

**THE 2000s: THE NATIONAL TECHNOLOGY
INITIATIVE AND TÜRKİYE'S FUTURE
PERSPECTIVE**

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THE 2000s: THE NATIONAL TECHNOLOGY INITIATIVE AND TÜRKİYE'S FUTURE PERSPECTIVE

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Abstract

Türkiye failed to launch an industrialization drive and ensure production-driven development for a long time. Whereas the country came up with various development models to address that problem at different points in the Republic's history, the desired success began to be seen in the 2000s thanks to political stability and, by extension, the development of a long-term perspective on R&D, innovation, production, and development. Today, Türkiye has become a country that takes major strides in production and technology. This study analyzes the transformation that the National Technology Initiative has fueled in our country in recent years and the future of that transformation. Primarily, it demonstrates what Türkiye has achieved in R&D, technology and production, with contributions from an overhaul of the regulatory and institutional infrastructures, over the last two decades with the help of concrete indicators. Subsequently, this article establishes how the defense industry's idiosyncratic governance model inspired the National Technology Initiative's initial achievements. In this regard, it presents some of the projects that are successfully implemented today thanks to the momentum that the defense industry has generated. The third part of this study, in turn, underscores why it is absolutely necessary for Türkiye, a country with great ideals for the future, to focus on paradigm shifts and disruptive technologies (as it has in the defense industry) and to develop a long-term and systematic perspective as humanity witnesses the Fourth Industrial Revolution. It also explains the various steps, which Türkiye plans to take in the area of innovative and disruptive technologies for this purpose within the framework of its 2023 Industry and Technology Strategy and the existing sector-oriented strategies and roadmaps. Last but not least, pointing out that the country building on its National Technology Initiative with human capital, technology entrepreneurship, R&D and investment incentives, along with public investments, shall determine the outcome, direction and momentum of that venture, this article notes that the National Technology Initiative, which the Turkish people have embraced with a spirit of mobilization, shall be valuable for Türkiye as well as humanity as a whole.

Keywords

National Technology Initiative, R&D, Innovation, Disruptive Technologies, Defense Industry, Self-sufficiency, TEKNOFEST

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1. Introduction

By the late twentieth century, Türkiye had failed to become a pioneer of the industrial revolutions, which had made their mark over the previous two hundred years, and to gain high momentum in its pursuit of development. The country could not successfully complete the Heavy Industry Drive in the 1970s. Whereas Türkiye made an attempt to claim a larger share of the global value chains by adopting export-oriented policies over the following decade, its competence in developing high-tech products remained limited. In the 1990s, as those global corporations that pioneered new business models, which emerged out of the Internet's rapid expansion, became larger than national economies, Türkiye experienced a period of political and economic instability. During that period, the public policy did not sufficiently support research, development and innovation processes. The country could not develop the critical infrastructure for research, just as the private sector failed to play any role in the technology development and innovation processes. Indeed, by 2000, Türkiye's total R&D spending amounted to 798 trillion Turkish Lira (approximately \$1.270 billion) and the number of full-time equivalent R&D staff was just 27,003. Moreover, the private sector accounted for barely one third of all R&D spending and employed less than a quarter of all R&D workers (TÜİK, 2021).

In the 2000s, the achievement of political stability facilitated the implementation of long-term public policies and increased the level of predictability, which paved the way for private sector entrepreneurship. Accordingly, that period marked the starting point for Türkiye's unique venture into technology development and the development processes which came to be known as the National Technology Initiative.

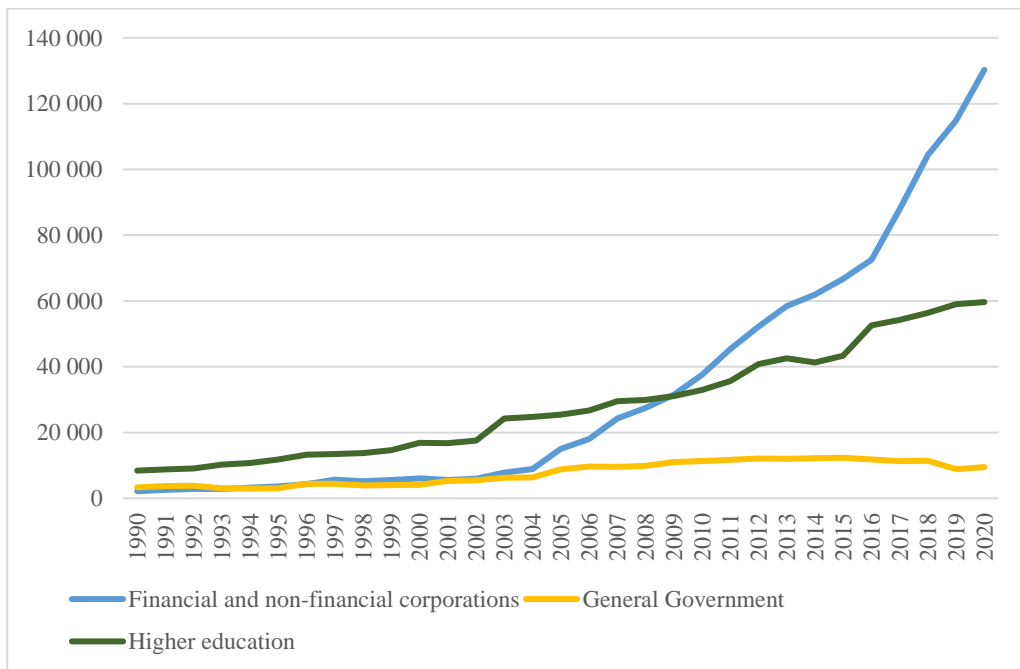


Figure 1. R&D Human Resource by Sector (Full Time Equivalent) (TÜİK, 2021)

