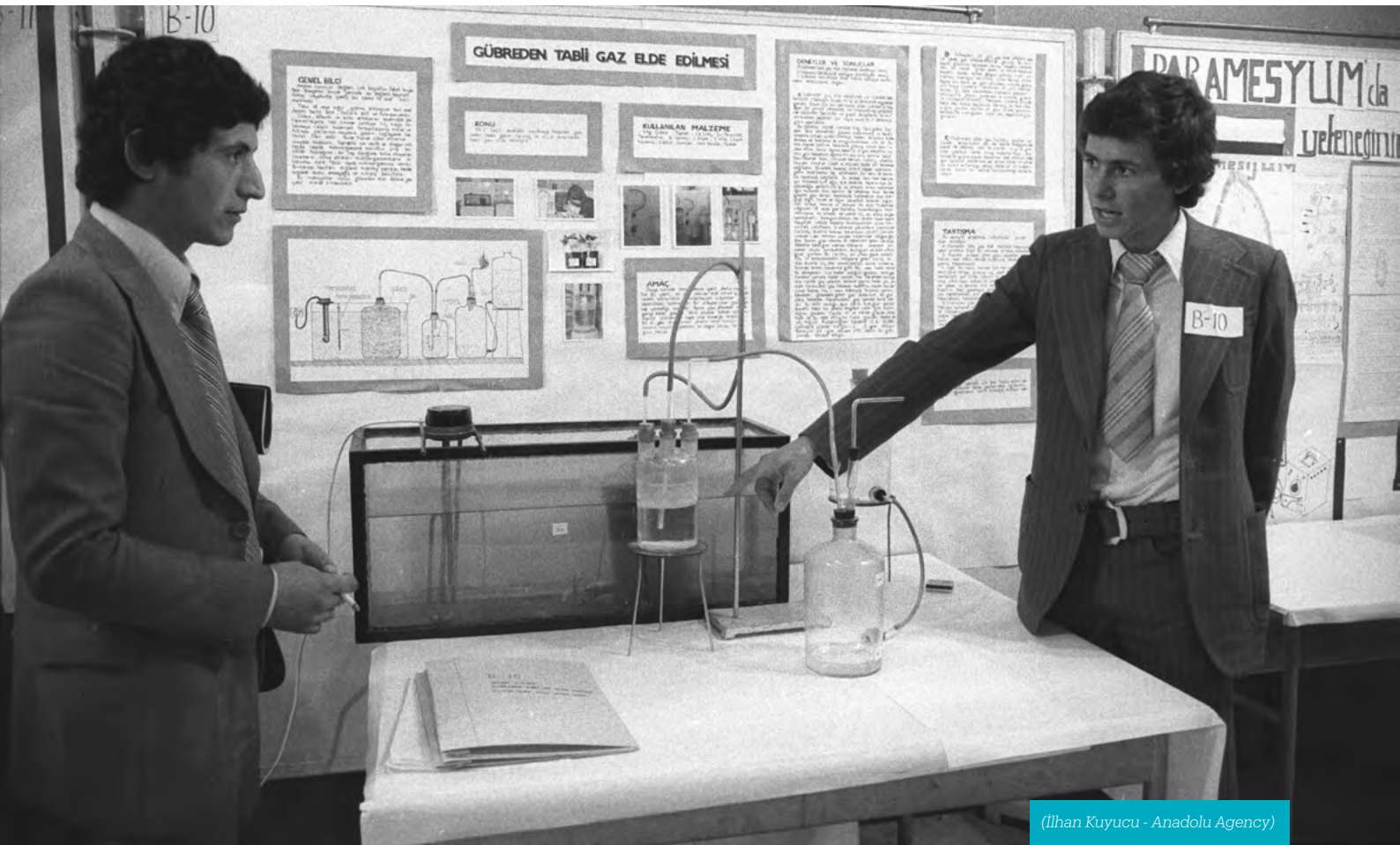


Historical Milestones in Türkiye's Tech Evolution

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(Ilhan Kuyucu - Anadolu Agency)

Türkiye's technological journey reflects a rich history of continuous innovation, from the Ottoman Empire's advancements in military technology and architecture to modern-day achievements. Mustafa Kemal Atatürk's 20th-century reforms, including the establishment of key institutions, played a crucial role in modernizing the country's scientific and technological landscape. The mid-20th century emphasized industrialization and infrastructure development. Economic liberalization in the 1980s and 1990s fueled growth in the IT sector. Today, the National Technology Initiative drives Türkiye's digital transformation, focusing on AI and cybersecurity, positioning the country as a global tech leader. This policy outlook explores how these historical and contemporary developments have shaped Türkiye's progress.

