TEKPOL STI POLICY NEWSLETTER

Science, Technology and Innovation Policy in Turkey, ***July 2021***

The aim of the TEKPOL STI Policy Newsletter is to present information regarding the science, technology and innovation (STI) policy landscape in Turkey.

What is in this issue?

Topic in focus:

The Strategic Studies for Digital Transformation in Turkey

by Erkan Erdil

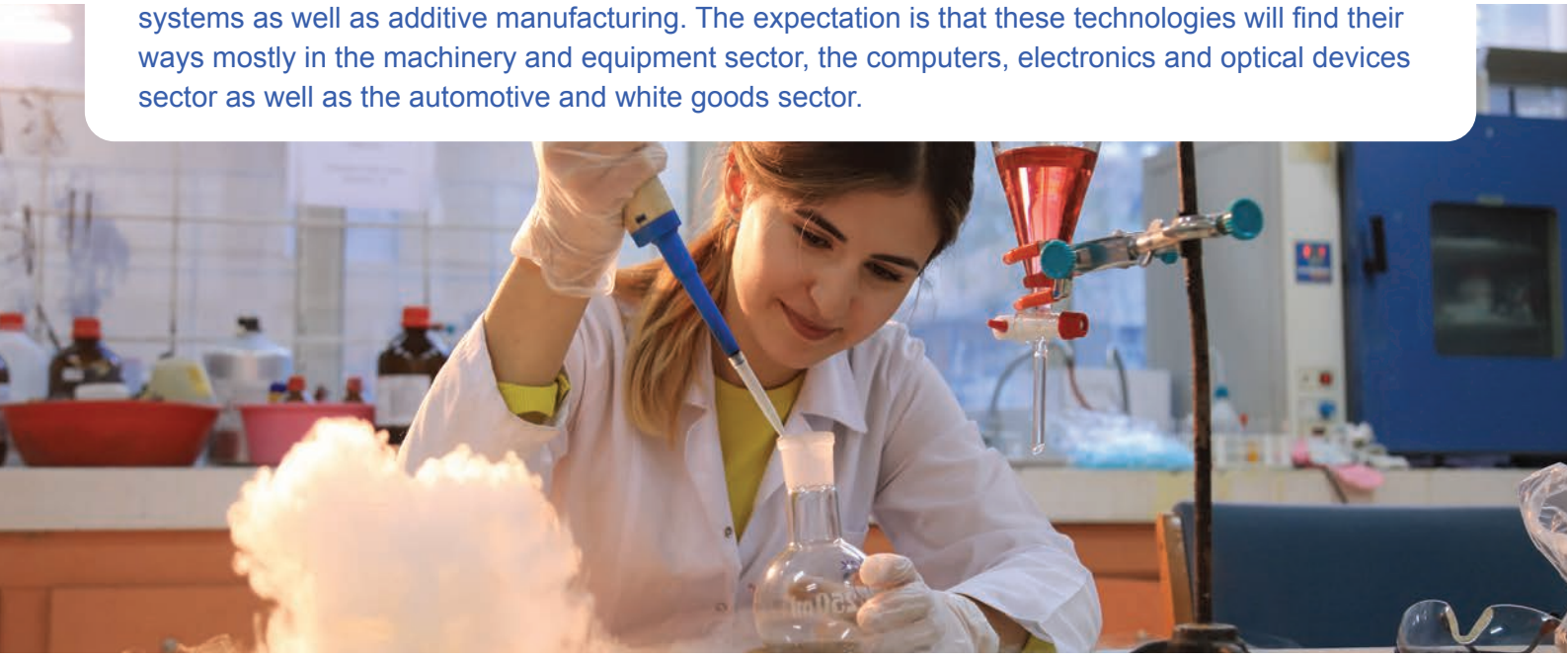
The academic literature on the policy approach for digital transformation is almost non-existent in Turkey. The national literature on policy is mainly concerned with the impacts of information society and associated discussions rather than the implications of the ICT revolution. The most comprehensive study is financed by the Turkish Industry and Business Association (TÜSİAD) and written by the Boston Consulting Group (BCG) (TÜSİAD, 2016a). This study concludes that *"There is, therefore, a need for a platform where every aspect of the Industry 4.0 approach can be addressed and both the strategic and operational needs and applications can be discussed in depth with the participation of all of the actors responsible for transforming our industrial sectors."* (TÜSİAD, 2016a:13).