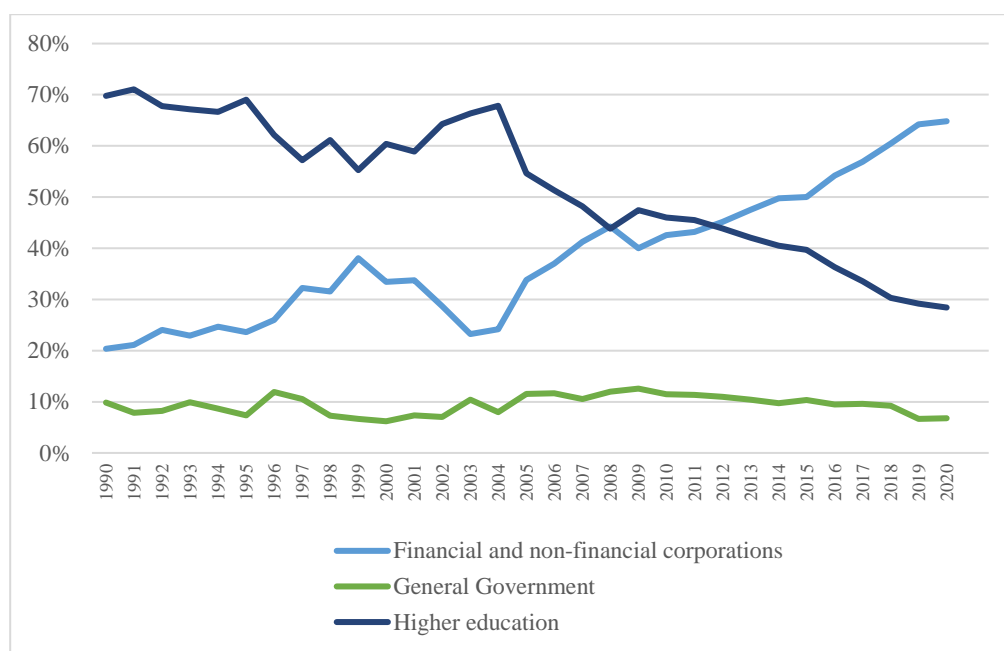


Figure 2. Distribution of R&D Spending Across Sectors (%) (TÜİK, 2021)

There was a sharp increase in all industrial and technological indicators, including the number of companies operating in the manufacturing industry and organized industrial zones, the production of domestic appliances and automobiles, and the number of technology development zones (Teknopark). As agencies like The Scientific and Technological Research Council of Türkiye (TUBITAK) and the Small and Medium Enterprises Development Organization (KOSGEB) witnessed an uptick in their level of activity and support budgets, the newly-established Development Agencies became catalysts for reaching regional development goals. At the same time, the increase in production and the development of R&D human resource went hand in hand with the expansion of the country's intellectual property capacity. It would be misleading not to identify legislative efforts, new regulations and institutional improvements among those factors that facilitated such developments.

Türkiye implements two main models for developing its industrialization infrastructure: Organized industrial zones (OSB) and industrial zones (EB). Since 2002, the number of OSBs soared from 192 to 340, as the total number of OSB employees increased from 370,385 to 2,072,640. Meanwhile, the EBs, which focus on large-scale and integrated investments, began to operate in 2018 and their total number has reached 29 by July 2022 (Ministry of Industry and Technology, 2022d).

The manufacturing industry's share within the Turkish economy, together with export figures and the level of production in the main industrial sectors, came to reflect those improvements in infrastructure. Accordingly, the manufacturing industry's total exports climbed from \$25.5 billion in 2000 to \$212.9 billion by 2021 (TÜİK, 2022). Again, in 2021, the manufacturing industry accounted for 95 percent of Türkiye's total exports and 23.6 percent of its gross national product. The total number of domestic appliances made in Türkiye reached 34 million in 2021, as the number of exported domestic appliances approached 26 million – making the country Europe's largest and the world's second largest producer of domestic appliances (White Goods Manufacturers' Association of Türkiye,

2022a; White Goods Manufacturers' Association of Türkiye, 2022b). As Europe's fourth (and the world's fourteenth) largest automotive producer, Türkiye's annual automotive production and annual automotive exports neared 1.3 million and 954 thousand respectively (Automotive Industrialists' Association, 2022).

In addition to the improvement of infrastructure, various forms of investment incentives and support for the industry played a major role in that development.

Government incentives for investment are among those factors that have a positive impact on the decision-making of domestic and international investors. In 2002, Türkiye offered investors exemptions from the VAT, the Customs Tax and the Mass Housing Fund as well as discounts and exemptions regarding certain taxes, tolls and fees in exchange for their investments within the framework of the body of law on investment incentives. The country overhauled its incentive system in 2009 to make a distinction between different regions and sectors to reduce the development gap across regions as well as to introduce a separate scheme for encouraging large-scale investments (to channel savings into R&D and high-value-added investments). The new system also featured various forms of support, including tax cuts, interest subsidies and subsidies for the employer's share in social security premiums (Ministry of Industry and Technology, 2022f).

The incentive system, which has been in place since 2012, in turn, has aimed to reduce Türkiye's import dependency for intermediary goods by transforming the Turkish industry's production structure, to ensure that those goods, for which Türkiye depends on foreign suppliers, be produced domestically, and to support medium- and long-term efforts to address the problem of current account deficit by encouraging high-value-added investments. Thanks to the generous incentives offered to investors, the Turkish government presents the greatest investment opportunities in the Republic's history and allows investors to take advantage of tax-related, employment-oriented and financial incentives to ensure that the country plays a more significant role in the global economy, becomes more competitive in the international arena and achieves sustainable growth.

Whereas the incentive system, which was introduced in 2002, made no distinction between the various regions and sectors, the existing structure features six regions and incorporates sector-specific mechanisms into the system. Furthermore, the "Strategic Investments Incentive Scheme" to create a production system that will increase Türkiye's exports of high- and medium-high-tech products to reduce its current account deficit. Changes to the duration, share and terms of the existing incentives ensured their increased effectiveness, as the identification of priority investment areas served to provide stronger support to investments geared toward clustering and sector-wide cooperation. Accordingly, investments in medication, informatics, communication devices, medical devices and air- and space vehicles, which falls within the scope of high-technology industry according to the OECD, as well as investments in defense and toward the commercialization of products developed with R&D have been categorized as "Priority Investments" to enable them to take advantage of high levels of support. At the same time, to reach the investment system's goal of "reducing development gaps across regions," with stronger means, Türkiye put in place additional incentives to minimize the various financial burdens, including employment-related taxes and social security premium payments, with regard to investments in the least developed provinces in a socio-economic sense. Finally, the most recent changes to the body of law regarding government incentives made it possible for businesses to receive additional support for their investments in renewable energy, water

preservation, emission/waste reduction and recycling within the framework of their green transformation (Ministry of Industry and Technology, 2022f).