Introduction

Türkiye, a bridge between the East and the West, has always been a melting pot of cultures, ideas, and innovations. The country's journey through technological evolution is marked by significant milestones that have shaped its current standing in the global tech landscape. From the innovations of the Ottoman Empire to the modern-day advancements in various technological sectors, Türkiye has consistently demonstrated its capacity for innovation and adaptation. This policy outlook explores the key milestones in Türkiye's technological development, highlighting how historical and contemporary advancements have contributed to the nation's growth.

The Ottoman Empire

Contributions to Astronomy, Medicine and Geography

The Ottoman Empire, extending from the late 13th century to the early 20th century, was renowned for its technological and scientific advancements. From its inception until the early 20th century, [madrasas](#) were central to education and science in the Empire. While maintaining the core Islamic educational framework, these institutions evolved over time, thanks to financial support from waqfs (public foundations). This support enabled madrasas to attract a diverse range of scholars.

The first madrasa, founded in 1331 by Orhan Bey in Iznik, marked the beginning of this tradition. Following the conquest of Istanbul, Mehmed II established the Fâtih Külliye, an educational complex featuring the *Sahn-i Samân Madrasas*. This complex, which included various social and religious facilities, set a standard for future structures, resembling modern university campuses. The Ottoman period also saw the establishment of [numerous hospitals](#), particularly in Istanbul, known as *shifahanes*. These hospitals, overseen by chief physicians (*hakimbashi*), played a crucial role in medical education. Additionally, the Ottomans continued the classical tradition in geography, blending earlier Muslim and European knowledge to manage their expanding territory and oversee military and commercial activities. [Ottoman geographers](#) produced original material by integrating their observations with existing works.

Beyond madrasas, institutions dedicated to medical sciences and astronomy operated through the master-apprentice method. This included the [Istanbul Observatory](#), founded by the polymath Taqi al-Din, renowned for its advancements in astronomy, engineering, and mathematics. Other key institutions were the office of the *munajjim-bashi* (chief astronomer) and the *muvaakkithanes* (timekeeping houses), with the Istanbul Observatory being one of the most advanced of its time.

Military Technology and Engineering

The Ottomans also [excelled in military technology](#), particularly in the development of artillery. Their strategic use of large cannons and advanced siege techniques during the conquest of Constantinople in 1453 exemplifies their technological ingenuity, marking a significant turning point in world history. The Ottomans' expertise in artillery engineering was demonstrated using massive cannons, such as the [Basilica](#). This colossal cannon played a crucial role in breaching the walls of Constantinople, enabling the Ottoman forces to conquer it. The Ottomans continued to innovate in military technology, developing advanced siege engines, firearms, and fortification techniques that were unmatched by their contemporaries.

The Ottoman Empire was self-sufficient in most things, but particularly in its production of weaponry and ammunition. Unlike many of its rivals, the Ottomans were [largely independent](#) in this regard, possessing most raw materials. They mined significant quantities of iron and copper, essential for casting ordnance and producing artillery supplies. Alongside the copper mines, numerous furnaces operated, producing hundreds of thousands of cannonballs. Further, the Empire sourced saltpetre and sulphur from various Ottoman regions for gunpowder production. Consequently, the Ottomans faced no significant challenges in mass-producing weaponry and were [not reliant](#) on European or other external sources for their military needs.

Architectural and Urban Developments

In addition to their military prowess, the Ottomans made significant contributions to architecture and urban development. The construction of iconic structures reflected their architectural innovation and aesthetic sensibilities and served not only as symbols of the empire's power but also as centres of cultural and intellectual life. For example, the Topkapi Palace was built after 1459 in Istanbul and its complexity [symbolises](#) Ottoman power, social order and hierarchical governance.

While various buildings were constructed to meet societal needs, mosques stood out as indicators of the state's economic power. The architecture of Ottoman mosques [underwent a development process](#), reaching its peak with the contributions of Mimar Sinan. Sinan, who lived during the 16th century—the heyday of the Ottoman Empire—is considered the greatest master builder of Ottoman architects. The Süleymaniye Mosque is a prime example of Ottoman architectural brilliance. Completed in 1558, the mosque's design integrates functional and aesthetic elements, creating a harmonious and majestic structure. Sinan's use of domes, semi-domes and minarets became a defining characteristic of Ottoman architecture, influencing the design

of mosques and public buildings throughout the land.

In the 1860s, the Ottoman state sought to modernise its [road infrastructure](#) as part of a broader reform of provincial administration. Roads were promoted not only to connect provinces to the central government but also to stimulate economic growth within the provinces. They built extensive networks of roads, bridges, and aqueducts, facilitating trade and communication across their vast empire.