Following this report, TÜSİAD continued to study on the possible impacts of digital transformation and readiness of Turkish Industry for the transformation with two more studies (TÜSİAD, 2016b and 2017).

At the 29th meeting of the Higher Council for Science and Technology in February 2016 (Decree 2016/101), three significant decisions were taken towards the transition of Turkish industry for increasing international competitiveness in technology production:

- Developing an implementation and monitoring model for smart manufacturing in coordination with all stakeholders
- Increasing goal-oriented R&D efforts in critical and pioneering technology areas (cyber-physical systems, AI/sensor/robotics, IoT, big data, cyber security, cloud techs, etc.)
- Designing support mechanisms for manufacturing infrastructures to develop critical and pioneering technologies.

In accordance with these decisions, TÜBİTAK prepared a road map on “smart manufacturing systems” and carried out a survey with the stakeholders, then a prioritization study was carried out through an expert workshop, followed by a focused group meeting. According to results of the survey on 1,000 firms, only 22% reported that they have a detailed knowledge on smart manufacturing systems (TÜBİTAK, 2017). The highest awareness is observed in the electronics, software and materials sectors. Among the surveyed firms, 50% have a strategy to integrate smart manufacturing systems in their production processes (TÜBİTAK, 2017). Regarding the level of digital maturity, the Turkish industry is between the 2nd and 3rd industrial revolution and the most mature sectors are the materials sector (rubbers and plastics), computers, electronics and optical devices as well as the automotive and white goods sector. Three technologies that will provide the most added value according to Turkish firms, are automation and control systems, advanced robotic systems as well as additive manufacturing. The expectation is that these technologies will find their ways mostly in the machinery and equipment sector, the computers, electronics and optical devices sector as well as the automotive and white goods sector.



1) TÜSİAD Reports

According to TÜSİAD (2016a), the expected impact of the digital transformation on the Turkish economy is as follows:

- **Productivity gains of 4 to 7 percent** on an annual basis.
- Despite the predicted low skilled job loss, **5 percent absolute increase in employment** is expected.
- **Higher-skilled labour force** structure is expected to prepare a **stronger know-how base** for Turkey.
- Additional total manufacturing-based growth of up to 3 percent per year, meaning **1 percent growth effect on Turkish GDP**. Turkish producers are required **to invest about 3 to 5 billion Euro per year** over the next ten years.

Four sectors have considerable strength in digital transformation, namely automotive, machinery, white appliances and chemicals. Turkey has various strengths towards this transformation.

- First of all, Turkey has a long tradition of manufacturing expertise and exhibits significant progress with the development of key industries and growing trade and investment.
- Second, the last decade has witnessed a rapid export growth which in turn accelerates the articulation of Turkish industry with the global counterparts. The well-developed and relatively large domestic market provides opportunities to process market information and feedback for production.
- Finally, rising public incentives targeting to increase private sector RDI, export share of hi-tech sectors, to strengthen research commercialization and entrepreneurship.

TÜSİAD's second study is directed towards measuring perceptions of CEOs: "CEO Perspective on Digital Transformation in Turkey". The study was carried out in collaboration with Samsung Electronics, Deloitte, and GfK in 11 sectors (TÜSİAD, 2016b). The study intends to understand how senior executives of 58 leading corporations operating in various industries in Turkey perceive digital transformation in their corporations, what they focus on, and how they manage the process of change.

According to this study, digital transformation seems to be a significant concern of CEOs with a high level of awareness. One of the main stylized facts from the perceptions of CEOs is that Turkey has a long way to reach the desired destination. However, the existence of an extensive awareness is promising if the transformation is accompanied by new business models to utilize digital technologies through a creative manner. Therefore, the concepts of "digitally innovative corporation" and "comprehensible digital strategy" are frequently underlined in the report (TÜSİAD, 2106b).