R&D incentives have paved the way for Türkiye's growing manufacturing industry to adopt high technology, thus enabling it to generate more added value. Indeed, supporting the private sector's R&D projects has been among the main areas of activity for TUBITAK, the country's long-standing agency for scientific and technological research, since the 2000s. Whereas the agency allocated a total of 36.2 trillion Turkish Lira (approximately \$24 billion) to companies within the framework of the Technology and Innovation Support Programs (TEYDEB), that amount had skyrocketed to 950.2 million Turkish Lira (approximately \$107 million) by 2021. Between 2003 and 2021, TUBITAK provided 22.8 billion Turkish Lira under the TEYDEB programs in addition to 25.8 million Turkish Lira as part of support programs for academia and the public sector (i.e. ARDEB, KAMAG and SAVTAG) and 5.8 billion Turkish Lira within the framework of the Scientist Scholarship and Support Program (BIDEB) – based on 2022 prices (TUBITAK, 2022a).

Whereas KOSGEB allocated 25.3 trillion Turkish Lira (approximately \$14 billion) to 11,675 businesses in 2003, the agency provided 1.7 billion Turkish Lira (approximately \$192 million) to 53,083 enterprises (KOSGEB, 2022). In recent years, the support provided to small and medium-sized enterprises, or SMEs, which account for approximately 72 percent of all jobs in Türkiye, have focused on R&D and innovation. Altogether, the share of support payments to the manufacturing industry within the total amount paid has increased to 70 percent in 2022 (KOSGEB, 2022).

In 2006, Türkiye kicked off the establishment of Development Agencies, which have been developing policies for reducing income and development gaps among the various regions, promoting regional development, ensuring sustainable development and bridging intra-regional development gaps. There are currently 26 development agencies that continue their activities with a focus on regional development and by taking into consideration the local dynamics. There are also a number of investment support offices that operate at the provincial level within the purview of the Development Agencies.

In addition to improving the industrial infrastructure and offering public incentives, Türkiye took important steps in the 2000s toward increasing the private sector's R&D capacity and building an ecosystem rooted in cooperation between universities and the industry. It was with that goal in mind that the country established a series of Technology Development Zones, popularly known as 'teknopark's, as well as R&D Centers and Design Centers. The number of the Technology Development Zones, where companies engaging in R&D enjoy tax and social security incentives as well as financial support for staff members that specialize in the fundamental sciences and joint development infrastructures, increased from just two in 2001 to 94 by 2022. Within the TDZs, where more than 8000 businesses continue their activities with a focus on R&D and innovation, over 47,000 R&D projects have been completed to date. The number of ongoing R&D projects is more than 12,000 (Ministry of Industry and Technology, 2022e). In 2016, Türkiye amended the 2006 Law on Supporting Research and Development Activities (No. 5746) to expand its scope to cover design activities. For the purpose of bringing together R&D and design activities with production, that piece of legislation empowers the authorities to offer various kinds of support to R&D and design centers to be established as part of companies that employ a certain number of R&D and design staff. Accordingly, the law aims to strengthen Türkiye's innovation and design ecosystem to transform the national economy in a way that enables it to compete internationally, to promote the generation of technological knowledge, to

raise quality standards through the adoption of innovative methods for products and the production processes, to develop new mechanisms, such as pre-competition cooperation, that are widespread globally yet limited in Türkiye, to ensure the influx of foreign capital to support R&D and innovation, and to encourage the employment of qualified individuals (TBMM, 2007). As of July 2022, the number of the R&D Centers and Design Centers, which received support for those purposes, had respectively reached 1,242 and 324 (Ministry of Industry and Technology, 2022b; Ministry of Industry and Technology, 2022d).

Another visionary step, which the Turkish government took in the 2000s, was to adopt the Law on Supporting Research Infrastructures (No.6550) in 2014. That piece of legislation serves to support centers for advanced research, thematic research and centralized research at institutions of higher education that engage in R&D activities with a highly qualified human resource and equipment, hardware and software that use modern technology. Accordingly, Türkiye adopted a model akin to the United States, where certain research centers operate under the name of National Laboratories, to ensure that those centers, which are expected to conduct research groundbreaking, strategically valuable and critical technologies, provide ample opportunities to researchers in the private sector, academia and the public sector. As of 2022, the Turkish government supports seven Research Infrastructures that employ 325 researchers (TÜBİTAK, 2022b).

The most fundamental element in Türkiye's R&D and innovation ecosystem is the country's rapidly growing human resource. Whereas the total full-time-equivalent number of R&D workers was 27,698 (whereof 5607 operated within private companies) in 2001, that number climbed to 199,371 (including 130,279 at private companies) by 2020 (TÜİK,2021). During the same period, the share of R&D spending within the gross domestic product increased from 0.53 percent to 1.09 percent (TÜİK, 2021).

Much like production and R&D statistics, there was a sharp increase in intellectual property indicators in the 2000s. Whereas 337 domestic patent applications were filed in 2001, that number reached 8,439 by 2021 – a 25-fold increase (TPMK, 2022). One of the major innovations that the 2016 Law on Industrial Property entailed was to assign the ownership of inventions, which represent the result of scientific research conducted at universities, to the relevant institution of higher education. In this regard, that law contributed to the emergence of a patent climate at institutions of higher education and made it easier for the relevant inventions to become commercialized and be incorporated into the national economy. However, the level of commercialization among patents developed at Turkish universities remains below expectations. In this sense, one of the steps, which the country must take over the next years, is to work harder for increasing the ability of developing original and high technology.

