entered into force in 2003. This law obliged public institutions to prepare five-year strategic plans. In this context, MoIT initiated the first strategic planning process with its strategic plan for the period 2013-2017. This Plan is also the first strategic plan prepared by the Ministry after its restructuring. The strategic plans of the MoIT are long-term road maps for Türkiye's development in the fields of industry, technology, innovation, entrepreneurship and scientific research. These plans are formulated to ensure the development of various sectors within the mandate of the Ministry, to increase competitiveness, to support sustainable development and to transform Türkiye into a country that produces advanced technology at the global level. The main components of the strategic plans of the MoIT include development and transformation of industry, increasing R&D and innovation capacity, supporting entrepreneurship and SMEs, regional development and investment incentives, science, technology and innovation policies. The Strategic Plan for 2024-2028 includes the implementation of the TT Portal and the planning of the activities required for the effective monitoring and evaluation of the National Technology Entrepreneurship Strategy. In the same plan, the importance of strengthening the institutional structures of TTOs and the scientific and technical capacity in the field of productivity through applied trainings; increasing the quality of scientific publications and activities and increasing the ability to do joint work between university-industry-public sector in this context is emphasized.

- **R&D and Design Centers**

The Ministry of Industry provides various supports to both private sector companies and university researchers in order to produce technological knowledge, innovate products and production processes, improve product quality and standards, increase productivity, reduce production costs, transfer technology, commercialize technological knowledge and encourage technology-intensive production in order to make the national economy internationally competitive through R&D and innovation [24]. In order to strengthen the cooperation between universities and industry, to realize TT and to make it sustainable, the Ministry of Industry provides various supports and incentives to companies that carry out the above-mentioned activities by giving them the title of R&D/Design Center. Under Law No. 5746 on Supporting Research, Development and Design Activities, there are many support and incentive mechanisms for companies such as tax incentives, insurance premium supports, 100% R&D and Design discount. In addition, legal and financial facilities are provided for university researchers to work in these centers exempt from revolving fund. One of the important strategies of the Ministry is to ensure the sustainability of UIC and TT processes through the performance index model it offers to R&D/Design Centers every year.

The performance index model includes many indicators such as the employment of R&D personnel with doctorate and master's degrees, the intensity of publicly funded or self-funded UIC projects, and the number of articles and papers. This model is among the important national strategies that ensure the permanence and continuity of TT processes that will take place under the umbrella of UIC. Within the scope of this support of the Ministry, the number of R&D Centers in operation as of 2024 reached 1326 and the number of Design Centers reached 332 [25].

- **TDZs**

One of the most important national strategies is the TDZs Law No. 4691² of 2001, which was enacted and is currently being implemented with the aim of ensuring the cooperation of universities, research institutions and organizations and production sectors, facilitating and effectively carrying out TT through this cooperation, commercializing technological knowledge, supporting technology-intensive production and entrepreneurship, and ensuring the adaptation of SMEs to new and advanced technologies. Within the scope of this law, companies located in TDZs can benefit from many tax incentives, as well as being in the same ecosystem with many companies carrying out R&D and innovation activities in the region, and benefit from the opportunity of TT from company to company and create cooperation and network. The definition of a TDZ within the scope of the relevant law is defined as technoparks where the companies in the zone produce/develop technology or software by utilizing the facilities of a specific university or high technology institute and thus contribute to the development of the region. It is also emphasized that a technopark is a campus where academic, economic and social structure is integrated within or near a university or high technology institute. This strategy, which encourages cooperation with universities and institutes of high technology, supports economic development in the region and ensures the rapid implementation of the TT process within the scope of UIC. As of July 2024, a total of 102 TDZs have been established, 90 of which continue to operate, and 12 of which continue their infrastructure works within the scope of this Law, which has been put into practice since 2001 and will bring industrialists, researchers and universities together to develop new products and production methods for technological production.

- **National Technology Initiative**

The concept of the National Technology Initiative was first emphasized in the 2019-2023 Strategic Plan published by the MoIT in 2018. In this strategy document, it is stated that Türkiye needs to develop domestic and national solutions in critical technology areas in order to achieve its 2023 targets, and the "National Technology Initiative" is placed at the center of this vision. This initiative aims to increase Türkiye's independence in a wide range of strategic sectors, from defense industry to digital transformation, advanced technologies to energy, and envisages the implementation of various projects and initiatives in cooperation with the public and private sectors. This strategy, which Türkiye is carrying out under the name of the National Technology Initiative, aims to strengthen the country's technological and economic independence, develop domestic and national technologies and raise social awareness. Türkiye is implementing this strategy in order to reduce its dependence on foreign technologies and to develop its own technology. This strategy covers a broad spectrum of technologies, starting with achievements in the defense industry. With the vision of "defending the global common interest instead of the interests of only a few global companies and countries", the National Technology Initiative includes "policies that will increase Türkiye's global competitiveness and ensure a breakthrough in critical technologies that will ensure Türkiye's economic and technological independence". The first successful example of the National Technology Initiative was seen in the defense industry. With the national technology development projects, the share of domestic suppliers in production increased from 20% to 68%, and the product capacities of advanced technologies such as satellites, radar missiles and unmanned aerial vehicles increased [31]. Bayraktar Mini Unmanned Aerial Vehicle (UAV), Türkiye's first domestic and national unmanned aerial vehicle, was introduced to the Türkiye Armed Forces in 2007. In the following years, Bayraktar UAV and Bayraktar TB2 were produced for reconnaissance and intelligence missions. The Bayraktar Akıncı UAV project, designed to fulfill some of the missions performed by fighter

jets, was also successfully completed. Necessary studies are being carried out and road maps are being developed for the expansion of these important developments in the defense industry to other sectors. Within the scope of the Technology-Oriented Industrial Initiative Program, medium-high and advanced technology areas and priority (high value-added) products according to these areas were identified for which R&D, product development (P&D), investment and export support will be provided "in line with the aim of increasing value-added production", and a special support mechanism was developed to provide support and incentives for the production of these products with domestic facilities and capabilities.

- **Strategy for Support with Public Funds**

Project support and incentives offered by the public to universities, industry and the public are an important strategic tool for Türkiye to achieve its development goals, increase domestic and national technology production and strengthen its industrial infrastructure. This strategy has been developed to promote economic growth, support innovation and ensure sustainable development. This strategy is delivered through institutions such as TÜBİTAK, KOSGEB, Development Agencies, Health Institutes of Türkiye (TUSEB), General Directorate of Agricultural Research and Policies, etc. In particular, TÜBİTAK support stands out in terms of enabling the realization of innovative ideas by providing support to projects that encourage R&D activities. TÜBİTAK is an institution established to support academic and industrial R&D activities and innovations, to carry out R&D activities in line with national priorities, to determine Türkiye's Science and Technology policies and to raise awareness in all segments of society. This institution provides support for R&D projects and TT from both universities and industry. This support ranges from scientific research to technology development projects and includes projects that encourage TT. The TÜBİTAK 1004 Center of Excellence Support Program, one of the academic supports offered to universities, is an example of this strategy. The aim of the program is to support domestic research programs with high scientific quality and high commercialization potential in priority areas determined within the scope of national goals and policies in order for HEIs' research infrastructures to specialize and become centers of excellence by cooperating with R&D/design centers and public R&D units. In addition, TÜBİTAK 1505-University-Industry Cooperation Support Program, which is one of the supports offered to the industry, aims to contribute to the commercialization of knowledge and technology in universities and research institutes by transforming them into products or processes in line with the needs of companies and transferring them to industry. Offering project support in more than thirty different scenarios, TÜBİTAK provides 60-75% grant support to companies, and nearly 100% grant support to universities. The strategy of supporting TT processes with effective R&D support and incentives carries this efficiency to higher levels.

- **Foreign Capital investments**

Since a significant portion of the world's R&D activities are carried out by large American, Japanese or European multinational companies, these companies are naturally seen as rich sources of new products, production techniques, marketing methods and managerial approaches. The investments of these countries in developing countries mean that technology also enters that country [30]. The General Directorate of Incentive Implementation and Foreign Investment of MoIT encourages technological investment projects to be realized in Türkiye by companies with national or international capital through investment support system (tax incentives, investment allocation, profit share support, etc.).

- **Research University**

The concept of Research University was established with the strategy developed by YÖK an official state institution that supervises, regulates and coordinates HEIs in Türkiye. Research universities are defined as universities with a research priority and research culture reflected in research outputs that play a major role in the development of science, from education and training to knowledge transfer activities, from cooperation with the public and industry to international cooperation. Universities that actively carry out industrial cooperation, R&D intensity, entrepreneurship and TT processes and have high outputs in this field can gain Research University status. Universities that gain this status are provided with special

funding and resource support, and a special R&D budget is allocated. Research universities can receive a larger share of special R&D funds provided by the state. Research universities are also given priority in research project supports provided by TÜBİTAK and other public institutions. Within the scope of academic staff incentives, special incentive allowances are provided for academic staff engaged in research activities, encouraging them to focus more on research. In addition, research universities are allocated more academic staff, thereby attracting qualified researchers and increasing the number of research projects. Such privileges offered to research universities aim to ensure that these institutions play a leading role in Türkiye's scientific and technological development. Thanks to these privileges, research universities are able to conduct high-quality research, train qualified academic staff and students, become competitive at national and international level, and contribute to Türkiye's development goals. This strategy facilitates the transfer of academic knowledge and technology to industry and contributes to increasing the country's technology and innovation capacity.

- **Horizon Europe Program and Other International Cooperation**

Türkiye encourages international cooperation in the process of TT through its strategy of participating in EU research and innovation programs such as Horizon Europe. Such programs support and enhance TT and international R&D collaborations. Türkiye also actively participates in other international research and innovation initiatives such as EUREKA, European Cooperation in Science and Technology (COST) and North Atlantic Treaty Organization (NATO) Science and Technology Program. These programs accelerate TT processes and integrate Türkiye research institutions and industrial enterprises into global innovation networks. In this way, local knowledge and technology can be brought to international markets and Türkiye can gain a stronger position in global R&D collaborations.

- **TTO Support Programs**

In order to develop and strengthen TTOs in Türkiye, it is one of the national strategies to introduce programs that directly support these structures financially. Providing financial resources to TTOs enables them to manage their processes more effectively and increase their capacity. In this context, TÜBİTAK has established and continues to establish many different support mechanisms from past to present to support TTOs within the scope of TÜBİTAK 1601. TÜBİTAK has taken an important step to support TTOs in Türkiye to better position themselves strategically and make greater contributions to the country's R&D ecosystem by publishing the 1601 - Preparation for Technology Transfer Offices calls between 2014-2017. Also in 2016, it published the Call for the Establishment and Capacity Building of TTOs in TDZs, encouraging the establishment of TTOs in TDZs in Türkiye and increasing the capacity of existing TTOs. As a next step, the TÜBİTAK 1513 call was opened for TTOs to plan and implement actions that will ensure the sustainability and increase the effectiveness of TT activities by using the core competencies they have developed. With this program, TÜBİTAK financially supports TTOs in the Institutional Capacity Building and Target-Oriented Growth Phases and contributes to the commercialization of knowledge and technologies produced in universities and TDZs, thereby creating economic, social and cultural value. In order to ensure that TT experts with the necessary competence and capacity contribute to the performance of TTOs and ensure their permanence in the institution, 1613-Technology Transfer Professional Employment Support Call was opened in 2023. The program supports the personnel costs of the TT experts employed and the training expenses of these experts to improve their existing competencies and gain new competencies. In addition, RDAs operating across Türkiye also provide financial and technical support to the capacity building activities and projects of TTOs. In particular, projects that encourage the development of TTOs are carried out according to regional needs.

- **Exemptions for University Researchers**

In order to encourage university researchers in UIC and TT, exemptions are provided in many different laws. Under Law No. 2547¹² on Higher Education, it has been decided that no tax deductions will be made from the revolving fund income to be obtained for R&D activities to be carried out within the framework of UIC. In addition, with the Law No. 4691² on TDZs, university researchers are exempt from revolving fund and can establish a company in the zone and operate in an autonomous status. With Law No. 5746¹ on

Supporting Research, Development and Design Activities, faculty members whose services are needed as researchers, designers or administrative staff in the activities carried out in R&D or design centers can be assigned full-time or part-time to companies exempt from revolving fund with the permission of university boards of directors. Such support and incentives are among the important strategies to support TT.

3.1. Global strategy of HEIs in TT

In recent years, TT has become one of the most effective tools in the development and improvement strategies of countries. Considering the definition of TT as "a broad set of processes involving a series of interactions such as the flow of knowledge, experience and equipment between different stakeholders such as the public, companies, financing institutions, research and education institutions, non-governmental organizations (NGOs), etc. [31], it can be said that one of the important stakeholders is HEIs. While universities traditionally had teaching and research functions, these functions have evolved with current/world developments, and universities have a mission to meet the social and technical needs of society by playing an active role in TT.

TT is of great importance in HEIs, as it is usually an activity carried out to transfer the results of academic and scientific research (technological knowledge, patents, products, services, etc.) to industry to provide economic value and to commercialize them efficiently.

In this direction, strategies have been developed on behalf of TT in Türkiye as in the rest of the world.

TT Strategy of HEIs in Türkiye

Establishment of Technology Transfer Offices: The transfer of knowledge and technology produced at universities to the economy, and thereby increasing the competitiveness of the private sector and the economic welfare of the country, was adopted as TT in Türkiye after 2012, when TÜBİTAK started to support TTOs. Establishing institutional structures in HEIs to provide expertise in TT processes and to sustain TT activities has been one of the main steps. In this direction, strategies have been developed to establish and increase the capacity of TTOs.

In this context, the first strategy for establishing TTOs and strengthening their capacities was developed by TÜBİTAK. TÜBİTAK was tasked with "Supporting Technology Transfer Offices" with the decision of the High Council of Science and Technology [32]. As a result of the call opened by TÜBİTAK in 2012, TTOs in Türkiye were supported and established by public and foundation universities or technopark companies and started their activities. The TTO support provided by TÜBİTAK has been an extremely important strategy for the transformation of TTOs into a professional structure.

TTOs, which were established as a result of the vision created by TÜBİTAK, are not only based on patent licensing and entrepreneurship, but also cover all the steps of raising knowledge and awareness in universities, developing project competencies and capabilities, expanding UIC, managing licensing and patent processes, and entrepreneurship. This structure of TTOs has played an important role in the co-development of processes, capacity building and ecosystem development in Türkiye.

The University-Industry Collaboration Centers Platform of Türkiye (ÜSİMP), of which most TTOs and similar interface structures in Türkiye are members, has made a significant contribution and supported TTOs in carrying out their activities in a way to cover the whole process (within the scope of 5 modules). In the process of designing TÜBİTAK's TTO support, ÜSİMP supported the design of the best model for Türkiye through different workshops with national and international participants [33].

Regulation on HEIs Technology Transfer Office: The 'Regulation on Technology Transfer Office of HEIs' was established in 2017, which enables universities to establish a TT office under the status of a scientific research project or a revolving fund-based capital company, aiming to facilitate the TT processes of public universities and to take part in the competitive environment in the TT ecosystem. Based on the additional article 32 of the Higher Education Law No. 2547¹², the Regulation was prepared to cooperate with the

public and private sectors regarding R&D and innovation in HEIs, to protect the information produced and inventions made within the scope of intellectual property and to transfer them to practice.

The following tasks are defined for the TTOs established in the Regulation;

- Contributing to the definition of university R&D strategies and working in line with these strategies.
- To promote national and international R&D funds within the university and to organize trainings, seminars, workshops and similar activities in order to benefit more from these funds, to support project preparation, application, execution and monitoring.
- To contribute to the development of project writing and management culture within the university.
- To cooperate with the public and private sector on R&D and innovation.
- To provide promotion, information and training services on issues related to TT within and outside the University.
- To carry out analysis, promotion, activities and similar studies that reveal the potential, opportunities and the like on the university and industry side in order to improve university and industry cooperation, and also to mediate contracted projects.
- To protect the information produced and inventions made within the scope of intellectual property and to put them into practice.
- Providing and supporting in-university incorporation and entrepreneurship services.
- To work in cooperation with TTOs of international universities and to prepare working environments with national/international stakeholders (such as domestic/foreign companies, universities).
- To inform about intellectual rights in order to protect the knowledge created as a result of R&D studies carried out in HEIs.
- To prepare a three-year strategic plan for the activities carried out and to prepare a strategic plan progress report every year.

The offices established by this regulation can be either a unit within the university or independent structures (capital companies) serving one or many universities.

It is seen that the organizations that carry out TT activities have different structures in Türkiye. The structures and corporate identity of TTOs vary according to the institutions they are affiliated to and the preferences of the institutions. The main distinction is between the Interfaces within the University and the Interfaces within the TDZ. In recent years, interfaces in the structure of capital companies established in accordance with the Regulation on TTOs of HEIs have also been operating. When the National TT Ecosystem Statistics Report published by ÜSİMP in 2022 is examined; 40% of the interfaces are structured as "Unit Established within the University", followed by "Application and Research Center Established within the University" with 20%. While 15% of the interface structures operate as "TDZ Managing Company Operating in accordance with the TDZ Law", 15% operate as "TTO Company Established within the TDZ". Interface structures of "Capital Company Operating According to the Regulation on TTO in HEIs" have not yet become widespread compared to the others and are the least preferred among the establishment structures with 10% [34].

The majority of TTOs in Türkiye were established following the TÜBİTAK TTO Support and the subsequent regulation. With the establishment of TTOs, it has been observed that the majority of the activities related to TT, entrepreneurship and innovation ecosystem in Türkiye and the TT and commercialization activities of the university have started to be carried out through TTOs.

In order for TTOs to provide an efficient service to the target audience, funding needs for the development of infrastructure and expert staff capacities need to be met. Funds for this purpose can be provided from state-funded sources as well as from universities' own budget resources. The largest share of direct support provided to TTOs is provided by TÜBİTAK's 1513 and 1601 [35]. In return for this support, TÜBİTAK provides TTOs with certain performance indicators. These performance indicators are indicators that

contribute to the TT ecosystem such as the number of international project applications/acceptances, the number of UIC project applications/acceptances, the number of national/international registered patents, the number of licensed patents, etc.

In addition, expert staff working in TTOs, which operate as a unit affiliated to the university, can be assigned from the university's academic staff, and the financial resources for patent research and application processes that will be subject to TT by researchers within the university are covered by the university.

Entrepreneurial and Innovative University Index (EIUI): EIUI was prepared for the first time in Türkiye by TÜBİTAK in 2012 and has been prepared every year since then in order to trigger the innovation and entrepreneurship activities of universities and to measure their performance in this field. Within the scope of the index, the 50 most entrepreneurial and innovative universities are ranked according to 23 indicators under the dimensions of "scientific and technological research competence", "intellectual property pool", "cooperation and interaction" and "economic and social contribution" [36]. The main objective of this ranking is to increase entrepreneurship and innovation-oriented competition among universities and to develop the entrepreneurship ecosystem. Published studies have compared the scope of the EIUI with the indicators in publications published in higher education journals that examine entrepreneurial university activities, and it has been determined that the five categories in the EIUI include more than the prominent entrepreneurial activities for universities [37]. Therefore, it can be said that the performance indicators measured for universities to take part in this competition also contribute to the TT ecosystem.

Research University: Around the world, research universities play critical roles in training professionals, senior experts, scientists and researchers needed by the economy and in generating new knowledge to support national innovation systems. In Türkiye, there are a total of 23 Research Universities, 20 public and 3 foundation universities, designated by the YÖK within the scope of the Research Oriented Mission Differentiation and Specialization Program. In addition to staff support for Research Universities, top-performing universities are provided with Additional Budget Support by the Presidency of the Republic of Türkiye Strategy and Budget Presidency, PhD Education Abroad support and Center of Excellence Support by TÜBİTAK. The Presidential Strategy and Budget Presidency allocates resources to research universities based on the results of the performance evaluation conducted by the YÖK every year. This performance evaluation is based on indicators in the TT ecosystem such as the number of projects received from national/international R&D and Innovation Support Programs, the number of national/international patent certificates, and the number of UIC R&D projects [38].

The goal of becoming a research university aims to improve the competitiveness of universities in the international arena by increasing their scientific research capacity, and the studies carried out in this process make significant contributions to TT. Highly qualified academic staff and advanced research enable the development of innovative technologies and patents, while strengthened collaborations with industry facilitate the commercialization and integration of academic research into industry.

Development Plans of the Republic of Türkiye: Development Plans also contribute to the development of UIC in Türkiye, which forms the basis of the TT ecosystem [39].

The goals of creating a research environment and establishing basic infrastructures for research, which started with the First Development Plan, were followed by policies and strategies developed directly or indirectly for the development of UIC and TT ecosystem in Türkiye in almost all Development Plans [34].

When the ongoing Twelfth Development Plan (2024-2028) is examined, there are strategies defined in this context. These strategies are as follows [16];

- Support mechanisms will be implemented to increase knowledge and TT through collaborations between universities, research infrastructures and the private sector, and the effectiveness of interface structures will be enhanced by improving their institutional capacities.

- Institutional structures of TTOs will be analyzed and studies will be carried out to improve their effectiveness, efficiency and human resource capacity, and performance-based support will be provided.
- The academic incentive system will be revised to prioritize knowledge and TT activities.

TT Strategy of Innovative Companies

Industrial organizations are the units where the knowledge produced in universities is put into practice and commercial added value is added. Companies use various TT methods to increase their competitiveness and improve their innovation capacity. Among these methods, cooperation programs with academic institutions have an important place. Joint research projects, academic consultancy services and laboratory use agreements with universities facilitate companies' access to new technologies. In addition, internship programs and efforts to create a talent pool are also effective in bringing young and innovative ideas into companies. Therefore, collaboration between universities and industry plays an important role in the socio-economic development of a country [40].

For this reason, strategies have been developed to improve UIC.

- Law No. 5746¹ on Supporting Research, Development and Design Activities

Companies granted the title of R&D/Design Center by the Ministry of Industry can benefit from various supports and incentives (tax incentives, insurance premium supports, 100% R&D and Design discount, etc.). In addition, R&D and Design Centers are provided with a performance index model that will make UIC and TT processes sustainable (employment of R&D personnel with doctorate and master's degrees, density of publicly funded or self-funded UIC projects, number of articles and papers, etc.).

- Law No. 4691² on TDZs

Companies located in TDZs can cover the expenses (infrastructure, building, machinery, equipment and software to be used in workshops, R&D and innovation activities, etc.) related to the incubation programs, TTO services and technology cooperation programs they carry out, limited to the appropriation allocated to the Ministry's budget, tax exemptions are provided, priority is given for the production permit certificates of the technological product initiated and finalized in the region, and support is provided for the R&D personnel they employ within the framework of the conditions determined by the Ministry by regulation. In addition, this law allows university researchers to be employed in the zone exempt from revolving funds and to establish companies in the zone and operate in an autonomous status.

- Law No. 2547¹² on Higher Education

Within the scope of the Law, no deduction is made from the income obtained as a result of R&D, design and innovation projects and activities within the scope of UIC. The academic staff working within this scope is paid 85% of the income without any tax deduction. While this deduction is normally between 35-40%, with this incentive, only 15% is deducted, which encourages academics.

3.2. Stakeholders Map

Türkiye is taking steps to develop a strong TT ecosystem to increase the contribution of technology and innovation to economic growth. This ecosystem has a dynamic structure where various stakeholders come together and effectively manage knowledge and technology from production to commercialization. In Türkiye, the participation and implementation performance of stakeholders from the private sector and universities in innovation policies implemented by the public sector contribute to the development of the innovation process. The main actors of the TT ecosystem in Türkiye, the main sectors where research and innovation are concentrated, and the numerical data of various structures that contribute to this process are evaluated in detail.

The stakeholder map of Türkiye's main actors related to TT in the national ecosystem is given in Figure 5.

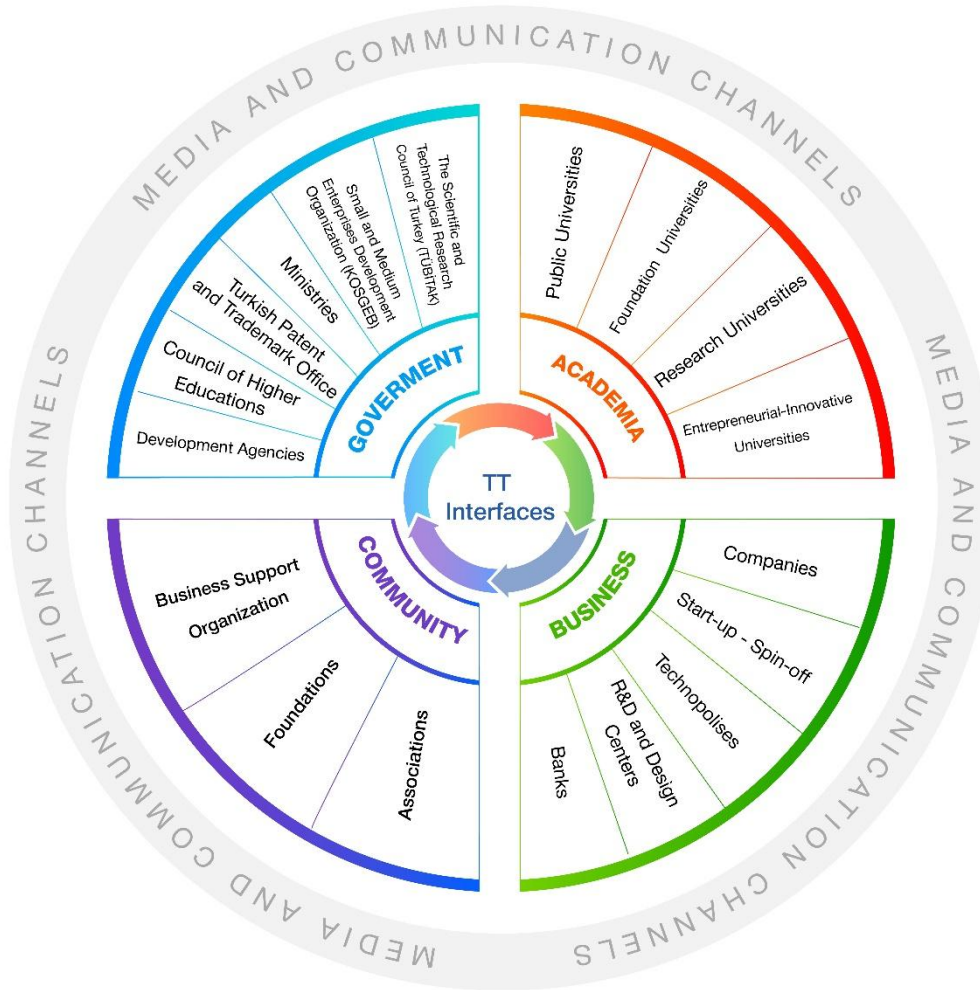


Figure 5. Stakeholders Map for Türkiye

The actors defined within the scope of the stakeholder map participate and contribute to the national innovation ecosystem in line with the priority sectors in which they operate institutionally.