The lack of strategy seems to be the most significant barrier for digital maturation. Moreover, because of the differences in demand structures, the firms in B2C and B2B activities should seem to have different strategies concerning digital transformation. As general-purpose technologies, the firms in the ICT and finance sectors do not limit themselves just to prioritize digitalization but to allocate their investment for this target (TÜSİAD, 2016b:16).

The CEOs are asked to rank the obstacles blocking an increase in digital technology development level. As it can be seen from Figure 3, the most important factors that impede digital transformation in Turkish industry are listed as (TÜSİAD, 2016b:38);

- lack of competency and strategy,
- security problems and,
- lack of association with robust commercial results.

In a more recent study, TÜSİAD (2017) carried out a field survey with 108 firms and 110 technology suppliers to measure the competencies of firms for digital transformation. In the questionnaire, firms' competencies are assessed with 23 dimensions. The most widespread digital technologies are cybersecurity, sensors and robotics and automation (TÜSİAD, 2017:43).

Although 61% of the respondents noted that their firms are ready for digital transformation, competence levels of firms are low and most of the projects can be thought as pilot projects in areas such as data-focused quality control, smart factories, production management, cyber security, infrastructure, social business network, and electronic performance panes (TÜSİAD, 2017:45). The lowest level of competences is observed in the case of governance, additive manufacturing and advanced robotics. Moreover, the competence levels of firms do not differ across sectors, however, there is a positive correlation between competence and firm level as expected.

The most significant barriers are found to be cost of investment (27%), uncertainty of return on investment (18%), lack of qualified personnel (16%), problems in technology infrastructure (13%), and lack of local suppliers (10%) (TÜSİAD, 2017:49). There is a significant level of market imbalance in the sense that technology firms complain about the insufficient number of suppliers while technology suppliers highlight insufficient demand. The need assessment of firms underlines that the most demanded technologies are robotics and automation, big data analysis, artificial intelligence, and smart systems (TÜSİAD, 2017:55).

The report suggests a strategic approach in which firms should determine the digital transformation strategy before the investment decisions because of the risk-awareness of the firms and not to waste the limited resources. It recommends three steps for this end, namely steering investments in line with strategic targets, shaping the future, ensuring value created is maintained in Turkey (TÜSİAD, 2017:57). Finally, the report offers a triple-helix like model in which a cooperation between the public, private sector, academia and all stakeholders is underlined as summarized below:

- Government should identify the technologies that should be focused on and establish incentive mechanisms for companies to attract investment to these fields.
- Since a significant portion of domestic suppliers' revenues (70%) is derived from domestic markets, the need for developing a portal to bring companies and suppliers together becomes significantly important.
- Creating necessary regulations to support the venture capital sector will increase accessibility of financing in Turkey. As a result, it will increase the development pace of technology suppliers.
- Establishing a high-tech institute which will enable the creation of a sustainable innovation ecosystem by serving as a bridge between the academy and the industry.
- Research shows that there is a significant difference between the competency levels of large and small companies. This increases the importance of the steps taken towards SMEs. Large industrial companies have a major role in the development of both subsidiary industries and technology suppliers. Large companies can encourage their suppliers to realize digital transformation by setting procurement standards.

Although the report and the survey provide extensive information of the existing situation in Turkey, the information is highly normative in the sense that it describes the policy recommendations, yet it does not specify the policy tools to reach the strategic objectives. Some suggestions are not novel and in accordance with the "one-size-fits-all-approach." Moreover, the recommendations do not generally consider the context-specificity of the country and challenges of the national innovation system which will be discussed in the next sections.

2) Digital Turkey Road Map of MoSIT

The latest official study, titled Digital Turkey Road Map, was prepared by Ministry of Science, Industry and Technology (MoSIT, current Ministry of Industry and Technology) and published in July 2018. The report was prepared with the contribution of various public sector agencies including universities and private sector NGOs (TOBB, TİM, TÜSİAD, MÜSİAD, YASED, TTGV) under the coordination of MoSIT. In fact, the structure can be treated as a platform. The studies started in the late 2016 and six dimensions were considered, namely human resources, technology, infrastructure, suppliers, users, and governance. The report, initially starts with the analysis of the existing situation on the global scene and Turkey, then presents the road maps for each dimension. The targets of each dimension and major steps necessary for the implementation are summarized in Table 1.