Early Years of the Republic

Atatürk's Vision and Reforms: Emphasis on Education and Science

Mustafa Kemal Atatürk, the founder of the Turkish Republic, had a vision for a secular, progressive and modern state including a strong focus on education and scientific progress. Atatürk understood that the future of Türkiye depended on its ability to harness and develop technological expertise. To this end, several key reforms aimed at transforming Türkiye's educational and scientific landscape were implemented.

One of Atatürk's major reforms was the overhaul of the [educational system](#). The establishment of new schools and universities, such as Ankara University in 1933, was part of a broader strategy to promote technical and scientific education. Atatürk emphasised the importance of basing education and scientific inquiry on continuous development and asserted that science is the truest guide for progress, and relying on outdated principles is ignorance. Before implementing major educational reforms, such as the Unification of Education Law, the new Latin alphabet, university reform, teacher training, and the establishment of public schools and educational institutions, comprehensive scientific studies were conducted. Atatürk's approach aimed these reforms to be grounded in scientific research, to be able to meet the demands of modernisation.

Foundation of Key Institutions

The establishment of institutions dedicated to advancing technology and science was a cornerstone of Atatürk's vision. The Turkish Aeronautical Association ([Türk Hava Kurumu](#) or THK), founded in 1925, played a crucial role in promoting aviation and aerospace research in Türkiye. The organisation was instrumental in developing Türkiye's early aviation capabilities and training a new generation of pilots and engineers. For instance, Türkiye was able to conduct aerial agricultural spraying for the [first time](#) in April 1947 using an aircraft developed by THK. Türkiye's strong emphasis on aviation and aeronautical engineering, deeply ingrained in its national institutions and culture, has significantly contributed to the country's expertise in developing unmanned aerial vehicles (UAVs), which have now

become [crucial components](#) of many nations' defence arsenals.

TÜBİTAK, another [key institution](#) established early in 1963, supports Türkiye's science, technology and innovation (STI) by formulating policies, funding research and development projects, performing STI research and promoting scientific literacy. Initially focused on basic and applied academic research and encouraging scientific careers, it now manages ten research grant committees and a Science Fellowships and Grant Programmes Division. TÜBİTAK oversees several research institutes, including the National Research Institute of Electronics and Cryptology (UEKAE), Marmara Research Centre (MAM), Defence Industries Research and Development Institute (SAGE), Space Technologies Research Institute (UZAY), National Metrology Institute (UME) and others. These institutes support STI infrastructure, international collaborations and the publication of academic and popular science materials. TÜBİTAK's efforts have helped to position Türkiye as a growing player in the global scientific community.

Establishment of Heavy Industries and Centralised Planning

The 1950s and 1960s marked a transformative period for Türkiye as the country embarked on a path of rapid industrialisation. The government's focus on establishing heavy industries aimed to reduce reliance on imports, boost economic growth, and modernise the country's industrial base. The creation of state-owned enterprises, such as the Turkish Petroleum Corporation ([TPAO](#)) in 1954 and the Turkish Iron and Steel Industry Corporation ([Erdemir](#)) in 1960, was a significant step in this direction. TPAO was established to develop Türkiye's oil resources and reduce dependency on foreign energy supplies. The company played a critical role in exploring and exploiting oil reserves, which was essential for fuelling Türkiye's growing industrial sector. Erdemir, on the other hand, was pivotal in the development of the steel industry. As one of the largest integrated steel plants in Türkiye, Erdemir's establishment marked a significant milestone in the country's industrial capabilities. The production of steel was critical for supporting infrastructure projects and manufacturing sectors, including automotive and construction.

The [State Planning Organisation](#) (SPO) was founded in September 1960 and centralised economic planning and intervention to [streamline economic development](#) and manage resources more effectively. The SPO set ambitious growth targets, aiming to transform Türkiye from a predominantly agrarian society into an industrialised nation. Throughout the 1960s, Türkiye experienced rapid economic growth, expanding at the target rates set by the SPO. This period marked Türkiye's industrialisation, characterised by increased [support for industry](#) taking over agriculture, urbanisation and labour migration abroad.

Turkish workers in Europe, [particularly Germany](#), played a crucial role by sending significant amounts of foreign exchange back home, helping to finance industrial imports and maintain balance of payments stability.

Advancements in Transportation and Communication

Infrastructure development was a key focus during this period, with significant investments in transportation and communication networks. The construction of major infrastructure projects, such as bridges, highways, and railways, played a crucial role in facilitating economic growth and improving connectivity across the country. One of the [most iconic projects](#) of this era was the Bosphorus Bridge, completed in 1973. Spanning the Bosphorus Strait and connecting the European and Asian sides of Istanbul, the bridge not only enhanced transportation but also became a symbol of Türkiye's engineering capabilities. The Bosphorus Bridge facilitated the movement of goods and people, promoting trade and integration within the country and with its neighbours.