As the main actors in TT;

The **Government**, which enables national participation in government incentive mechanisms and fulfills the necessary legislative obligations on behalf of the Ministries,

Universities hosting R&D projects at universities and channeling scientific studies into TT,

Business World, which has a share of 61.4% [19] in R&D expenditures in order to ensure that their competitiveness capacities rapidly adapt to today's technological needs,

The circulation and impact area of TT was defined by evaluating the industrialists, investors, angel investors, entrepreneurs and mentors in the national ecosystem, as well as the Civil Society Organizations whose industrialists, investors, angel investors, entrepreneurs and mentors have an impact on the national and international circulation of TT by using their network and power.

In order to ensure the highest level of interaction between stakeholders, **TTOs** in Türkiye are defined as structures that implement UIC, patenting and commercialization, participation in grant programs, internationalization and entrepreneurship capabilities with an interface role.

3.2.1. Main Actors of the TT Ecosystem

3.2.1.1. Government (Public Institutions & Policy Makers)

In the case of Türkiye, policy-making public institutions determine the strategic direction of technology through laws adopted by the main actors and interfaces of TT at the national level. In Türkiye, national participation in R&D and innovation, in particular, is widely influenced by government incentives supported by cooperative legislation. The main actors in the sector, who actively comply with government incentives, implement legal regulations to encourage TT, offer financial incentives and develop national innovation strategies. The support of national innovation policies by the state authority ensures that the TT ecosystem in Türkiye takes shape, that the culture of innovation reaches down to the smallest actor at the grassroots level, and that TT grows in volume with a fair distribution of R&D projects.

Coordination between the private sector and organizations is ensured through the strategies developed by the state in its policy-making role. In the 12th Development Plan, which was created by the Presidency of the Republic of Türkiye with a long-term perspective within the framework of the year 2053, with the participation of its affiliated Ministries, private sector representatives and university scientists, it published its new goals in the vision of a stable Türkiye that aims economic development and development and produces high added value based on advanced technology. In Türkiye, the transfer of R&D and innovation-based government incentives to public and private sector organizations across the country through grant programs is carried out through Ministries.

The MoIT has a key role in determining and implementing TT policies in Türkiye. TÜBİTAK, TÜRKPATENT, KOSGEB, TUBA, Türkiye Standards Institute (TSE) and TUA are the affiliated institutions and organizations of the Ministry, which directly support Türkiye's efforts to achieve its strategic National Initiative Policy. The Ministry directs the technological transformation of the country, supports the technological transformation of the industrial sector, encourages domestic technology production and develops international technology collaborations through initiatives such as the Technology-Oriented Industrial Initiative Program and the Digital Transformation Office. In addition, it aims to increase the technology development capacity of the public and private sectors by providing incentives for R&D centers and design centers and contributes to the strengthening of Türkiye's technology ecosystem through its R&D and innovation support programs.

The Ministry of Trade implements incentive programs that support the ability of national companies to become a global player in the international market, especially for product groups with strong branding potential and competitive advantage in TT processes. The Ministry, which stands out with the international trade and investment dimension of companies, encourages technology-oriented exports of Türkiye brands through incentives such as the Support for the Development of International Competitiveness program and Turquality Branding supports, encourages foreign technology companies to invest in Türkiye, and supports domestic technology companies to expand into global markets. These efforts and policies accelerate the integration of Türkiye companies into global value chains and strengthen Türkiye's position in the global technology ecosystem.

The Directorate for EU Affairs under the Ministry of Foreign Affairs of the Republic of Türkiye is the institution coordinating the harmonization and integration activities related to Türkiye's EU membership process. The Directorate for EU Affairs ensures cooperation between countries with the funds financed by the EU through the implementation of EU Programs. In Türkiye, programs such as HORIZON Europe, Interreg NEXT, ERASMUS+ are carried out for the emergence of new projects with a wide range of impact and the emergence of new future projects by conducting R&D activities of institutions with multiple collaborations with EU countries.

TÜBİTAK, Türkiye's leading science and technology institution, is the implementing agency of inclusive support programs for the benefit of academics, industrialists and entrepreneurs with the financial resources allocated by the Ministry. It contributes to global TT processes through international collaborations and makes significant contributions to the development of Türkiye's technological infrastructure and innovation capacity through the support programs and incentives it provides.

KOSGEB pumps government incentives into the market for businesses and entrepreneurs to ensure that SMEs are involved in TT processes. KOSGEB offers support such as the R&D and Innovation Support Program and KOBİGEL - SME Development Support Program, providing businesses with financing support for technology-focused projects, consultancy services and training programs. Through these programs and activities, SMEs are encouraged and targeted to increase their technological capacity, develop innovative projects, adopt innovative technologies and increase their competitiveness in their sectors.

Contributing to the development of Türkiye's intellectual property portfolio and innovation ecosystem, playing an active role in the field of intellectual property at national and international level and operating for the effective protection of IPRs at national and international level, the TÜRKPATENT is the institution operating with experienced engineers in the valuation and commercialization of inventions in Türkiye. TÜRKPATENT cooperates with the European Patent Office (EPO) and WIPO for the protection, internationalization and commercialization of patented information and is one of the 39 signatory countries to the European Patent Convention. It has the most privileged area of the TT ecosystem with the organization of International Invention Fair (ISIF) patent fairs that enable inventors to come together with investors, the PATENTLE Türkiye Competition for young inventors to gain early awareness, and information activities carried out by 58 Patent Library (PATLIB) organizations in its role as a patent information center.

3.2.1.2. Universities

Universities in Türkiye are defined as public universities and foundation universities. Universities in Türkiye are ranked as research universities and entrepreneurial and innovative universities if they achieve certain performances. Universities are evaluated as research universities and entrepreneurial and innovative universities in the stakeholder map according to the ranking of universities according to their field-based competencies, R&D infrastructures, entrepreneurship and innovation capabilities, research quality and interaction criteria. These two concepts are important as they are equivalent to the share of HEIs in R&D expenditures in Türkiye, which considers R&D activities as an element of value.

In Türkiye, universities play an important role in TT and innovation processes and ensure the transfer of academic knowledge to industry by establishing TTOs, research centers, design centers, application and research centers and technoparks. These universities develop new technologies by conducting

theoretical and applied research and mobilize collaboration through the TTO, which acts as an interface for the commercialization of these technologies. Universities make valuable contributions to the technology and innovation ecosystem through TTOs that strengthen the collaboration between academia and industry.

3.2.1.3. Business - Business

Companies

Of the nearly 2.5 million active commercial enterprises in Türkiye, 61.4% are private companies seeking UIC with R&D expenditures and constitute the demand side of the TT process. These companies carry out joint projects with universities and research institutions, transform academic knowledge into industrial applications and contribute to the commercialization of new technologies. The first academia-industry meeting, which started on the basis of UIC, is being strengthened through matchmaking studies, the development of patented technologies and R&D/Design Centers. The participation of the private sector in the intellectual innovation culture obtained through academia cooperation ensures that TT is transformed into economic value.

R&D and Design Centers

In Türkiye, R&D Centers carry out specialized R&D activities in specific technology areas. These centers contribute to the development of advanced technology products, improvement of industrial applications and acceleration of TT. Public R&D centers also collaborate with the private sector to implement technology-oriented projects. There are 1326 R&D centers and 332 design centers in Türkiye, spread across sectors such as defense industry, pharmaceuticals and biotechnology, manufacturing industry, etc [41].

TDZs

They are institutions that have mechanisms to protect first-stage entrepreneurs against financial difficulties for the development of innovative ideas and technologies, allow them to benefit from the experience and networks of other industrial enterprises operating in the sector, and provide a suitable environment before commercialization. Technoparks host R&D companies, start-ups and technology-oriented initiatives and offer tax advantages and infrastructure support. Technoparks serve an important function in strengthening UIC and accelerating TT. In Türkiye, TDZs are home to nearly 16.600+ companies [42].

Start-Up - Spinoffs

Entrepreneurs (Start-ups and Spin-offs) are important in the TT process in terms of commercializing innovative ideas and bringing them to market. These initiatives transform technologies that usually originate from universities or research institutions into commercial products and thus realize the practical applications of TT. Start-ups and spin-offs add speed and flexibility to the TT process thanks to their dynamic structure.

Banks

Banks play an important financing role in TT processes and the innovation ecosystem. They provide critical solutions for the realization of R&D projects, meeting the capital needs of start-ups and spin-offs, as well as regulating the cash flow of companies located in Technopark. Especially in financing innovative projects, banks provide risk-minimizing financial support through various loan and investment instruments.

3.2.1.4. Civil Society Organizations

Chambers of Commerce, Chambers of Commerce and Industry, Exporters' Associations, ÜSİMP, etc. act as large-scale interfaces for the participation of their committee members in TT activities. In Türkiye, regional TTOs or technoparks access the most suitable investor and industrialist profile for matching in TT

tools through Business Support Organizations (BSOs) and work in cooperation. These institutions inform member enterprises about TT, organize training programs, create platforms for UIC, create international partnerships through sectoral fairs, and develop innovative production methods and processes in cooperation with academia in their industrial work. Chambers of Commerce and Industry especially encourage SMEs to engage in TT processes. They are on the same platform with the Governorship, Municipality and universities in the development of regional innovation strategies.

Specific to the stakeholder map, the BSO, foundations and associations operate as the most effective and positively provocative group for TT to reach the end user at the grassroots level.

3.2.2. TT Ecosystem Interface Structures - TTOs

TTOs act as a bridge between universities and industry. In Türkiye, TTOs are structured as joint stock companies within Technopark managements or as units affiliated to university rectorates. The main objective of the 90+ TTOs within TDZs and universities is to develop qualified projects with high added value between academia and industry, to create technology-based initiatives in the national/international market, and to manage the processes related to the priority patenting and commercialization of technologies. TTOs are unique interfaces that provide appropriate matching to the needs of actors by analyzing government incentives in the creation of an effective TT ecosystem and channel all financial grant resources published in the country to their regions.

Since 2012, TÜBİTAK has laid the groundwork for the dissemination of TTOs with the "TÜBİTAK 1513" within the scope of the support provided for the development of innovation culture in Türkiye.

3.2.3. Main Sectors Where Research and Innovation is Concentrated

Research and innovation in Türkiye is concentrated in various strategic sectors. These sectors host intensive R&D and technology development activities to support the country's economic development and increase its global competitiveness. Main sectors where research and innovation is concentrated in Türkiye:

Defense Industry

The defense industry in Türkiye has a great R&D potential to develop high-tech products and increase domestic production capacity. Defense industry projects cover land, naval and air defense systems. In this field, Türkiye develops advanced technology products such as national weapon systems, satellite technologies, unmanned aerial vehicles, ammunition and electronic warfare systems. The Presidency of Defense Industries and the Defense Industry R&D Institute play a leading role in this field.

Energy

The energy sector is another important area of Türkiye's research and innovation activities. In this sector, there are projects focusing on the use of renewable energy resources, energy efficiency and sustainable energy solutions. R&D activities are carried out in areas such as solar energy, wind energy, biomass energy and hydrogen energy. TÜBİTAK's energy projects and R&D investments by energy companies support developments in this sector.

Information and Technology

The information and technology sector conducts intensive research and innovation activities in areas such as software development, information security, artificial intelligence, big data and the Internet of Things. Türkiye hosts important developments in this field with technoparks and incubation centers that support technology-based startups. ICTA and various private sector companies contribute to R&D and innovative projects in this field.

Health, Biotechnology and Chemistry

The health and biotechnology sector focuses on the development of new drugs, bioengineered products and medical devices. Türkiye carries out various R&D projects in the fields of health technologies, genetic research, bioengineering and medical imaging. The Ministry of Health, TÜBİTAK and private healthcare companies are conducting important research for innovative solutions in this field.

Agriculture and Food Technologies

The agriculture and food technologies sector hosts various research activities to increase agricultural productivity, ensure food security and develop sustainable agricultural methods. Smart agricultural practices, genetic engineering, food processing and packaging technologies are among the prominent topics in this field. The Ministry of Agriculture and Forestry, various universities and private sector companies support agricultural innovations through R&D activities in this field.

Automotive and Transportation Technologies

Automotive and transportation technologies focus on advanced technologies such as electric vehicles, autonomous driving systems and transportation infrastructures. Türkiye carries out projects to develop innovative solutions in domestic automotive production and transportation systems. Automotive industry representatives and R&D centers support innovations in this sector and offer advanced transportation solutions.

Construction and Material Technologies

The construction and material technologies sector conducts research on sustainable construction methods, smart buildings, environmentally friendly materials and structural engineering. R&D projects in this field in Türkiye aim to improve quality and efficiency in the construction industry. Various universities and construction companies encourage innovations in this field.

3.2.4. Media and Communication Channels

Media channels for TT dissemination play an important role in disseminating information and raising awareness. These channels share TT success stories, announce new technological developments and promote relevant events. The effective use of media channels contributes to the expansion of the TT ecosystem and the involvement of more stakeholders and users.

4. TT Structures

TTOs aim to commercialize the knowledge and technology produced within the organization in which they are established by transforming it into practice and to help it gain economic, social and cultural value as a result of this process, to create cooperation between universities and private sector organizations, to increase existing cooperation, to help produce the knowledge and technology needed by the private sector, to exchange between the supply and demand parties of information and technology as a result of these collaborations and to contribute to the development of concrete outputs.

With the development of knowledge and TT in the United States and Europe, "support/coordination offices" were established within research and business support organizations in Türkiye to support the supply and demand sides of knowledge and technology.

The first important start of TT structures in Türkiye can be described as the incubation centers (Technology Development Centre-TEKMER) initiated by KOSGEB. These centers, which started to be established in the early 1990s, played an important role especially in the creation of start-ups and some spin-outs.

TTGV has made significant contributions to the development of UIC, technological development and TT with the programs it has carried out since its establishment in 1991. In particular, university-industry joint research projects have played a role in establishing a culture of collaboration between industry and universities in Türkiye and have rewarded such collaborations.

The University-Industry Joint Research Centers Program (ÜSAMP), which was launched by TÜBİTAK in 1996 and lasted for 10 years, was an important experience. ÜSAMP was the first institutional structure that aimed to transfer the knowledge and technology produced in universities to industry, and in which the industrial sector was involved and actively involved. This program, which aims to accelerate technological development by ensuring the transfer of technology and knowledge in different sectors and to solve the problems of the sector with the help of universities, was active until 2006 and created many success stories.

Another structure that encouraged the increase in UIC and TT activities in combination with tax advantages was the establishment of technoparks. With Law No. 4691² on TDZs, which entered into force in 2001, many universities started to establish technoparks, and the number of technoparks increased rapidly, reaching 102 as of today. On the one hand, Technoparks encourage universities and industry to work together, and on the other hand, they aim to develop new technologies and transfer them to the society. Therefore, Technoparks have become an institutional structure that aims to develop and TT in the TT process and supports the establishment of academic and student companies through its incubators and pre-incubators. With the technical support services provided, the establishment of academic start-ups and thus the transformation of the knowledge developed at the university into a socio-economic value directly through products and services has started to be ensured.

TTO have been established in Türkiye since 2010. In line with the decisions taken at the meeting of the Supreme Council of Science and Technology on December 27, 2011, legislative studies were started to be carried out under the co-chairmanship of TÜBİTAK and YÖK, and implementation started in 2012 [32]. Especially after the TÜBİTAK 1513, there has been a significant and positive leap in TTO activities in Türkiye in terms of both number and quality, and many units aiming to carry out "TT", "Licensing" and "Interface" activities with different structures and names have been established in Türkiye.

TÜBİTAK 1513 and 1601 Support Programs: Especially after the TÜBİTAK 1513, which started to be provided in Türkiye in 2012, TTOs have made significant strides. Most of the TTOs have been established or have become active since this year. These supports have served as a "lever" to increase TT activities in the university and the region and have contributed to "guidance" in the design of TTO processes and services.

The TÜBİTAK 1513 Support Program aims to

- To ensure that research results are effectively utilized and turned into economic value-added products.
- To increase academic entrepreneurship in order to contribute to UIC.
- Supporting the commercialization of innovation-based technology.
- To act as a bridge between the university and the industry and to facilitate the processes carried out by both sides.
- Measuring and evaluating entrepreneurship and innovation activities at universities.
- Increasing competition between universities.

In order to achieve these goals, to trigger the innovation and entrepreneurship activities of universities and to measure their performance in this field, the "EIUI" was launched by TÜBİTAK in 2012 for the first time in Türkiye. Within the scope of the index, the 50 most entrepreneurial and innovative universities are ranked according to 23 indicators under the dimensions of "scientific and technological research competence", "intellectual property pool", "cooperation and interaction" and "economic and social contribution" and shared with the public.

Since 2012, the TÜBİTAK 1513 has been supporting the existing or to be established TTOs of universities ranked in the top 50 in the Index. Within the scope of the TÜBİTAK 1513, 4 calls were opened in 2012, 2013, 2014 and 2019. In addition, within the scope of the 1601 coded "Support Program for Increasing Capacity in the Fields of Innovation and Entrepreneurship", which was also initiated by TÜBİTAK and aimed to expand TTOs in Türkiye, calls were opened in 2014, 2015, 2016 and 2017 for universities ranked in the top 50 in the EIUI. Unlike the TÜBİTAK 1513, in the calls opened within the framework of the 1601

Program, TTOs were supported for periods ranging from 24 to 30 months and it was aimed to provide Preparation, Start-up and Capacity Building for TTOs.

TTO in Türkiye can be defined as "interfaces that contribute to the commercialization of knowledge and technologies produced in research institutions and universities by transforming them into applications and gaining economic/social/cultural value as a result of this process, creating cooperation between universities and private sector organizations, producing the knowledge and technology needed by the industry at the university, transferring knowledge and technology between universities and industry as a result of these collaborations, and developing concrete outputs", based on the explanations in TÜBİTAK's program on the support of these structures.

With the support provided by TÜBİTAK in Türkiye, the relevant interface structures were guided to operate in 5 modules. In this context, especially universities have realized their own special constructions in accordance with the above-mentioned business models of TTOs according to their institutional strategies. Accordingly, there are examples of active activities in every module, as well as interface structures where some module services are emphasized, or some modules are not active at all. The remaining areas can also be undertaken by different units/structures.

The service units (modules) defined by TÜBİTAK are defined as follows.

- **Module 1: Awareness, Promotion, Information and Training Services**
 - o Guiding researchers in line with the needs of private sector organizations within the scope of supported TTO project activities, introducing the competence of researchers and infrastructure to private sector organizations.
 - o Informing researchers and private sector organizations on research, technology development, innovation and IPRs, raising awareness and providing training on these issues.
- **Module 2: Services for benefiting from support programs**
 - o Providing project preparation, application and monitoring services to organizations that provide national/international research, technology development, innovation and entrepreneurship support.
 - o Informing private sector organizations and researchers about financing R&D and innovation, facilitating their access to funds and directing them to relevant funds.
- **Module 3: University Industry Cooperation Activities**
 - o Advising private sector organizations and researchers on access to information, technology and cooperation opportunities, guiding them and brokering national/international partnership agreements.
 - o Presentation of project results.
 - o In multi-partner projects, coordinating or organizing activities such as project team formation, etc.
 - o Facilitating contractual research (using databases, face-to-face meetings, matching methods such as bringing project idea owners together).
- **Module 4: IPRs Management and Licensing Services**
 - o Providing consultancy and services on the identification of IPRs assets and the follow-up of legal protection procedures of these assets.
 - o Managing the transfer of rights arising from IPRs to the public and private sectors in the form of licensing and commercialization processes.
 - o Cooperation with other TTOs and relevant institutions/organizations in the commercialization of IPRs.
- **Module 5: Incorporation and entrepreneurship services**
 - o Providing incubation center services and conducting accelerator programs to support the commercialization of the knowledge produced at the university through entrepreneurship.
 - o Providing support services such as business guidance and mentoring to these initiatives.

- Finding resources from within and outside the higher education institution for prototype development at the concept validation stage of the business idea and making them available to entrepreneurs.

Almost all of the TTOs and derivative units in Türkiye that were established with support under TÜBİTAK 1513 and/or 1601 programs, or that have diversified and enriched their activities, continue to offer their services to their target audiences within the scope of these modules. To date, TÜBİTAK has supported the establishment of TTOs in a total of 64 universities and technoparks through two different programs (1513 and 1601). TTO support has led to a rapid increase in the number of TTOs in Türkiye. While there were only 2 TTOs in Türkiye before 2000, this number increased to 9 in 2011. Today, the number of TTOs supported by TÜBİTAK alone is over 60, and when all other TTOs are taken into account, this number is over 90 [39].

The TTO support provided by TÜBİTAK has been an extremely important and visionary strategy in terms of professionalizing TTOs. It is also critical that this support is diversified and that different programs supporting TTOs are encouraged. In this mechanism, TTOs have designed the TT process in such a way that it is not only based on patent licensing and entrepreneurship, as in the US, but also includes support from the beginning of the process. Therefore, TTO activities in Türkiye cover all the steps of raising knowledge and awareness in universities, developing project competencies and capabilities, promoting UIC, managing licensing and patent processes, and entrepreneurship. This structure of TTO has played a critical role in the co-development of processes, capacity building and the overall development of the ecosystem in Türkiye.

ÜSİMP, of which almost all TTOs and similar interface structures are members, has made a significant contribution to and supported TTOs in carrying out their activities in a way to cover the entire process. In the process of designing TÜBİTAK's TTO support, different workshops with national and international participants supported the design of the best model for Türkiye.

HEIs TTO Regulation: In 2017, the HEIs TTO Regulation published by YÖK determined the principles of the establishment, duties and management of the TTO with the status of a capital company within the scope of the Türkiye Commercial Code No. 6102¹³ in order to cooperate with the public and private sector regarding R&D and innovation in HEIs, to protect the information produced and inventions made within the scope of intellectual property and to transfer them to practice. With this article, which was adopted to facilitate the TT processes of state universities and to eliminate the problems currently encountered in these processes, it is aimed for state universities to take their place in the competitive environment in the TT ecosystem. One of the most important features of this regulation is that it allows TTOs to be established under the legal entity of Inc., allows the international plat establishment capital to be transferred from the university's research budget and revolving fund budget, and perhaps most importantly, it is exempted from state procurement laws. By taking advantage of this regulation, TTOs with Inc. legal personality have started to be established. How effective this system is will become clear in the coming years.

TDZs Implementation Regulation: With the TDZs Implementation Regulation published by MoIT in 2016, the Managing Companies of TDZs were given the task of establishing a TTO by creating a unit within its own structure or within the framework of a protocol to be arranged with another legal entity within three years after starting operations in the Zone area. With this regulation, a step has been taken for the first time to establish a TTO structure in order to provide TT services for the companies within Technoparks or to receive these services from other TTOs. With the help of this service, it is aimed to bring the high value-added goods and services produced in Technoparks into the economy with the help of TTOs.

Current TT Structures in Türkiye and Their Characteristics

In Türkiye, the structures that serve as interfaces in the field of TT, which have been established and shaped as a result of the developments and historical process summarized above, continue to exist in the following statuses.

- A unit established within the higher education institution for TTO activities,

- A company owned by HEIs and established for TTO activities,
- TTOs established as a joint venture between HEIs and TDZ Managing Companies
- TTOs established as a unit under the Managing Companies of TDZs
- A company established for TTO activities and in which the TDZ Managing Company is a partner,
- Industrial R&D Centers (Industrial R&D Centers established within the scope of Law No. 5746¹ work as an "Interface Structure" in the field of TT for their own companies).
- Research Infrastructures (Although very few in number, these centers, which were established within the scope of Law No. 6550¹⁴ and are obliged to provide basic and applied research and services in the process from idea to product, are designed as a complete "Interface Structure" that triggers and supports TT between academia and industry).

The interface structures that continue their activities in the current situation have been shaped in line with both the support mechanism determined by the relevant legislation and the support mechanism developed in parallel. As can be understood from this, these structures operating as interfaces have been established with different legal statuses. These structures can be "affiliated units", centers or companies within universities and technoparks, as well as R&D centers or research infrastructures established under the law.

TTOs with Application and Research Center or Company status within the university: The interface structures established within universities and research centers are designed to provide different services as an output of the relevant university and TTO business model. Establishing these structures as affiliated units or centers within the university enables the human resources costs, which are the biggest expense item, to be met with public resources. Therefore, the relevant units prevent TTO activities, which do not generate income or generate less income but are at least as important as others, from being put on the back burner with the concern of generating income.

As explained in detail above, the TÜBİTAK 1513 offers the following service items in line with its implementation principles and modular structure. However, in some universities (especially large ones), each module activity is carried out under the responsibility of different units and centers instead of being carried out under a single center. In order to prevent the confusion that may arise as a result of this situation, "research deanships" have been established within universities in recent years and all relevant units have been affiliated to this deanship.

- Awareness Raising, Promotion, Information, Training Services (in the field of TT)
- Benefiting from Support Programs (focused on national/international research, project and technology development)
- UIC (Public R&D supports, Industry Partnered Projects, Contracted Projects, etc.),
- Patent and IPRs and Commercialization (Licensing / Transfer),
- Entrepreneurship and Incorporation

TTOs within TDZs provide services to tenant companies in their respective zones to start production, increase capacity, improve R&D competencies and establish collaborations. TDZ Managing Companies, which serve under the MoIT, are obliged to provide TT services within the scope of Law No. 4691² and the relevant regulation. One of the most important tools for the commercialization of knowledge and technology is undoubtedly research and technology focused start-up and spin-off companies. These companies operate within technoparks in Türkiye, with exceptions. Service items;

- Service procurement and coordination for R&D needs,
- Utilization of university facilities,
- It consists of mergers and license agreements.

Industry R&D Centers, whose ultimate beneficiary is the enterprise in which they are located, provide services in transforming the R&D activities of their own companies, which need new ideas, approaches, and the support of R&D and P&D with basic science, into commercial products and services. Service items

- Creating and executing R&D projects,
- New technology development, realization of new patent applications.