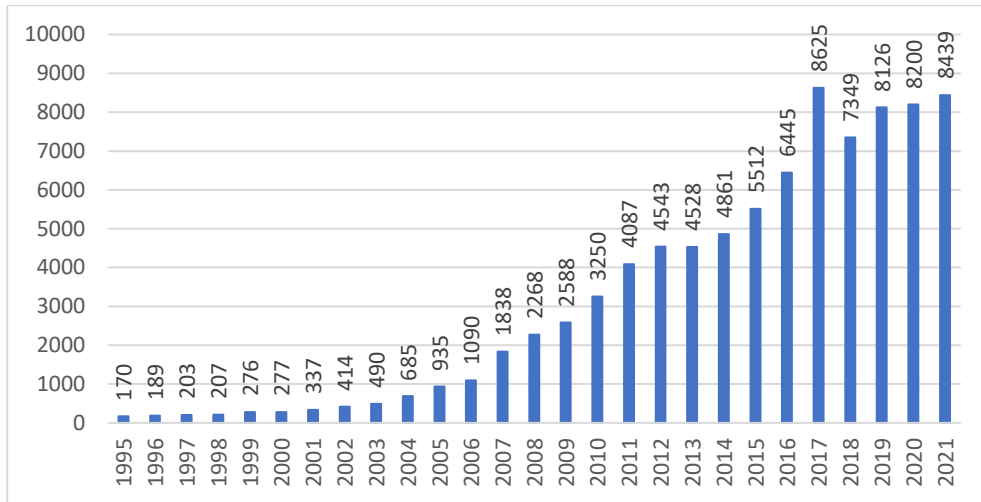


Figure 3. *Number of Domestic Patent Applications (TPMK, 2022)*

2. The Defense Industry: Pioneering the National Technology Initiative

Most of the technological developments, which largely transform our lives and shape many activities and changes in our personal lives and economic activities, were born out of the many products and systems originally developed at times of war. Personal computers, the Internet, satellite technologies, radars, jet engines, flu shots and penicillin immediately come to mind. The work of highly motivated and skilled research teams, which was made possible by government incentives, has not only changed the course of wars but also had applications that became commercialized in the civilian realm over time. Whereas Türkiye did not participate in World War II, it has been the target of external threat and domestic terror attacks for decades as an heir to the Ottoman Empire –which collapsed after World War I and whose territory covered the lands of 45 modern states— in a challenging part of the world. Those threats and attacks represented a major obstacle before Türkiye’s pursuit of development. What the nation experienced over many years, however, led to the conclusion that address existing and potential security issues would only be possible by domestically developing original technologies. Accordingly, the various embargoes, which targeted Türkiye in the aftermath of the Cyprus Peace Operation in 1974, led to ASELSAN’s establishment in 1975 to work on military electronics and, subsequently, other defense companies, including ROKETSAN and TUSAS, within the purview of Turkish Armed Forces Foundation.

It was in the 2000s, however, that the defense industry took a giant leap forward. During that period, the defense industry became one of Türkiye’s most important sectors with its prime contractors, subcontractors, SMEs, research institutes, universities, original products and exports. Whereas just 56 companies operated within the defense industry in 2002, that number skyrocketed to approximately 1,500 at present. The number of defense projects, too, increased from 62 to more than 750 since 2002. Likewise, the total budget of defense projects amounted to approximately \$5.5 billion in 2002, whereas that amount increased elevenfold by 2021 to reach nearly \$60 billion. Between the same years, Türkiye’s defense exports soared from \$248 million to \$3.224 billion, breaking a record. Meanwhile, the total number of countries importing Turkish defense products has reached 170, as the number of export products (including UAVs and armed drones, land vehicles and sea platforms) climbed to 228. The Turkish defense and aerospace industry’s export volume is expected

to exceed \$4 billion in 2022. That success is undoubtedly rooted in the fact that Türkiye's defense products have proven themselves on the ground. Indeed, experts note that Türkiye's domestically produced, original defense products represent a major force that challenge the combat paradigm and the geopolitical balance of power around the world (SSB,2022b; Marson&Forrest, 2021).

It is no coincidence that the defense industry has emerged as the pioneer of domestic and original high-technology production in Türkiye. Unlike all other sectors, the defense industry has an idiosyncratic governance model that made possible its accomplishments. Undoubtedly, a stable government policy, long-term supply plans that prioritize native and original products, the holistic coordination of R&D and investment policies across the sector and a human resource backed by the national R&D policies all contributed to that striking success.

By virtue of its nature, the defense industry operates in line with the public administration's plans. In this regard, Türkiye made two fundamental choices that determine its *modus operandi*: The establishment of the Presidency of the Defense Industries (SSB) and the allocation of the relevant resources to the Defense Industry Fund. The superstructure that crowns those two choices, in turn, is the Defense Industry Executive Committee (SSIK) – which brings together cabinet ministers and the security bureaucracy, with the President chairing all meetings, to establish the principles, whereby the Defense Industry Fund will be used, and to approve long-term supply and domestic production plans at the highest level. That governance structure facilitates the launching and close monitoring of long-term R&D projects regarding critical technologies, the development of necessary infrastructure, and the active and efficient management of the relevant resources and capabilities. It is that body that ensures an overlap between the goal of addressing the needs of the security agencies and the industrialization policy.

There is no doubt that the Turkish defense industry's most resounding accomplishment in the recent past has been in the area of unmanned aerial vehicles. Specifically, a number of native and original designs have emerged in this field, where the country used to be completely dependent on foreign suppliers, as a result of public and tacit embargoes. UAV systems like the Bayraktar TB-2 and ANKA, which emerged out of the defense industry's long-term perspective and commitment to focusing on paradigm shifts, represent a force multiplier for Türkiye's defensive and offensive abilities by performing various tasks, including reconnaissance and surveillance as well as the detection, identification, definition and tracking stationary and mobile targets and real-time imagery intelligence. Those systems, which outperform their international competitors due to their cost-effectiveness and superior capabilities, have been exported to more than twenty countries to date. At the same time, the delivery of the Bayraktar AKINCIUCAV has already started, making Türkiye one of three producers of unmanned combat aerial vehicles in the world. The Bayraktar TB3, an armed drone capable of landing on- and taking off from aircraft carriers, and the Bayraktar KIZILELMA, a combatant unmanned aircraft system, are expected to complete their maiden flights in 2023 (SSB, 2022a).

In addition to the unmanned aerial vehicles, there are projects underway for developing next-generation combatant aircraft, training aircraft and helicopters to address the needs of the Turkish Air Force. Furthermore, the ongoing work on the National Fighter Aircraft aims to develop next-generation fighter jets for the Air Force with a native and original design. At the same time, Türkiye continues to build the HÜRKUŞ aircraft within the framework of the Turkish Beginner and Basic Training Aircraft Development Project. The

maiden flight of the HÜRJET, a jet training and light combat aircraft, is expected to be completed in 2023. In addition to those projects, Türkiye continues the production of ATAK helicopters to address its security forces' need for an assault and tactical reconnaissance helicopter and GÖKBEY, which was developed to address the need for training and light general purpose helicopters, is expected to be delivered within the year. Finally, domestically developed air defense systems, together with all-purpose missiles and rockets like SOM, SOM-J, Gökdoğan, Bozdoğan and Atmaca, serve to increase our native systems' effectiveness and ability to neutralize aerial threats (SSB, 2022a).

