2025 TECHPULSE TÜRKİYE

Tracking Technological Innovation and Trends

Gloria Shkurti Özdemir, Erman Akıllı, Safa Uslu

SETA

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FOREWORD

In the 21st century, technology is no longer a secondary or supportive factor in international affairs, it has become the core infrastructure upon which power, politics, influence, and progress are constructed. What once complemented statecraft now defines it. With every passing day, we witness how emerging technologies are reshaping global hierarchies, dictating strategic alliances, and intensifying competition among both traditional state actors and powerful non-state entities. This unprecedented shift signals the dawn of a technopolar order, where technological capability, more than territory or military power, determines a state's influence and reach on the world stage.

Recent developments further underscore this transformation. The return of Donald Trump to the White House has reignited the already heated U.S.-China rivalry, thrusting technological supremacy once again to the forefront of international discourse. Semiconductors, artificial intelligence, and quantum computing are no longer confined to the tech sector but they have become the main currency of geopolitical influence. The race to dominate in these fields is not only about economic gain, but about defining the rules of the emerging global system.

At the same time, the rise of new non-state actors, particularly big tech companies, has complicated traditional governance structures. These digital giants

now wield influence over critical infrastructure, social discourse, and even national security, giving rise to urgent debates around techno-feudalism and the shifting balance of power between states and private companies.

Furthermore, the obvious absence of effective global governance mechanisms around technology has left a vacuum, one that nation-states are scrambling to fill. There is no cohesive international framework for AI regulation, data ethics, or cross-border cyber norms. As a result, states are faced with an urgent imperative: either keep pace with technological change or risk strategic irrelevance. Inaction is not a neutral stance; it is a step toward obsolescence.

In this evolving landscape, remaining on the sidelines is no longer an option. States must proactively shape, regulate, and compete within the new technological paradigms. Falling behind in this ongoing digital revolution risks not only economic marginalization but also a loss of diplomatic and strategic leverage.

Against this backdrop, Türkiye stands at a critical juncture. As a nation uniquely positioned at the crossroads of East and West, with a vibrant youth population and an increasingly robust technological ecosystem, Türkiye has both the responsibility and the opportunity to shape its own digital destiny.

The *TechPulse Türkiye 2025* report is our strategic attempt to reflect this evolving reality. It is more than a record of technological progress, it is a forward-looking compass that highlights where we are, how far we have come, and where we need to go. This publication provides a comprehensive overview of Türkiye's most dynamic sectors, including artificial intelligence, aerospace technologies, energy, semiconductors, and digital infrastructure. It offers not only data and analysis but also contextualizes how technological development is redefining our national priorities, global positioning, and future prospects.

At a time when global power struggles are increasingly fought on digital battlegrounds, Türkiye's vision for technological self-sufficiency is essential. Through strategic investments in local talent, homegrown innovations, and national initiatives such as the National Technology Initiative and the National Artificial Intelligence Strategy, Türkiye is asserting its place in the emerging technopolar order. This report illustrates the depth of that commitment.

A distinctive strength of this report lies in its multidimensional methodology. Drawing from a wide-ranging national survey and expert interviews, the authors ensured the participation of four core stakeholder groups: academics, public officials, private sector professionals, and youth. Their insights paint a nuanced picture of Türkiye's technological transformation, one that combines ambition with realism, and optimism with awareness.

We are also reminded that technological leadership cannot be achieved in isolation. As the survey results clearly show, competition and cooperation coexist in this new global reality. Türkiye's emerging partnerships, especially with the Turkic world, with Asian innovation hubs, and with Africa's resource-rich markets, are testaments to its strategic depth. At the same time, the report makes it clear that stronger alignment with global trends, international standards, and institutional reforms are needed to ensure sustainability and competitiveness.

At the SETA Foundation, we remain committed to producing knowledge that supports Türkiye's national interests and future aspirations. This report is part of our broader mission to provide reliable, evidence-based analysis at the intersection of technology, policy, and strategy. We envision *TechPulse Türkiye* becoming an annual publication, a reference point for decision-makers, researchers, and the wider public. In doing so, we aim to create not only a chronicle of innovation but also a platform for shaping it.

On behalf of our editorial and research teams, I extend my sincere appreciation to everyone who contributed to this endeavor: the authors, the survey participants and all our institutional supporters.

May *TechPulse Türkiye 2025* serve as both a record of achievement and a call to action, as we continue our journey toward a more innovative, resilient, and globally competitive Türkiye.