Table 1: Digital Turkey Road Map

Dimension	Target	Major steps for implementation
Human	Providing a skilled labor force and enhancing educational infrastructures to design, manage and sustain the digital transformation during the process of digital transformation of the manufacturing industry.	• To train and educate digital technology users in Continuous Education Centers and thematic technical colleges, • To raise the number of programmes for digital technology developers in universities, • To provide digital skills to educators at each level of education, • To support Ph.D. training in digital technologies, • To bring together the labor force with digital skills and the industry with special supports and incentives, • To raise and spread awareness of digital transformation, • To develop collaboration with digital transformation stakeholders.
Technology	Constituting a global and national collaborative technology infrastructure in digital technology research with strong capabilities.	• To prepare technology road maps for focused technology areas (cloud computing, big data, artificial intelligence, autonomous robotics, etc.) • To prepare applied R&D strategy, • To establish applied research centers in focused technology areas, • To start the Digital Technologies Programme.
Infrastructure	Strengthening the data communication infrastructure needed by the manufacturing industry in the process of digital transformation	• To provide broadband internet connection to technology developing firms and industry. • To integrate international studies on data communication standards and support the diffusion of standards, • To take measures for industrial cyber security,
Suppliers	Developing the skills of national suppliers that provide the digital technology products and services meeting the needs of the Turkish manufacturing industry in order to sustain the digital transformation and even to create global technology suppliers.	• To prepare an inventory of national digital technology firms, • To strengthen technology transfer and development possibilities, • To support the access of national suppliers to customers, • To enhance the accessibility of long-term finance (credits, capital investments etc.).
Users (manufacturing firms)	Using digital technologies in a more efficient way.	• To establish digital transformation centers, • To train consultants for supporting the digital transformation of SMEs, • To ease the digitalization trip of manufacturing firms with a digital transformation support programme.
Governance	Establishing an efficient and effective governance structure to direct the digital transformation process and to coordinate the stakeholders.	• To provide the sustainability of working groups (committees, boards, etc.) for the specific areas (i.e. curriculum) covered by different institutions and organizations. • To establish a national industrial cloud platform and to raise the industrial demand for data centers.

Source: MoSIT, 2018.

The road map is an extensive and participatory account to prepare Turkish industry. However, it has some shortcomings. First, it focuses on the manufacturing industry and ignores the services and other sectors such as energy, construction, etc. These sectors have a significant share in the Turkish economy. Second, although some cross-cutting issues are discussed in the road map, the mechanisms regarding the coordination of these issues are partially touched upon. In a general sense, these are placed under the heading of governance yet the mechanisms are not clarified. This may cause problems in the implementation of the road map. Third, the resources to implement the road map are not identified in an extensive manner. This shortcoming may also create problems during the implementation. Finally, the participatory process can be enhanced with the participation of other actors such as trade unions, other NGOs, etc. towards the perspective of digital transformation for the society.

3) Technology Prioritization for Digital Transformation by TÜBİTAK

In the prioritization phase, in accordance with the decisions of the Higher Council for Science and Technology and road map explained above, 3 technology groups, 8 critical technologies, 10 strategic targets and 29 products were determined (TÜBİTAK, 2017: 6). Moreover, 3 sectors were prioritized in the context of the strategy as automotive, white durables, and chemistry and food (TÜBİTAK, 2017: 6).