The military crises in Türkiye's neighborhood require the strengthening of its naval forces and the addressing of its military needs with native and national capabilities. TCG Büyükada, TCG Burgazada and TCG Kınalıada, which were built as part of the MILGEM project for those reasons, have been delivered to the Turkish Navy. Likewise, TCG Bayraktar and TCG Sancaktar, which were designed and built domestically, boosted Türkiye's amphibious operational capabilities and made it possible to respond to natural disasters rapidly. TCG Anadolu, a multi-purpose amphibious assault ship which is expected to be delivered in 2023, will be able to deploy to any crisis zone with its own logistical support. Piri Reis, the first of Türkiye's next-generation submarines that shall increase its deterrence at sea, was launched in March 2021 and the delivery of six additional next-generation submarines will begin in 2023 (SSB, 2022a).

Furthermore, the Turkish defense industry domestically builds various kinds of armored vehicles with high level of protection and mobility, including Kirpi, Kirpi II, Ejder Yalçın, Pars and Vuran, that were developed based on Türkiye's years of experience with counter-terrorism and the security forces' needs and can address operational needs in all regions and on all terrains. As part of Project ALTAY, which was launched to address the Land Forces' need for a main battle tank, the first native main battle tank has been designed and developed. A contract has also been signed for ALTAY's serial production. Currently, there are ongoing efforts for the creation of necessary infrastructure and the endenization of foreign-origin sub-systems (SSB, 2022a).

In addition to air, sea and land, Türkiye has been taking major steps in space. The development of BILSAT, an earth observation satellite, together with foreign partners represented a milestone in that area. Ultimately, the knowledge, experience and infrastructure that Türkiye accumulated through its work on BILSAT resulted in the development of RASAT, its first observation satellite, in 2011. By launching the GÖKTÜRK 2 satellite 2012, Türkiye became one of sixteen nations capable of indigenously developing high-resolution earth observation satellites. Once the satellite IMECE, which remains under development, reaches the orbit, it will serve as an observation satellite with sub-meter resolution to address our nation's military and civilian needs for high-definition images. Furthermore, Türkiye will gain access to many important indigenous sub-systems with its national capabilities. The country's ongoing work on the Micro Satellite Launch System (MUFS) aims to achieve independent access to space. As part of that project, the first domestically produced sounding rocket reached an altitude of 136 kilometers –breaking the 100-kilometer mark, which is considered the starting point of outer space. Moreover, the National Hybrid Propulsion System, which is rooted in hybrid-propellant rocket technology (that represents an alternative to solid and liquid fuelled rockets and makes it possible to access space effectively), has successfully completed its ignition tests (SSB, 2022a).

A variety of new products and services, which are built on disruptive technologies, continue to quickly replace the traditional products and services in the defense industry. Provided that the traditional players face various challenges in quickly adapting to new situations, new players emerge in the relevant areas. For example, it is extremely difficult for a new player to emerge in mature technology areas like civil aviation and the automotive industry with a fresh investment today due to the obvious strengths of existing stakeholders, including the amount of intellectual property that they have accumulated over time, and their supply chains and manufacturing operations management having been optimized in light of past experiences. By contrast, new players that join the race for the development of new technologies and products, such as next-generation propulsion systems and autonomous systems, could enjoy certain advantages in the face of existing players.

3. Focusing on Paradigm Shift in the Age of the Fourth Industrial Revolution

We observe that the history of global industrialization was shaped by different revolutions and faced a fresh fork in the road each time. The construction of railroads and steam engines allowed mankind to incorporate machines into its production processes, carrying out the first great revolution in the history of industrialization. Later, the increased use of electricity and the development of assembly lines introduced serial production to our lifestyle. Since the 1960s, the rise of computers and semi-conductors has facilitated automation and digitization in production processes to pave the way to the third great revolution.

Today, as technology progresses at a mind-boggling pace, humanity witnesses a new industrial revolution. This process, which one could call 'the digital revolution', results in companies digitalizing all of their work and processes, machines communicating with each other and, at the same time, production systems collect data to perfect their operations. This process not only creates new opportunities for mankind but also causes the balance of power among nations to shift. Whereas the developed nations seek to prevent others from using innovative technologies to take over their production capabilities, the developing world attempts to seize the opportunities, which disruptive technologies present them, to claim a larger share of the global economy.

Türkiye maintain that the Fourth Industrial Revolution created an atmosphere, in which it could be more competitive on a global scale, achieve sustainable development and promote social welfare. The most significant model for the kind of transformation, which the Fourth Industrial Revolution requires, was developed by the defense industry. That is why the National Technology Initiative, which reflects the goal of making Türkiye more competitive at the global level and achieving economic and technological independence, aims to focus on a paradigm shift in the civilian domain, just as in the defense industry, and to increase the nation's indigenous production and design capabilities. The 2023 Strategy for Industry and Technology, which the Ministry of Industry and Technology unveiled in September 2019, was made public as a document that translated the above-mentioned vision into concrete objectives. In this regard, Türkiye identified a series of steps in the 2023 Strategy for Industry and Technology as well as the relevant sector-specific strategies and roadmaps that it would take in the areas of innovative and disruptive technology.

3.1. 5G and Beyond Technologies

The Fourth Industrial Revolution added to the importance of strong communication infrastructures, whereas the COVID-19 pandemic caused large parts of the general population to become aware of that need. The increased data transmission speed and capacity, coupled with a large number of devices becoming connectible and shorter lag times shall enable 5G to trigger new developments in various sectors and schemes. Meanwhile, it is an indisputable fact that the communication infrastructure requires a critical level of security. That is why TUBITAK supports approximately twenty companies to help them develop an indigenous 5G infrastructure. Furthermore, the manufacturing industry and mobility vehicles and technologies are prioritized in the development of domestic products and services in terms of 5G applications. It is important to note that Türkiye remains among a handful of nations capable of developing indigenous goods and services in terms of the 5G infrastructure and applications.