6550 Research Infrastructures established under the Ministry of Development are also obliged to provide basic and applied research and services to academia and industry in the process from idea to product. Service items

- Establishing information and technology infrastructure,
- Creating economic benefits by transferring the knowledge generated to the private sector,
- Training qualified researcher manpower,
- Attracting researchers from abroad,
- It consists of the main topics of shaping science communities and building collaborations.

Business Support Organizations Although they do not seem to fit the concept of TT, business support organizations representing the private sector have also established and continue to operate various structures to meet the knowledge and TT-oriented needs of their members or the group they serve. Although not as holistic as on the knowledge and technology supply side, these structures act in a way to cover some module activities. On the other hand, these structures and their knowledge and technology-oriented activities are supported through international projects and networks in which various institutions and organizations are involved (e.g. the European Business Network).

The Specialization of TTOs

The structures that exist as interfaces in the field of TT in Türkiye, whose status and service items are given above, are specialized according to their functions and the structure of their target audiences, rather than any specific technology or knowledge. Although the founding objectives of TTOs are the same, the functions they perform differ according to the region where they were established, the audience they serve and the institution. However, if we list the common points [43];

- To support the practical implementation of an idea put forward by the researchers and to support them to benefit from appropriate funding programs
- To ensure that research results are effectively evaluated and turned into economic value-added products
- To ensure that the inventions made by researchers are protected within the framework of IPRs
- Increasing academic entrepreneurship
- Contributing to R&D studies and the transformation of the knowledge obtained as a result of these studies into practice
- Acting as a bridge between the university and the industry and facilitating the operations carried out by both sides
- To ensure the effective use of IPRs by issuing license agreements
- To follow the licensability of the products created by searching for the right market and the protection of property rights
- Providing funding support for new research from industry and NGOs
- Supporting the commercialization of innovation-based technology
- Encouraging entrepreneurship and innovation activities at universities
- To share the income from value-added products equally among the beneficiaries
- Supporting entrepreneurship activities and the establishment of start-up companies by working in partnership with venture capital providers

Major Agents Involved

In addition to TTGV, TÜBİTAK, KOSGEB TEKMERS (incubation centers), which are among the actors mentioned above within the scope of the information given above about the historical development and structures of TTOs in Türkiye, other actors that have an important place in the TT ecosystem in the country are as follows;

ÜSİMP: ÜSİMP, which has become an important civil initiative with more than 100 institutional members operating as of 2007, hosts the representatives of **"University, Business World and NGOs"** under its umbrella. ÜSİMP, of which almost all TTOs and similar interface structures are members today, has made a significant contribution and support to TTOs in carrying out their activities in a way to cover the whole process. In the process of designing TÜBİTAK's TTO support, ÜSİMP supported the design of the most appropriate model for Türkiye through different workshops with national and international participants. Through various events it organized, it drew attention to the problems of the national R&D, innovation and entrepreneurship system, opened them up for discussion, created an agenda, organized trainings specific to the needs, carried out "policy-making" studies through institutions and organizations such as Ministries, TÜRKPATENT and TÜBİTAK, organized workshops with Association of University Technology Managers (AUTM) and presented the outputs as recommendations to YÖK, MoIT and TÜBİTAK, and made significant contributions to the "Dissemination of IPRs Awareness in Türkiye Universities" projects being carried out by EPO and TÜRKPATENT.

Although there is no official definition of the "TT Expert" profession in the world, the international TTP associations that have a say in the TT ecosystem in the world are as follows

- AUTM-Association for University Technology Managers
- ASTP-Association for Science and Technology Professionals
- ATP-Alliance for Technology Transfer Professionals
- EuKTS-European Knowledge Transfer Society
- ÜSİMP has relations with these institutions in the form of membership, goodwill agreements or strategic partnerships, and transfers their experiences to Türkiye.

TTOs are in great need of trained manpower to operate effectively and provide impactful services. However, since TTO processes started to mature later in Türkiye, the number of trained specialized personnel has remained low. In order to eliminate this problem and to establish the definition of the profession and the criteria for specialization, ÜSİMP applied to the Türkiye Vocational Qualifications Authority and established the definition of the profession of TT expert. Training programs have started to be organized in order to raise the professional knowledge and skills of the experts who will work in TTOs to international standards. With these trainings, experts with international standards (Registered Technology Professionals-RTTPs) are trained. These trainings contribute greatly to the development of the human capacity of TTOs.

TÜRKPATENT: TÜRKPATENT is a subsidiary of MoIT established to serve Türkiye's economic and technological development by raising intellectual property awareness in all segments of society, contributing to the effective protection and commercialization of IPRs, and to be effective in international platforms in the field of intellectual property. TÜRKPATENT contributes to the increase of Türkiye's intellectual capital and innovation capacity and directs national and international policies in the field of intellectual property. In addition to serve the economic and technological development of our country in line with the National Technology Initiative by increasing the awareness of intellectual property in all segments of the society, contributing to the effective protection and commercialization of IPRs, and playing an active role in international platforms, TÜRKPATENT authorizes relevant institutions in Türkiye (TTOs, universities, BSOs, etc.) as Information and Documentation Units (currently over 300) and provides expert and organizational support to trainings, seminars, competitions, fairs, workshops, etc. according to the needs of the target audience in cooperation with these institutions, making significant contributions to the TT ecosystem. In addition to this;

- It mediates the participation of TT interface structures and ecosystem actors operating in Türkiye (54 units in total) in the PATLIB network and projects carried out by the EPO through the TÜRKPATENT in Türkiye. Through the PATLIB project; cooperation is carried out in order to encourage innovation, increase commercialization and competitiveness, support qualified employment and contribute to economic growth.

- In 2006, TÜRKPATENT developed and implemented the Hezarfen Project to increase the innovation capacity of SMEs. The Hezarfen Project has been a regular feature of Türkiye's Development Plans and has been running successfully for 18 years. The Hezarfen Project provides information and awareness raising activities for SMEs on the identification and management of all assets that may be subject to IPRs.
- The Patentle Türkiye competition, which was first organized by the TÜRKPATENT in 2017 and held every two years, raises awareness about patents among university students, equips them with the technical knowledge they will use in their professional life or academic studies in the future, and encourages students to engage in invention activities, which play an important role in the technological development of the country.

Türkiye Intellectual Property Valuation, Engineering and Consultancy Services Inc. (TÜRKSMĐ): TÜRKSMĐ was established in 2018 as a subsidiary of TÜRKPATENT to provide services in the fields of intellectual property valuation, venture capital partnership and intellectual property portfolio consultancy in order to transfer Türkiye's intellectual property portfolio to the real sector at the point of commercialization. Operating with 45 personnel, 35 of whom are intellectual property consultants, TÜRKSMĐ aims to contribute to the commercialization of IPRs;

- Patent and utility model preliminary research report,
- Preliminary brand research report,
- Patent and utility model valuation report,
- Brand valuation report,
- Freedom to operate report
- Invalidity analysis report,
- It provides consultancy services in TT transactions.

A cooperation process was initiated between TÜRKSMĐ and the Credit Guarantee Fund (CGF) in order to improve the valuation capacity of IPRs assets in Türkiye and increase their contribution to the national economy. In this context, it is planned to provide a certain amount of financing based on the valuation reports prepared by TÜRKSMĐ for patents/utility models and to provide loans by CGF partner banks.

Communication Strategies and Management in TTOs

Within the scope of the publication titled "Technology Transfer Offices" prepared by ARINKOM TTO in Türkiye in 2023, data was collected from a total of 30 people who work/worked as experts/professionals in 34 TTOs established within the scope of TÜBİTAK 1513 and 1601 Programs [44]. Accordingly, a critical crossroads is whether TTOs in Türkiye, especially those established with state support, have a strategy for communicating with internal and external target audiences. The results of the survey conducted with TTO employees who have started to have a say in the field of R&D, TT and innovation in Türkiye are listed below:

- Although TTOs communicate with internal and external target audiences at a rate of 93%, they are limited to 63% in terms of effective communication with the target audience. Accordingly, the rate of communication with the target audience does not seem sufficient.
- One of the main objectives of TTOs is to ensure their self-sufficiency. However, "ensuring profitability" has a rate of only 43.3% among the objectives of corporate communication activities.
- Corporate communication activities are based on traditional methods such as fairs, meetings and organizations. While this option received 100% of the responses, it was observed that the sales development activity, which is one of the issues that TTOs should focus on the most, was limited to 20%.
- In a period when mobile technologies and applications are popular, the usage rate was limited to 23.3%. Increasing the use of mobile applications as a communication medium and tool is thought to increase interest, especially in the field of entrepreneurship. Although radio and

- television are limited with 13.3% in terms of the use of communication media and tools, their effectiveness in terms of TTOs can be questioned.
- Participation of TTOs in fairs, meetings and organizations is observed as a generally accepted means of communication with the sector. However, despite this, the perspective that does not prioritize "sales development" at the point of participation in the relevant organizations creates question marks about reaching the sector. It is thought that studies to be carried out with a sales development-oriented perspective during participation in or hosting such organizations will increase TTO recognition.
- The stakeholder/target group with the lowest TTO recognition appears to be students. It is assumed that increasing the use of mobile technologies in such organizations may be of interest especially for the new entrepreneur candidates of Generation Y.
- The most effective method of communication with the sector is face-to-face meetings. The methods starting with face-to-face meetings/communication, in which not all corporate communication tools are used effectively and which do not proceed within the framework of a strategy, do not constitute a unity. It would be useful to perceive the methods that will provide effective results after the meeting as a whole within the corporate communication strategies of TTOs.
- Within the scope of TÜBİTAK 1513, there is an "Awareness, Promotion, Information and Training Services" Module defined in each TTO for the execution of communication activities and the job description is as follows: "With this module, it is aimed to inform the business world about conducting R&D projects, developing projects in cooperation with universities, technology and innovation. The activities that can be carried out within the framework of the module can be listed as introducing the competencies, resources and cooperation opportunities of universities for the business world, organizing training organizations on new technologies, R&D systematics, etc., and organizing various information activities for UIC." In the light of the data obtained as a result of the research, it has been observed that the relevant module works effectively in terms of promotion, training/organization/event organizing function, but it is incomplete in terms of introducing the university/researcher profile/infrastructure requested by TÜBİTAK to the business world and reaching out to the business world about technology and innovations. Some TTOs transformed the Module 1 structure into different organizational structures within themselves, while others continued their activities as they were originally established. However, the above-mentioned requirements and the importance an organization attaches to its communication strategy are in line with the perspective of the TTOs management. It has emerged as a subject open to evaluation that TTOs' building their corporate identity, i.e. creating a corporate communication strategy, by allocating the necessary budget with the right stakeholder communication with up-to-date technologies and the awareness they will develop about future trends, depends entirely on their own vision and policies.

Aspects to be Improved

- Qualified Staff

In particular, people working in jobs that require qualified manpower are expected to have a good command of the subject and a certain amount of experience in this field. In addition to the fact that TTOs have little history in Türkiye, the personnel working in these offices were sometimes transferred from industry, sometimes from the private sector, and many of them started their careers in this field as new graduates without any training in the field of TT, even though they graduated from various departments.

Within the scope of the analyses and reports prepared on the TT ecosystem in Türkiye, when the "weaknesses" are analyzed, it is seen that "lack of well-trained and experienced TTO staff" comes to the forefront. As a result of the inadequacy of the staff in terms of knowledge, the system operates extremely slowly, leading to a serious financial loss and most importantly, loss of time. TTOs are in great need of trained manpower in order to operate effectively and provide impactful services. However, since TTO

processes started to mature relatively later in Türkiye, the number of trained specialized personnel has remained quite low until recent years.

In order to eliminate this problem and to establish the definition of the profession and the criteria for expertise, ÜSİMP initiated studies in 2014 to define the profession of "**TTO Expert**" and to carry out professional recognition processes before the Vocational Qualifications Authority. On 9 June 2018, the definition of TT specialist was officially accepted by the Vocational Qualifications Authority (VQA) law numbered 5544¹⁵ published in the Official Gazette and the TT specialist qualification certificate was approved and published by the VQA.

VQA authorizes the institutions that will establish national qualifications for the professions it determines and the examination system on how to measure them, and then certify people according to the result of the exam.

ÜSİMP is currently working to become a TTO Expert Certification body. Training programs have started to be organized in order to raise the professional knowledge and skills of the experts who will work in TTOs to international standards. With these trainings, experts with international standards (RTTPs) are trained. These trainings contribute greatly to the development of the human capacity of TTOs.

- **IPRs and Portfolio Issues**

In general, IP policies of TTOs vary and there is a lack of comprehensive and detailed implementation principles, starting from revenue sharing principles. TTOs' usable or commercializable IP portfolios are also relatively small and there is no consistency across TTOs in how their IP portfolios are managed. It is observed that TTOs have limited budget and resources for IP and are dependent on TÜBİTAK funds. As a result, the overall quality and stability of IP developed by TTOs is problematic.

This is not only due to the weakness of the patent content, but also due to the fact that TTOs do not aim to specialize based on university capabilities and prefer to have individual patents. However, it is deemed necessary to have a patent tree or group approach in areas that are prominent in university research and in certain thematic subjects, taking into account the needs of the regional industry. Looking at the developments in the world, it is thought that TTOs in Türkiye will realize that they need to develop strategies in this direction over time.

Within the scope of TTOs' duties of "Carrying out the commercialization activities of the technology portfolio", the issue of "Ensuring that market research of the invention is carried out" is particularly missing. In order for market research to be sound, it needs to be based on concrete data and expensive, commercial databases should be used to access this data. Except for a few foundation universities, TTOs do not have access to databases. As the market size for such a service is also insufficient, there are no private organizations that can conduct such research. Another aspect that needs to be improved is patent or invention valuation. When it comes to the licensing or sales stage, the financial value of the patent or invention needs to be known, but it is observed that there is not yet the necessary specialization in this field in Türkiye.

- **Startup Supports and Programs**

Researchers often utilize TTO services to get more support for their research. It is understood that TTOs are focusing on new support programs and/or activities focusing on start-ups in line with the world. Many TTOs are interested in developing an angel investor network in the region. More effort and networking is needed on how to create effective angel networks to invest in higher risk ventures that are the product of TTO's activities and innovation programming. TTOs often do not receive a direct investment stake in the start-ups they support and therefore do not maximize the value of their activities. TTOs need to generate more sustainable income from their start-up efforts.

- **Venture Finance**

Angel networks generally do not focus on high-tech investments. Therefore, there is a need to better develop institutional ties with investors beyond individual relationships. Many TTOs find it useful for their affiliated universities to participate directly in investment opportunities. A structure that enables this investment from institutions to startups should be developed as a way to maximize revenue from institutional sources.

- **Other Aspects**

One of the biggest problems facing TTOs is the issue of sustainability. The majority of existing TTOs are not in a position to survive on their own revenues. The sustainability concerns of TTOs should not transform them into a structure that provides project consultancy services in the market and can compete with other players.

As predicted, many TTOs are under-resourced and under pressure for sustainability and successful outputs. Under pressure for sustainability and short-term results, many TTOs have focused on contract projects for revenue rather than commercialization activities. TTO staff seem to be more focused on support activities rather than actual licensing work.

Most legal entities for TTOs need to be restructured and activities reprioritized. There is a general feeling that support for TTOs at the highest level of institutions (Vice Rectorate or higher) is not as strong as it should be.

The need for TTOs to focus on 5 modules of TÜBİTAK Support programs has led to a reduction in activities and lack of specialization. It is recommended that TTO can focus and specialize in the future based on their competencies and missions.

Especially for TTOs that receive TÜBİTAK support, reporting to TÜBİTAK as a measure of "success" is prominent in their measurement targets, and this fact is becoming more important than commercialization outputs.

Another key problem is that the motivation of academics for commercializable research is very low as a result of the lack and inadequacy of existing laws. However, despite all these problems, it is observed that there have been significant developments and capacity increases in the commercialization of knowledge and TT ecosystem in Türkiye, led by TTOs, most of which are still young.

4.1. TT System Diagram

The TT process in Türkiye involves many different actors and mechanisms from research to commercialization. This process starts with knowledge and technology producing institutions such as universities, research centers, technoparks and R&D and design centers. These actors play an important role in the production of the technology to be transferred.

Although private companies are prioritized among the parties requesting TT, technology producers may occasionally be among the technology demanders. Institutions such as TTOs, consultancy companies focusing on TT, R&D units of private companies interested in TT, BSOs, etc. are involved between those who produce knowledge subject to TT and those who demand this knowledge. These structures act as a bridge between the parties producing and demanding knowledge. This ensures that the process of technology and knowledge transfer proceeds efficiently. The support and coordination provided by these interfaces is crucial for the transfer of knowledge and technology to the market as requested.

There are many methods for realizing TT. These include the establishment of start-ups and spinoffs, contractual collaborations, project design, acquisitions, license agreements and license transfers. TT management in Türkiye is supported by laws, incentive mechanisms and intellectual property management. Laws ensure that TT processes proceed within a legal framework. Tax incentives function as tools to facilitate the commercialization of technology. This system aims to direct technology production

in a way that contributes to economic growth and plays an important role in supporting innovative initiatives in this context. A scheme summarising the actors of the TT ecosystem in Türkiye and the relationship between these actors is given in Figure 6.

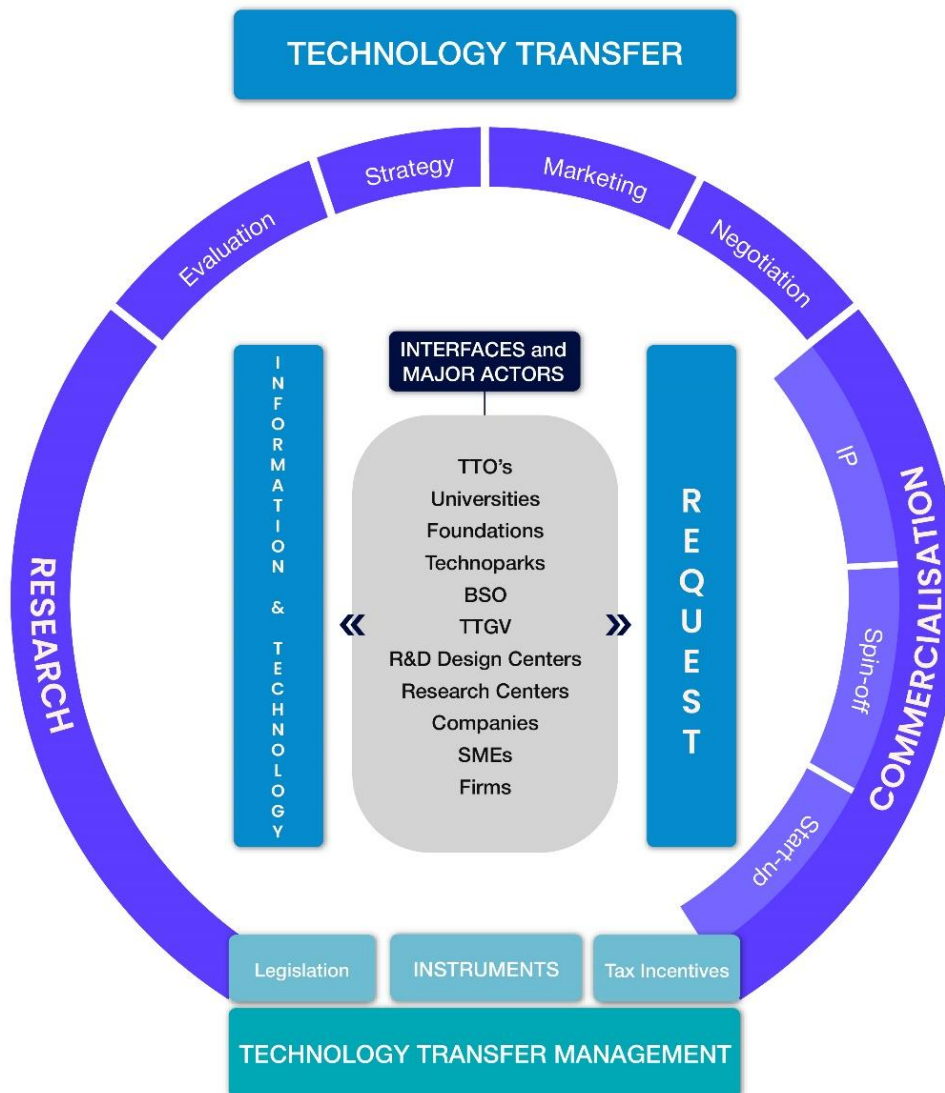


Figure 6. TT Ecosystem Scheme for Türkiye

The main actors involved in TT processes are as follows;

- **TTOs:** Serve as a bridge between technology producing institutions and technology demanding sectors.
- **Universities:** At the center of R&D activities that play a fundamental role in knowledge and technology production.
- **Foundations:** Funders and strategic partners supporting technology and innovation processes.
- **Technoparks:** Innovation centers that enable the commercialization of R&D activities.
- **Development Agencies:** Organizations that promote and support technology and economic development at the regional level.
- **R&D and Design Centers:** Institutions that conduct focused research for the development of new products and technologies.
- **Research Centers:** The main actors producing and developing scientific and technological knowledge.

- **Enterprises:** SMEs that show demand for innovative technologies and use these technologies in their business processes.
- **BSOs:** Support organizations that provide support in TT, innovation and development processes.

TT Procedures

HEIs are considered as structures that play an important role in the process of commercialization of knowledge and technology. These institutions play a central role in the management and implementation of TT processes.

In Türkiye, HEIs are defined as the structures directly responsible for TT processes. This responsibility is generally carried out through TTOs, the number of which has increased rapidly since the 2010s. In Türkiye, ÜSİMP, which started in 2008, and the TTO support programs launched by TÜBİTAK in 2012 have increased the contribution of universities to TT processes. In Türkiye, TTOs play critical roles in and are responsible for the management of TT processes such as patent applications, licensing, incorporation and the development of collaborations with industry.

Researchers such as have argued that HEIs have a great influence on the effectiveness of TT processes and that the successful management of these processes increases the innovative capacity of universities [45,46].

TT is realized through various procedures. The procedures set for TT processes in Türkiye generally cover patenting, licensing, joint research projects, and the establishment of start-up and spin-off companies. TÜBİTAK's support programs and the initiatives of the MoIT have contributed to the standardization of these procedures. However, it is observed that in some universities these processes are still not fully established and standardized. According to YÖK and ÜSİMP reports, these procedures are still under development in some universities and are not implemented at the same level in all universities [47]. Especially in small and newly established universities, it is observed that these procedures are not fully defined and TT processes remain limited.

Procedures for various types of TT, such as patents, the establishment of technology-based companies and licensing agreements, are usually defined in detail. However, the scope and details of these procedures vary from country to country and there may also be inter-institutional differences in Türkiye. In Türkiye, TT is categorized into several types. Inter-industry TT is the transfer of technology developed in one sector to another sector. An example of this is the transfer of innovations produced in the defense industry to other sectors for commercial purposes. Inter-firm TT refers to the transfer of technology from one firm to another and this process can take place through TT agreements, marketing agreements, joint projects or management agreements. In addition, intra-firm TT between multinational companies has been one of the reasons for countries to allow FDI [48].

The terms and forms of services offered in TT processes vary depending on the organization's strategies and resources. The way services are delivered is usually defined by the policies of the institutions and organizations. It is stated that TTOs have developed certain guidelines and protocols to standardise service delivery in TT processes [49]. TTOs in Türkiye are based on the modular structure determined by TÜBİTAK as a result of the call opened in 2012 and started to carry out their activities under 5 modules when they were established. These 5 modules consist of awareness, promotion, information and training services, services for benefiting from support programs, project development/management services (UIC activities), IP management and licensing services, and incorporation and entrepreneurship services.

In Türkiye, TTOs generally determine the terms and forms of the services they offer in TT processes according to the policies and support programs of universities and institutions, and TTOs offer services in areas such as technology assessment, project management, patent strategies, and collaboration development. However, the manner and scope of service provision may vary across universities. In large

universities, these services are provided in a more comprehensive and systematic manner, while in smaller universities, services may be limited [50]. The most commonly used methods of TT include patents, licensing agreements, entrepreneurship, knowledge diffusion and consultancy. Each method is shaped by the nature of the technology, the needs of the market and the competencies of the parties involved. Different tools are used in TT processes in Türkiye. These tools for transferring technology, knowledge and innovations to industry and society may differ from each other. These tools enable TT directly or indirectly. Various TT tools are used in Türkiye. Some of them are: patenting an invention or technology and transferring it to industry or enterprises through licensing agreements; licensing technologies developed by universities or research institutions to industry through licensing agreements for a certain price; direct transfer of a technology or information package to another institution in a way that includes confidential information (Know-how Transfer); the execution of a project by one institution in partnership with another institution or a private sector firm, on the intellectual and industrial elements that constitute its own production, operation and marketing system (Franchise Agreement), the realization of direct capital investments by multinational companies in Türkiye through TT (FDIs); transfer of production systems and technologies through the acquisition of national firms by multinational companies; training of experts, joint R&D activities and idea consultancy; import of machinery and equipment; leasing of production facilities and machinery from abroad (financial leasing); employment of foreign personnel; use of free zones; learning how to design a product or any object by practice (reverse engineering); employment of foreign experts [51] and entrepreneurship. Each institution and organization determines the terms of these instruments through contracts.

In the process of TT, the acquisition, adoption, adaptation and reproduction of technology requires certain costs. Clearly defining the costs of the services provided in TT processes is critical for the transparency and efficiency of the process. These costs are usually detailed in contracts and agreements. It is emphasised that the costs determined for TT services should be appropriate and understandable for both academic institutions and industry [45]. However, in some studies, it has been stated that these costs are not clearly defined in all cases and this may lead to uncertainties in TT processes. In Türkiye, the costs of services provided in TT processes are generally determined within the framework of TTOs' budgets and support programs. The support provided by MoIT covers the costs of these processes to a large extent. In addition, some TTOs cover the costs of many activities from their own resources from activities such as patenting, licensing, consultancy, UIC and entrepreneurship activities. However, in some cases, it is stated that these costs are not clearly defined and this may lead to uncertainties in the processes [47]. Nevertheless, in general, costs are detailed in contracts and agreements and a transparent structure is tried to be provided.

As a result, HEIs are generally responsible for TT processes and provide a variety of procedures and services for the effective management of these processes. However, the scope of these procedures and services, the way they are provided and the definition of costs may differ between institutions. The literature emphasizes that effective management of these processes can be achieved through clearly defined procedures and transparent cost structures.