SETA Foundation General Coordinator

Nebi Miş

EXECUTIVE SUMMARY

2025 TechPulse Türkiye: Tracking Technological Innovation and Trends offers a strategic and comprehensive evaluation of Türkiye's technological transformation throughout 2024 and its anticipated priorities for 2025. In an era defined by rapid digitalization, great power rivalry, and shifting global alliances, this report analyzes Türkiye's efforts to assert itself as a competitive and autonomous technological actor.

Through an extensive mixed-methods approach —including surveys with experts, policymakers, industry professionals, and youth— this report presents a multifaceted understanding of how Türkiye is shaping and being shaped by the evolving global tech ecosystem. Key focus areas include AI and machine learning, digital transformation, defense technologies, energy, telecommunications, education, semiconductors, and cloud infrastructure.

To support a strategic and sustainable technology agenda, the report proposes several policy recommendations. These recommendations span four strategic pillars: Innovation and Governance, Infrastructure and Security, Human Capital and Society, and Domestic Adoption and Global Engagement. Together, they outline a comprehensive roadmap for policymakers, industry leaders, and stakeholders aiming to position Türkiye as a leading force in the technopolar world order.

Each recommendation is designed to build on Türkiye's existing achievements -particularly in defense, AI, and digital transformation- while addressing areas of improvement such as R&D investment, digital infrastructure, talent retention, and global integration.

Policy Recommendations:

1. **Increase Investment in Research and Development (R&D):**

   Significantly boost public and private sector funding for R&D, particularly in high-impact fields such as artificial intelligence, semiconductors, quantum computing, and energy technologies.

2. **Adopt a Holistic Approach:**

   Türkiye has taken important steps in advancing technologies in defense, AI, and health. However, sustaining this momentum requires a cross-sectoral strategy—ensuring that technological advancements in one domain complement and reinforce innovation in others, ultimately contributing to national resilience and competitiveness.

3. **Establish AI Directorate and AI Safety Institute:**

   Create a dedicated national AI Directorate to oversee cross-sector coordination, regulation, and implementation of AI technologies. In parallel, establish an AI Safety Institute tasked with conducting ethical, technical, and risk-focused research on artificial intelligence. These institutions will play a pivotal role in ensuring Türkiye's leadership in secure, transparent, and responsible AI development, while also enhancing its visibility and strategic influence in the global AI arena.

4. **Strengthen Digital and Physical Infrastructure:**

   Accelerate the development of critical infrastructure to support emerging technologies such as 5G, cloud computing, and data centers, with a focus on security and national sovereignty.

5. **Enhance Cybersecurity Capabilities:**

   Invest in national cybersecurity infrastructure and create robust protection mechanisms against cyber threats in both public and private sectors.

6. **Expand AI in Public Services and National Governance:**

   Promote the adoption of AI technologies in public administration to increase efficiency, transparency, and data-driven decision-making.

7. **Foster International Technology Partnerships:**

   Deepen cooperation with strategic partners, (especially in terms of regional cooperation with the Turkic States) in AI, defense, green energy, and semiconductor production to facilitate technology transfer and innovation.

8. **Promote Domestic Software Adoption and Trust:**

   Increase incentives and public sector mandates for the use of domestically developed software to reinforce technological independence and innovation.

9. **Develop and Retain a Skilled Workforce:**

   Align education systems with technological needs by expanding STEM education, vocational training, and university-industry collaboration to reduce brain drain.

10. **Improve Public Awareness and Engagement:**

    Launch national campaigns to raise public awareness about Türkiye's technological initiatives, achievements, and opportunities, especially among youth and non-tech sectors.

YÖNETİCİ ÖZETİ

2025 TechPulse Türkiye: Teknolojik İnovasyon ve Trendlerin İzinde raporu Türkiye'nin 2024 boyunca geçirdiği teknolojik dönüşümü ve 2025'e yönelik öngörülen önceliklerini stratejik ve kapsamlı bir çerçevede değerlendirmektedir. Dijitalleşmenin ivme kazandığı, büyük güç rekabetlerinin derinleştiği ve küresel ittifakların yeniden şekillendiği bir dönemde bu rapor Türkiye'nin bağımsız ve rekabetçi bir teknoloji aktörü olma yolundaki çabalarını mercek altına almaktadır.