3.2. Mobility Vehicles and Technologies

Mobility vehicles, which are among the largest labor- and capital-intensive sectors in the world and account for the largest share of Türkiye's manufacturing exports, underwent certain transformations in recent years, as the fight against climate change gained further importance, the cost of battery production dropped significantly and certain groundbreaking developments took place in communication and innovative technologies. That transformation, which manifests itself in all modes of mobility, occurs more rapidly in the automotive industry. Indeed, electric vehicles, self-driving vehicles, connected vehicles and shared vehicles have come to play a more significant role in the marketplace. As the sale, maintenance and insurance of vehicles creates less and less added value, the amount of added value that digital services generate continue to increase (Togg, 2019).

Taking into consideration that transformation in the mobility industry, Türkiye launched a project to build its indigenous electric car, Togg, to fulfill the Turkish people's dream of many years. Togg, which is seen as a smart device and a first step toward building the next-generation mobility ecosystem rather than just a vehicle, is expected to leave the assembly line in 2022 and hit the road the following year. That project, whose intellectual and industrial property rights belong to Türkiye, also enables cooperation with domestic technology enterprises. At the same time, many Türkiye-based companies continue their work on the production and export of electric and self-driving buses. Likewise, the production of commercial vehicles has been shifting toward electric vehicles. Whereas land transport, starting with the automotive industry, remains the most important mode of transportation (based on production capacity and the frequency of use) in Türkiye, the country has a significant production potential for maritime and air transport as well as rail systems. Over the next years, the Turkish government aims to transform the country into a regional hub for battery production by promoting the development of battery modules and strengthening the test infrastructure through public incentives. At the same time, Türkiye seeks to raise the level of indigenous components to 75 percent for electric vehicles. Moreover, the country intends to implement a number of projects in the maritime sector to ensure that its prominent shipbuilding industry adopts eco-friendly technologies without delay and to become a leader in exporting eco-friendly, energy-saving fully electric ships. By building on its existing capabilities regarding the production of electric trains and locomotives and completing additional projects on rail transport technologies, Türkiye is expected to become one of the ten global centers for the development of rail transport technologies. Finally, in the area of aviation, which is another mode of transportation, the

knowledge and experience that our country has accumulated thanks to the military unmanned aerial vehicles shall be channeled into smart airborne mobility in the civilian domain (Ministry of Industry and Technology, 2022c).

3.3. Smart Living and Health

The rise of the average life expectancy, together with environmental changes, cause humanity to suffer from new kinds of illness and, in particular, make chronic illnesses more widespread. Over the next two decades, countries around the world are expected to spend approximately \$30 billion to diagnose and treat chronic illnesses, which occur more often as the population increases in size and grows older, as the growing demand for healthcare services places an additional burden on public budgets due to increased spending (Ministry of Industry and Technology, 2022a). Accordingly, the public authorities have been striving to develop new models for healthcare services.

Türkiye aims to adopt key policies and complete a series of projects to adapt to the healthcare industry's transformation in line with the Roadmap for Smart Living and Medical Products and Technologies. In this regard, the country focuses on using advanced technologies and information technologies to provide more predictive, preventive, personalized and participatory healthcare solutions and systems as well as to seize the relevant opportunities for developing new technologies. It is possible to view evidence-based decision-making, coordination among stakeholders and the close monitoring of patients as the keys to success in this large-scale transformation. By implementing critical projects, such as the National Drug Molecules Cybrary, the National Omics Platform and the Strategic Biotechnology Development Project, and taking steps to support them, Türkiye aims to promote the development and production of healthy living/aging technologies and smart systems, to ensure the endenization of critical drug, medical device and health informatics technologies, and to strengthen its healthcare infrastructure by facilitating the R&D and P&D processes (Ministry of Industry and Technology, 2022a). Moreover, it is important to recall that the Human Genome Project's completion in the 2000s resulted in a rapid increase in the number of scientific publications on personalized medicine. That field, which is expected to trigger a major paradigm shift, could result in the rise of Türkiye-based global technology companies. Türkiye, whose healthcare data and information infrastructure is paralleled by a handful of nations alone, also has the potential to become immensely successful in artificial intelligence applications.

3.4. Digital Transformation in Finance and Trade

The rapid growth of the digital economy fuels a transformation in finance and trade along with all other sectors. Experts forecast that the blockchain and distributed ledger technology will have reached 50 percent penetration rate in Europe by 2030, which would increase its influence over the gross domestic product to 6 percent. At the same time, the reconfiguration of production systems in line with the Fourth Industrial Revolution and the increasing volume of e-trade effectively change trade routes, methods and models. Those developments in the area of trade and finance pave the way to the emergence of new enterprises globally. The twenty-fold increase in the number of fintech firms over the last decade attests to that fact (Ministry of Industry and Technology, 2021).

Our country's geographic and demographic attributes, together with its strong financial system and significant production infrastructure, represent an opportunity for it to benefit from the technological transformation of the financial and trade sectors as well as requires it to catch up with that transformation in order to remain competitive on a global scale. By

adopting an innovation-friendly approach to regulation and closing the competence gap, Türkiye could have an opportunity to become a country that sells products and services related to the financial and trade technologies and to give rise to financial technology enterprises that become global leaders.

3.5. Artificial Intelligence

Artificial intelligence-backed systems, which have developed rapidly in recent years, cause a transformation in all aspects of life, including production processes, professions, everyday life and institutional structures. Artificial intelligence technologies, which are expected to contribute approximately \$13 trillion to the global economy by 2030 thanks to its various benefits, such as process optimization, increased efficiency and personalization, also threaten to turn people into prisoners of algorithms and to make the existing forms of injustice and inequality more widespread (Ministry of Industry and Technology & Digital Transformation Office of the Presidency of Türkiye, 2022).

In this regard, to successfully manage the potential and threats associated with artificial intelligence technologies is a necessity, not a choice. Türkiye has already laid the groundwork for the necessary human resource, institutional structures and R&D capabilities. On the basis of those foundations, the country set certain goals for itself, which have been established in the National Artificial Intelligence Strategy, to ensure that the ongoing transformation in the world, which is supported by artificial intelligence, benefits humanity and to take advantage of artificial intelligence technologies at the highest possible level. Accordingly, the public and private sectors ought to benefit from artificial intelligence as much as possible, as the country strengthens its human resource, data and R&D infrastructure and institutional capacity, which is needed for the development of artificial intelligence, to ensure that artificial intelligence's contribution to the gross domestic process reaches 5 percent by 2025 (Ministry of Industry and Technology & Digital Transformation Office of the Presidency of Türkiye, 2022).