4.2. Strengths and Weaknesses of TT Units/Offices

Table 1. Strengths and Weaknesses of TT Units/Offices in Türkiye

Strengths	Weaknesses
<ul style="list-style-type: none"> - TTO staff is eager to learn, easily motivated and aware that they need to learn a lot in this field, - TTOs are open to collaboration. Good relations with grant providers, other TTOs and stakeholders - TTOs are recognized by technology-based start-ups as an interface in their relations with industry and access to funding - TTOs have the competencies to create pools of researchers and experts [35] - TTOs or derivative organizations acting as mediators in relation to disputes, conflicts and/or disagreements - TTOs or derivative organizations to proactively follow the relevant laws, regulations, legislations and regulations carefully and to carry out activities by taking particular account of developments and changes in this context - TTOs or derivative organizations should work to encourage entrepreneurial researchers/academics by communicating with relevant managers/administrators and lobbying when necessary - TTOs or derivative organizations learn from mistakes or malpractices and demonstrate a learning character - Marketing methods and strategies defined and operated by TTOs or derivative organizations - TTOs contribute to the process management (administrative, financial, etc.) in the collaborations to be made, alleviating the workload [52] 	<ul style="list-style-type: none"> - Lack of well-trained and experienced TTO staff - Failure to ensure the continuity of TTO staff - Insufficient knowledge in IP management and commercialization processes (problems with marketing and business model) - Lack of experienced mentors - Lack of databases on important issues - The predominance of academic mentality in TTO management - Lack of written policies and strategies - Lack of motivation for commercialization in researchers - Lack of success stories - Lack of relationship and coordination with industry - Weak cooperation with international networks, failure to follow international trends - TTO's lack of effectiveness in regional development plans - Lack of sufficient relationships with angel investors and VCs [35] - Revenue recognition issues for services/licensing in different TTO structures - Uncertainty of the process and mechanisms for transferring academic results to industry - Financial sustainability challenges for TTOs or derivative organizations to continue their activities - Lack of experienced staff in TTOs, - Failure to institutionalize TTOs [53]

4.3. TT Structure Best Practices

There are many successful institutions operating in the field of technology transfer in Türkiye. These institutions range from public institutions, state and foundation universities, research infrastructures within universities, private companies and other structures that contribute to the technology transfer ecosystem. Each plays a different role in supporting Türkiye's goal of building an innovative and competitive economy.

While some of these institutions support research and development activities by opening project calls, others contribute to the ecosystem by transferring academic know-how to industry. The functions of these institutions are critical for the effective operation of technology transfer processes.

In Türkiye, one of the first institutions that comes to mind when technology transfer is mentioned is TÜBİTAK. TÜBİTAK offers comprehensive support programs and encourages strategic projects to strengthen the technology and innovation ecosystem across the country. In addition, there are institutions whose achievements have been recognized by the official organs of the Republic of Türkiye and exemplary structures that have added value to their work in the ecosystem at the national and international level.

Such institutions have developed models that facilitate university-industry collaborations, accelerated innovation and R&D processes, and made significant contributions to the ecosystem by encouraging technology transfer. These success stories in Türkiye's technology transfer ecosystem set an example both in national strategies and on international platforms.

URAP is a non-profit assessment organization that ranks universities worldwide based on scientific criteria and provides guidance to universities, especially in developing countries, to help them improve their position in global rankings. Looking at successful practices in the field of technology transfer in Türkiye, Middle East Technical University (METU) and Istanbul Technical University (ITU), the top two ranked universities in the 2023-2024 URAP rankings, are among the leading institutions in this field. The technology transfer processes and practices of these universities will be examined in detail.

In addition, the Sabancı University Nanotechnology Application and Research Center (SUNUM), one of the first research centers in Türkiye, exemplifies one of the best practices in technology transfer. SUNUM is an important model in this field with its various successful activities.

Finally, Development Agencies are strategic building blocks that analyze regional needs and provide financial and technical support to local actors, strengthen the technology transfer ecosystem in line with sustainable development goals, and lead initiatives that create economic value.

Considering this information, we have identified these 5 institutions as the most successful implementations of the TT structure in Türkiye.

- Scientific and Technological Research Council of Türkiye (TÜBİTAK)
- Middle East Technical University (METU)
- Istanbul Technical University (ITU)
- Sabancı University Nanotechnology Research and Application Center
- Development Agencies

Scientific and Technological Research Council of Türkiye

TÜBİTAK was established on July 24, 1963. TÜBİTAK is Türkiye's largest scientific and technological research institution with the vision of leading Türkiye's national technology thrust and acting with the mission of determining Türkiye's Science and Technology policies for a sustainable future, conducting studies in these areas in cooperation with stakeholders and strengthening the ecosystem.

TÜBİTAK is a comprehensive institution that plays a central role in Türkiye's technology transfer ecosystem. In this ecosystem, which brings together different stakeholders such as universities, industry, public institutions and entrepreneurs, TÜBİTAK accelerates technology transfer through a wide range of funding support mechanisms, encourages the establishment of technology transfer offices across Türkiye, and focuses on priority areas such as defense, energy, health and artificial intelligence. It also leads the development of Türkiye's science, technology and innovation strategies and integrates these strategies into technology transfer processes. The number of patent applications and license agreements resulting from TÜBİTAK-supported projects is on the rise, while the number of spin-off companies has also seen a significant increase.

By working in integration with international programs such as Horizon Europe, TÜBİTAK facilitates Turkish entrepreneurs and academics to enter the global arena. Developing special mechanisms to transform technology production into commercial output, the organization also makes significant contributions to the development of entrepreneurship culture. Integrating digitalization processes into technology transfer mechanisms and offering fast and effective processes, TÜBİTAK continues to be one of the cornerstones of Türkiye's technology transfer ecosystem.

Middle East Technical University and Technology Transfer Office

Founded on November 15, 1956 as the "Middle East Institute of Technology", METU is a university that aims to train qualified specialists in the fields of science and social sciences. METU is one of the leading

universities in Türkiye with its scientific level, cultural and intellectual activities. METU Technology Transfer Office was established in 2007 within METU Technopolis to support academics in patent processes and to raise awareness within the university about intellectual property rights. It is also the first Technology Transfer Office in Türkiye.

By METU TTO:

- Developing creative processes and fast patenting methods to commercialize R&D projects,
- Evaluating academic inventions according to their commercialization potential and matching them with appropriate companies,
- Direct contact with industry using digital channels and fairs for technology promotion,
- Providing consultancy to academics and industry in areas such as project development, patent application, finding funding,
- Supporting collaborations by establishing strategic partnerships with national and international companies,

offers applications such as.

As a result of the strategies pursued by METU TTO to make technology transfer processes more effective, the following programs have been developed [54]:

- METU TTO Pre-Seed Fund Program: It was launched in 2022 to increase the Technology Readiness Level of early-stage academic inventions in the METU TTO portfolio. The program, which was initiated to increase the commercialization potential of the METU TTO patent portfolio, is the first program carried out with TTO's own resources for the development of academic inventions in Türkiye. Within the scope of the program, Inventor academicians are provided budget support for 12-month project activities.
- LabsOut Program: Launched in 2018 in cooperation with METU TTO, Growth Circuit and Berkeley University, the LabsOut program was designed for METU academics, doctoral and graduate students in order to accelerate the commercialization of technologies produced at METU and to increase the number of academic initiatives based on intellectual property rights. In 2018 and 2019, 11 academics gained experience in presenting their commercial ideas to international investors in the program held in San Francisco after participating in two-stage training modules in Türkiye.
- Co-Tech Program: With the "Develop First, Commercialize Later" strategy, research results obtained at the university are matched with start-ups in the relevant sector to establish mutually beneficial collaborations. The Co-Tech program, which was launched in the first half of 2016 to solve the problem that university inventions are generally early-stage technologies and investors do not show interest in these areas due to "high risk", is one of the most effective tools of METU TTO. Through this program, the technology development process of inventions before commercialization is initiated and early-stage inventions are turned into products with the support of national and international funds.
- Proboost Program: The ProBoost acceleration program, implemented within the framework of university-industry cooperation, brings together academics and companies and provides them with the necessary support to benefit from various grant programs for the projects they will develop. Within the scope of the program, academics are matched with academics in line with the demands from the industry and industrial project partners suitable for their areas of expertise are identified.
- Patent Acceleration Support Program: This program was developed to support companies in ODTÜ TEKNOKENT to gain a competitive advantage in the market and was launched in 2018. This program provides support for the preparation of preliminary research and application documents of inventions and designs developed by companies, filing patent or design applications, following up the research report processes and paying attorney fees.

As a result of the activities carried out between January 2017 and May 2024, a total of 56 inventions were commercialized with 53 licenses, assignments and know-how transfers. These commercialization activities generated more than EUR 2.2 million in revenue. According to Patent Effect data, for the last three years, METU TTO has ranked first in commercialization activities among universities [55].

METU TTO has provided patent support to more than 250 inventions, filed 750 patent and design applications and obtained 420 patent/design registrations. In addition, 17 start-ups/spin-offs were established and more than 500 university industry cooperation projects were realized [56].

Istanbul Technical University and Technology Transfer Office

Founded in 1773, ITU is Türkiye's first technical university and is known for its engineering and architecture education [57]. It is one of the oldest and most respected technical universities in Türkiye. It has been a pioneer in science, technology and engineering for over 250 years.

Established in 2013, ITÜNOVA TTO, as the technology transfer office of Istanbul Technical University, serves for the commercialization of research and innovation activities within the university, establishing collaborations with industry and encouraging entrepreneurship. In this process, it is in close cooperation with ITU ARI Teknokent and ITU Çekirdek. This structure ensures that ITU's research, technology development and entrepreneurship ecosystem operates in an integrative manner, transferring the academic knowledge and experience of the university to the economy and industry.

The applications offered to the ecosystem by ITUNOVA TTO are presented below:

- Innovative approaches, technology marketing strategies and industrial collaborations,
- Evaluation and monitoring of technology transfer projects, realization of internationalization activities,
- Protecting inventions and providing support for the integration of business ideas into commercial life,
- ITU Çekirdek Early Stage Incubation Center provides pre-incubation, accelerator, financial service mechanism (Big Bang) and incubation services to entrepreneurs who want to realize their technology-based ideas.

The practices developed by ITÜNOVA TTO to make technology transfer processes more effective are listed below [58].

- ITU ARI Technopolis: ITU ARI Technopolis is a technology development zone operating within ITU and is one of the largest technopolis in Türkiye. Founded in 2003, ITU ARI Technopolis operates to provide support to entrepreneurs and companies that carry out research, development and innovation-oriented projects. The Technopolis provides an important platform for the realization of innovative projects and the development of university-industry cooperation.
- ITU Çekirdek: One of Türkiye's leading incubation centers operating within ITU. Founded in 2011, ITU Çekirdek aims to help technology and innovation-focused entrepreneurs develop, grow and commercialize their projects. The center, which provides support for both early-stage entrepreneurs and projects at the idea stage, is considered one of the most important parts of the entrepreneurship ecosystem.
- Big Bang: It is a start-up competition organized by ITU Çekirdek since 2012 and offers entrepreneurs the opportunity to present their business ideas. This event is open to entrepreneurs from both Türkiye and internationally and enables entrepreneurs to meet with investors, expand their business networks and promote their projects.

Since its establishment, ITU NOVA has achieved significant successes such as 269 national and 145 international patent applications, 1600 incorporated startups, 4700 supported startups, 1185 university-industry cooperation projects. It has also supported the writing of 701 national and international projects [59].

Sabancı University Nanotechnology Research and Application Center

Sabancı University's Nanotechnology Research and Application Center (SUNUM), established in 2010, was selected as one of Türkiye's first National Research Infrastructures in 2017.

The main services of SUNUM are as follows;

- Developing pioneering projects in line with the needs of the country and industry through interdisciplinary research,
- Providing services such as consultancy, design and prototype production to stakeholders through nanotechnology infrastructure,
- Transforming research results into socioeconomic value by establishing strategic industry collaborations,
- Contributing to the maintenance of long-term collaborations between academia and industry and technology transfer,
- Providing opportunities for knowledge sharing and international cooperation to train the researchers of the future,
- Supporting new products and initiatives that contribute to economic development through nanotechnology solutions.

SUNUM offers an ecosystem that aims to transform academic research into commercial value through its projects and programs in the field of nanotechnology and advanced materials. In this context, it organizes various programs and calls that accelerate the commercialization processes of researchers and entrepreneurs and support product development stages. The details of the internal processes and practices offered by SUNUM for such purposes are as follows [60] ;

- SUNUM e-Store: It is a virtual platform where prototypes, products and services obtained from the outputs of SUNUM-supported research meet with users. It supports the transition of nanotechnology solutions, products and services to commercial processes.
- ArTS Program: The Research Commercialization Strategies (RTS) Workshop identifies the commercial potential of SUNUM research and supports the creation of a technology roadmap and business plan.
- Strategic Product/Prototype Portfolio (SPPP): The commercial potential of new technologies emerging from SUNUM projects is evaluated, and those deemed appropriate are developed with internal funds and directed to the commercialization process.
- seed.SUNUM Program: It is an acceleration program that provides support for rapid product development and prototyping according to market demands and supports research outputs with high productization potential.
- BIGG - LABSOUT Program: TÜBİTAK 1512 Entrepreneurship Support Program that supports academic entrepreneurs and provides mentorship, training and business plan support in the process of transforming innovative ideas into commercial success.
- spnSUNUM Program: It is a program that supports the rapid product development processes of early-stage start-ups in the field of nanotechnology and advanced materials by benefiting from the infrastructure of SUNUM.
- NORMDEA Call: It is a call opened to support innovative commercial ideas in fields such as biology, chemistry and engineering at universities. Some of the evaluated projects continue negotiations in the fields of pharmaceuticals, functional food and cosmetics.

In 2017, SUNUM was granted the title of National Research Center and since then, it has applied for 129 patents, 63 of which have been registered. In addition, 438 national and international projects have been successfully realized [61].

Development Agencies

Development Agencies provide financial and technical support to regional actors in the areas specified in regional plans and programs, annual work programs and related application guides in line with predetermined eligibility criteria in order to accelerate the development process of regions in Türkiye and to implement activities of critical importance for the region. Working for local development in 26 regions of Türkiye under the coordination of the Ministry of Industry and Technology, Development Agencies are the coordination, financing and advisory centers of the regions by dynamically analyzing regional needs in the face of changing public administration demands and mobilizing appropriate structures. The plans implemented by Development Agencies create a vision for local stakeholders' future visions, sustainability goals and new initiatives that generate economic value [62].

The main services of the 26 Development Agencies, which are included in Türkiye's regional values as an intermediary institution in achieving a qualified structure, are as follows

- Preparing strategies related to regional development
- To carry out studies to identify the resources and opportunities of the regions, to accelerate economic and social development and to increase competitiveness and to support the studies carried out in this regard
- To support cooperation and coordination between public, private sector and non-governmental organizations in order to achieve regional development objectives
- To research and promote business and investment opportunities in the regions and to attract resources to the region
- Supporting entrepreneurship and entrepreneurship ecosystem
- Contributing to the development of technical capacities of local governments and organizations in the region
- To carry out mediation and coordination activities in the utilization of international funds by stakeholders in the region and to strengthen the R&D and innovation infrastructure of the region with all these components

Development Agencies analyze the unique dynamics of each region and prepare strategic documents for the region. These documents include elements such as Development Plans, National Strategy for Regional Development, Regional Plans, Regional Action Plans and Specialization Commission Reports. Agencies implement various practices to support regional development and increase efficiency. These practices can be summarized as follows:

- **Support Programs:** Development Agencies contribute to regional development goals by providing financial and technical support to local projects through programs such as Supporting Attraction Centers, Supporting Social Development and Working and Producing Youth.
- **Monitoring and Evaluation:** Monitoring and evaluating the alignment of the projects with the objectives is among the priorities of the agencies. These studies increase the impact of projects by preparing the ground for strategic corrections.
- **International Cooperation:** Development Agencies carry out joint studies with international organizations and benefit from funding sources, especially in the fields of energy efficiency and green transformation.
- **Support for Youth:** Through projects to increase youth employment and entrepreneurship support, agencies contribute to both individual development and regional development goals.

These activities aim to lead sustainable development by mobilizing local potential.

5. TT Instruments

In order to strengthen the TT ecosystem, it is aimed to enable university researchers to carry out their research by utilizing national/international grant resources, transform their research ideas into effective projects, ensure partnership and cooperation with other actors in the ecosystem, protect their innovative

products and ideas, transform their technological and innovative ideas into added value, validate and mature their business ideas, and meet with investors. Accordingly, there are tools used to promote TT in HEIs. The choice of TT instruments varies depending on the type of technology being transferred, the needs of the parties and other factors. These instruments establish the legal framework for TT and ensure the protection and commercialization of technology. Moreover, the content of the instruments used varies depending on the university/public institution or industry side. On the industrial side, contracts with a stronger legal basis, license and/or transfer agreements are used as instruments of significant value.

Call Information Form: 'Call Information Form' is used to present current/open project and grant calls with summary information. This form contains the answers to the most important and curious questions (Who can apply?, Purpose/Budget/Support Rate of the Project, etc.) in the guide of the relevant call for the target audience. The prepared form is shared with researchers through the relevant announcement channels to increase their awareness.

Training Activities: In order for researchers to apply for national and international support programs, trainings to improve their project writing knowledge and skills, patent research training, contract preparation training, company establishment training are organized.

Guidance Support: To inform researchers about the financing of R&D and innovation, to facilitate their access to funds, to direct them to relevant funds, and to direct them to establish company and/or industry collaboration projects and collaborations by evaluating the suitability of their ideas for the industry and their commercialization potential.

Participation in International Networks: In order for researchers and institutions to be more effective in the international arena, in accordance with the internationalization strategy, activities are carried out and guidance is provided for participation in international networks in order to improve international cooperation, increase the quantity and quality of project proposals submitted to international funding programs, and ensure participation in international project consortia.

Project Preparation, Budgeting, Evaluation and Application Support (Administrative and Technical Support): Direct support is provided to academics and industrialists from the project creation stage to the application preparation, preparation of the project proposal form in formats suitable for national/international grant programs, project writing, budgeting, reading the project, giving feedback, execution and monitoring of the project. In addition, after the project is entitled to receive support, TTOs provide support such as accounting procedures, completing the paperwork and signature procedures. Technical support services play a critical role in promoting TT. The comprehensive support provided to academics and industrialists during the project creation, application preparation and execution stages makes R&D processes more efficient. Assistance in project writing, feedback and monitoring improves the quality of projects and contributes to successful outcomes. In addition, assistance in the accounting and paperwork processes of supported projects reduces bureaucratic obstacles and accelerates TT. The support provided at all stages of these processes makes it possible for researchers to conduct joint research with international researchers, to combine academic knowledge and industrial experience more effectively, and to bring innovative solutions to the market quickly.

UIC Process Management: TTOs use standardized workflows and models for UIC activities in order to encourage TT. In its activities for the needs of the industry, it effectively implements activities such as communication with companies, field visits, demand collection and business development. Project titles for product and/or process development are determined in line with the needs of the industry and companies. Simultaneously, according to the fields of activity of the companies, the demands of the academicians for the project topics they want to develop are learned and collaborations are established between the university and the industry. Collaborations can be realized in many different ways such as R&D partnerships, private sector or publicly supported collaborations, assignments, etc. and there is a certain workflow for all models.

UIC Service Procurement Contracts: Under the umbrella of UIC, TTOs prepare contract drafts for the services to be provided by researchers and support the process as a party to the contracts. The fact that TTOs standardize the contract processes, help prevent legal and commercial disputes, and the presence of TTO as a party to the contracts is an incentive for researchers in terms of trust and process. By undertaking the contract preparation processes of TTOs, it reduces the time and effort that researchers will spend on this issue and encourages cooperation by ensuring that cooperation processes are carried out smoothly and professionally.

Creating an Academic Pool: Information on academics who want to take part in all studies such as consultancy, project partnership, mentoring, training and test-analysis services designed for the needs of the industry is collected by TTOs with different methods and a pool is created. The relevant pool contains information such as the academic studies, field of specialization, UIC experiences, etc. of the academician. This pool can be opened to the industrialists, as well as a special pool/catalog etc. can be created for the industrialists.

Creating pools of academics is an important strategy to promote TT. Compiling information on academics' areas of expertise, academic studies and experiences with industry enables more targeted and effective collaborations with industry. These repositories enable industrialists to quickly and efficiently find the right experts for their needs. In particular, creating industry-specific repositories and catalogs supports the development of innovative solutions and the rapid progress of R&D projects by encouraging TT. This structure facilitates the combination of academic knowledge and industrial applications, paving the way for greater collaboration and innovative projects.

Patent License Agreements: A patent license agreement is a contract in which a patentee undertakes to grant a licensee the right to use a patented invention in exchange for a certain consideration. Such agreements enable the commercialization of patented technology and its reach to a wide audience. In Türkiye, when an invention is transferred or licensed, it is either sold through a tender process or directly. Patent licensing agreements take place in the form of exclusive and non-exclusive licensing. In non-exclusive license agreements, the licensor may use the right itself or grant other licenses to third parties. In exclusive license agreements, the licensor cannot grant licenses to others and cannot use the relevant right itself unless it expressly reserves its right [63].

Know-How Agreements: Know-how agreements are contracts involving the transfer of confidential technical knowledge and experience. Such agreements are used in the transfer of technologies that are not subject to patent protection. Know-how agreements usually contain confidentiality clauses and licensing provisions. In Türkiye, this process usually continues in the form of the academic providing consultancy along with the patent.

Trademark License Agreements: A trademark license agreement is a contract in which a trademark owner undertakes to grant a licensee the right to use its trademark in exchange for a certain consideration. Such agreements can help increase brand awareness and market share. A similar process is followed for a trademark as for a patent license.

Design License Agreements: A design license agreement is a contract in which a design owner undertakes to grant a licensee the right to use its design in exchange for a specified consideration. Such agreements help to promote the marketing and sale of designed products.

Geographical Indication (GI) License Agreements: A GI license agreement is a contract whereby a GI owner undertakes to grant a licensee the right to use its GI in exchange for a certain consideration. Such agreements help to protect the authenticity and reputation of GI products. These agreements are mostly realized in organizations such as municipalities, chambers of commerce, etc.

Transfer of IPRs: IPRs can be transferred through an acquisition or merger, or through a contract of sale. A takeover is the acquisition of all the assets and liabilities of a company. A merger is when two or more companies come together to form a single company. A contract of sale is a contract involving the transfer

of a specific IPR. Such agreements enable the commercialization of patented technology and make it available to a wide audience. In Türkiye, when an invention is transferred or licensed, it is either sold through a tender process or directly.

Attorney Company Service: Applications for the protection of intellectual property are realized through applications to the relevant institution. In this process, for example for a patent; documents such as description, abstract, claim, technical design must be prepared and filed in the institution system. These procedures can be carried out individually or by Patent/Patent Attorneys authorized by the TÜRKPATENT. The use of attorneys helps to accelerate the processes on both the industry and university/public side and to facilitate patent, utility model, design, trademark and geographical indication applications and registration processes.

Confidentiality Agreements: Ensures that the parties commit not to share shared confidential information with third parties. This ensures the protection of technological information and prevents unauthorized use.

Commercialization Support: TÜBİTAK 1702 supports institutions to transfer patented technologies developed in universities, research institutions and TDZs to industry. In the TÜBİTAK 1702 Patent License call, projects are supported for a maximum of 60 months. The upper limit of the project budget is €4 million. The upper limit of the support rate is 60% for large-scale Client Organizations and 75% for SME-scale Client Organizations. This support provides commercialization advantages for both industry and public institutions [64].

Patent Incentives: Different incentives are also applied for the commercialization of the registered patent. One of these incentives is the tax exemption granted by TÜRKPATENT. There is a corporate tax incentive if the industrialist uses and sells the registered patented technology within the company. Commercialization is supported with this incentive [65].

Another incentive is the TÜBİTAK patent incentive. The TÜBİTAK 1602 project provides both support for international patent application fees and a registration award in case the relevant invention is registered. These incentives enable qualified technologies to enter the national and international market.

Publications on IPRs: Tools such as commercialization booklets, patent promotion cards, IPRs booklets, invention summaries booklets prepared for technologies in universities/public institutions can be considered as tools for commercialization and transfer of the invention to industry. A patent portfolio booklet containing the details of the invention is prepared by collecting the summary information of IPRs. This booklet is published on the website. In addition, support is provided for the commercialization of the invention in universities by exhibiting it in organizations such as industrialist meetings, fairs, competitions, etc.

Pre-incubation Programs: One of the cornerstones of the entrepreneurship ecosystem. These programs create the first steps of the entrepreneurial journey by supporting projects that are still at the idea stage. Usually run by universities or TTOs in Türkiye, pre-incubation programs offer prospective entrepreneurs the opportunity to test, validate and develop their ideas. During the program, participants meet with mentors, receive training and benefit from networking opportunities. At the end of this process, entrepreneurs take their business ideas to a more mature level and are ready to present them to investors. In universities, it is usually carried out within the framework of activities such as idea development and idea validation. Pre-incubation graduates can then be directed to more advanced programs.

Accelerator Programs: Intensive programs targeting the rapid growth of more advanced startups. In Türkiye, they are usually carried out by TTOs, consulting companies, private sector companies in certain periods. There are also accelerator programs that are carried out at the preliminary stage of competitions or grant programs organized by the public (TÜBİTAK 1812 Program, GCIP Program, etc.). These programs last 3-6 months and aim to help startups grow and receive investment in a short period of time. Investment networks and angel investors can participate in accelerator programs in Türkiye to make seed

investments. Accelerators provide mentorship, training and office space to selected startups in line with the facilities of the executor. Throughout the program, startups work intensively on developing their business models, improving their products and acquiring customers. At the end of the accelerator program, a demo day is usually organized and the startups are presented to investors. This gives the startups the opportunity to secure the necessary financing for growth.

Incubators: Long-term programs that support startups in their early years. These centers aim to increase the survival rate of startups and ensure their sustainable growth. Incubation programs usually last 1-3 years, during which time startups are offered office space, mentoring, training and networking opportunities. Incubation centers are also located within technopark. With this long-term support, startups have the opportunity to increase their market share, develop their products and achieve financial sustainability. Incubation centers play a critical role in ensuring that startups are built on solid foundations and are successful in the long term.