Uzmanlar, karar vericiler, sektör profesyonelleri ve gençlerle yapılan anketleri içeren ve çok yönlü bir araştırma yöntemiyle hazırlanan bu rapor Türkiye'nin küresel teknoloji ekosistemini nasıl şekillendirdiğini ve bu ekosistemden nasıl etkilendiğini çok boyutlu bir bakış açısıyla ortaya koymaktadır. Raporda odaklanılan temel alanlar arasında yapay zeka (YZ) ve makine öğrenimi, dijital dönüşüm, savunma teknolojileri, enerji, telekomünikasyon, eğitim, yarı iletkenler ve bulut altyapısı yer almaktadır.

Sürdürülebilir ve stratejik bir teknoloji vizyonunu desteklemek amacıyla rapor dört temel stratejik sütun altında toplanan bir dizi politika önerisi sunmaktadır: inovasyon ve yönetişim, altyapı ve güvenlik, insan kaynağı ve toplum, yerli uyum ve küresel etkileşim. Bu öneriler Türkiye'yi teknopolar dünya dü-

zeninde öncü bir konuma taşıma hedefiyle politika yapıcılar, sektör liderleri ve tüm paydaşlar için kapsamlı bir yol haritası sunmaktadır.

Her öneri Türkiye'nin özellikle savunma, YZ ve dijital dönüşüm gibi alanlarda elde ettiği başarıları temel alırken Ar-Ge yatırımları, dijital altyapı, yetenekli insan kaynağının elde tutulması ve küresel entegrasyon gibi gelişime açık başlıklara da stratejik çözümler sunmaktadır.

Politika Önerileri

1. **Stratejik Ar-Ge Ekosisteminin Güçlendirilmesi**

   YZ, yarı iletkenler, kuantum teknolojileri ve enerji sistemleri gibi yüksek öncelikli alanlarda uzun vadeli, kamu-özel sektör iş birliklerine dayalı bir Ar-Ge ekosistemi oluşturulması, kamu fonlarının etki odaklı projelere yönlendirilmesi ve risk sermayesi desteklerinin artırılması önerilmektedir.

2. **Sektörler Arası Bütünleşik Teknoloji Politikalarının Geliştirilmesi**

   Savunma, sağlık, eğitim ve enerji gibi stratejik sektörlerdeki dijitalleşme süreçlerinin birbiriyle etkileşimli bir şekilde planlanması; böylece teknolojik ilerlemelerin ulusal dayanıklılığı artıracak şekilde birbirini beslemesi sağlanmalıdır.

3. **Ulusal YZ Yönetişim Mekanizmasının Oluşturulması**

   YZ teknolojilerinin düzenlenmesi, sektörel koordinasyonu ve uzun vadeli stratejik planlamasının yapılabilmesi amacıyla bir başbakanlık ile bu alanda etik, güvenlik ve risk odaklı çalışmalar yürütecek bağımsız bir YZ Güvenliği Enstitüsünün kurulması önerilmektedir.

4. **Kritik Dijital ve Fiziksel Altyapıların Hızla Geliştirilmesi**

   5G, bulut bilişim, büyük veri merkezleri ve siber güvenlik ağları gibi altyapıların hem teknolojik bağımsızlığı destekleyecek şekilde geliştirilmesi hem de siber dayanıklılık kriterlerine uygun olarak planlanması gerekmektedir.

5. **Ulusal Siber Güvenlik Dayanıklılığının Artırılması**

   Siber tehditlere karşı hem kamu hem de özel sektör nezdinde ortak savunma kapasitesinin artırılması, yerli siber güvenlik çözümlerine yatırım yapılması ve ulusal bir siber tehdit erken uyarı sisteminin kurulması önem arz etmektedir.

6. **YZ Tabanlı Kamu Hizmetlerinin Yaygınlaştırılması**

   Kamu yönetiminde veri odaklı karar alma süreçlerinin güçlendirilmesi ve hizmet sunumlarında YZ uygulamalarının etkin şekilde entegre edilmesi şeffaflık, verimlilik ve vatandaş memnuniyetine katkı sağlayacaktır.

7. Uluslararası Teknoloji İş Birliklerinin Stratejik Hale Getirilmesi

Türkiye'nin özellikle Türk devletleriyle bölgesel teknoloji ortaklıklarını derinleştirmesi; ayrıca Avrupa ve Asya pazarlarıyla YZ, yeşil enerji ve yarı iletken üretimi gibi öncelikli alanlarda teknoloji transferini kolaylaştıracak mekanizmaların oluşturulması önerilmektedir.