In addition to the Bosphorus Bridge, the expansion of Türkiye's telecommunications network was another significant achievement. The Turkish Post, Telegraph, and Telephone Authority (PTT) played a crucial role in expanding and [modernising](#) Türkiye's telecommunications infrastructure: in 1967, Northern Electric & Telekomunikasyon A.S. (NETAS) was established as a joint venture between the PTT and Northern Telecom (NT) to manufacture electromechanical exchanges until 1984, and subsequently DMS digital exchanges. It extended telephone lines to rural areas, upgraded from manual to automated systems, and provided comprehensive communication services. The PTT collaborated internationally to import advanced technology and regulated the sector to ensure quality and compliance, laying the foundation for Türkiye's modern telecom network. The introduction of [television broadcasting](#) in 1968 on Turkish Radio and Television (TRT) marked a major advancement in communication technology. The development of a national telecommunications network helped to improve access to information and connect remote areas, contributing to the overall modernisation of Türkiye's communication infrastructure.

Development of the Automotive Industry

This period also saw the [growth of Türkiye's automotive industry](#), which became an essential part of the country's industrial landscape. In 1954, Jeep entered the Turkish market following a failed 1929 attempt by Ford to manufacture cars in the country, establishing a factory in Tuzla for military and commercial vehicles. Between 1958 and 1961, Türkiye produced its first car, the Nobel 200. In 1961,

the 'Devrim', Türkiye's first fully national car, was manufactured at the Eskisehir State Railway factory under President Cemal Gursel, but mass production failed due to inadequate investment and low demand. Significant growth came with the 'Anadol' brand, producing 87,000 cars from 1966 to 1982. The industry gained momentum with the founding of Tofas in 1968 and Oyak-Renault in 1969, with Oyak-Renault introducing the Renault 12 and Tofas producing Murat 124 models under Fiat's license. During this period, companies like Man, Karsan, and BMC emerged, further strengthening the Turkish automotive sector. This period demonstrated Türkiye's ambition and potential in automotive technology and laid the foundations for its burgeoning domestic car industry of today.

The 1980s-1990s: Liberalisation and Technological Diversification

Economic Liberalisation and Technological Growth

The 1980s brought a new era of [economic liberalisation](#) under the leadership of former Prime Minister Turgut Özal. The liberalisation policies aimed to modernise Türkiye's economy by encouraging private investment, reducing state control, and opening up to global markets. This shift had a profound impact on Türkiye's technological landscape, fostering innovation and diversification across various sectors. For example, his economic policy's introduction of [VAT privileges](#) for leasing was a game-changer for Turkish technology companies like Vestel and Arçelik that helped them emerge as major players in consumer electronics. This policy provided significant financial incentives, making it easier for businesses to acquire high-tech equipment and expand their operations. The lower VAT rates on leased goods enabled these companies to invest in advanced technology and scale up rapidly, fostering innovation and growth. Özal's forward-thinking approach helped nurture a dynamic tech sector in Türkiye, setting the stage for companies like Vestel and Arçelik to become key players in the global market. The growth of the private sector led to increased investment in research and development, the establishment of technology firms, and the expansion of the electronics and IT industries.

Rise of the Information Technology Sector

During the 1980s, former Prime Minister Özal's administration emphasised the expansion of telecommunications services as a foundation for economic growth. A Master Plan for Telecommunications was developed, [prioritising](#)

[ing rapid expansion](#) of the telecommunications network, the introduction of new services and technologies, conversion from analogue to digital systems, and fostering a competitive telecommunications sector. The plan's implementation led to substantial growth between 1982 and 1986, with an 83 percent increase in telephone exchange capacity, an 80 percent rise in telephone subscribers, and a 162 percent increase in villages with telephone service. In 1986, the state owned Türk Telekom introduced various new communications services, including an experimental packet-switched data network, a cellular mobile radio telephone system, radio paging, and fibre optic cables. By 1988, every Turkish village had telephone service. The mobile phone market also experienced rapid growth, particularly after Türkiye adopted GSM as its mobile standard in 1990. By 1993, GSM service was available, leading to exponential growth in subscribers. Revenue-sharing agreements with Türk Telekom allowed TurkCell and TelSim (now Vodafone Türkiye) to offer GSM services, with TurkCell capturing about 67 percent of the market. The competitive environment and technological advancements ensured that Turkish companies were well-positioned to adopt and integrate new communication technologies. Additionally, Türkiye invested in [satellite communications](#), becoming a shareholder in INTELSAT and EUTELSAT and establishing its own national satellite system. Significant milestones included the launch of TURKSAT-1B in 1994 and TURKSAT-1C in 1996, providing extensive coverage and supporting communications for Turkish embassies, military, and security organisations.