The technology groups, strategic targets and underlying technologies are as follows:

1. Digitalization, with a focus on big data and cloud computing, virtualization and cyber security. The following targets are being defined:

    - Secure, private cloud service platform: develop secure, private, intelligent and scalable cloud service platforms for end devices, algorithms and applications.
    - Big data analytics: collect, process, correlate, analyse, report and use in decision support systems. Cyber security solutions: develop cyber security solutions Industry 4.0 applications.
    - Modelling and simulation: development of modelling and simulation technologies

2. Connectivity, with a focus on the Internet of Things (IoT) and sensor technologies. The following targets are being defined:

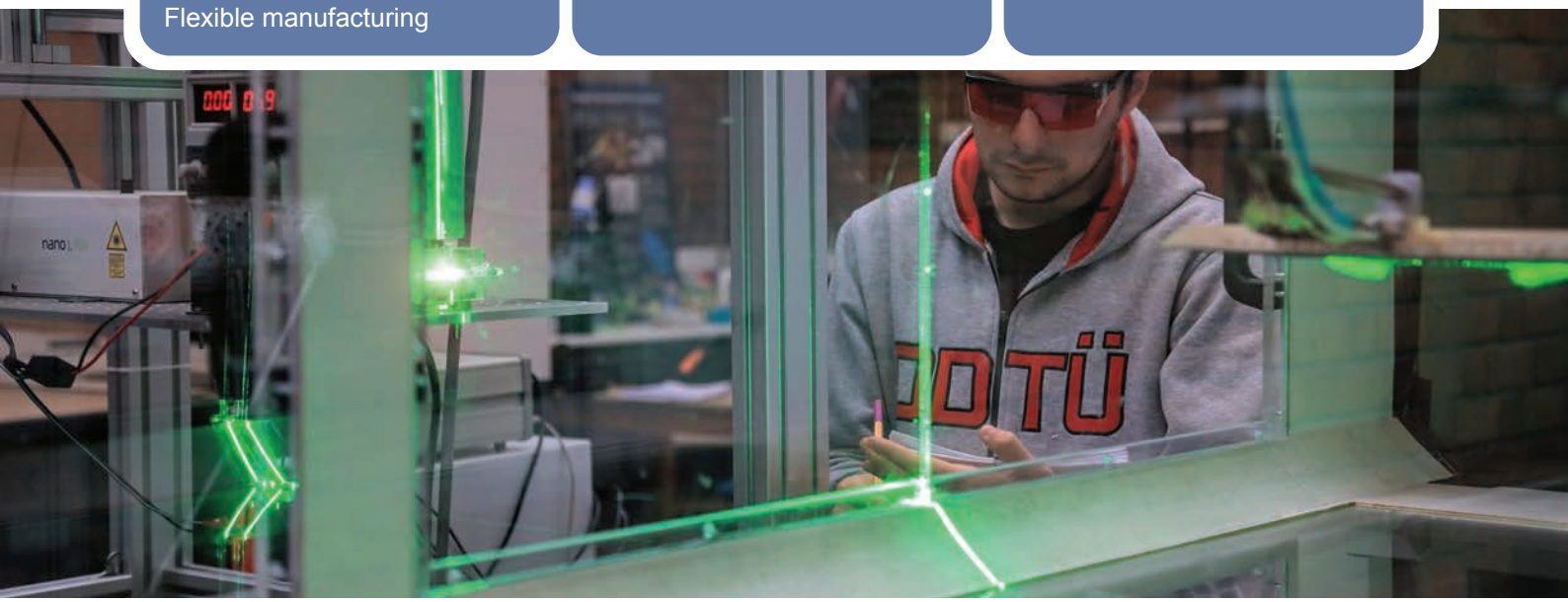
    - Industrial IoT platform: establishment of a digital platform of industrial IoT with interoperability, increased security and reliability, and development of software and hardware for industrial endpoint equipment.
    - M2X software and equipment: development of data storage technologies suitable for data emerging with reliable and innovative M2X (Machine-Machine, Human-Machine, Machine-Infrastructure) software and / or hardware that will increase the quality and productivity during the product life cycle.
    - Innovative sensors: development of industrial, physical, chemical, biological, optical, micro-nano sensors; intelligent actors; industrial, wireless, digital sensor networks; artificial vision, image processing, innovative sensor applications and heavy conditions resistant sensors.