3.6. Space

The human venture into space, which dates back to the scientific rivalry between the United States and the Soviet Union in the second half of the twentieth century, has turned into a multi-dimensional competition, which additional countries join every passing day. One of the main reasons behind that development is the decrease in launching costs. Whereas attempting to launch a rocket to space, which only the great states could do, cost up to \$500 million in the early 2000s, the involvement of private companies has resulted in a 90-percent drop in that amount. That decline in the price of launching transformed space into a domain with applications for many disciplines, including medicine and electronics, as the development of new technologies ceased to be subject to the monopoly of several states and thus gained great momentum. That momentum was also reflected by the budget allocated to space research: The size of the global space economy, which amounted to \$245 billion in 2009, is expected to reach \$805 billion by 2030.

The high cost of space research, the required technical infrastructure, equipment and human resource and the interdisciplinary nature of those studies made it necessary for any given country to conduct their work within the framework of a strategy and in a coordinated manner. In this sense, many nations have established their space agencies to be responsible for coordination. Those agencies are in charge of implementing their nation's space strategy and looking out for the rights and interests of their country in space.

Türkiye launched the Türksat 1B satellite in 1994, the Türksat 1C satellite in 1996 and the Türksat 2A satellite in 2001. The operational life of those satellites has since ended. As of July 2022, five communication satellites (Türksat 3A, Türksat 4A, Türksat 4B, Türksat 5A and Türksat 5B) and three earth observation satellites (Göktürk 1, Göktürk 2 and RASAT), which were sent into space after 2002, remained operational. Furthermore, the experience accumulated through the indigenous production of the Rasat and Göktürk 2 satellites enabled the indigenous design and production of IMECE, an imaging satellite with sub-meter resolution, and Türksat 6A, Türkiye's first national communication satellite. As such, Türkiye has become a country that is capable of developing, testing and producing its own satellites and that has the necessary human and physical capital to perform those tasks. However, the nation's goals and ideals in the area of space have required an improvement of space capabilities, the identification of needs and major areas of technological development, the defending of an increasing amount of rights and interests in space, and the ensuring of various space-related public institutions to operate harmoniously. In light of those needs, the country established the Turkish Space Agency in late 2018.

Türkiye set 10 concrete and ambitious goals, which it aims to reach by 2030 within the framework of the National Space Program that was developed with contributions from public institutions, the private sector and academics. It has also identified the resources and competencies needed to meet those targets. Certainly, the most striking of Türkiye's 10 goals is to reach the Moon with an indigenously produced, original hybrid rocket and to complete a hard landing as part of the "Moon Program." By completing that project, where it will work with international partners for launching the rocket, Türkiye will have joined a select group of nations to have landed on the Moon. Following the hard landing phase, the country aims to reach space with a indigenously propelled rocket by 2028 and to complete a soft landing on the Moon, where it will conduct scientific research.

3.7. Green Transformation

The impact of climate change has reached a certain level, where people feel it in their daily lives. At the global level, policymakers continue to make an effort to situate development policies within a sustainable and eco-friendly framework. Although those nations, which are chiefly responsible for the senseless industrialization that caused climate change, have not assumed responsibility for their past actions, Türkiye adopted a responsible position for humanity's future and set a goal to become "carbon neutral" by 2053. In this regard, the Green Deal Action Plan represents a roadmap for Türkiye's green transformation that is compatible with the European Union, promotes green investments and supports value-added production. The plan aims to prepare the industry for eco-friendly regulations and underscores Türkiye's commitment to put in place the necessary financing models for the green transformation (Ministry of Trade, 2022).

Another key element at the heart of Türkiye's eco-friendly policy is the transformation of energy sources. By implementing a variety of incentive policies, the country increases the share of renewable energy in its energy mix every passing day and develops the necessary R&D and production infrastructure in the area of renewable energy. In the near future, it will be possible for Türkiye, whose domestic R&D and production capabilities for wind and solar energy have already reached an advanced level, to expedite its work on hydrogen and to develop capabilities related to next-generation nuclear technologies including molten salt reactors and small and modular reactors.

4. Conclusion

Under the leadership of President Recep Tayyip Erdoğan, Türkiye implemented long-term policies and offered various kinds of public incentives in the areas of infrastructure, investment, R&D and innovation to fuel the drive for indigenous, original and domestic production in the 2000s. Specifically, the defense industry’s achievements have propelled to Türkiye’s re-emergence as a playmaker on the stage of history. In this sense, the Republic enters its second century by consolidating its original claim to total independence with the National Technology Initiative.

The meaning of the National Technology Initiative is not limited to high technology, value-added production and becoming self-sufficient. It refers to a strategy and point of view with multiple dimensions from education and international relations to development and sustainable living. On the one hand, the lessons of the Turkish defense industry’s success spread more rapidly to other sectors, causing the number of success stories related to all technological areas to increase. In many fields, from healthcare and energy to mobility and space applications, the country is taking major steps toward development, seeking to catch up with paradigm shifts, as the private sector, academia and the public administration remain in alignment. At the same time, Türkiye continues to create additional educational opportunities to highlight human dignity, based on the assumption that the ability to develop technology is a fundamental right –just like literacy—in this day and age. The country’s efforts to democratize the development of technology also contribute to the idea of building a fairer world by creating an alternative approach to the globally monopolized venture into technology. The development of technology for the benefit of humanity, in turn, gives Türkiye an opportunity to breathe new life into the present by living up to the mission that it inherited from the history of its civilization.

The continuation of that journey along four main axes will determine the outcome, direction and momentum of the National Technology Initiative.