Furthermore, the Turkish government initiated Technology Development Centres (TEKMERS) in the 1990s, led by [KOSGEB](#) under the Ministry of Science, Technology, and Industry. These centres aimed to [support technology-based start-ups](#) and foster innovation for economic growth. TEKMERs provided essential services such as office space, consultancy, training, financing, and networking opportunities to help start-ups thrive. Financial support from KOSGEB was crucial in aiding new firms during their early stages. TEKMERs also focused on enhancing R&D within SMEs, promoting technology-oriented enterprises, and facilitating advanced technology use. These initiatives strengthened the collaboration between research and business sectors, reflecting the government's commitment to an innovation-driven economy and the growth of Türkiye's technology sector. Currently there are 28 TEKMER centres across the country. With the [enactment](#) of Law No. 4691 on Technology Development Zones in 2001, Türkiye made significant strides in fostering university-industry collaboration and establishing prominent technology zones nationwide, such as the Istanbul Technical University (ITU) [ARI Technopark](#) founded in 2002. They have become hubs for research and development, attracting both local and international entrepreneurs and investors.

Introduction of the Internet

The Internet was introduced to the country in 1986 with Türkiye establishing its [first BITNET connection](#), designed primarily for academic and research institutions, linking Ege University in Izmir to the European Academic and Research Network (EARN) through Pisa, Italy. By 1989, a group of network managers from Turkish universities established an IP-based network. Pilot studies between Middle East Technical University (METU) and Bilkent University started in 1990. By 1992, five universities had TCP/IP connectivity for internal communication, though no international links were yet in place. The [first international connection](#) was established in October 1992 with a brief IP link over X.25 to RIPE. The official launch of the internet in Türkiye occurred in 1993 when METU and TÜBİTAK set up a dedicated 64 Kbps connection to the National Science Foundation (NSF) in the United States. This marked Türkiye's formal entry into the global internet community.

Following this, Internet growth in Türkiye was fuelled by academic, governmental, and commercial entities, with METU serving as the main internet service provider and [managing](#) the .tr domain. Bilkent University also played a significant role in promoting internet usage and organising annual conferences on Turkish Internet issues. This highlights the importance of [university cooperation](#) with the public sector that provided the foundational research and infrastructure, which eventually private companies helped scale and commercialise.

The 2000s-2010s: Digital Revolution and Innovation Ecosystem

Expansion of Mobile and Broadband Networks

The early 2000s marked the beginning of Türkiye's digital revolution. Türk Telekom lost its [monopoly](#) on telecommunications services in the country with the implementation of the Telecommunications Law No. 4502, which was enacted on November 23, 2000. In the mobile segment also, both Telsim and Turkcell, which earlier had revenue agreements with Türk Telekom and so were not able to set prices, now could operate more freely. This shift towards liberalisation was part of Türkiye's broader efforts to modernise and improve its telecommunications infrastructure and services. By the end of 2002, Türkiye had approximately 23.32 million Global Technologies for Mobile (GSM), or 2G, subscribers.

Telsim introduced the [first General Packet Radio Service \(GPRS\) service](#) in 2000, followed by Turkcell, which launched its GPRS service in 2001 and a Multimedia Mes-

saging Service (MMS) in 2002. The MMS application combined videotext, graphics, and voice within a single message, making Turkcell one of the first mobile operators in Europe to promote MMS technology to its subscribers. In 2001, Turkcell launched one of the world's largest mobile portals, GPRSland, offering customers access to a variety of data applications with the goal of providing faster internet access than the Wireless Application Protocol (WAP). In 2003, GPRSland transitioned to a new interactive platform called 'Shubuo', which offered a range of customer services including sports, news, finance and music.

The introduction of 3G services in 2009 accelerated the growth of mobile internet usage, with Türkiye witnessing a rapid diffusion of mobile telecommunications technologies. By September 2022, these technologies served [over 80 million subscribers](#) and had effectively surpassed traditional telephone technology in usage and popularity. The rise of smartphones and mobile applications created opportunities for innovation and entrepreneurship.