3. Future factories, with a focus on additive manufacturing, advanced robotic systems and automation & control systems.

    - Robotic, automation, equipment, software and management systems: developing intelligent production robots, equipment and software / management systems that can compete in the international markets in terms of technology and cost, also accessible by SMEs.
    - Supplementary manufacturing materials, equipment and software: development of raw materials, production equipment and necessary software and automation systems used in additive manufacturing.
    - Intelligent factory systems: development of intelligent factory systems and components and middleware software technologies.

TÜBİTAK's national call for research proposals topics for 2016-2018 already reflected a focus on advanced manufacturing technologies as well as the internet of things (IoT). These calls are under the calls of the "Prioritized R&D Grant Programme" for industry and academia (1003 and 1511 respectively). Specific focus is on:

Additive Manufacturing:	Internet of Things	Artificial Intelligence
Multilayer additive manufacturing	Sensors and sensing systems	Advanced level driver support systems for detection and processing
Rapid prototyping and 3D printing technologies	Virtualization	Embedded systems for smart energy management
CAD/CAM, simulation & modelling software	M2M communication	
Robotics and mechatronics	Cloud computing	
Flexible manufacturing		



In sum, the current situation in Turkey is promising for policy development and innovative sustainable policy-making. However, the most significant problem is the intensive participation of sub-tiers in the domain of these actors such as SMEs, university research centres, etc. in policy making and probable transformation actions.

References:

MoSIT (2018), Dijital Türkiye Yol Haritası. Ankara: MoSIT.
TÜBİTAK (2017), Yeni Sanayi Devrimi Akıllı Üretim Sistemleri Teknoloji Yol Haritası. Ankara: TÜBİTAK.
TÜSİAD (2016a), Industry 4.0 in Turkey as an Imperative for Global Competitiveness,. An Emerging Market Perspective. İstanbul: TÜSİAD.
TÜSİAD (2016b), Türkiye'deki Dijital Değişime CEO Bakışı. İstanbul: TÜSİAD.
TÜSİAD (2017), Türkiye'nin Sanayide Dijital Dönüşüm Yetkinliği. İstanbul: TÜSİAD.

Main statistics

Main STI Indicators for Turkey

	TR 2005	TR 2010	TR 2015	TR 2018	TR 2019	EU 2019
GDP per capita (€)	5,964	8,060	10,001	8,148	8,287	31,279
GERD (million €)	2,287	4,642	6,814	6,752	7,228	307,845
GERD as % of the GDP	0.57	0.80	0.88	1.03	1.06	2.2
GERD (€ per capita)	33.6	64.0	87.7	83.5	88.1	688.7
R&D personnel (FTE) as a percentage of active population	0.24	0.33	0.42	0.55	0.56	1.13
Human resources in Science and Technology as a percentage of active population	---	20.9	26.3	28.8	30.3	46.9
Employment in high and medium-high tech. manufacturing as a share of total employment (%)	---	3.0	3.3	3.5	3.6	6.2
Employment in total knowledge-intensive activities as a share of total employment (%)	---	18.3	20.5	24.2	25.8	39
Exports of high technology products as a share of total exports (%)	---	2.0	1.9	2.4	---	17.9

Source: TurkStat, Eurostat. GERD: Gross Expenditure in R&D. FTE: Full time equivalent. GDP: Gross Domestic Product.. GDP per capita is calculated as GDP in current prices (millions of €) divided by population 1st of January. The definitions of active population, human resources in S&T, high and medium-high technology and knowledge-intensive activities are available in the links given for each indicator. The figures for EU 27 are preliminary.

TEKPOL STI POLICY NEWSLETTER

Recent STI related statistics

Foreign Trade Statistics, issued by TurkStat on 30 June 2021, stated that exports and imports increased by 65.7% and 54.0% respectively in May 2021. Energy products and non-monetary gold-exports and imports increased by 68.6% and 61.7% respectively. The foreign trade deficit increased by 20.2%. The ratio of manufacturing industries products in total exports is 94.1%. The main trading partners are Germany for exports and China for imports.