Demo Days: It is one of the exciting events of the entrepreneurial ecosystem. On these days, startups present their products and business models to investors and potential customers. The main purpose of demo days is to enable startups to meet investors and increase their chances of finding funding. This tool, which is frequently used in Türkiye, both increases the awareness of the entrepreneurship ecosystem and increases investment support. During the event, entrepreneurs usually make short, effective presentations, followed by one-on-one meetings with investors. Startups with successful presentations have the opportunity to receive investment and establish strategic partnerships. Demo days also help startups gain media visibility and connect with potential customers.

Entrepreneurship Competitions: They are important organizations where innovative ideas and projects are awarded. These competitions are organized to encourage new ideas, motivate entrepreneurs and make successful projects visible. In Türkiye, entrepreneurship competitions are organized by TTOs, private companies, Technopark, Foundations and the Public Sector. In these competitions, entrepreneurs present their projects, which are usually evaluated by an expert jury and the winners are determined. Entrepreneurship competitions not only offer participants the chance to win prize money, but also provide mentoring, training and investment opportunities. These competitions encourage the emergence of new ideas in the entrepreneurship ecosystem and help successful projects reach a wider audience.

Experience Sharing Days: These are important events for sharing knowledge and experience in the entrepreneurship ecosystem. On these days, successful entrepreneurs and industry leaders share their experiences, the challenges they faced and how they overcame them. Commercialization of academic studies has an important place in TT processes. Based on this, experience sharing of academic initiatives can often take place, especially at universities. In experience sharing, topics such as the motivation of entrepreneurs to start, the challenges they face, financing management, team management are often discussed. The events are usually organized as panel discussions, speeches or question-and-answer sessions. Experience sharing days inspire new entrepreneurs, help them avoid potential pitfalls and provide insights for success. They also provide networking opportunities, foster connections between entrepreneurs and strengthen collaboration within the ecosystem.

Co-working Spaces: They are an important element of the physical infrastructure of the entrepreneurship ecosystem. These spaces offer flexible, cost-effective and collaborative working environments for freelancers, small teams and early-stage startups. Co-working spaces can be provided free of charge by universities and, unlike the traditional office rental model, they can offer short-term and flexible rental options, which is especially ideal for startups that want to use their resources efficiently. These spaces not only provide a physical working environment, but also offer opportunities for community building and networking. Entrepreneurs can come together with people from different industries and disciplines to exchange ideas, develop collaborations and meet potential customers or investors. Many co-working spaces also support the personal and professional development of their members by organizing training programs, workshops and social events.

Entrepreneurship Ecosystem Platforms: These are online tools that support and facilitate entrepreneurship processes with the opportunities brought by the digital age. They function as virtual meeting points that bring together all stakeholders in the entrepreneurship ecosystem (entrepreneurs, investors, mentors, corporates and support organizations). Entrepreneurship ecosystem platforms typically offer a wide range of services: resources and educational materials for entrepreneurs, mentorship matching programs, investor databases, event calendars and business opportunity announcements. These platforms also help track the progress and success of startups, analyze trends within the ecosystem and provide data to policymakers. Some platforms also offer online incubator or accelerator programs, creating support mechanisms that transcend physical limitations and reach a wider audience. Entrepreneurship ecosystem platforms play a critical role in increasing the connectivity and efficiency of the ecosystem, especially with increased digitalization in the wake of the COVID-19 pandemic. These platforms contribute to building a global entrepreneurship network across geographical boundaries, thus enabling local ecosystems to establish international connections. In Türkiye, examples of these platforms can be publicly supported or even directly created by the government (bigg.tubitak.gov.tr).

5.1. Exchange of Research Personnel with Companies

UIC is defined as R&D, education-training and service providers by applying the knowledge produced at the university and the resources available in the industry together with the right planning and timing with the aim of providing benefits at the national economy and social level [66].

Universities are institutions that have duties such as conducting research and encouraging research, producing publications, educating qualified students and revealing innovative information through R&D activities by creating a knowledge infrastructure. Industries, on the other hand, are organizations that aim to ensure the continuity of the competitive environment by using the resources of the country in which they live in the most efficient and beneficial way, to provide economic returns, to create social benefits and to use science to gain speed in production. UIC is defined as researchers and industrialists working for the same purpose with common goals [67].

On the basis of UIC, it is thought that by integrating R&D, innovation and technology enhancement activities carried out by universities and the industrial sector together into industrial production processes, the existing production technology will be improved and at the same time contribute to the economic development of the country. UIC ensures that the information obtained as a result of research conducted at universities is not only limited to publications but also put into practice. This cooperation is a method that aims to transfer technological developments and knowledge to production processes in line with the needs of the industry and puts this into practice. The cultural differences between universities and industry enable research approaches to diversify. Effective collaboration between industry and academia requires a special rapport; understanding mutual interests, setting common goals and focusing on complementary capabilities are key elements for successful collaboration.

When the university-industry mobility in the country is analyzed, it is seen that the mobility mainly follows a course from universities to industry. This shows that the academic world plays a more active role in transferring knowledge and technology to industry.

In this framework, current practices are listed as follows;

TÜBİTAK 2244 Industry Doctorate Program: This program aims to strengthen the link between academic knowledge and industrial applications and aims to train qualified human resources with doctoral degrees needed in the industry through UIC, and to encourage the employment of doctoral researchers in industry. In this process, doctoral students are provided with a scholarship, 75% of which is covered by TÜBİTAK and 25% by the company. In this situation, which continues during the doctoral process, 40% of the monthly salary is covered by TÜBİTAK during the period when the company employs the scholarship holder for 1 year.

LIFT UP Industry-Focused Graduation Projects Program: Türkiye Aerospace Industry (TAI), in order to strengthen UIC, to carry out aviation studies with universities and to make TT in the field of aviation sustainable within the university, students are provided with the opportunity to carry out their graduation projects under the guidance of company engineers, benefiting from the scientific and technological infrastructure of TAI. In this way, aviation problems are solved with universities, and undergraduate, graduate and doctoral students can carry out their thesis studies on aviation issues.

Student Exchange Programs: Programs such as Erasmus, Farabi, Mevlana, etc., which Türkiye is also involved in, allow students to gain experience in different cultures and business environments, while offering new talents and perspectives to the business world. Students bring the knowledge and skills they acquire through internships and projects abroad or in different institutions to their home universities and future workplaces. This interaction fosters innovation and builds bridges between the needs of business and academia, leading to more effective and efficient solutions.

Creating Internship Opportunities through Academy and Industry Pairings: These collaborations, which play a critical role for innovative solutions and economic growth, contribute to the development of new products, processes and technologies by transforming academic research into practical applications. Universities support industry with their knowledge and research capacity, while industry provides universities with funding, real-world problems and application areas. In addition, with the environment of trust that emerges as a result of these collaborations, mutual benefit is achieved, internship and job opportunities are created for students, career development is supported and graduates are better prepared to join the business world.

Career Gateway National Internship Program: It is a comprehensive program initiated by the Presidential Human Resources Office to ensure that students benefit from internship opportunities offered by public and private sector organizations. This program enables students to gain professional experience, meet the business world and take an important step in achieving their career goals. The program, which offers internship opportunities in various fields in the public and private sectors, contributes to the development of young talents' knowledge and skills, while supporting the training of qualified human resources needed by the business world. Thus, students have the chance to transform their theoretical knowledge into practice and expand their professional network.

R&D and Design Center Assignments: These assignments, which are of great importance in terms of developing innovative solutions and accelerating technological advancements, bring academia and industrialists together to work on joint projects. R&D Centers support the transformation of creative and innovative ideas into concrete products and services by providing researchers with advanced laboratories, high-tech equipment and financing resources. In addition, by combining the knowledge and experience of experts from different disciplines, these centers allow for more comprehensive and effective solutions. Law No. 5746¹ on Supporting Research, Development and Design Activities makes it legal for companies with R&D Centers to employ full-time or part-time academics with the permission of university boards of directors, thereby encouraging cooperation between universities, industrial organizations and government agencies and increasing national and international competitiveness.

Assignments in TDZs: Law No. 4691² aims to establish TDZs in Türkiye and regulate the activities in these zones. Within the framework of this law, faculty members at universities can be assigned to TDZs within the framework of Article 39 of Law No. 2547¹² in order to contribute to R&D and innovation studies by transferring their knowledge and experience to industry. Faculty members are assigned part-time with the permission of the University Administrative Board. The income that part-time faculty members receive in return for their services is excluded from the university revolving fund. The assignment of faculty members in TDZs both ensures the integration of academic knowledge into industry and strengthens UIC.

5.2. Internationalization of Knowledge Transfer

The TT process has been one of the most effective tools in the development strategies of countries for the last hundred years, and this process has become indispensable due to the globalization of the economy

and the increasing internationalization of technology and technological activities. In addition, today, the basic condition for developing countries to become capable of producing technology depends on the good functioning of domestic TT mechanisms and the effective use of international TT. What is meant by effective utilization is not only the importation of technology, but also the development of technology after importation to enable countries to become capable of producing their own technologies.

The internationalization of Türkiye's TT is continuously evolving to increase the country's innovation capacity and strengthen its global competitiveness.

In this context, when the Development Plans prepared as a road map within the scope of Türkiye's development vision with a long-term perspective (especially the 10th (2018-2022), 11th (2019-2023) and 12th (2024-2028) Development Plans) are examined, it is seen that the following objectives, policies and strategies are included;

- Bilateral, regional, multilateral and multilateral trade and economic relations and cooperation will be developed in line with Türkiye's national rights and interests, and Türkiye's share in world trade will be increased in line with growth targets. A significant improvement will be achieved in the financing quality of the current account balance with the impact of foreign direct investments that provide TT.
- Increasing FDIs Domestic companies operating in high-tech sectors with high growth potential will be matched with international investors and their investments based on TT will be supported.
- Public-private partnership projects, public procurement, licensing, offsets, etc. of public institutions and organizations that have the potential for private sector investment will be carried out within the framework of the decisions of the Industrialization Executive Board, with the perspective of attracting FDI and TT to Türkiye.
- Supports will be designed to increase advanced participation in global value chains, and company collaborations that can provide technology and knowledge transfer will be strengthened.

Various tools and strategies are used for the internationalization of knowledge and technology in Türkiye. These instruments are designed to ensure that scientific research, technological innovation and knowledge sharing take place effectively at the international level.

Some important tools are as follows;

International TT Agreements: Türkiye transfers technology from many countries and signs TT agreements. These agreements facilitate access to international technology for Türkiye companies and research institutions.

Partnerships with Global Companies: Türkiye companies and technoparks are developing joint projects and collaborations with global technology giants and research centers.

TTOs and Derivative Units: TTOs and derivative units operating in institutions such as HEIs, Research Centers, BSOs, Technoparks, etc. support the establishment of international collaborations, protection of IPRs and other rights owned by the institution, determination of commercialization processes, and management of transfer processes in this context.

Technology Fairs: Türkiye participates in various international technology fairs to promote its technologies in the global market. These fairs are important platforms for creating international business opportunities and developing collaborations.

Science and Technology Conferences & Seminars: International conferences help Türkiye researchers and technologists gain global visibility and establish international collaborations.

International Investors: Türkiye seeks to attract international investors to technology-oriented entrepreneurs. Investors contribute to international growth targets by funding innovative projects in Türkiye.

National and International Funding and Support Programs: Türkiye internationalizes TT by taking advantage of various funding and support programs. International Publications and Databases: It enables researchers in Türkiye to publish worldwide, to follow international literature, and facilitates international access to research articles and scientific publications.

International Technology and Innovation Networks: Networks that bring together experts, entrepreneurs, researchers and companies from various countries and sectors are utilized.

National Strategies: Türkiye develops policies that encourage international cooperation within the scope of its technology and innovation strategies. These policies aim to increase the effectiveness of TT at the international level.

Legal and Regulatory Frameworks: Legal and regulatory frameworks required for international TT are being established and updated.

Türkiye benefits from many opportunities by participating in international research and cooperation programs. ***Examples of some of the most important instruments and programs that Türkiye, as a member state, can benefit from and has benefited most from in the context of internationalization of TT are as follows;***

Horizon Europe: The EU's research and innovation program for the period 2021-2027. Türkiye is a full member of the Horizon Europe program. This program promotes scientific research, funds innovative projects and supports international cooperation. Horizon 2020, FP7 (7th Framework Program) and FP6 (6th Framework Program), the framework programs that preceded Horizon Europe, were also used by Türkiye. These programs provide funding opportunities that promote cooperation in research and technology. As of the second quarter of 2024, statistics and data show that 1107 stakeholders from Türkiye have been involved in 486 projects so far in the Horizon Europe Program, which started in 2021, and it has been stated that a total budget of €243.4 million has been provided [68].

Erasmus+: A European program that supports international cooperation in the field of education, youth and sport. Türkiye is involved in the Erasmus+ program, benefiting from higher education, vocational training, youth projects and student exchange programs. The development of international cooperation is possible especially within the Strategic Partnerships program, which aims to support the development, transfer and/or implementation of innovative practices at institutional, local, regional, national or European level.

COSME: By participating in the EU's COSME program for SMEs, Türkiye facilitates access to international markets and business development opportunities for SMEs. SMEs can benefit from COSME to enhance their international TT activities.

EUREKA Network: Eureka was established in 1985 as an agreement between 18 countries and the European Commission to foster competitiveness and market integration and to encourage R&D cooperation. Since then, Eureka has expanded to include 47 countries (in Europe and beyond) who share the same goals and provide national funding to organizations. Türkiye joined the Eureka Network in 2004, which aims to develop international cooperation projects especially for SMEs. The opportunities and support provided by the program, which contributes significantly to increasing Türkiye's research and innovation capacity at the international level and establishing global collaborations, enables Türkiye companies and research institutions to increase their competitiveness and develop innovative solutions, promotes TT and innovation among member countries.

Cross-Border Cooperation Programs: Cross-border cooperation programs, which are one of the instruments of the EU Regional Policy as well as the European Neighbourhood Policy and the EU Enlargement Policy, contribute to the development of border regions, aim to improve the research and innovation capacities of the program countries, and to increase and improve the adoption of advanced technologies. Türkiye is participating in 1 cross-border (Interreg A) and 2 transnational (Interreg B) cooperation programs in 2021-2027. These are Interreg IPA Bulgaria-Türkiye Cross-border Cooperation

Program (Interreg A), Interreg NEXT Cross-border Cooperation Program in the Black Sea Basin (Interreg B) and Interreg NEXT Cross-border Cooperation Program in the Mediterranean Basin (Interreg B). In the periods 2003-2006, 2007-2013 and 2014-2020, a total of €79 million under the Bulgaria-Türkiye Program and €41 million under the Cross-Border Cooperation in the Black Sea Basin Program were allocated for projects with Türkiye partners and a total of 310 projects were successfully implemented under the two programs [69].

Bilateral and Multilateral Programs: TÜBİTAK offers various cooperation programs to support Türkiye's scientific and technological research and to integrate more effectively with the global scientific community. Within the scope of these programs, bilateral agreements are signed with various countries to conduct joint scientific and technological research and to implement research and innovation projects at the international and national level. The programs, carried out under the national coordination of TÜBİTAK, are designed to increase Türkiye's integration into international research networks and strengthen scientific collaborations.

International Memberships: It is essential that researchers collaborate with international colleagues and comply with international standards to facilitate the transfer of technology resulting from their research, have a broad international network and trusted collaborators to form international consortia. Türkiye actively participates in the activities of various research programs, networks and memberships such as COST, Enterprise Europe Network (EEN), Global Research Council-GRC, IRASME, Collective Research Network-CORNET and European Molecular Biology Conference-EMBC; regional organizations such as Black Sea Economic Cooperation-BSEC, Partnership for Research and Innovation in the Mediterranean Region-PRIMA and Organization for Economic Cooperation-ECO; and international organizations such as NATO, OECD and United Nations Educational, Scientific and Cultural Organization-UNESCO. The participation of Türkiye scientists in relevant activities organized by these organizations is supported or monitored by TÜBİTAK. These participations enhance the international TT activities of Türkiye. Additionally, within the scope of 'TÜBİTAK Network Membership Support Program', TÜBİTAK provides grant support for the payment of membership fees for organizations operating in Türkiye to become and maintain their membership in network structures that are active in the field of science and technology across Europe.

The **COST** program and **EEN** stands out for Türkiye among the above-mentioned programs and networks. According to the statistics provided by the **COST Organization**, Türkiye achieved notable success in 2022 and 2023. In 2022, Türkiye achieved the distinction of becoming the third most participating country, with a participation rate of 99% in all active actions. Additionally, the country reached a notable number of members, with 3.084 individuals participating in Working Groups. In the same year, Türkiye was the fifth most successful country in terms of individual participation in COST network activities, with 1.113 participants, and the fourth country with the highest budget allocation of approximately EUR 1.5 million [70]. The existing literature frequently emphasizes that participation in international networks and consortiums has positive effects on researchers' career development, knowledge transfer and encourage innovation among researchers by fostering interdisciplinary networks.

EEN is a network supported by the European Commission that aims to increase international business opportunities for SMEs. EEN helps businesses innovate and grow on an international scale. It provides services to help companies find international partners, enter new markets, and access funding. Bulgarian businesses can use EEN to connect with partners across Europe and beyond, enhancing their TT capabilities. Türkiye benefits from various opportunities as a member of this network with 11 consortia consisting of 50 organizations including KOSGEB directorates, chambers, universities, research centers, technoparks, development agencies and TTOs.

5.3. Tools Used for Dissemination of Generated Knowledge

The TT ecosystem in Türkiye has been developing rapidly in the last 10 years with the national technology drive, the alignment of incentive programs with technology, and legal processes that have created a space for action for TT actors. In this development process, effective dissemination of knowledge plays a critical

role. Various tools used in Türkiye enable innovative ideas and technological developments to be brought to the public and accelerate TT processes.

5.3.1. Fairs and Events

In Türkiye, fairs, events and summits have become one of the most visible and effective tools of the TT ecosystem. These platforms attract a lot of attention due to their potential to reach large audiences, provide direct interaction and encourage new collaborations. Especially in recent years, large-scale technology events organized with government support and private sector partnerships have played an important role in the development of Türkiye's innovation ecosystem. These events not only bring together technology providers and potential buyers, but also inspire young entrepreneurs and showcase Türkiye's potential in technology in the international arena. By organizing these technology-shaping events in specific cities each year, a wide range of participants with a wide age range can be reached.

TEKNOFEST Aviation, Space and Technology Festival, organized for the first time in 2018 in Istanbul, is an aviation, technology and space technology festival organized in Türkiye. The festival is held every two years in Istanbul and every other year in one of the Anatolian cities, open to the public. The festival hosts competitions on a wide range of topics such as smart transportation, blockchain, biotechnology innovation, environment and energy technologies, rocket technologies, civil defense, wireless communication technologies, and has been visited by more than 4.5 million people across the country. One of the comprehensive events organized to promote TT priority areas across the country and create a multiplier effect of the technology language is observed in Türkiye with TEKNOFEST. As one of the key TT events, TEKNOFEST is more than just a fair, it has become a platform that reflects Türkiye's technology vision and guides young people towards STEM fields.

ISIF, organized for the 9th time in 2024, is held together with TEKNOFEST as an invention fair open to participants on an international platform, where new components are included every year. The patent fair, which is organized with the aim of bringing together invention, R&D and innovation activities that add value to Türkiye's development with national and international participants and commercializing the technical knowledge produced and presenting it for the benefit of society, hosts over 5.000 technologies from 62 different countries.

Organized to support the regional TT ecosystem, Karadeniz Technical University (KTU) Project Market from Dream to Reality is held periodically every year to enable young engineer candidates to project the technologies they have developed with early awareness, to exhibit them with prototype works and to meet with investors.

The events, fairs and summits organized by state authorities in Türkiye, which have adopted the national technology Initiative policy as a TT culture, not only strengthen Türkiye's innovation ecosystem, but also reinforce the country's position in the global technology market and the transformation in TT.

5.3.2. Websites and Online Platforms

The use of websites and online platforms in the TT process in Türkiye has increased significantly in recent years. Digital tools are widely used to provide fast and easy access to information, reach large audiences and reduce costs. Especially after the COVID-19 pandemic, the importance of these platforms has increased and the digitalization of TT processes has accelerated. Universities, research institutions and technology companies in Türkiye are developing their own websites and online platforms, increasing transparency in the TT process and making it easier for potential business partners to find each other.

TTOs, startups, technoparks, SMEs, incubation centers, public institutions, angel investors, banks, TT platforms, innovation companies, etc., which are the actors of the TT ecosystem in Türkiye, carry out all TT processes through their official websites and complete them through online platforms within the scope of transparency policy. All actors publish their annual performance indicators for the attention of third parties. Sharing analyses are evaluated with software that monitors the statistics of visits to the web pages, and the most impactful posts are made at the most appropriate times.

Such platforms make Türkiye's TT processes more efficient and accessible, thus contributing to increasing the country's innovation capacity.

5.3.3. Social Media and Digital Communication Channels

The role of social media and digital communication channels in the TT ecosystem is increasing in Türkiye. These platforms are widely preferred due to the rapid dissemination of information, interactive communication and the advantage of reaching large audiences at low cost. Especially effective in reaching young entrepreneurs and start-ups, social media channels play a critical role in Türkiye's dynamic and rapidly growing technology ecosystem. By using these channels, universities, technoparks, research centers and technology companies not only share information, but also serve various purposes such as building communities, creating networking opportunities and triggering new collaborations.

LinkedIn, a meeting point for business professionals, Instagram, an active platform for young entrepreneurs, and WhatsApp, an international interactive communication channel, are popular social media and communication channels for TT in Türkiye, where entrepreneurs showcase their innovative technologies and reach large audiences. In addition, YouTube is used as an educational platform by all TT actors. YouTube is among the privileged platforms that provide high participation advantage with its live broadcast feature.

In the case of entrepreneurs, new startups using LinkedIn accounts bring their technologies to the users on the platform that has exceeded the 1 billion user threshold on social media with strong visuals of the prominent aspects of their technologies thanks to the showcase feature.

YouTube channels are the communication channels where powerful institutions such as TÜBİTAK in Türkiye record all the comprehensive trainings carried out by academics, industry and entrepreneurs in the sector and make use of them as a sustainable platform for their users.

It shows how social media and digital communication channels can be used effectively in the TT ecosystem in Türkiye. These channels go beyond traditional communication methods and offer the opportunity to reach a wider and more diverse audience, receive instant feedback and create an interactive communication environment. Thus, making Türkiye's TT processes more dynamic, participatory and transparent.

Türkiye ranks 9th on LinkedIn with 16.4 million users and is among the countries that actively use the platform [71].

Country	LinkedIn Users 2024	LinkedIn Users 2023
United States	236M	200M
India	135.4M	99M
Brazil	71.1M	59M
United Kingdom	42.7M	35M
Indonesia	27.9M	23M
Canada	26M	21M
Mexico	22.8M	19M
Philippines	17.7M	13M
Turkey	16.4M	13M
Australia	15.9M	14M
Colombia	14.8M	12M
Argentina	14.3M	11M
South Africa	13.9M	11M
Pakistan	13.4M	9.3M
Egypt	11.4M	7.9M
Nigeria	10.2M	7.5M

Figure 7. Number of LinkedIn Members by Country

5.3.4. Webinars

In Türkiye, webinars have become an indispensable part of the TT ecosystem, especially in recent years. These digital events offer the opportunity to reach a wide range of participants by eliminating geographical limitations, providing an interactive learning environment and cost-effective knowledge sharing. During the COVID-19 pandemic, the use of these tools has become more widespread, and many institutions have moved their training and information sharing activities to these platforms. Webinars bring together stakeholders from different regions of Türkiye, facilitating knowledge and experience sharing and contributing to the spread of TT culture across the country.

A prominent example in this area is the webinar series organized by TÜBİTAK under the BiGG program. TÜBİTAK regularly organizes webinars under this program. In 2022, over 15.000 entrepreneur candidates participated in more than 30 webinars, which resulted in a 40% increase in the number of applications to the program compared to the previous year. These webinars provide young entrepreneurs with valuable information on how to develop their technology-based business ideas, business plan preparation techniques and access to funding sources. Another notable example is the webinar series organized by Sabancı University Inovent Research Commercialization (IRC). Sabancı University IRC organized a webinar series titled "Success Stories in Technology Transfer" in 2022. This 10-week series, which was attended by more than 5000 people in total, discussed successful examples of TT in Türkiye and provided practical information to the participants. This webinar series provided valuable insights to ecosystem stakeholders by sharing the details of TT processes in Türkiye. These examples demonstrate how webinars and online seminars can be effectively used to disseminate TT knowledge in Türkiye. These digital events overcome the limitations of traditional face-to-face trainings and seminars, reaching a wider audience and enabling continuous learning. Furthermore, interactive sessions, question and answer sessions and case studies through these platforms enable participants to engage in active learning and contribute to a more effective internalization of knowledge.

5.3.5. Press Releases and Media Publications

In Türkiye, press releases and media publications are important tools used to disseminate information in the TT ecosystem. These tools are widely used to provide fast and reliable information to large audiences, raise public awareness and support the transparency of TT processes. Universities, technoparks and research institutions in particular make effective use of these tools to publicize their technologies, success stories and collaboration opportunities. Press releases and media publications also serve to promote Türkiye's technological achievements at national and international level.

A prominent example in this area is Teknopark Istanbul's media relations strategy. Teknopark Istanbul issued more than 100 press releases in 2022, announcing the achievements and technological developments of its companies. As a result of these press releases, more than 1.000 news articles appeared in the national media and investor interest in Teknopark Istanbul companies increased by 30%. This example demonstrates the potential of press releases and media coverage not only to share information but also to create tangible economic value. Teknopark Istanbul's strategy has succeeded in attracting both domestic and international investors by making visible the achievements of Türkiye's technology ecosystem.

Another notable example is Bilkent CYBERPARK's "Technology Journalism Project". Within the scope of this project, which was launched in 2022, Bilkent CYBERPARK collaborated with sectoral media organizations and regularly shared the technologies and success stories developed in the technopark with the national media. Thanks to this project, the media visibility of companies in CYBERPARK increased by 50%. One of the most important features of this project is that it takes a professional approach to technology journalism and conveys TT processes in a language that can be understood by a wide audience. In this way, complex technological developments and innovation processes have become more easily understood by the general public.

These examples illustrate how press releases and media coverage can be used strategically in the TT ecosystem in Türkiye. These tools not only share information, but also create opportunities for collaboration among ecosystem stakeholders, attract investor interest and promote Türkiye's technological achievements at national and international level. In addition, the public awareness generated through these publications contributes to raising social awareness on technology and innovation and supports the development of Türkiye's technology ecosystem in the long term.