Birth of Turkish Consumer Tech Giants

With the widespread adoption of mobile devices, Turkish consumers became more connected. This rise in connectivity [spurred demand](#) for innovative technology solutions that offered convenience and accessibility in daily life, including mobile payment systems, e-commerce platforms, and micro-mobility options. Notable success stories include companies like Yemeksepeti, Gittigidiyor and Biletix, amongst many others. Founded in 2001 by Nevzat Aydın, Melih Ödemiş, Cem Nufusi and Gökhan Akan, Yemeksepeti is Türkiye's leading online food delivery platform. Initially serving Istanbul, it quickly expanded to major Turkish cities and became a household name. Yemeksepeti distinguished itself with a user-friendly interface, reliable service, and features like online payment and real-time order tracking. It also ventured into international markets, operating under the name "Foodonclick" in several countries. In 2015, Yemeksepeti was [acquired](#) by Delivery Hero for 589 million USD, marking a significant milestone in the Turkish tech industry. Post-acquisition, Yemeksepeti continued to innovate and expand, solidifying its position as a major player in the food delivery sector.

Gittigidiyor was founded in 2001 by Serkan Borançılı, Burak Divanlıoğlu and Tolga Kabataş, as one of Türkiye's pioneering e-commerce platforms. It provided a wide array of products, including electronics, clothing, and home goods, with a user-friendly interface and secure payment system. Modelled after eBay, Gittigidiyor quickly gained popularity in Türkiye for its diverse product offerings and efficient online shopping experience. In 2011, eBay acquired a [majority stake](#) in Gittigidiyor, integrating it into its global network and leveraging its infrastructure to enhance eBay's presence in Türkiye. The acquisition marked a significant moment in Turkish e-commerce, highlighting

the country's growing digital marketplace.

Metin Tamer founded Biletix in 2000 which is still a prominent Turkish online ticketing platform. It revolutionised how tickets for events such as music concerts, sports, and theatrical performances are sold in Türkiye. The platform offered a user-friendly interface for purchasing and managing tickets, significantly enhancing convenience for eventgoers. Biletix's success and innovative approach in the ticketing space led to its [acquisition](#) by Ticketmaster in 2008, a move that allowed it to leverage Ticketmaster's global expertise and resources. As noted above, Biletix continues to operate as a major player in the Turkish ticketing market, maintaining its reputation for efficient service and extensive event coverage.

The success of startups like Yemeksepeti, Gittigidiyor and Biletix inspired a new generation of entrepreneurs with successful, sustainable business models. The rise of the ["exit" culture](#) in the early 2010s further boosted investor confidence, leading to increased risk-taking and larger investments. By the latter half of the decade, Istanbul saw its first billion-dollar startup emerge in 2020, followed by four unicorns and one decacorn within the same year. These included Peak Games, a mobile gaming company who were acquired by Zynga in 2020 for 1.8 billion USD, Trendyol, an e-commerce platform, Hepsiburada, another ecommerce platform and Bitaksi, a ride hailing app, all having achieved unicorn status. Getir, a rapid delivery service founded in 2015, [became a decacorn](#) with its impressive valuation exceeding 10 billion USD. This remarkable growth underscores Istanbul's, and Türkiye's, emergence as a significant player in the global entrepreneurship landscape.

Investments in Aerospace and Defence Technologies

The Turkish defence sector has experienced remarkable growth and transformation, particularly since 2010. Historically challenged by technological limitations, the sector began a significant [positive shift](#) with the establishment of the Defence Industries Research and Development Institute (SAGE) in 1985 and the modernisation of the Turkish Armed Forces (TAF).

Post-2010, the Turkish government focused on self-sufficiency and reducing foreign dependency when it came to defence, leading to notable advancements in naval, air, land, electronics, and ammunition production. This emphasis has shifted Türkiye from a major arms importer to a significant arms exporter, [ranked 14th globally](#) in 2023. The increase in defence expenditures, reaching 17.25 billion USD by 2019, highlights Türkiye's commitment to strengthening its defence capabilities. A notable achievement was the significant strides by Turkish Aerospace Industries (TUSAŞ) and the Turkish aerospace company Baykar Makina in developing and deploying Unmanned Aerial Vehicle (UAV) systems. By 2020, Türkiye had accumulated a fleet of [144 UAVs](#), including 110 Bayraktar TB2s, 24 ANKA

drones, and 10 Gözcü-1 Herons. The Bayraktar mini-UAV, introduced in 2005 and first used by the Turkish Armed Forces (TAF) in 2007, marked Türkiye's entry into indigenous drone technology. The Bayraktar TB2, which began development in 2012, achieved notable milestones, including a record 24-hour flight and the successful test-firing of a rocket in 2015.