According to the **Economic Confidence Index** released by TURKSTAT on 29 June 2021 the index number is 97.8, with a 5.6% increase compared to 92.6 in May. Consumer, real sector (manufacturing industry), services, retail trade and construction confidence indices have increased.

Sectoral Confidence Indices, issued by TurkStat on 24 June 2021, has revealed that the confidence index increased in services, retail trade and construction sectors in June 2021 compared to the previous month.

Turkish Statistical Office (TurkStat) has issued an assessment study for Turkey's **Industrial Production Index** on 11 June 2021. According to this study, industrial production increased by 66.0% annually and decreased by 0.9% monthly.

According to the 2020 **Income and Living Conditions Survey** Regional Results, issued by TurkStat on 22 June 2020, TR 1 İstanbul has been defined as the region with the highest income, while TRB2 (Van, Muş, Bitlis, Hakkari) had the lowest income.

Statistics in focus

Patent Report of Turkey 2020 that compiles data on patents from TURKPATENT, EPO and WIPO data was recently released (in Turkish). Turkey's patent applications to TURKPATENT have increased slightly and reached 8,200 in 2020, while applications to EPO have increased by 26% reaching 594. However, this performance could not top Turkey's 2017 performance (911 applications). With this performance in patent applications to EPO, Turkey ranks 24th in the World and 13th among developing 20 countries.

Turkey's patent application performance from 2016 to 2020.

	TURKPATENT	EPO	WIPO
2016	6,445	523	1,065
2017	8,625	911	1,251
2018	7,349	574	1,398
2019	8,126	471	1,689
2020	8,200	594	1,705

Source: Patenteffect Patent Report Turkey 2020.

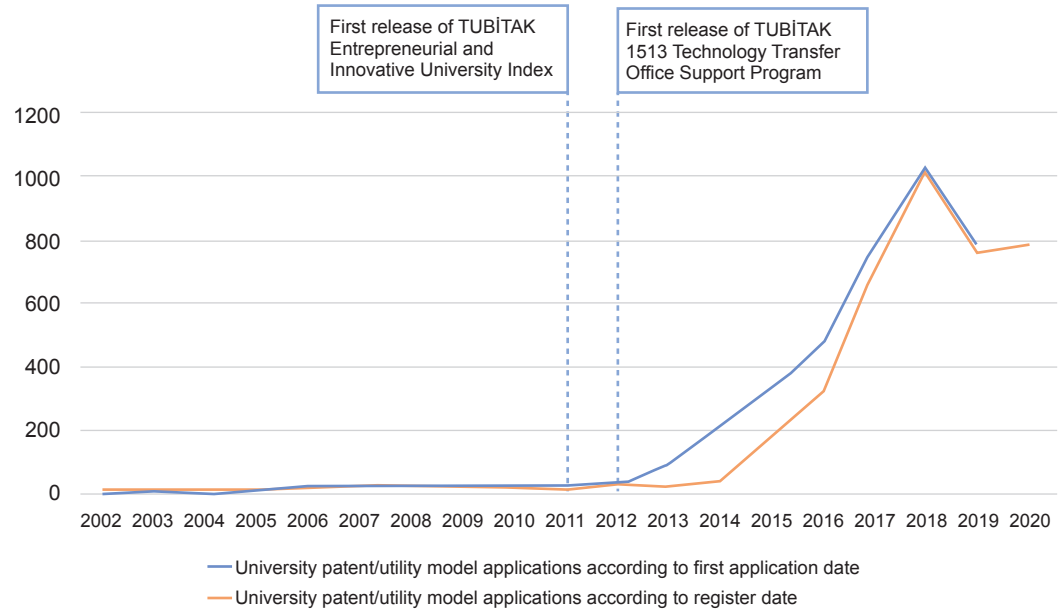
According to WIPO data Turkey's patent applications have increased by 60% in the past five years,

- Technology companies such as Arçelik, Turkcell and Vestel top the list of companies with the highest number of applications. With its 256 applications in 2020 Arçelik is responsible for about 15% of the applications from Turkey.
- The top-10 list includes Medipol University with 31 patent applications.
- Except for two companies in the top-10 list, all companies have increased their patent applications in 2020 compared to 2019. Turkish defence sector company Havelsan has increased its patent applications to 17 in 2020 (only 4 in 2019).