5.3.6. TT Reports and Publications

In Türkiye, TT reports and publications are critical for tracking the development of the ecosystem, documenting success stories and providing guidance to policy makers. These tools are used to document developments in the sector, share success stories and measure the effectiveness of TT processes. At the same time, these reports and publications constitute an important data source for analyzing the current state of Türkiye's TT ecosystem, identifying its strengths and weaknesses, and shaping future strategies.

The "Technology Transfer Offices Performance Index Report" published annually by TÜBİTAK evaluates the performance of TTOs in Türkiye according to various criteria and provides a comparative analysis. It is considered as an indicator of Türkiye's increasing awareness of IPRs and innovation capacity. The report also examines the role of TTOs in UIC projects, licensing activities and the effectiveness of start-up support programs. This comprehensive analysis provides guidance to policymakers and ecosystem stakeholders by identifying the strengths and areas for improvement in Türkiye's TT ecosystem.

The "Technology Investment Report" published annually by TTGV provides a detailed analysis of technology investments in Türkiye. It is interpreted as an indicator that Türkiye is becoming increasingly competitive in advanced technology fields. The report also examines technology investments by sector, investment rounds and examples of successful exits. This comprehensive analysis is a valuable resource for understanding the financial dynamics of Türkiye's technology ecosystem and for predicting future trends.

These reports and publications increase the transparency of Türkiye's TT ecosystem and encourage information sharing among ecosystem stakeholders. They also provide an opportunity to assess Türkiye's position in the global technology market by enabling international comparisons. Such publications contribute to the development of Türkiye's technology ecosystem by providing an important reference source for academics, entrepreneurs, investors and policymakers.

5.3.7. Catalogs and Brochures

In Türkiye, catalogues and brochures are one of the traditional but still effective tools used for information dissemination in the TT ecosystem. These materials are widely used to present technologies and research results in detail and visually, providing easy-to-understand information to potential business partners and investors. Especially at events such as fairs, conferences and B2B meetings, these materials play an important role as the first point of contact between technology providers and potential buyers.

Technology Transfer Centers, Technology Development Zones, TEKNOKENT, TÜBİTAK, Development Agencies, Chamber of Commerce and Industry, etc., which keep the pulse of innovation and technology in our country. The structures take care to publish nationally their activities such as university-industry collaboration, patent licensing, sectoral fairs, internationalization activities of industrialists, and entrepreneurship. E-catalogues and brochures are used in a structure that reflects the sectoral activities of the actors in the ecosystem and are the most professional form of providing detailed information transfer about services and programs. Our university offers its e-catalog capacity to third parties as Patent Catalog, Academician R&D Catalog, COST Catalog, ARDEB & TEYDEB Brochure, KOSGEB Brochure and e-bulletins. Professional brochures and catalogs that keep commercialization interaction at a high level contribute to the recognition policy of KTÜ Technology Transfer Application and Research Center in the region [72].

These examples show that catalogues and brochures still play an important role in the TT ecosystem in Türkiye. These materials attract potential business partners and investors by presenting complex technological information in an understandable and attractive format. They also serve to promote Türkiye's technological capacity and innovation potential on national and international platforms. In the future, such materials are expected to evolve into more interactive and personalized formats, enriched with technologies such as augmented reality. This evolution will contribute to making knowledge dissemination processes more effective and impressive in Türkiye's TT ecosystem.

While KTU Technology Transfer Application and Research Center uses the catalogue and brochure strategy in writing, it creates R&D catalogues with academicians in wide variations by adapting to the content related to the rapid development of technology and the changing TT ecosystem, patent portfolios in priority areas and with commercialization potential in the last 5 years, and COST catalogues in the category of internationalization in promotion and awareness activities. Patent cards, where patented technologies are presented to investors on a page with pill information, are actively used in channeling TT investors.

5.3.8. Training Programs and Practical Training Studies in TT

In Türkiye, training programs and practical training activities play a critical role in the development of the TT ecosystem. These programs are widely used to increase the capacity of stakeholders involved in TT processes, provide them with practical skills and strengthen collaborations within the ecosystem. In particular, universities, technoparks and TTOs make significant contributions to the development of the human resources of Türkiye's innovation ecosystem by organizing such training programs.

One of the prominent examples in this field is the training program organized by Istanbul Technical University (ITU) Çekirdek Early Stage Incubation Center. In 2022, ITU Çekirdek organized a comprehensive early-stage entrepreneurship program lasting 6 months. Within the scope of the program, 100 startups received mentorship and training support, and 20 of these startups received a total investment of 10 million TL. The program provides entrepreneurs with training on critical topics such as business model development, financial planning, IPRs, and marketing strategies. In addition, entrepreneurs meet with industry leaders and investors during the program, providing valuable networking opportunities. Such programs directly contribute to the development of Türkiye's start-up ecosystem and accelerate the commercialization of innovative ideas.

Another important example is the internship program organized by Middle East Technical University (METU) Teknokent TTO. In 2022, METU Teknokent organized a 3-month internship program for university students. The 50 students who participated in the program took part in real TT projects, and 10 of these students were employed in companies within the technopark at the end of the program. This program provides students with the opportunity to put their theoretical knowledge into practice, while contributing to the training of qualified human resources needed in Türkiye's TT ecosystem. During the program, students gain hands-on experience in patent research, technology valuation and licensing processes.

Such training programs and hands-on activities play an important role in increasing the level of knowledge and skills in Türkiye's TT ecosystem. Through these programs, a common language and understanding is developed among ecosystem stakeholders, which facilitates collaboration processes. Moreover, these programs contribute to spreading Türkiye's innovation culture and strengthening the entrepreneurship ecosystem. In the future, it is expected that such programs will diversify further, with more specific trainings focusing on advanced technology areas such as artificial intelligence and blockchain. These developments will help Türkiye become more competitive in the global technology market.

5.3.9. Meetings and Visits

In Türkiye, meetings and visits are one of the key tools used in the TT ecosystem to disseminate knowledge and foster collaborations. These face-to-face interactions enable direct communication and information exchange between technology providers, investors, researchers and other stakeholders. Such events are especially critical for understanding complex technologies, building trust and laying the foundations for long-term collaborations.

A prominent example in this area is the "Industry Meetings" series of events organized by Ankara Technopark. In 2022, Ankara Technopark brought together companies within the Technopark and industrial organizations as part of these monthly events. As a result of these meetings, more than 30 R&D cooperation projects were initiated. These events provide technology development companies with the opportunity to establish direct contact with potential customers, and industrial organizations with the opportunity to discover the technological solutions they need. The events are usually organized around a specific theme (e.g. industrial automation, energy efficiency, artificial intelligence applications), allowing participants to have more focused discussions based on their areas of interest.

Another notable example is the "Open Door Days" organized by TÜBİTAK MAM. Within the scope of these events, industrial organizations and SMEs have the opportunity to visit TÜBİTAK MAM's laboratories and research infrastructure. More than 200 companies participated in the Open Door Days organized in 2022, and 15 new joint R&D projects were initiated as a result of these visits. Such visits enable companies to see TÜBİTAK MAM's technological capabilities and areas of expertise up close, thus helping to identify potential areas of cooperation in a more concrete way.

These examples illustrate how meetings and visits can be used effectively in the TT ecosystem in Türkiye. Such events play a critical role in building trust between ecosystem stakeholders, understanding mutual expectations and laying the groundwork for joint projects. Moreover, these face-to-face interactions provide an opportunity to address the cultural and social dimensions of TT beyond the technical aspects. This is crucial for successful TT processes, especially in a country like Türkiye, where business culture is based on relationships and trust.

By enabling ecosystem stakeholders in different regions of Türkiye to come together more frequently and effectively, it will contribute to accelerating TT processes across the country.

5.4. Barriers to the Commercialization of Knowledge Produced in HEIs

The performance of intellectual property practices, the skills of TT experts, government incentives and participation in incentives, the demands of industrialists supporting the industry to license patented technologies, and legal processes are critical in transforming academic studies into economic value.

The IPRS picture in today's Türkiye has been accessed through actions that eliminate obstacles such as the creation of valuation analysis reports to develop a common language in commercialization processes in Türkiye, supporting legal processes with applicable laws, and creating a roadmap of government incentives. The factors preventing access to improvement efforts were evaluated in legal, intellectual and sociological terms.

5.4.1. Legal Processes in the Field of IPRs

Prior to 2017, the legal process for IPRs protection in Türkiye was carried out under the Decree Law. Before the 2017 IPL, there was no explanatory information on applications made in HEIs, the obligation to use the invention subject to patent, the compatibility of patent protection periods with the European Patent Convention, employee invention, free invention, licensing, licensing income, patent protection scope. Inventions arising in HEIs were not included in the patent ecosystem due to articles not included in the law, and only inventors could be patent owners. The insufficient elements of the law caused HEIs in

Türkiye not to be included in the patent ecosystem and to fall short in the field of IPRs in the global ranking of universities.

With the 6769¹⁰ IPL, which entered into force in Türkiye in 2017, the quantity of university-based applications increased as HEIs were identified as one of the strongest actors of the patent ecosystem (6769 IPL, 2017). Elements such as licensing, licensing income and income distribution related to service invention were eliminated in the law. The European Patent Convention, which is defined as an autonomous legal system where European patents are granted by the EPO, is in force for the 17th time in 2020 with its current version in line with the needs arising according to the diversification, speed and direction of the growth areas of technology. With the actions of foreign companies in Türkiye towards patent protection, changing inventor profiles and the potential for technology to create rapidly changing classes of technology, IPC No. 6769¹⁰ renews itself and adapts to the changing patent world.

2023 number of foreign companies applying to the Turkish Patent and Trademark Office Germany: 1521, Amerika (USA): 1231, Italy: 565, China: 544, Japan: 526 [73].

With the definition of the concepts of service invention and employee invention, which are linked to the business relationship in the IPL, and the determination of the obligations of HEIs in the relevant patent processes, patent application, contract, portfolio management, and commercialization processes are carried out operationally by TTOs with the full right claims of universities. The systematic management of patented technologies by a single unit and TT professionals within a cumulative portfolio provides the advantage of directing inventions made in HEIs to commercialization efforts. With the obligations arising from the law, TT professionals prioritize the technologies in the FSMH Portfolio (patents, utility models, designs and trademarks) within the university according to technology classes, identify the appropriate investor for the technology through the university's national and international networks, and guarantee patents with high commercialization potential through patent valuation strategy.

With the IPL in Türkiye, the annual average number of patent applications and the share of universities in this share is around 17 thousand. Graph 1 shows the number of patents and utility models applied for in Türkiye between 2017 and 2023. The number of patent and utility model registrations of official applications varies around 10-15 thousand. Chart 2 shows the number of registrations obtained for patents and utility models applied for in Türkiye between 2017 and 2023.

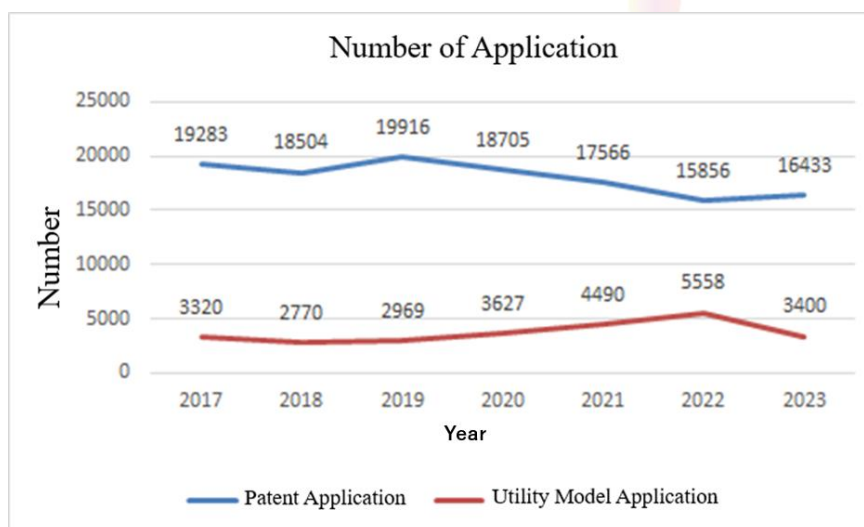


Figure 8. Number of Patent and Utility Model Applications [73]

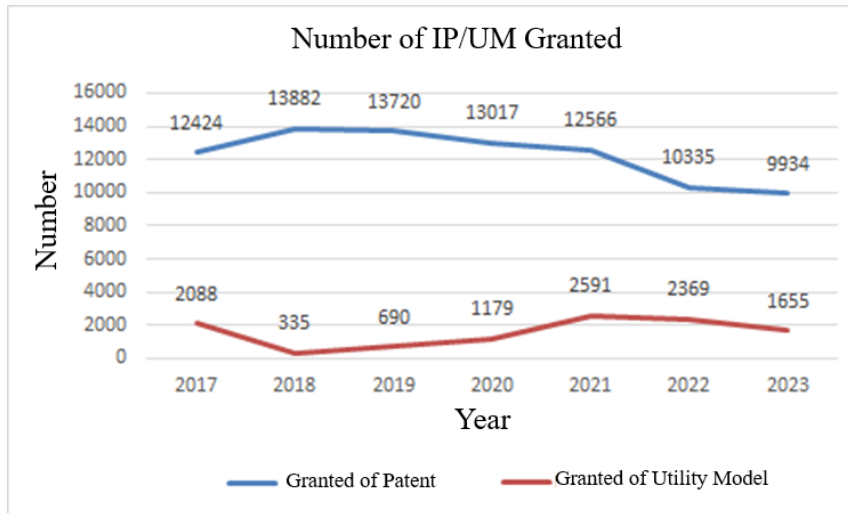


Figure 9. Number of Patent and Utility Model Registrations [73]

According to WIPO, approximately 2 to 2.3 million patent and utility model applications are filed every year in the world [74]. According to the records of the TÜRKPATENT, this number is between 17 thousand patents and utility models in Türkiye. The contribution rate of state-owned institutions such as public institutions, universities and research institutes to the number of patent and utility model applications and registrations in Türkiye is approximately 10-12% annually. Even if the law acts as a supportive buffer, the low ratio of university applications to the total number of intellectual property applications shows that innovative approaches and good practices are needed in the TT ecosystem.

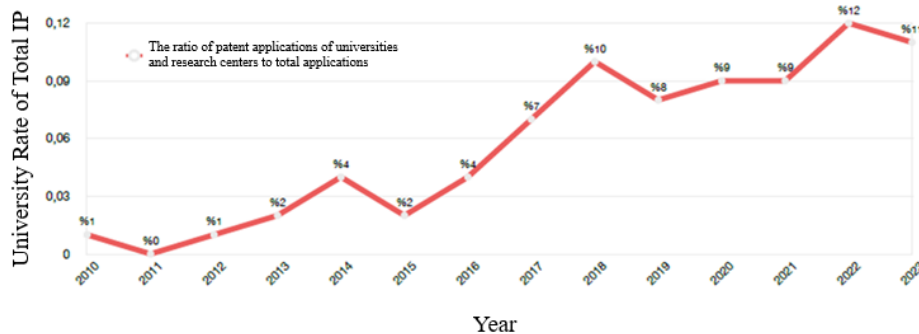


Figure 10. Contribution rate of universities to the number of patent and utility model applications and registrations in Türkiye [75]

5.4.2. Commercialization of Patents

Technology and inventions are important parts of the innovation process that transforms inventions into marketable products. The final stage of the innovation process, which is highly complex and therefore requires a lot of specialized professional expertise and know-how, is the marketing and commercialization stage, which is vital for the success of any invention and innovation [76]. Patent and utility model applications in the world are not growing in line with technology. Even China, the world's largest economy, does not grow in the same direction with its patents commercialized in universities. The patent commercialization rate in Chinese universities is around 5% [77]. However, global companies, which are increasing the number of patented technologies year by year, understand that IPRS plays an important role in achieving value-added products. Investment and production in these areas are taking place in the global market. While the share of intangible assets of companies was 20% in the past 40 years, this rate

has reached 80% in recent years. The share of these assets in the world economy is around 50% [78]. As for IPRS assets, the number of intellectual property assets scanned and registered by TÜRKPATENT from past to present is around 2.220.000 (patents, utility models, trademarks and design registrations registered by domestic applicants and still valid).

According to the data on the commercialization of patents in Türkiye, the largest investors showing interest in patents are SMEs. The ranking in this area is SMEs, Large Scale Enterprises, Start-Up companies and universities. When the licensing data for the 2018-2021 period in Türkiye are examined, it is seen that the commercialization of patented technologies in universities in order to bring them to industry has increased from 15% to 48% [79].

Until 2023, the number of commercialization agreements concluded by universities was 329. The number of patents commercialized through licensing and transfer was 350. The upward trend seen in the patent commercialization success of universities in the 2019-2022 period ended in 2023. While 46 commercialization (license/transfer) agreements were signed in 2023, 49 patents/utility models were licensed or transferred under these agreements [75]. The patent commercialization success of universities in 2023 has decreased by approximately 35% compared to the previous year. Chart 4 shows the number of patents and utility models licensed and contracts signed between 2015 and 2023.

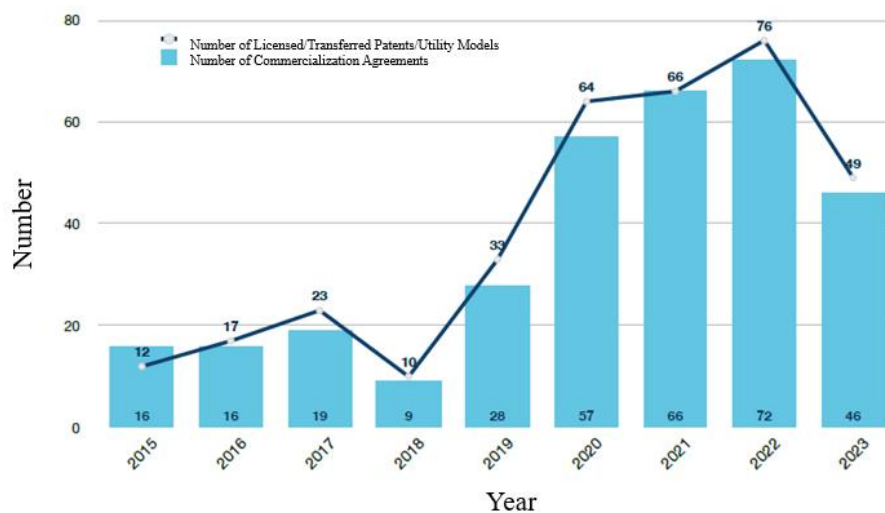


Figure 11. Number of patent commercialization through universities in Türkiye [75]

5.4.3. Legal Competence

In Türkiye, TTO expertise has not yet been differentiated by field, and experts should be interested in technology in all fields. At the same time, a strong legal system needs to be in place for commercialization activities to be successful. Although this legal structure is met by the legal consultancy in universities, the evaluations made by the legal unit that is not specialized in the field of intellectual property are insufficient.

In the patent ecosystem that develops in line with the needs of the modern world, TT professionals make a difference in the system with their ability to take quick action on the problems they encounter and share this with their stakeholders in the TT ecosystem in Türkiye as good practice processes. It is not possible for TT professionals to manage/monitor the portfolio, carry out contract processes and at the same time create the network required for commercialization. As in Europe and the US, TT professionals and Patent Attorneys should be considered in a separate legal dimension. In Türkiye, patent experts take multiple actions in patent portfolio management, follow-up of protection processes, preparation of contract

documents as a contract authority and ensuring commercial collaborations, and this intensive work distribution in certain experts results in legal inadequacy. The identity of a patent attorney needs to be clearly defined and implemented in Türkiye.

5.4.4. Inadequacy in Technology Readiness Level

The fact that the developed technology is not yet mature enough for the industry creates problems in the transfer process. This is due to the low technology readiness level (TRL). IPRs obtained from knowledge generated at universities are usually at TRL 5 or below. These inventions have not passed the laboratory level, but scale tests have been carried out. The established industry in Türkiye does not yet contribute to the commercialization of TRL 4-5 levels. The general perception is on the commercialization of the R&D completed product ready for direct sale. This desire of the industrialists creates an obstacle in the commercialization of patented technologies in the university.

5.4.5. Disconnect between Public Institutions and Industry

Universities in Türkiye generally emphasize the protection of inventions and innovations resulting from scientific R&D activities. These institutions try to manage IPRs in a balanced manner with the principles of academic freedom and knowledge dissemination. In contrast, companies view IPRs as strategic assets that provide competitive advantage and create commercial value. Private sector organizations prefer strict protection and management of IPRs to protect R&D investments and generate commercial returns. In UICs, it is crucial to balance these two different perspectives and to fairly share the IPRs arising from joint projects. For this reason, collaboration agreements need to explicitly address IPRs and clearly set out the expectations of the parties. TT interfaces play a critical role in this regard. In practice, there are some differences of opinion between knowledge institutions (HEIs, technology centers, research institutes, public institutions, etc.) and companies. These disagreements can be summarized as follows;

Objectives: The main goal of academics is to generate and disseminate new knowledge. The goal of companies is to make a profit and increase their market share. At this stage, the first goal of companies when commercializing patented technology is to generate income from that technology.

Risk Taking: While academics are generally more open to experimenting with new and risky ideas, companies are more interested in improving existing business models and minimizing risk. At this stage, higher returns with lower risk are important factors for companies based in Türkiye.

Time Frame: While academics often work on long-term projects, companies expect shorter-term results. At this stage, legislative extensions in the sale of a patent or at the contract stage can reduce the appetite of companies to commercialize patents.

Resources: While academics often work with limited resources, companies have more resources. However, instead of spending these resources on a patent and doing R&D on it, they are more inclined to take a patent with R&D work done and bring it into industry.

5.4.6. Legislative Problems in Patent Sale/Transfer Transactions in the Public Sector

In today's world where technology is rapidly developing and changing, technology needs to be brought to the market. Therefore, it is important that TTPs carry out the process correctly and on time. In addition, inconsistencies in legal regulations and cumbersome bureaucratic structures are among the main problems of commercialization. In the case of commercialization of a patent in universities, multiple methods emerge for the sale of the patent. The most appropriate of these methods in accordance with the legislation and laws is the sale of the patent through a tender procedure. Since the patent is an intangible asset, it is appropriate to sell it as a sale of goods from the university. However, this tender method causes delays in the commercialization of the product and delays in the internalization of the product by the

company. The inability to sell directly with an estimated price becomes one of the obstacles in commercialization in terms of the bureaucratic process.

The biggest disadvantages and unpredictable effect of the auction method is that transactions carried out without proper valuation methods in the sale of patents, which are considered as fixtures in an institution under Türkiye law, through transfer in future periods may give rise to a legal obligation.

5.4.7. Lack of Patent Valuation

Another hurdle in the technology appraisal stage can be defined as the process of estimating a mutually agreed value for the licensing of a product or intellectual property from seller to buyer. Technology assessment is a very difficult and complex process. The most important evaluation criterion is to determine the future value of the technology. Various methods and formulas have been developed to determine this value. The most common valuation method is the discounted cash flow method, which calculates the present value of future earnings. The present value reflects the price that the IP buyer must pay to obtain the expected income from future sales. There are risks in determining this price as it depends on different variables such as the unavailability of expected data and the development of competing technologies. In addition, the fact that the industrialist does not want to give that value even if the value of the patent is determined, and imposes a value determined by himself, causes obstacles to the commercialization of patented technology.

5.4.8. Network Requirement

One of the obstacles in universities is the problem of communication. In today's world, communication is widespread due to its global structure. This process is much faster with the online meeting/meeting structures that entered our lives with the pandemic. However, the industrial focus is mostly grouped in the north-west, west, south-west and southern parts. The obstacle to the commercialization of patented technologies in universities located in Anatolia is the lack of access to industrial foci, in other words, the inability to create a network. Even if a suitable industrial institution is found for the commercialization of the patented technology, the lack of access to the person in charge or responsible for that institution emerges as a commercialization problem. It is very difficult to predict future revenue from an undeveloped or untested technology.

Industry in Türkiye is mostly concentrated in Central Anatolia, western and north-western regions. Ankara, Istanbul, Bursa, Bursa, Izmir, Kocaeli are the main regions where these industrial groups are concentrated. Figure 12 shows the distribution of industrial R&D centers [41]. As can be seen, the industrial and network needs of the central and eastern regions of Türkiye are quite high. Even if a university in Anatolia has a qualified patent, its commercialization potential decreases due to lack of access to industry or lack of network.

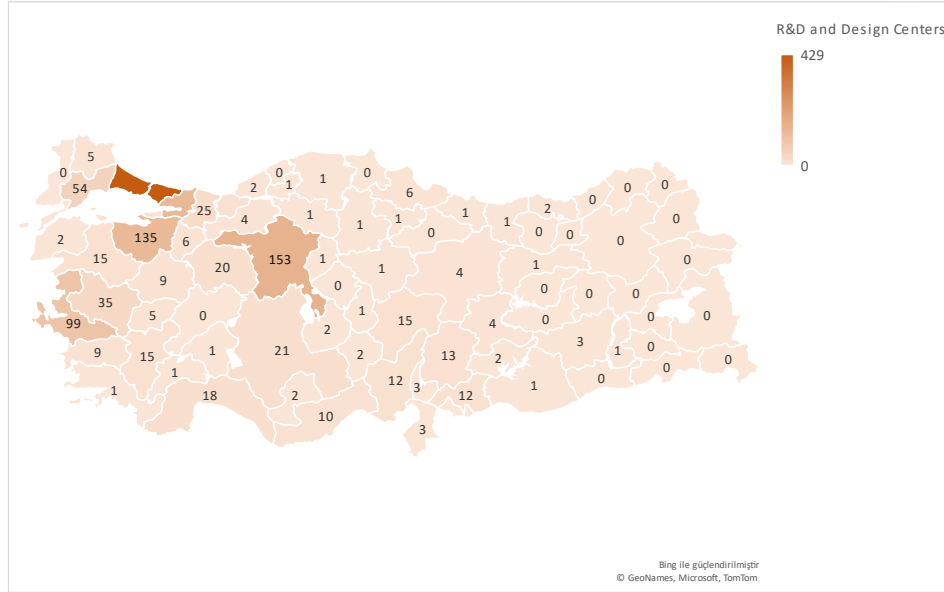


Figure 12. Distribution of R&D Centers

5.4.9. Official Fee Obligation

Another obstacle to patent commercialization is the need to pay the annual registration fees for the patent. In order for the protection of an invention to continue, annual registration fees must be paid. These fees increase every year at the rate of inflation and each year they move to a higher payment level. The high number of patents in universities multiplies the obligation to pay registration fees. A 100-unit annual registration fee payment may increase to 200 units the following year with the cost of backward inventions. The official fees of the TÜRKPATENT are shown in Table 2 for 2023 and Table 3 for 2024. While the 20th year payment was ₺6993.22 in 2023, this value was ₺14840 in 2024. These values increase every year according to the revaluation and inflation rate. Due to these high payment costs, universities support patented technologies for a certain period of time. Some universities provide support for 5 years, while others cannot provide support for up to 8-10 years and pay the registration fee. The university that provides 5 years of support does not pay after 5 years and the invention remains free. However, since it is not known when an invention will be commercialized, this abandonment also prevents possible commercialization.