In addition to being used operationally by the Turkish Armed Forces (TAF), six indigenous Bayraktar TB2s were exported to Qatar in 2018, marking this to be the [first export](#) of this kind. Türkiye's second export customer was Ukraine, with a batch of drones delivered in 2020. Türkiye has [expanded](#) its defence equipment exports to numerous countries, including Azerbaijan, Bahrain, Kazakhstan, Kyrgyzstan, Libya, Malaysia, Pakistan, Poland, Somalia, Tunisia, Turkmenistan, Ukraine and others. Spearheaded by the burgeoning sales of its UCAVs, particularly the Baykar TB2 drones, Türkiye's defence industry exports reached a record high of over [4.4 billion USD](#) in 2022, marking an increase of more than 36 percent compared to 2021. This growing international presence reflects Türkiye's expanding role as a global defence equipment supplier and its success in establishing itself in the global arms market.

Growth of Renewable Energy Sector

The development of renewable energy in Türkiye has advanced significantly over the past decades. Historically, like many other countries, Türkiye's energy sector was also heavily reliant on fossil fuels, leading to economic and environmental challenges, including high import costs and pollution. Recognising the potential of its renewable resources, Türkiye began transitioning towards more sustainable energy solutions. By 2019, Türkiye had [achieved 54 percent](#) of its total energy production from renewable sources, driven by substantial investments in hydro, wind, and solar energy. Hydropower emerged as a major player, with Türkiye ranking second in Europe for installed hydropower capacity in 2020, only behind Norway. As of June 2020, Türkiye operated 682 hydroelectric power plants.

Wind energy also saw impressive growth. Installed capacity surged from 9 MW in 1998 to 131.35 MW in 2007, thanks to government policies like the [Renewable Energy Law No. 5346](#). This legislation guaranteed the purchase of wind-generated energy and planned for significant capacity increases over two decades. By July 2017, wind energy accounted for [74 percent](#) of Türkiye's renewable-based installed power capacity.

Solar energy, though starting from a lower base, gained traction with the support of the Renewable Energy Law of 2005, which offered financial incentives and regulatory support. A notable example of Türkiye's commitment to solar energy is the Kalyon Karapınar Solar Power Plant. Inaugurated in 2020, this facility in Konya covers 1,920 hectares and features nearly 3.5 million solar panels, with a capacity

of 1.35 GW. It is the [largest solar power plant](#) in Europe, expected to meet the electricity needs of two million people annually, and was launched in May 2023. Kalyon Holding, awarded Türkiye's first solar power auction (YEKA-1 GES) in 2017, constructed the plant using panels from its Ankara factory, demonstrating Türkiye's dedication to expanding its renewable energy capacity and reducing dependence on fossil fuels as well as focusing less on foreign energy sources.

The 2020s and Beyond: Digital Transformation and Global Integration

Government Support and National Technology Initiative

The 2020s have marked a significant phase in Türkiye's technological evolution with the launch of the National Technology Initiative (NTI), which was announced in 2018. Upon inauguration in 2020 of the Centre for the Fourth Industrial Revolution Network to manage digital transformation, President Recep Tayyip Erdoğan [stated](#) that "we aim to make Türkiye a hub of the Fourth Industrial Revolution products and technologies in line with our National Technology Initiative".

The National Technology Initiative (NTI) in Türkiye serves as a consolidation effort to unite various stakeholders and mobilise them towards strategic objectives crucial for national interests. Comprising [five main elements](#) including developing high technology and innovation, facilitating digital transformation and industrialisation drive, supporting entrepreneurship, cultivating human capital and building infrastructure, it aims to bring together government agencies, private sector companies, universities, research institutions and NGOs, ensuring coordinated efforts in key areas like artificial intelligence, cybersecurity, advanced manufacturing and aerospace. For instance, the above-mentioned success in exporting indigenous defence products is a direct result of this initiative, showcasing Türkiye's commitment to reducing reliance on foreign technologies. The NTI has driven economic growth by fostering innovation, creating high-tech jobs and providing training opportunities such as through [DENEYAP](#) Technology Workshops and specialised scholarships. Policies supporting the NTI include tax incentives for R&D activities and the creation of more than a 100 specialised technology zones, [87 of them](#) being fully operational across the country. Educational programs, such as those offered by the [Kesif Kampus](#) and [Bilim Türkiye](#) aim to improve science communication and foster interest in science and technology on a national scale. By aligning technological progress with national interests, the NTI strives to create

a self-sufficient, innovative and globally competitive technology ecosystem in Türkiye. This strategic initiative is designed to propel Türkiye towards greater technological self-sufficiency and innovation in a more organised and directed manner.

Advancements in Artificial Intelligence (AI)

Türkiye's AI startup ecosystem was set for a transformative journey, fuelled by proactive governmental support. Recognising the [dynamic nature](#) of AI and its pivotal role in national development, Türkiye introduced its first [National Artificial Intelligence Strategy](#) (NAIS) in 2021. President Erdoğan emphasised the [indispensability of AI](#), declaring it a cornerstone of Türkiye's developmental aspirations. The NAIS, crafted through collaboration among public institutions, academia, industry leaders, and international entities, outlined six strategic pillars. These included initiatives for nurturing AI talent, fostering innovation, regulating AI applications, and promoting global collaboration. The strategy detailed 24 objectives and 119 actionable measures, charting Türkiye's AI journey from 2021 to 2025 with a focus on achieving AI autonomy and reducing reliance on external technologies.