8. Yerli Yazılımın Benimsenmesi ve Güvenilirliğinin Artırılması

Kamu sektöründe yerli yazılım kullanımına yönelik teşviklerin artırılması, sertifikasyon mekanizmalarının geliştirilmesi ve kullanıcı güveninin güçlendirilmesi teknolojik egemenlik açısından kritik önemdedir.

9. Nitelikli İnsan Kaynağının Yetiştirilmesi ve Türkiye'de Tutulması

STEM eğitimlerinin erken yaşlardan itibaren yaygınlaştırılması, üniversite-sanayi iş birliklerinin derinleştirilmesi ve yurt dışına yönelen yeteneklerin geri kazanımına yönelik programların oluşturulması stratejik öncelik olarak ele alınmalıdır.

10. Toplumun Teknolojik Dönüşüme Katılımının Artırılması

Toplumun her kesimini kapsayan ulusal farkındalık kampanyalarıyla teknolojiye olan güvenin pekiştirilmesi, gençlerin teknoloji alanında kariyer tercihlerine yönlendirilmesi ve dijital kapsayıcılığın artırılması sağlanmalıdır.

INTRODUCTION: THE EVOLVING INTERNATIONAL SYSTEM IN TURBULENT TIMES

The international system has undergone significant changes in recent decades, particularly since the end of the Cold War. Over the past 30 years, it has been continuously tested by a series of diverse and complex crises, ranging from full-scale wars, regional conflicts, and transnational terrorist attacks to global pandemics, as well as environmental threats like climate change to the ongoing refugee crises. While the end of the Cold War initially inspired optimism and promises of a more peaceful international order, reality has proven far more challenging. The international system has undergone, is currently undergoing, and will continue to experience profound transformations.

The international system has always been, and will always remain, a dynamic arena fraught with challenges. For mainstream International Relations (IR) theories, this arena is often characterized as a zero-sum game due to the inherently anarchic nature of the system. Realist scholars argue that states act

in pursuit of their survival and relative gains within this system. In contrast, constructivist perspectives suggest that anarchy is not a given but is instead shaped by the social interactions of states. As Alexander Wendt famously argued, "Anarchy is what states make of it."[1]

> Within this evolving framework –where the technological imperative and anarchy coexist– leveraging cutting-edge innovations is no longer just advantageous but essential for state survival and strategic positioning.

Despite theoretical divergences, one constant persists: the enduring presence of challenges within the international system. States, as the principal actors on this "grand chessboard," must continuously adapt to enhance their positions and mitigate risks in an increasingly volatile environment. However, while anarchy has traditionally served as the primary framework shaping state behavior, a new paradigm has become more visible than ever: technological imperative.

Though technology has always played a role in international affairs, recent advancements and its unprecedented fusion with politics are reshaping the global order, giving rise to what can now be termed a technopolitical order. This transformation is not merely an extension of previous technological revolutions; rather, it signifies a fundamental shift in how power is distributed and exercised on the global stage.

Within this evolving framework –where the technological imperative and anarchy coexist– leveraging cutting-edge innovations is no longer just advantageous but essential for state survival and strategic positioning. Consequently, many contemporary geopolitical developments are intrinsically linked to technological advancements. Foremost among them is the escalating U.S.-China great power rivalry, where technology has moved to the very core of competition. However, unlike past technological revolutions, today's transformation is not confined to great powers alone. Middle powers, recognizing the profound shifts brought about by the emerging technopolar order, are actively capitalizing on these developments. By adopting effective policies, they are seizing new opportunities to enhance their influence within the evolving international system.

Türkiye stands as a compelling example of a state that has embraced technological development as a cornerstone of its strategic vision. Driven by the

1 Alexander Wendt, "Anarchy Is What States Make of It: The Social Construction of Power Politics," *International Organization*, Vol. 46, No. 2 (Spring, 1992), pp. 391-425.

pursuit of an autonomous foreign policy, regional leadership, and global influence, Türkiye's approach to technological advancements extends far beyond mere imitation or dependence on technologically advanced states. Instead, for years, it has prioritized the development of national and domestically produced technologies, reducing reliance on external actors and ensuring that its policies align with its national interests. This commitment is embodied in the National Technological Move, an initiative that underpins Türkiye's strategy for technological self-sufficiency. Unlike a reactive or externally dependent approach, Türkiye's vision is deeply rooted in its unique national dynamics – encompassing both software and hardware development, fostering a highly skilled talent pool from programmers to engineers, and bridging the aspirations of visionaries with the expertise of implementers. This comprehensive strategy is pivotal in securing Türkiye's position within the emerging global technological order, ensuring that it remains a key player in shaping the future of technology-driven geopolitics.