Table 2. TÜRKPATENT official annual registration fees for 2023 [80]

Registry fee	₺
2nd Year Registry Registration Fee	323,73
3rd Year Registry Registration Fee	340,68
4th Year Registry Registration Fee	476,27
5th Year Registry Registration Fee	900
6th Year Registry Registration Fee	1281.36
7th Year Registry Registration Fee	1484.75
8th Year Registry Registration Fee	1722,03
9th Year Registry Registration Fee	1916,95
10th Year Registry Registration Fee	2145,76
11th Year Registry Registration Fee	2501.69
12th Year Registry Registration Fee	2993,22
13th Year Registry Registration Fee	3527,12

14th Year Registry Registration Fee	4061,02
15th Year Registry Registration Fee	4747,46
16th Year Registry Registration Fee	5238,98
17th Year Registry Registration Fee	5874,58
18th Year Registry Registration Fee	6315,25
19th Year Registry Registration Fee	6688,14
20th Year Registry Registration Fee	6993,22

Table 3. TÜRKPATENT official annual registration fees for 2024 [81]

Registry fee	₺
2nd Year Registry Registration Fee	2160
3rd Year Registry Registration Fee	2190
4th Year Registry Registration Fee	2450
5th Year Registry Registration Fee	3250
6th Year Registry Registration Fee	3980
7th Year Registry Registration Fee	4360
8th Year Registry Registration Fee	4810
9th Year Registry Registration Fee	5190
10th Year Registry Registration Fee	5620
11th Year Registry Registration Fee	6300
12th Year Registry Registration Fee	7230
13th Year Registry Registration Fee	8250
14th Year Registry Registration Fee	9260
15th Year Registry Registration Fee	10.570
16th Year Registry Registration Fee	11.500
17th Year Registry Registration Fee	12.710
18th Year Registry Registration Fee	13.550
19th Year Registry Registration Fee	14.260
20th Year Registry Registration Fee	14.840

5.5. TT Instruments Best Practiques

Within the scope of the project, Best Practices identified by our office were presented for evaluation in an online meeting attended by all project stakeholders (PPs). As a result of the scoring conducted by the stakeholders, the best practices for TT tools for Türkiye were identified as follows

- TTO Liaison Office in Organized Industrial Zones
- The Impact of International Networks on Grants, R&D, Knowledge and Technology Transfer - COST Network and the Case of KTU
- Scientific and Technological Research Council of Türkiye 1812- Investment Oriented Entrepreneurship Support Program

TTO Liaison Office in Organized Industrial Zones

KTÜ TTM has strengthened university-industry cooperation by establishing TTO contact offices in OIZ in order for industrialists to access the university's information and technology resources more easily. These contact offices were opened in the OIZ Regional Directorate buildings in line with the protocols signed by

KTU TTM with the OIZ administrations. At least one day a week, specialized TTO personnel actively serve in OIZs.

This practice aims to strengthen university-industry cooperation by facilitating industrialists' access to the university's information and technology resources. This strategy is based on providing guidance on R&D incentives and cooperation opportunities by providing on-site services to industrialists, analyzing the R&D levels of companies and matching them with academics suitable for their needs. Thus, it is aimed for industrial companies to benefit effectively from public support, increase their R&D capacities and develop a sustainable cooperation environment.

The TTO contact offices established by KTU TTM in OIZs have become one of the best practices in Türkiye in this field by eliminating the physical and logistical barriers to university-industry cooperation. The main reasons why it is considered a best practice are as follows:

- This model solves the physical access difficulties of industrialists to Technology Transfer Offices (TTOs), enabling companies to benefit more effectively from university information and technology opportunities. Consequently, contact offices have enhanced interaction between industry and academia, creating a more sustainable cooperation environment.
- Since 2018, TTO's presence in the OIZ has led to a significant increase in the number of industrial companies benefiting from TTO services. With 43 companies matched with academics through contact offices, 20 different projects were supported with public funds. The tripling of the number of companies benefiting from TÜBİTAK support and the fact that two of the industrial companies received the title of R&D Center are concrete success indicators of this practice.
- Thanks to continuous and regular contacts, a strong sense of trust has developed between industrialists and TTO, and companies have started to communicate directly with TTO. This relationship of trust has ensured the sustainability of university-industry collaborations and increased the recognition of TTO among companies.
- This model not only solved industrialists' difficulties in accessing TTO, but also contributed to regional economic growth by improving the local innovation ecosystem. For example, in 2020, a company established a Test Center within Trabzon Technopark, reflecting the long-term benefits of this practice for industry and the spread of the university collaboration culture.

These achievements show that the TTO contact office in the OIZ makes significant contributions to the industry at both local and national level, and proves that this structure is an exemplary model in university-industry cooperation.

The Impact of International Networks on Grants, R&D, Knowledge and Technology Transfer - COST Network and the Case of KTU

The COST Program promotes scientific and technological collaborations by supporting the research community in Europe. Established in 1971, the program brings together scientists, SMEs, public institutions and other stakeholders from across Europe to work in "Actions", which are joint research networks. A COST Action is an interdisciplinary network focusing on a specific research topic, with participants from at least 7 different countries. COST Actions allow participants to expand their professional networks, develop their careers and establish international collaborations. In addition, regular meetings, seminars and workshops are organized to exchange knowledge between research groups.

KTU TTM carries out a special strategy to promote this program to university researchers and to ensure the participation of researchers in COST Actions. As of 2019, COST Actions were analyzed, suitable researchers were identified and participation was encouraged through one-to-one meetings. Guidance was provided to researchers in application processes through programs such as technical support services, Short Term Scientific Visits, ITC Conference Support and guidance was provided to local support programs such as COST 2515.

KTU TTM's COST program strategy stands out as a successful model for the university to achieve its internationalization goals. The main indicators and innovative aspects that make this strategy a "best practice" are as follows:

- While participation in COST Actions was limited before 2019, by the end of 2023 after the strategy was implemented, 252 researchers from KTU were actively involved in a total of 528 COST Actions. This increase enabled the university to rank first in Türkiye as the institution with the highest number of COST researchers in Europe.
- Increased participation in the COST program led to a 92.3% increase in international project applications and a 366% increase in the acceptance rate. These developments have increased the acceptance rates of high quality projects by strengthening researchers' access to international funding sources.
- KTU TTM's strategy encourages university-industry collaborations while supporting the individual career development of researchers. This model, which brings together stakeholders operating in different fields and encourages knowledge transfer, supports a sustainable structure not only for academic research but also for the development of sectors.

Through the opportunities provided by the COST program, KTU researchers have integrated into research networks covering more than 40 countries across Europe, significantly enhancing the university's international visibility. These networks offer crucial advantages, including facilitating knowledge sharing, establishing international research consortia, and transferring advanced R&D outputs.

Scientific and Technological Research Council of Türkiye 1812- Investment Oriented Entrepreneurship Support Program

1812 Investment-Based Entrepreneurship Support Program (BiGG Investment) is a program developed by TÜBİTAK and designed to support technology and innovation-oriented startups in Türkiye. This program starts supporting entrepreneurs from the idea stage and provides a comprehensive roadmap until the process of establishing a commercial presence. This three-stage support system helps start-up entrepreneurs develop business ideas that have the potential to be turned into a business plan, supports successful entrepreneurs to establish a company, and finally provides R&D support to optimize the commercial potential of the product or service they develop.

The BiGG Investment Program aims to guide entrepreneurs from the idea stage and help them turn their innovative ideas into successful businesses. This strategy aims to create more technology-based companies in Türkiye and strengthen the country's position in global competition.

In the first phase, authorized implementing organizations guide applicant entrepreneurs through the process of developing their business plans. In this process, they provide multifaceted support such as mentoring, networking opportunities, training and technical-commercial assessments. The accelerator services provided by the implementing organizations facilitate the development of appropriate business plans by analyzing the feasibility of ideas. At the end of this phase, business plans are finalized for submission to TÜBİTAK.

In the second phase, entrepreneurs selected by TÜBİTAK and awarded the Seal of Excellence establish a company and receive a certain amount of financial support under the program. With this support, entrepreneurs develop technology-based prototypes, demo applications or software and carry out activities to transform their conceptual and technical designs into commercial value.

In the third and final stage, research and development activities are carried out to increase the commercial potential of the products developed. In order to further optimize their projects, entrepreneurs can apply to TÜBİTAK 1507 SME R&D Startup Support Program and obtain additional financing. In addition, under this program, entrepreneurs benefit from additional advantages such as 10% overhead support.

The 1812 Investment-Based Entrepreneurship Support Program stands out as a "best practice" with several innovative aspects and indicators of success. First, the model of collaboration with implementing organizations allows entrepreneurs to develop their projects in a robust way. The program provides not only financial support, but also a wide range of services, offering entrepreneurs mentoring, training and technical analysis support during the business plan development process. This increases the success rate of entrepreneurs' projects and contributes to their maturity.

Secondly, quality indicators such as the "Seal of Excellence" and the obligation to establish a company prevent entrepreneurs from remaining at the idea level and encourage them to move to a real business structure. The opportunity to apply for SME R&D Start-up Support, offered at the third stage of the program, provides entrepreneurs with the opportunity for longer-term growth and sustainability.

In terms of innovative aspects, the program does not require entrepreneurs to apply independently by prioritizing the guidance and accelerator services of implementing organizations in the application process, which ensures that ideas are transformed into business plans with a higher success rate. In addition, incentives such as the right for entrepreneurs to apply on a rolling basis and 10% overhead support contribute greatly to Türkiye's entrepreneurship ecosystem and boost the country's competitiveness in the international market by supporting local innovation. For these reasons, the program is recognized as a best practice that enables the creation of high quality startups.

6. Economic Indicators and Financing

TT is the process of commercializing R&D activities into economic value and plays a vital role in increasing the competitiveness of countries. In Türkiye, various programs and funds supported by the public and private sectors aim to ensure that this process is carried out efficiently. The main motivation behind these supports is to improve Türkiye's scientific and technological capabilities, increase its competitiveness in the global market and promote sustainable economic growth. Thus, by strengthening the local innovation ecosystem, innovative products and services are aimed to take place in national and international markets. In this direction, there are various units that act as interfaces in the process of supporting researchers in Türkiye in many different areas such as accessing national and international funding sources that can finance their work, continuing their scientific studies and being included in expert researcher networks. These include units established within a university, OIZ, TDZ or R&D center, and TT interfaces established in accordance with the regulation on TTOs, which have a capital company structure. The units acting as these interfaces are supported by various financing sources such as national and international funded projects, their own resources and the university or technology development center to which they are affiliated, thus ensuring their economic sustainability. Some important data in the national TT ecosystem statistics report published by ÜSİMP in 2022 are as follows: While 50% of the interface structures obtain financing from their own resources, 44% receive support from the university or TDZ to which they are affiliated. 38% of the structures participating in the research benefit from the national funding provided by TÜBİTAK to the TT ecosystem. Contracted R&D projects carried out in UIC stand out as the main sources of financing for TT interface units with 31% and licensing revenue models with 13%. It is seen that the financing source obtained by TT interfaces from national and international funded projects is one of the important income models with 25% [34].

The financing and revenue models of the units undertaking the TT interface mission are given below;

Public Supports: TTOs benefit from the funds provided by TÜBİTAK for TTOs. These funds are used especially for the commercialization of R&D activities, project development, patent applications and licensing processes. Since 2012, since the establishment of TTOs by TÜBİTAK, support has been provided to support units in the interface position with many different support programs from 2013 to the present. These supports are called for in a wide range of areas such as mentoring programs, employment projects for TTO professionals, and increasing the capacity of TTOs. Calls are opened under two different call headings: TÜBİTAK 1601 and TÜBİTAK 1513 Support Programs.

TÜBİTAK 1601 program is a program where different calls can be opened with the aim of increasing capacity in the fields of entrepreneurship and innovation. The program aims to ensure that the private sector gets efficient results from its investments in R&D and innovation, to revitalize UICs and to contribute to the faster development of start-up companies established by entrepreneurs with technological business ideas. To date, calls such as Establishment and Implementation of Entrepreneurship Certificate Program in Universities, Development and Implementation of Mentoring Mechanism to Increase the Innovation Capacity of SMEs, Provision and Implementation of Preparation, Start-up and Capacity Building for TTOs, TÜBİTAK 1512 Individual Young Initiative (BiGG) / 1812 BiGG Investment Program 1st Stage Implementing Organizations Calls have been opened. In line with the calls opened within this scope, TTOs' personnel expenses, travel expenses, tools, equipment, software, publication purchases and service procurement expenses are covered.

The aim of the TÜBİTAK 1513 program is to support TTOs that operate to contribute to the commercialization of knowledge and technologies produced in universities and TDZs and thus to create economic, social and cultural value. TTOs have an upper budget limit for personnel, travel, tools, equipment, software and publication purchases and service procurement expenses. The budget cap is set at ₺1.25 million per year and ₺2.5 million for the target-oriented growth phase.

Own Resources: TTOs operating in Türkiye create various revenue models within universities in order to utilize their own resources efficiently. These offices can generate significant revenue through the commercialization of R&D activities and patent licensing. The licensing of patents owned by universities by the private sector stands out among the sustainable income sources of TTOs. Patent-based TT programs supported by TÜBİTAK enable TTOs to facilitate this process and reduce licensing costs. At the same time, through these licenses, TTOs strengthen their financial structures with the revenues generated from patents. In addition, TTOs also generate income through additional services such as UIC, project consultancy and training. Such activities enable TTOs to support the education, research and community service missions of universities, while guaranteeing their financial sustainability. In addition, TTOs established within universities can receive qualified academic staff support from the universities to which they are affiliated, in addition to their own financial resources, by allocating staff as lecturers.

International Funding Sources: Funding from international funding sources stands out as an important income model for TTOs to maintain their sustainability. With internationally funded projects, TTOs have the opportunity to showcase their work in the international arena and have the chance to gain relatively higher grant support than national funded support. In particular, EU programs such as Horizon Europe, COST Actions and EUREKA not only support TTOs' R&D activities, but also facilitate their integration into international networks. These programs provide TTOs with a wide range of financial and technical support, from patent and licensing activities to the commercialization of research projects, from access to international markets to technology consultancy services. Thanks to this support, TTOs are able to strengthen collaborations between universities and industry and enable innovative products to enter global markets faster. Furthermore, by expanding their technology consultancy services through international collaborations, TTOs increase their own capacity and contribute to regional economic growth.

In the process of supporting the national and international studies of a wide target group such as researchers, industrialists, entrepreneurs, students, etc. in order to disseminate TT, achieve qualified results and improve Türkiye's competitive potential, the relevant institutions operating under the MoIT provide support in many TT processes such as scientific research projects, UIC, IPRs, incorporation, etc. In 2024, the table published by MoIT containing the budget amounts allocated for the relevant institutions in 2024, 2025 and 2026 is given below.

Table 4. 2024 Budget Presentation of MoIT [82]

ADMINISTRATION	2024 BUDGET	2025 BUDGET	2026 BUDGET
STB	78.995.069.000 ₺	98.009.153.000 ₺	112.151.268.000 ₺
TÜBİTAK	32.084.581.000 ₺	39.510.191.000 ₺	44.648.497.000 ₺
TUBA	119.138.000 ₺	147.924.000 ₺	168.442.000 ₺
TSE	3.213.465.000 ₺	3.981.684.000 ₺	4.563.183.000 ₺
TÜRKPATENT	848.927.000 ₺	1.045.629.000 ₺	1.187.461.000 ₺
KOSGEB	7.733.324.000 ₺	9.526.191.000 ₺	10.827.268.000 ₺
GAP RDA	839.316.000 ₺	961.006.000 ₺	1.035.924.000 ₺
DAP RDA	405.088.000 ₺	489.358.000 ₺	554.653.000 ₺
KOP RDA	439.699.000 ₺	541.955.000 ₺	615.395.000 ₺
DOKAP RDA	742.277.000 ₺	914.413.000 ₺	1.037.648.000 ₺
SPACE AGENCY OF TÜRKİYE	1.702.764.000 ₺	2.095.640.000 ₺	2.375.608.000 ₺
GENERAL TOTAL	127.123.648.000 ₺	157.223.144.000 ₺	179.165.347.000 ₺

6.1. Distribution of Budget among Related Institutions

Activities such as the evaluation of research results at universities, the realization of UIC activities, the protection of IPRs of inventions that have the possibility of turning into economic value and generating income as a result of transferring these rights to industry through contracts are all part of the TT process.

The legislation and guidelines in Türkiye regarding the distribution of the revenues/budget generated in this direction among the stakeholders in the TT process are as follows;

According to IPL No. 6769¹⁰: The distribution of revenues to be obtained from patents resulting from scientific studies carried out in HEIs is carried out in accordance with the article of the IPL No. 6769¹⁰.

The sharing of the income from the invention between the higher education institution and the inventor is determined in such a way that the inventor receives at least one third of the income. The HEI's share of the income from the invention is recorded as own income in the budget of the relevant HEI and used to meet the needs of the higher education institution, especially scientific research. Each university decides on the distribution of income according to its own FSMH Protocol, without deviating from the ratios stated here.

Pursuant to Law No. 6769¹⁰, in the case of commercialization of an invention for which a public institution (such as a university, hospital or ministry) is the applicant, at least one-third of the revenue generated belongs to the inventors. While the majority of universities and institutions comply with this minimum percentage, different percentages are often allocated. For example, when an invention for which KTU the applicant is commercialized, a policy has been developed to allocate 30% of the revenue to KTU and 70% to the inventors. While the minimum share for inventors is one third, higher percentages are allocated across Türkiye to incentivize inventors and academics.

According to Law No. 2547¹² on Higher Education: In HEIs, a revolving capital enterprise is established upon the proposal of the university board of directors and the approval of the YÖK. Revenues generated from the activities of revolving capital enterprises are monitored in separate accounts for each unit.

A certain percentage of the budget collected from revolving fund revenues is used for the purchases of goods and services, all kinds of maintenance, repair, leasing, construction works for the completion of

ongoing projects and other needs and executive shares that the relevant higher education institution needs. The university board of directors is authorized to increase these rates up to 75%. At least 5% of the portion collected from revolving fund revenues is used to finance scientific research projects carried out within the university.

Within the scope of UIC, the revenues obtained as a result of R&D, design and innovation projects and activities are collected in a separate account of the revolving fund enterprise. Within this scope, 85% of the income to be paid to the academic staff is paid to the relevant academic staff without any tax deduction. While this deduction is normally between 35-40%, with this incentive, only 15% is deducted for R&D projects.

In addition, while there are many TTOs with different structures and statuses in Türkiye, especially those with company status have their own service portfolio and income distribution rates. However, in TTOs that are established as an official affiliated unit of the university and have their own revolving fund, 15% of the income is transferred to the TTO budget and the remaining 85% is transferred to other payments.

According to Law No. 5746¹ on Supporting Research, Development and Design Activities: Pre-competitive cooperation projects established by MoIT aim to provide grant support for the expenditures of R&D, innovation and design projects, as well as discounts, exemptions and incentives in pre-competitive cooperation projects, which support more than one organization to develop joint parts or systems or establish platforms before competition in order to increase efficiency and provide higher added value than the current situation by taking advantage of economies of scale.

In these projects, the contributions made by the organizations forming the cooperation are monitored in a joint special account specified in the cooperation agreement. These amounts transferred to the special account are considered as R&D and design expenditures of the contributing organizations in the period in which the expenditure is made and cannot be used for any other purpose other than the project. The amounts collected in the project account are not taken into account as income in determining the earnings of the organization opening the project special account. Up to 50% of the pre-competitive cooperation project budget can be supported on a non-refundable basis, up to a maximum of 50% of the pre-competitive cooperation project budget, limited to the appropriation allocated to the budget of the MoIT.

Distribution of the Institution's Share of Grants Provided to Research Projects by TÜBİTAK and Other Research Institutions: The institution's share is an allowance added to the project budget in return for utilizing the facilities of the institution during the execution and finalization of the project, calculated within the framework of certain criteria. Institutional share rates to be applied in projects to be carried out in HEIs are determined in line with the criteria and rules determined by the relevant institution. The institutional share is spent within the framework of the relevant Principles and Procedures¹⁶ to be used in R&D activities upon the request of the authority of the institution where the project is actually carried out.

Under Law No. 657¹⁷, public officials and academic staff can be employed within the scope of projects within the framework of the legislation to which they and their institutions are subject. Researchers assigned to the project must be on the payroll of the institution and a letter/approval must be obtained from their higher authorities that they are assigned to the project.

7. Human Resources and Training

Public institutions, especially universities, consultancy firms, Technoparks and companies carry out TT activities. During these activities, the process is carried out with specialized human resources.

TTOs, which serve as an interface for the transfer of knowledge and technology from universities or research institutions/organizations to industry, are becoming increasingly important in Türkiye as in the world. The effectiveness of these offices largely depends on the quality and quantity of their human resources. ÜSİMP's National TT Ecosystem 2022 Statistical Report states that 59% of the personnel working in TT offices are contracted project personnel, 29% are academics, 5% are civil servants and 7% are public workers [34]. In the same report, the education level of the human resources is proportionally given as 30% undergraduate graduates, 28% graduate students and 35% postgraduates. Looking at the length of service in TTOs, it is seen that 20% of the personnel have worked between 5-8 years, which can be considered as experienced. When we look at the number of personnel working in TTOs in Türkiye, it can be said that although many of them have only recently been established, they employ a sufficient number of personnel to be compared with TT offices around the world. In the Evaluation of the Effectiveness of TTOs study prepared by the General Directorate General of Strategic Research and Productivity of the MoIT, it was analyzed in the surveys and interviews conducted with TTOs and their stakeholders that the average staff in TTOs is 9.3 and the average working period is 3.6 years. It was determined that only 3% of these personnel have expert TTO certificates and that there is a serious problem in finding expert personnel with experience in patent, entrepreneurship, commercialization, EU projects and internationalization [83].

It is also important that TTOs have sufficient and qualified human resources within the scope of their activities. It is stated that TTOs, especially in developing countries, cannot provide sufficient training to their employees and this has a negative impact on TT processes [84]. In Türkiye, the staff of TTOs within universities and research institutions/organizations receive various trainings and become qualified in the TT ecosystem. In order to train professional human resources for TTOs, ÜSİMP launched the TTOs professionals training program in 2012 in order to meet the need of TTOs for appropriately trained personnel and started to issue the RTTP certificate, which is an internationally recognized TTP international professional recognition certificate since 2018. It is also authorized by ATTP to organize RTTP trainings. The RTTP certificate is an important document for TT personnel at the professionalization stage within the framework of an international standard, and as of 2024, 878 TT personnel in the world have this certificate [85]. In addition, ÜSİMP organizes basic and advanced TT trainings for TT personnel, and many different trainings on IPRs such as "Commercialization of research outputs", "Invention evaluation", "Reading patent maps". However, the fact that the trainings provided by ÜSİMP are paid makes it difficult for TT personnel to receive these trainings. In the process of training professional human resources for TT, not only ÜSİMP's training programs but also the support provided by TÜBİTAK and Development Agencies are of great importance. TÜBİTAK offers various training programs and funds to improve TT processes and increase the competence of staff in TT offices. In this context, the TÜBİTAK 1513 provides financial support to TT offices, enabling staff to receive training at international standards, including examples of good practices in the EU. In addition, in order to support regional development, Development Agencies across Türkiye offer special training programs and consultancy services to TT offices. Development Agencies support the services of specialized consultants and training firms to both improve regional R&D capacities and accelerate TT. These trainings, especially on technology management, project development, IPRs and commercialization, play an important role in improving the qualifications of TT staff. However, these trainings need to be repeated continuously, especially for the personnel involved in the ecosystem, and this is sometimes not economically feasible.

Although the contributions of these trainings are very important, difficult access to trainings and high costs may cause the staff in TT offices not to benefit from these opportunities sufficiently. In Türkiye, as in developing countries, access to human resources specialized in TT processes is limited due to both economic and structural challenges, slowing down the professionalization process in the TT ecosystem.

8. Relationships between Ecosystem Elements

The TT ecosystem includes various stakeholders such as TTO, HEIs, private sector companies, research centers, public institutions (MoIT, TÜBİTAK, KOSGEB, etc.), OIZ, incubation centers, investors, NGOs, consultancy firms, professional associations, TDZ and R&D and innovation consortia. Relationships between actors in this ecosystem are established and maintained in various ways.

The platforms and practices that the actors in the TT ecosystem are associated with are grouped and listed below.

8.1. International&National Platforms/Programs/Events

PATLIB Information Library Network: PATLIB centers provide local access to patent information and related issues. They are familiar with the local industrial, economic and business landscape, and provide valuable services to entrepreneurs, SMEs, private inventors and students. There are over 300 patent information centers spread regionally across the EPO's member states. Türkiye is one of the PATLIB country of the EPO. If any TT actors are lack the time, resources or experience to dedicate to patent searching or strategy, local patent information centers (PATLIBs) can almost certainly help needs. Many PATLIB center employees are experienced patent search experts. They may also offer other patent information services. These can include: technology and competitor watch, patent statistics, patent valuation/audits, advice on patent strategy, guidance on commercialization/TT. PATLIB centers can also provide practical assistance on other IPRs.

TÜBİTAK Network Membership Support Program: This program aims to encourage the participation of Türkiye researchers and institutions in international scientific networks and consortia, enabling Türkiye scientists and research institutions to establish stronger collaborations with global research communities. Support for membership in networks allows researchers to benefit from opportunities such as knowledge sharing, developing joint projects and accessing international funding sources. With this program, TÜBİTAK aims to strengthen Türkiye's scientific research capacity and play a more effective role in the international arena.