Financial and regulatory support for AI startups underscored the government's commitment to fostering indigenous AI innovation. Turkish institutions launched [over 50](#) new AI-related programs to advocate for comprehensive AI education and empower the workforce. Universities like Middle East Technical University (METU), Boğaziçi University (through initiatives like Artificial Intelligence and Data Science Institute ([AIDSI](#)), and Istanbul Technical University (ITU) established dedicated AI research centres, driving cutting-edge research and grooming future AI experts. TÜBİTAK further promoted collaboration between academia, industry, and government, fostering an ecosystem conducive to AI innovation. To attract and retain AI talent, Türkiye implemented national and local talent programs. The proliferation of online learning platforms offering AI courses democratised AI education, widening access to a diverse audience. State-backed initiatives like the [Tech-InvesTR](#) VC Program provided crucial support to early-stage AI startups, complemented by private venture capital firms.

Türkiye's proactive stance in forging international partnerships with tech giants like Microsoft and IBM bolstered its AI capabilities. Participation in European Union funded [AI projects](#) enhanced Türkiye's research prowess and facilitated cross-border collaboration, positioning the nation as a formidable player in the global AI arena.

Expanding Cybersecurity Sector

In addition to AI, cybersecurity has emerged as a critical focus of the NTI. The cybersecurity industry in Türkiye has been experiencing rapid growth in recent years, driven by increasing cyber threats, rising demand for secure digital technologies, and the government's commitment to building a robust cybersecurity ecosystem. One of the [key players](#) in the Turkish cybersecurity scene is the Turkish Cyber Security Cluster (Türkiye Siber Güvenlik Kümelenmesi). Established in 2018, this public-private partnership aims to promote collaboration and innovation in cybersecurity. The cluster unites various stakeholders from industry, academia, and government to develop new cybersecurity solutions, share best practices, and raise awareness about cybersecurity threats.

In addition to the Cyber Security Cluster, several other organisations and initiatives are contributing to the development of the cybersecurity industry in Türkiye. The National Cyber Incident Response Centre (USOM) plays a [critical role](#) in coordinating cybersecurity efforts across government and private sector organisations. The Cyber Defence Institute (CyDef) [offers](#) training and certification programs for cybersecurity professionals, enhancing the skills and expertise within the industry.

Global Integration

Türkiye has significantly advanced its technological capabilities and deepened its integration with the global tech ecosystem. Leveraging its strategic location, skilled workforce, and expanding tech scene, Türkiye has [actively engaged](#) in international collaborations, research initiatives, and technology exchanges. This involvement has been bolstered by participation in global forums, partnerships with leading tech firms, and collaborations with research institutions worldwide.

A notable example of Türkiye's commitment to global tech integration is Teknofest, an annual aerospace and technology festival organised by the Turkish Technology Team Foundation, under the NTI mentioned above. The [Turkish Technology Foundation](#) aims to involve people of all ages in technology development, support R&D, and create strategically important, high-value products domestically. It focuses on nurturing young talent and advancing tech entrepreneurship and scientific research. Teknofest is one of the world's largest technology festivals, showcases innovations in aerospace, robotics, and AI, facilitating networking, knowledge sharing, and international partnerships. On the Turkish Republic's centennial, Teknofest took place in Türkiye's three largest cities—Istanbul, Ankara and Izmir—with a record-breaking attendance of more than [4.5 million local and international participants](#).

Conclusion

The technological evolution of Türkiye, from its Ottoman roots to its modern advancements, is a remarkable journey of continuous innovation and progress. The Ottomans' advancements in military technology and architecture laid a strong foundation for future developments. Mustafa Kemal Atatürk's reforms in the early 20th century, including the establishment of key institutions like TÜBİTAK, were pivotal in modernising Türkiye's scientific and technological landscape. The mid-20th century's focus on industrialisation and infrastructure, marked by projects such as the Bosphorus Bridge, further advanced Türkiye's capabilities. The economic liberalisation of the 1980s and 1990s spurred growth in the information technology sector, while the 2020s have seen Türkiye embrace digital transformation through the National Technology Initiative, emphasising artificial intelligence, cybersecurity and global integration. As Türkiye continues to integrate with the global tech ecosystem and foster innovation through events like Teknofest and a thriving startup environment, its rich technological heritage serves as a solid foundation for future advancements and global contributions.