> Initiatives such as the announcement of the National Artificial Intelligence Strategy and the National Technology Initiative are emblematic of Türkiye's commitment to becoming a global technology leader.

Within this framework, Türkiye prioritized technological advancement as a matter of strategic importance. Initiatives such as the announcement of the National Artificial Intelligence Strategy and the National Technology Initiative are emblematic of Türkiye's commitment to becoming a global technology leader. These efforts represent only the visible tip of the iceberg in Türkiye's broader aspirations to shape the future of technology and innovation.

Türkiye's success in the defense industry provides a powerful precedent for extending its technological capabilities into other domains. Advanced technologies are not merely tools for economic or military power; for Ankara, they are essential instruments for achieving strategic autonomy and effectively addressing regional challenges. Moreover, as a state that upholds international law and diplomacy, Türkiye's ability to act as a mediator or strategic planner on the global stage is deeply intertwined with her technological independence.

Today, out of the 8 billion people worldwide approximately 5 billion actively use social media platforms to create, share, and most importantly, consume digital content. In an era where digitalization is revolutionary, becoming a prominent and influential state depends on taking an active role in this trans-

formation process. Türkiye should view digitalization not merely as a tool for economic growth, but as a strategic necessity across a broad spectrum – from national security to diplomatic influence – where all decision-making processes will be data-driven.

Digitalization is no longer an option but an imperative for technological independence and global competitiveness. It is inconceivable for Türkiye to fall behind in this area; on the contrary, Türkiye should aim to produce, lead, and create a competitive advantage globally through digital technologies. Strengthening digital infrastructure, prioritizing information technologies, and investing in AI and big data are essential steps. It is also a clear reality that countries unable to keep pace with digital transformation will inevitably see a decline in their global influence.

Furthermore, energy supply security and internet access, which can be characterized as the logistics of technological advancement, are becoming increasingly important for all countries. The rising global energy demand due to the growing significance of digital technologies further complicates the task of decision-makers who aim to reduce carbon emissions. Both critical infrastructures must be easily accessible, affordable, and sustainable. Türkiye continues to work in coordination on energy supply security and communication infrastructures in its journey toward achieving technological independence.

Given Türkiye's remarkable progress in technological development, it is crucial to continuously monitor its policies, strategies, and overall advancements to gain a deeper understanding of how these shape its broader foreign policy agenda. As technology increasingly intertwines with global geopolitics, Türkiye's strategic positioning in emerging domains is instrumental in defining its role as a regional leader and global actor.

This report aims to highlight the most significant technological developments in Türkiye throughout 2024, focusing on key sectors such as AI and machine learning, digitalization, aerospace technologies, semiconductors, telecommunications, education, and energy. By analyzing these advancements, we seek to provide a comprehensive overview of Türkiye's technological trajectory and its broader implications for economic, political, and security strategies.

To complement this analysis, the report not only examines Türkiye's technological progress in 2024 but also explores future policy directions for 2025. To achieve this, we conducted a mixed-method approach, including expert interviews and an online survey, to capture diverse perspectives on Türkiye's technological transformation. The survey, conducted between December 9-12, 2024, gathered insights from 90 respondents, categorized into four key groups:

- Academicians (23 participants): Experts from universities and research institutions specializing in technology, policy, and innovation.
- Bureaucrats/Public Sector Employees (23 participants): Government officials and policymakers directly involved in shaping national strategies especially those on technology.
- Students/Youth (22 participants): The next generation of professionals, whose perspectives reflect both the opportunities and challenges in adapting to the evolving technological landscape.
- Private Sector Employees (22 participants): Industry professionals from various technological sectors, offering insights into real-world applications, market trends, and corporate innovation strategies.

> As technology increasingly intertwines with global geopolitics, Türkiye's strategic positioning in emerging domains is instrumental in defining its role as a regional leader and global actor.

This segmentation was designed to ensure a multidimensional analysis, capturing the perspectives of stakeholders most impacted by and actively engaged in technological change, both globally and within Türkiye. Additionally, by comparing viewpoints across these groups, we aim to identify key divergences in how different sectors perceive technological progress, opportunities, and challenges. Understanding these gaps is essential for crafting well-informed and targeted policy recommendations that align with Türkiye's long-term economic, security, and diplomatic objectives.