İstanbul, Ankara, Bursa, İzmir and Manisa are the top-5 cities that patent applications (to TURKPATENT) cluster. Applications from İstanbul are three times higher than Ankara. Within the top-10 cities Gaziantep has increased its patent applications by 73% from 2019 to 2020.

One of the most interesting findings is the increased patenting behaviour of Turkish Universities as depicted below. The sharp increase after 2012 can be associated with the release of TUBİTAK's Entrepreneurial and Innovative University Index in 2011 and the foundation of university Technology Transfer Offices (TTOs). TUBİTAK's 1513 program that aims to support TTO's in 2012 and the change in Intellectual Property Law in 2016 that grants universities the right to own patents (inventions by the university personnel) were important developments that could explain increased university patenting.

Turkish Universities' overall patenting behaviour from 2002 to 2020



Source: Patenteffect Patent Report Turkey 2020

Reports, publications and official documents

In Turkish

Dijital Dönüşümün İş Süreçlerine Etkileri. (Effects of Digital Transformation on Business Processes). Independent Industrialists and Businessmen's Association (MÜSİAD). July 2020.

KOBİ'lerin Dijital ve Finansal Karnesi. (Digital and Financial Scoreboard of SMEs), Turkish Enterprise and Business Confederation. June 2021

Veri Merkezi Sektörünün Geliştirilmesi Değerlendirme ve Öneriler Ön Raporu (Development of the Data Center Industry Evaluation and Recommendations Preliminary Report), Informatics Association of Turkey (TBD). May 2021.

Türkiye'nin Patent Raporu 2020. (Turkey's Patent Report 2020), Patenteffect. May 2021.

Otonom ve Bağlantılı Araç Teknolojileri Geliştirme, Eğitim ve Test Altyapısı Projesi Raporu. (Autonomous and Connected Vehicle Technologies Development, Training and Test Infrastructure Project Report). İstanbul Development Agency. February 2021.

Batarya ve Yenilikçi Enerji Teknolojileri Çalışma Grubu Raporu. (Battery and Innovative Energy Technologies Working Group Report), TÜSSİDE (Türkiye Sanayi Sevk ve İdare Enstitüsü). 2021.

Dijitalleşme Yolunda Türkiye 2021: Trendler ve rehber hedefler (Turkey on the road to Digitization 2021: Trends and Guiding Targets). KPMG Türkiye & Digital Turkey Platform. 2021

Türkiye'nin Dijital Dönüşüm Endeksi. (Digital Transformation Index of Turkey). Informatics Industry Association (TÜBİSAD). 2020.

İnovasyon ve Dijital Dönüşüm Çalıştayı Sonuç Raporu. (Innovation and Digital Transformation Workshop Final Report). Turkish Industry and Business Association (TÜSİAD). October 2020.

Türkiye'de Dijital Dönüşüm Değerlendirme Aracı. (Digital Transformation Evaluation Tool in Turkey). Bosphorus University, Industry 4.0 Platform. March 2020.

TEKPOL STI POLICY NEWSLETTER

In English

The future of skills: case study of the automotive sector in Turkey. European Training Foundation, The Future of Skills, Draft Report. September, 2020.

Turkey's digitalization grade (long report in Turkish), TÜBİSAD, News. June, 2020.

Turkish Information and Communication Sector. See also the linked full report on ICT Market Data. TÜBİSAD, News. June, 2020.

Future of the Work: Turkey's Talent Transformation in the Digital Era. McKinsey & Company. January 2020.

July 2021 TEKPOL STI Policy newsletter is prepared by: İbrahim Semih Akçomak, Erkan Erdil, Seda Kılıçaslan, İpek Sanrı, Yelda Erden Topal, Esin Yazıcı. Graphic design by Yasemin Oran.

Science and Technology Policy Research Center (TEKPOL), Middle East Technical University
http://stps.metu.edu.tr
stps@metu.edu.tr