EEN: EEN, the world's largest network offering international cooperation opportunities to large companies and researchers, especially SMEs, directly contributes to the development of nearly 2.9 million SMEs globally. The network includes chambers of commerce and industry, TT centers, research centers and institutions providing support to SMEs.

COST: COST is a well-established platform that fosters transnational collaboration between researchers, engineers and scientists in Europe, providing a framework that allows scientists pursuing national research to move internationally and network across Europe. This gives researchers and scientists the opportunity to jointly develop ideas and initiatives in all areas of science and technology, including social sciences and humanities.

According to the participation statistics provided by the COST Organization, Türkiye achieved significant success in 2023 and maintained its effectiveness in COST by participating in 99% of all current Actions. With 7.096 Working Group members, Türkiye has by far the highest number of Working Group members, and with 1.849 individual participants in COST network activities, Türkiye has become the 3rd most successful country in this field. In addition, with a budget of approximately €2.27 million in 2023, Türkiye managed to become the 3rd country with the highest budget among 41 COST member countries [70].

European University Association (EUA): EUA is one of the largest organizations representing and defending the interests of HEIs in Europe and contributes to the development of the European higher education system by promoting cooperation and knowledge transfer among universities. EUA regularly organizes conferences, seminars, workshops and forums to promote cooperation and knowledge sharing among its members. These events increase direct interaction and exchange of experience between universities. EUA

also keeps its members in constant contact through various online platforms and networks. In these ways, a strong environment of cooperation and knowledge transfer is created among EUA members.

SAHA Istanbul: It is an ecosystem that aims to strengthen products and services based on domestic and national technologies in the defense, aerospace and space sectors. As Türkiye's and Europe's largest industrial cluster, SAHA Istanbul's main areas of work are to increase the institutional capacity of its members, support cooperation among them, increase their competitiveness, establish effective relations with public institutions and NGOs, and support R&D and innovation activities. This enables all actors in the sector to be more effective, cooperative, competitive and innovative.

ISIF: It is aimed to bring together inventions, R&D and innovation activities that will contribute to the development of Türkiye with national and international participants. In addition, it is aimed to commercialize the technical knowledge produced and present it to the benefit of the society. To this end, ISIF, Türkiye's first and only international invention fair, is organized. The MoIT and the TÜRK PATENT are the main organizers of the fair. The International Federation of Inventors' Associations is the international patron, while the WIPO and the Technology Team Foundation of Türkiye are among the partners of the fair. ISIF is home to many technologies.

TEKNOFEST Aviation, Space and Technology Festival: Türkiye's first and only aviation, space and technology festival organized in cooperation with many organizations that play a critical role in the development of national technology in Türkiye.

Organized in 2018 for the first time, TEKNOFEST Aviation, Space and Technology Festival aims to increase interest in technology in society through technology competitions, air shows, concerts, talks and various other events. It also aims to raise awareness about Türkiye's transformation into a society that produces and develops technology. Within the scope of TEKNOFEST, technology competitions in different disciplines and categories are also organized for many young people to realize their dreams.

TTGV: Established in partnership with the public and private sectors, TTGV provides support for R&D and innovation projects. The main objective of the Foundation is to contribute to economic development by increasing Türkiye's technological and innovation capacity. It encourages TT and attaches great importance to UIC. It has taken an active role in developing the culture of academia and industry working together [86].

Public-University-Industry Cooperation (PUIC): A comprehensive **PUIC** ecosystem has been developed to increase the synergy between the country's stakeholders and to transform the industry into a sustainable structure capable of producing innovative products based on high technology, with high competitiveness and added value. This ecosystem is located in all provinces of Türkiye and includes many actors such as public institutions, universities, academics, TDZs, R&D and design centers, TTOs, application and research centers of universities, OIZ and chambers of commerce and industry. The public sector undertakes critical tasks such as ensuring a sustainable structure for the PUIC activities, improving Türkiye's PUIC infrastructure, identifying industry and university problems, and establishing support and incentive mechanisms in these areas. Within this framework, policies that strengthen the link between the public, industry and universities are developed, and these policies are monitored and evaluated [87].

ÜSİMP: ÜSİMP, which contributes significantly to TTOs to carry out their activities with a holistic approach, is involved in TÜBİTAK's process of supporting TTO structures. Through various events organized with the participation of national and international stakeholders, it supports the creation of the most appropriate model for Türkiye. ÜSİMP operates as an umbrella organization that brings together different public and private sector groups.

TÜBİTAK 1004 Center of Excellence Support Program: A strategic support program that aims to increase scientific research and innovation capacity in Türkiye, this program encourages cooperation between universities, research centers and industrial organizations. In this way, it enables the development of high value-added projects in the country's priority areas. The program provides long-term and sustainable financing for projects that require advanced technology and know-how and aims to increase Türkiye's

international competitiveness. TÜBİTAK 1004 promotes scientific excellence and contributes to the country's strategic goals by supporting interdisciplinary research and innovative approaches.

Innovative Interface Structures Platform Project: This project, supported by the Istanbul Development Agency, aims to increase the capacities and competencies of various organizations such as universities, technoparks, TTOs and industrial R&D centers in Istanbul. By adopting user-oriented approaches, this platform aims to provide tailor-made services to interface structures at different levels of development.

International TT Symposium: This symposium is organized to promote innovation and strengthen cross-industry cooperation by addressing TT processes at the global level. This symposium brings together experts from academia, industry and the public sector to promote knowledge sharing and discuss best practices and strategies for TT. Participants can exchange ideas on topics such as the translation of new technologies into commercial applications, opportunities for cross-border cooperation and barriers to TT. The symposium also aims to contribute to the global innovation ecosystem by building strong connections between stakeholders from different countries. Türkiye's first TTOs Congress was hosted by Eskişehir Osmangazi University Technology Transfer Application and Research Center in 2019.

Association of TTPs: It is a professional organization that brings together professionals working in the fields of TT, intellectual property management, entrepreneurship and innovation in Türkiye. The Association aims to increase the effectiveness of TT processes by encouraging the sharing of knowledge and experience among its members. It also plays an important role in commercializing innovative ideas and bringing them to society by building bridges of cooperation between universities, research centers and industrial organizations. Through seminars, training programs and conferences, it supports the professional development of those working in this field and contributes to the strengthening of the TT ecosystem in Türkiye.

8.2. Other Practices

Project Market Events: Project markets are important platforms that contribute to the development of the innovation and collaboration ecosystem. These markets bring together researchers, entrepreneurs, industry representatives and investors, providing opportunities for the promotion of innovative projects and the realization of potential collaborations. At project markets, especially technology-based projects, patented inventions and ideas with commercial value meet with a wide audience and find both investment and cooperation opportunities.

Project markets are also important interfaces where projects developed by universities, TTOs and technoparks meet with industry and concrete cooperation and investment opportunities arise. Participants present their projects at these markets, while investors have the opportunity to evaluate new business opportunities. Project markets stand out as an important component of the entrepreneurship ecosystem in terms of bringing innovative solutions to industry and accelerating commercialization processes. These platforms also enable the realization of projects with high added value and the development of innovative products that can compete in national/international markets.

In Türkiye, financial support for these events is provided by the TÜBİTAK 1503 Project Markets Support Program. In order to benefit from this program, a project application must be submitted to TÜBİTAK two months prior to the event date.

Liaison Points in OIZs: The establishment of liaison points in OIZs by TTOs strengthens the interaction between industry and academia and enables the emergence of innovative solutions. These contact points encourage cooperation, accelerate the flow of technological information, support entrepreneurship and innovation, and facilitate UIC by providing training and awareness-raising activities.

External Stakeholder Meetings: These meetings, which play a critical role in the successful management of TT processes, allow external stakeholders such as universities, industrial organizations, investors and public institutions to come together and share their knowledge, experiences and expectations. These interactions serve as an important bridge in the process of commercializing research results, transferring

innovative ideas to industry and bringing academic studies together with the real sector. In addition, these meetings, organized with the participation of external stakeholders, contribute to shaping TT processes in a more tailored manner and strengthening collaborations.

Whatsapp Groups in TT: These groups, which contribute to the progress of processes in a more dynamic and collaborative manner by providing fast and effective communication, allow different stakeholders such as universities, industrial organizations, researchers and investors to come together and exchange information and ideas. Especially in complex processes such as TT, real-time communication helps to solve problems quickly, share innovative ideas instantly and manage projects more efficiently. Whatsapp groups also create a stronger bond between stakeholders involved in the process, paving the way for the development of long-term collaborations and networks.

9. Public Administration

9.1. Public Influence on TT Policies and Incentives

The public administration in Türkiye has developed a number of policies and incentive programs to promote TT. These policies and incentives are implemented at national, regional and local levels and aim to increase the country's scientific and technological capacity, support R&D activities, strengthen UIC and transform innovative ideas into economic value. Accordingly, the Presidency of the Republic of Türkiye's Presidency of Strategy and Budget has developed strategic development plans and policies supporting TT in this process. The work carried out in this context is carried out under the auspices of ministries. Relevant organizations under the ministries such as TÜBİTAK, KOSGEB, RDAs, TUSEB, etc. continue their work for researchers and interfaces in Türkiye at each stage of the TT process.

9.1.1. Incentives Provided by State Institutions

Incentives provided by government agencies to support TT in Türkiye play a vital role in strengthening the country's innovation ecosystem. These incentives facilitate the commercialization of R&D activities and encourage collaborations between universities, industrial organizations and SMEs. The programs run by the relevant institutions under the MoIT aim to increase Türkiye's scientific and technological capacity, both by providing financial support and by helping to overcome barriers to the commercialization of R&D projects. The scope and content of these incentives are designed to respond to the needs of actors involved at every stage of TT processes.

As a result of the work carried out under the auspices of the Ministries; 1107 stakeholders from Türkiye have been involved in 486 projects so far in the Horizon Europe Program, which started in 2021, and it has been stated that a total budget of €243.4 million has been provided. In terms of academic projects, it has provided significant support for students to take part in qualified R&D projects by providing nearly 14.000 scholarship support. Within the scope of Law No. 6550, it provided €2.3 billion financing to 9 national research infrastructures between 2017 and 2023. As a result of its efforts, it increased the number of scientific publications from 9.013 to 48.577. In the last 5 years alone, it has risen from 20th to 16th place among the countries producing the highest number of scientific publications in the world. Since 2002, the number of domestic patent applications from Türkiye has increased from 414 to 9.009, and the number of domestic patents eligible for registration has increased from 73 to 3.407. In this case, Türkiye ranked 13th in the world in domestic patent applications, 5th in trademark applications and 3rd in design applications. By the end of 2023, the country ranked 1st in Europe. In terms of international patent applications, Türkiye ranked 16th with 1.071 patent applications, 8th with 2.550 trademark applications and 11th with 505 design applications. Türkiye has achieved significant success in the world in this field by effectively utilizing the amount of support allocated for the protection of IPRs. Encouraging scientists working in the process of TT 610 scientists were awarded through the Young Scientist Award Program and 25 scientists were awarded through the International Academy Awards [82].

In the TT ecosystem, public support is diversified across different institutions and programs. Each institution continues its activities within the scope of the target group and program it is related to. In this context, the relevant institutions working under the ministries are listed below.

TÜBİTAK: TÜBİTAK is a public institution established to support and guide Türkiye's development in science and technology. TÜBİTAK makes significant contributions to the country's research, development, innovation and TT activities. TÜBİTAK operates as an institution that provides support and incentives in scientific and technological fields, funds national and international projects and conducts strategic research. TÜBİTAK operates under various directorates providing services in different fields. The institution provides services under 5 different directorates such as the Research Support Programs Directorate-ARDEB, the Technology and Innovation Support Programs Directorate-TEYDEB, the International Cooperation Department-UIDB and the Science and Society Directorate-BİTO. With this structure, TÜBİTAK aims to increase Türkiye's scientific and technological capacity, provide comprehensive support to researchers and institutions, and contribute to the achievement of the country's strategic goals. In this context, TÜBİTAK acts as a funding agency for a wide audience of researchers, industrialists, entrepreneurs and students within the scope of many different programs such as national and international scientific research projects, scholarships, UIC projects, patent applications, commercialization and entrepreneurship projects, training, events and support for participation in scientific conferences.

KOSGEB: KOSGEB is a public organization established to support the development of SMEs in Türkiye. Established in 1990, KOSGEB offers various incentive and support programs to increase the competitiveness of SMEs, support innovative projects and contribute to economic development. Accordingly, KOSGEB offers incentives that aim to increase the participation of SMEs in TT processes. These incentives include financing support for R&D, innovation and industrial application projects, support for prototype development, testing and analysis services, and special incentives for SMEs located in TDZs. In addition, KOSGEB's "Techno-investment Support Program" helps SMEs develop commercializable technologies and make the necessary investments to bring these technologies to market.

TUSEB: A public institution established in 2014 to support and guide Türkiye's development in the fields of health sciences and biotechnology. Operating under the Ministry of Health, TUSEB makes significant contributions to the country's R&D and innovation activities in the fields of health sciences, biotechnology, drug development, genetic research and medical technologies. TUSEB is structured to conduct strategic research in the field of health, fund national and international projects, and support commercialization and TT processes.

TUSEB provides services through different health institutes. These include the Türkiye Cancer Institute, the Türkiye Institute of Maternal, Child and Adolescent Health, the Türkiye Biotechnology Institute, and the Türkiye Institute of Public Health and Chronic Diseases. Each of these institutes aims to increase the country's health technology capacity by developing health-related research and projects in their respective areas of expertise.

TUSEB provides support to a wide audience of researchers, healthcare professionals, biotechnology entrepreneurs and students. In this context, it offers funds and incentives in many different areas such as national and international health research projects, scholarships, public-private sector cooperation projects, patent applications, biotechnology and drug development projects. TUSEB also aims to contribute to the development of health sciences through educational programs, scientific events and conferences, and continues its activities as an important institution to achieve Türkiye's strategic goals in the field of health.

TÜRKPATENT: A public institution established in 1994 to protect and develop IPRs in Türkiye. The Agency plays a strategic role in promoting innovation by regulating the country's patent, utility model, trademark, design and geographical indication registration processes. TÜRKPATENT provides various services to

accelerate the commercialization of R&D activities, secure the IPRs of domestic and foreign investors and increase Türkiye's international competitiveness.

TÜRKPATENT provides a wide range of services at national and international level, such as registration of IPRs, evaluation of patent applications, trademark and design registrations. It also organizes training and awareness programs on IPRs, encouraging entrepreneurs and industrialists in Türkiye to pay more attention to IPRs. In cooperation with WIPO, TÜRKPATENT also plays a facilitating role for international patent applications.

The institution provides services to a wide audience of entrepreneurs, researchers, industrialists and students. It provides consultancy and technical support for patent, trademark, utility model and design applications, as well as guidance in the protection and commercialization of these registered rights.

TSE: TSE is a public institution established in 1954 to carry out standardization activities in Türkiye, to support the development of national and international trade and to improve the quality of products. TSE plays a strategic role in promoting quality in the country's industry and trade by providing standardization, certification, testing and calibration services. The Institution ensures that products and services in different sectors comply with national and international standards and aims to increase Türkiye's competitiveness in international trade.

TSE operates for the preparation, implementation and development of Türkiye and international standards. TSE's services include product certification, system certification, environmental certification, laboratory services, conformity assessment and calibration services. TSE also cooperates with international standards bodies such as International Organization for Standardization (ISO), International Electrotechnical Commission and European Committee for Standardization to support Türkiye's compliance with internationally recognized standards.

TSE provides a wide range of services for manufacturers, exporters, public institutions, industrialists and consumers. Ensuring that products and services meet certain quality standards plays a critical role in the acceptance of these products in domestic and foreign markets. TSE also provides guidance in processes such as the certification of management systems (such as ISO 9001, ISO 14001) of industrial organizations and the implementation of environmental and energy management standards.

TÜBA: TÜBA is a public institution established in 1993 to promote scientific research, raise scientific standards and support scientists in Türkiye. Playing an important role in the fields of science, technology and innovation at national and international level, TÜBA aims to support the development of scientific research and ensure that this research contributes to Türkiye's economic and social development. TÜBA conducts various programs that encourage the production, dissemination and application of scientific knowledge. The institution aims to increase the quality of scientific studies by offering scholarships, awards and project support to researchers in different fields of science. TÜBA also produces scientific publications and ensures that knowledge reaches a wide audience through these publications. In line with academic freedom and ethical principles, the institution conducts studies that support scientific excellence and international cooperation.

TÜBA plays a supportive role at every stage of scientific development by offering special programs for Türkiye's scientists and young researchers. The TÜBA Outstanding Young Scientists Awards -GEBİP rewards young scientists and helps them compete internationally. In addition, the TÜBA Scientific Authored Book Awards-TESEP encourages the production and translation of scientific publications, thereby increasing the accessibility of scientific knowledge.

As an academy that aims to promote Türkiye's scientific potential at the international level and shape Türkiye's science policies, TÜBA collaborates with universities, research centers and international scientific organizations. TÜBA's support contributes to Türkiye's scientific and technological development and aims to help Türkiye play a more active role in the global scientific community.

RDAs: These are public institutions established in 2006 to support Türkiye's regional development, reduce regional economic and social development disparities and mobilize local potential. Operating under the MoIT, these agencies contribute to local development by supporting R&D, innovation and TT processes in their regions. Development agencies cooperate with public institutions, private sector, universities and NGOs in their regions and implement projects for sustainable development goals.

RDAs aim to increase regional competitiveness by providing financing and consultancy services to local businesses, particularly SMEs. Agencies strengthen technology development and innovation capacities by providing grants and loans to innovative regional projects through financial support programs. At the same time, investment support offices provide investors with information about the region, business development and facilitation of bureaucratic procedures.

RDAs contribute to R&D and TT processes by collaborating with universities, technoparks and research centers. Through these collaborations, an innovation ecosystem is created at the regional level and local businesses' access to technology is increased. In addition, project markets, entrepreneurship trainings, business development programs and mentoring services organized by the agencies aim to support local entrepreneurs. As an important actor in the implementation of regional development policies, these agencies also undertake the task of developing strategic plans at the regional level, mobilizing local dynamics and creating cooperation among local actors. RDAs are critical for Türkiye to achieve its balanced and sustainable development goals and aim to strengthen the technology, innovation and entrepreneurship ecosystem at the national level, starting from the local level.

9.1.2 Legal Regulations and Tax Incentives

Regional and local governments offer incentives tailored to the needs of their regions, complementing national incentive programs. These incentives aim to increase the participation of regional industry and academic institutions in TT processes.

Tax Reductions and Exemptions: Regional and local governments provide various tax reductions and exemptions for companies operating in TDZs. These incentives include significant advantages such as corporate tax exemption, VAT exemption, income tax withholding incentive and customs duty exemption. Such tax incentives reduce the start-up costs of innovative firms and encourage R&D investments.

Technopark Rent Discounts: Companies operating in TDZs also benefit from rent discounts provided by local governments. These discounts are structured so that the unit square meter rental fees applied in TDZs cannot be more than 25% for those with publicly funded R&D projects and 50% for others. These discounts allow firms to allocate more resources to R&D activities and accelerate technology development and innovation processes. Technoparks also support the growth of technology-based enterprises by providing entrepreneurs with business development, consultancy and networking services.

Mandatory Investment Obligation for R&D/Design Centers and Technopark Companies: Under Article 3-14 of Law No. 5746¹ on Supporting R&D Activities, companies operating in R&D and design centers and TDZs are required to set aside 2% or 3% of their annual revenues as venture capital if they exceed a certain turnover. This law was developed specifically to encourage large-scale technology firms and R&D centers to contribute directly to the entrepreneurship ecosystem. This regulation aims to support Türkiye's technological development and economic growth by facilitating the funding of innovative projects and early-stage startups. In this context, companies will either transfer this amount as a grant to incubation firms or transfer it to investment funds to support innovative projects through venture capital. This mechanism provides a continuous flow of resources to the technology and innovation ecosystem and contributes significantly to the growth of young entrepreneurs and incubators. Supporting the entrepreneurship ecosystem facilitates the rapid commercialization of new technologies and the access of local innovations to global markets. Moreover, this imperative increases the interaction of large firms and R&D centers within the ecosystem, encouraging knowledge and experience sharing.

Investment Support Offices and RDAs: RDAs and investment support offices in Türkiye provide financing for TT projects and direct investors to such projects. These agencies provide financial support to strategic

projects that promote cooperation between local industry and academic institutions and support regional development. In addition to strategy studies, development agencies also encourage innovation and R&D activities of different actors in their regions, especially SMEs, through financial support programs. On the other hand, project market themed events are organized by agencies to support innovative entrepreneurship. These events aim to improve cooperation and coordination among stakeholders in the R&D and innovation ecosystem and to support the commercialization of technology by bringing together R&D and innovation-based project owners and capital owners.

Regional Innovation Strategies: RDAs develop regional innovation strategies and implement policies that encourage TT within the scope of these strategies. These strategies aim to create synergies between universities, research centers and industrial organizations to achieve competitive advantages at the regional level. Regional innovation strategies facilitate the financing of innovative projects and support their success at national and international level.

9.1.3. Expert Personnel Integrated into TT Ecosystem

In line with the targets set by Türkiye, various efforts are underway to train specialized personnel integrated into TT processes and to manage these processes effectively. TÜBİTAK, KOSGEB, TUSEB and RDAs play critical roles in managing these processes by employing experts experienced in TT. These experts have in-depth knowledge of IPRs, market analysis, business development and commercialization strategies, and provide guidance to ensure that innovative ideas are transformed into marketable products. This process serves as a bridge that strengthens collaboration between universities, research centers and industrial organizations.

At the regional and local level, universities and municipalities aim to create collaboration and synergies between local businesses, academic institutions and international partners by creating dedicated teams focused on innovation and TT processes. These teams aim to support the development of the innovation ecosystem at the local level, while at the same time increasing the competitiveness of the regional economy.

The private sector also makes important contributions to this process. Efforts to train qualified personnel in TT and innovation management have also been adopted by industrial organizations and technology firms. In particular, large technology firms contribute to the effective management of TT processes by training specialized personnel in their R&D and innovation units. By collaborating with universities and public institutions, these companies increase the competencies of their personnel and support the success of TT processes.

10. Results

In conclusion, Türkiye's TT ecosystem has taken important steps and achieved various successes in recent years. With increased interactions between government, academia and industry, a strong foundation has been created for the development of the innovation ecosystem. However, despite these developments, the functioning of the national system has not fully reached the desired level and some structural problems still persist. Differences in the expectations and needs of different actors involved in TT processes sometimes undermine the effectiveness of the process. In particular, differences in vision between knowledge producers and industry negatively affect the speed and efficiency of TT.

An analysis of the strengths of the TT ecosystem in Türkiye reveals that government support for technology and R&D is a major driving force. In particular, incentives provided by MoIT and its affiliated institutions such as TÜBİTAK, the establishment of TDZs and support for R&D activities at universities contribute greatly to the development of the ecosystem. In addition, tax exemptions and incentive mechanisms for R&D and design activities encourage the private sector to engage in these processes. The establishment and development of TTOs also accelerate the commercialization of knowledge produced at universities and strengthen cooperation between academia and industry.

However, despite these strengths, Türkiye's TT ecosystem also has significant weaknesses. One of the most striking weaknesses is the lack of deep cooperation between universities and industry. While universities are generally successful in research and innovation generation, there are problems in transferring this knowledge to industry and transforming it into commercial value. Industry prioritizes short-term economic returns and does not make sufficient long-term investments in innovation processes. Moreover, lack of experience and expertise in TT processes leads to weak cooperation. Although many universities have high potential for R&D and innovation, the inability to use this potential commercially is seen as one of the biggest obstacles to TT.

Another important problem is the lack of financing. The resources allocated to TT processes in Türkiye are insufficient compared to developed countries, which negatively affects the commercialization rates of R&D projects. SMEs in particular face financial barriers in accessing technology, limiting Türkiye's ambitions for technology-based economic growth. In addition, the institutional capacity of TTOs in Türkiye is not strong enough. Many TTOs do not have sustainable funding sources and lack specialized staff. This makes it difficult for TTOs to operate effectively and slows down the pace of TT processes.

Despite these weaknesses, there are also opportunities for Türkiye's TT ecosystem. In particular, Türkiye's young and dynamic population, the growth of the entrepreneurship ecosystem and the increase in start-ups can contribute to accelerating TT processes. The increasing number of start-ups in TDZs and the rise in the number of patents produced at universities are among the factors boosting Türkiye's innovation potential. In addition, the expansion of the scope of government incentives for TT and the increase in international cooperation opportunities have enabled Türkiye to gain a stronger position in the TT ecosystem.

In this context, some suggestions can be made for Türkiye's TT ecosystem to function more efficiently. First of all, it is of great importance to strengthen the cooperation between universities and industry. This cooperation should not only be limited to R&D projects, but also ensure that industry plays an active role in the commercialization of inventions developed at universities. In order to increase cooperation between universities and industry, the institutional capacities of TTOs should be strengthened and the quality of the experts working in these offices should be increased. TTOs should be provided with access to sustainable financing sources and their efficiency in TT processes should be increased.

Moreover, investing more in R&D and innovation activities is a critical step for industry to contribute more to TT. Industrial enterprises should focus on long-term R&D investments instead of short-term profit targets and collaborate more with universities in these processes. It is also important to increase international cooperation to strengthen Türkiye's TT ecosystem. In this context, Türkiye needs to take a more active role in international TT networks and develop policies that will attract foreign capital investments.

Special emphasis needs to be placed on the differences in vision between those who produce knowledge and those who demand jobs. Universities and technology centers adopt a longer-term, research and innovation-oriented vision, while industry focuses on shorter-term economic returns. These differences in vision sometimes lead to incompatibilities in TT processes and reduce the effectiveness of information flow and cooperation. It is especially important for the industrial sector to increase its investments in R&D and to focus on long-term projects in order to overcome these differences in vision. In order to ensure sustainable success in TT, all parties should act in line with a common strategy and goal. Accordingly, research outputs of universities should be transferred to industry more rapidly, while industry should increase its capacity to transform this knowledge into innovation.

In conclusion, although there are many strengths and opportunities in Türkiye's TT ecosystem, important steps need to be taken to make these processes more efficient. Deepening cooperation between the public, academia and industry, increasing the capacity of TTOs and expanding financial resources are critical to ensure the sustainability of the ecosystem. Implementation of these steps will enable Türkiye to become more competitive in the global technology market and accelerate the commercialization of domestic technologies.

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