Human capital is the subject of that pursuit of development. Accordingly, the National Technology Initiative’s success depends on an unwavering commitment to taking the necessary steps for generating human capital. TEKNOFEST, an aerospace and technology festival that originally took place in 2018, attracted 1.720 million visitors in 2019 and hosted a number of tech competitions featuring nearly 150,000 teams in Türkiye and Azerbaijan in 2022 to become the world’s largest technology festival. At the same time, the DENEYAP Technology Workshops, which have become operational in all of Türkiye’s 81 provinces, enable the discovery and training of talented students from the age of eleven. The number of software developers in Türkiye, which was approximately 200,000 in 2022, continues to increase thanks to next-generation approaches like the foundation of 42 Software Schools in cooperation with the Turkish Open Source Platform. Moreover, TUBITAK’s International Fellowship for Outstanding Researchers Program –the most comprehensive “reverse brain drain” program to date— enables scientists from the world’s leading research centers, universities and R&D companies to relocate their projects to Türkiye. The continued and steady expansion of those programs and projects would continue to fuel the National Technology Initiative.

It is necessary to expedite efforts to support tech enterprises that have been rising through the global ranks at a rapid pace. Whereas Türkiye’s *teknoparks*, incubation centers and accelerators reduce the time needed for the commercialization of ideas, the venture capital ecosystem, which has grown significantly in recent years thanks to contributions from the

public funds and co-financing schemes, too has been a force multiplier in the country's tech entrepreneurship. Provided that borrowing and taking out loans from traditional banking methods will not create favorable conditions for the early growth of long-term tech enterprises, the venture funds, which rest on partnership models that have become increasingly widespread around the world, have increased their footprint in Türkiye in recent years. Accordingly, 322 tech startups in Türkiye attracted a total of \$1.6 billion in venture capital investments in 2021 (Startups.watch, 2022) That amount exceeded the total investment between 2011 and 2020. The prioritization of deep tech, which has a high impact on development, within the framework of public support and financing mechanisms for tech entrepreneurship would certainly give further momentum to the National Technology Initiative.

R&D and investment incentives have spurred Türkiye's growth, led by the private sector, in the 2000s and facilitated the development of additional R&D and innovation capacity. The National Technology Initiative, in turn, requires that growth in capacity to be maintained with a more specific focus. The most comprehensive among the structural steps, which reflect that approach, has been the Technology-Oriented Industry Move (HAMLE) that the Ministry of Industry and Technology launched to manage all R&D, SME and investment incentives in a holistic manner and from the same point of view. The R&D and investment projects, which will be supported as part of that program –which identifies advanced technology products, which create a significant amount of trade deficit in Türkiye, as a priority (together with areas of innovative technology) by taking into account the criteria of competitiveness and widespread impact— consolidate the industrial sector's role within the National Technology Initiative. The successful continuation of the HAMLE program would contribute to Türkiye's progress toward its goals of becoming a country with a trade surplus and achieving economic independence.

It has been possible to observe in recent years that government policy has come to play a more influential role in the economy all across the world. That process –encapsulated in the phrase: “The state is back”— was certainly influenced by the COVID-19 pandemic reminding the population of the global technology and trade rivalries (or wars) as well as the public administration's untransferrable responsibilities. Meanwhile, the breakdown of global supply chains fueled the pursuit of alternative production centers and self-sufficiency. The high level of efficiency, which the expedited digital transformation has entailed, in turn, continues to replace the advantages in production that once stemmed from the cost of labor. The experience that Türkiye has accumulated thanks to the National Technology Initiative made it possible for the country to be ready for such ideas. That level of preparedness, coupled with its production range and competent human resource, paves the way toward fresh opportunities. In this regard, Türkiye could build on the lessons of its achievements in the defense industry to seize opportunities in other sectors, where the public administration does/ought to lead the way. Long-term and stable industrialization policies that focus on technologies that fuel a paradigm shift in communications, energy, transportation and healthcare, the prioritization of industrialization in logistics investments and financial schemes and supporting indigenous and original production through public investment projects and supply processes shall play a key role in the successful completion of the National Technology Initiative. For this purpose, it is possible for certain bodies like the Industrialization Executive Committee, which was formed as a first step toward a governance model akin to the defense industry and will operate under the President's leadership, to assume prominent roles. It could also be possible to take into consideration the public administration's needs and the development of domestic production capabilities

simultaneously in the civilian sectors as well as to transfer knowledge from the defense industry to the civilian sectors. Finally, Türkiye ought to make legal arrangements to take necessary precautions to ensure that critical companies, production infrastructures and intellectual property stay in the country – in line with the increasingly commonplace precautions that the European states and the United States have taken in recent years.

Last but not least, Türkiye’s National Technology Initiative represents a process for building self-confidence. Accordingly, that process entails various social and cultural benefits that go far beyond its contributions to the public policy and the national economy. It could be possible to identify those gains and their results, beyond what this article has explained, by conducting social and psychological studies. At the end of the day, the single greatest safeguard of the National Technology Initiative, which has become a source of hope for the Turkish people and continues with their acceptance and support, is the population continuing to embrace it with the spirit of social mobilization. Achievements within the framework of the National Technology Initiative shall promote the participatory and inclusive idea of democratization in technology development processes against global monopolies to generate value for all of humanity – not just Türkiye.

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Mehmet Fatih Kacir was born in Istanbul in 1984. He finished the Istanbul High School and ranked 12th nationally at the university entrance exam in 2003. Kacir received his bachelor's degree with honors in Industrial Engineering from Boğaziçi University in 2008. He served as a student representatives during his college education and pioneered interdisciplinary research and project management courses. Kacir opted to become an entrepreneur upon graduating from the university and developed various useful models and industrial designs at several companies, which he founded and managed, to take innovative steps. In addition to being an entrepreneur, Kacir played an active role in non-governmental organizations. Having served as the Chairman of the Board of Executives at the Türkiye Technology Team (T3) Foundation, where he was on the trustee board as a founder, until 2018, he was among the pioneers of the DENEYAP Technology Workshops, the Future Technology Stars Program for kids with special skills, the Science Center and Entreprise Center programs and TEKNOFEST, the world's largest aviation, space and technology festival. Kacir was appointed as a member of the TUBITAK Science Board in 2018. Kacir was appointed as Deputy Minister of Industry and Technology on 31 July 2018 by presidential decree. Overseeing the National Technology Initiative and strategic transformation policies at the Ministry, he coordinates the work of the General Directorate for National Technology, the General Directorate for Strategic Research and Efficiency, TUBITAK, the Turkish Patent and Trademark Office, the Turkish Academy of Sciences and the Turkish Space Agency. Kacir, who serves on the executive board of Aselsan and the Prof. Dr. Fuat Sezgin Foundation for Research on the History of Islamic Science, is fluent in English and German. He is married with two children.