Türkiye's National Technological Move initiative has positioned it as a rising power in the global tech landscape, with increasing investments in AI, IT, cloud strategies, defense technologies, and digital infrastructure. However, the rapid pace of technological change presents both opportunities and risks, requiring adaptive governance, strategic foresight, and cross-sector collaboration. This report, therefore, serves as a critical resource for policymakers, industry leaders, and scholars aiming to navigate the complexities of Türkiye's technological transformation and its implications for global geopolitics.

By providing an in-depth assessment of 2024's developments and potential directions for 2025, this report seeks to contribute to a more strategic, forward-looking approach to Türkiye's role in the evolving technopolar world order.

Finally, we aspire for this report to become an annual publication, serving as a benchmark for tracking Türkiye's technological advancements. We would also like to extend our sincere gratitude to everyone who contributed to this

report, including Arda Kalaçoş, Buğra Bakmaz, Enes Balcıoğlu, Esma Nur Tunç, Melike Kır, and Md. Anwar Hossen, for their efforts in data collection. At the same time, we extend our heartfelt thanks to all survey respondents whose insights and feedback have been instrumental in shaping this report.

SURVEY RESULTS

First of all, we must gain a general understanding of Türkiye's technological ecosystem, which has indeed just started to develop in the last decades.[2] Transitioning from a traditional industry and manufacturing-oriented economy to one based on innovative technologies, Türkiye has achieved significant advancements in artificial intelligence, information technologies, cloud strategies, defense technologies, and digital infrastructure. This ecosystem, supported by public policies, private sector investments, academic research, and entrepreneurial initiatives, is shaped in alignment with the objectives of technological independence and sustainable development. Therefore, analyzing Türkiye's progress within this technological ecosystem and anticipating future trends is crucial for understanding future directions and informing strategic decision-making.

As participants were asked to rate Türkiye's current technological ecosystem, despite the fact the ecosystem in Türkiye is quite new, the survey results reveal a moderately positive perception, with the majority rating it fair (3) or good (4).[3] Specifically, 42 respondents viewed Türkiye's technological ecosystem as good, while 36 considered it fair, indicating that most recognize significant advancements but also acknowledge room for improvement. With only two participants rating the ecosystem as very poor, the overall perception remains largely positive, indicating that most respondents acknowledge Türkiye's technological progress (Figure 1). Going into more detail on the groups, academics/researchers and bureaucrats/public sector employees expressed the highest confidence, likely due to their direct involvement in technological policies, research, and national initiatives. These groups tend to positively evaluate the current pace of progress within the ecosystem, as they closely observe the impact of government-supported R&D projects, public investments, and national technology policies.

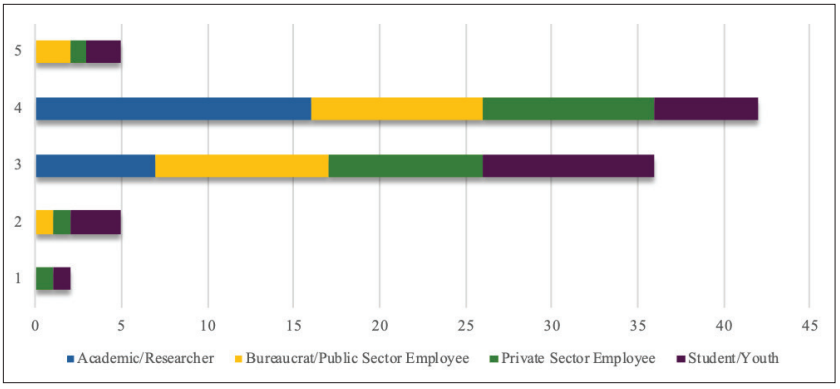
Private sector employees generally exhibit an optimistic outlook; however, their responses highlight specific challenges faced by each sector. This stems from differing sectoral perceptions of factors such as investment climate, global competition, financing, and talent availability.

2 "SETA TechTalks: Türkiye'nin Teknolojik Girişimcilik Ekosistemi - Fırsatlar ve Zorluklar," *Youtube*, retrieved from https://www.youtube.com/watch?v=A6aoBHTXclw.

3 The response scale was defined as follows: 1 - Very Poor, 2 - Poor, 3 - Fair, 4 - Good, 5 - Excellent.

Students and younger participants align closely with the overall trend, reflecting a balanced viewpoint. As individuals closely monitor technological advancements who will soon enter the workforce, this group maintains an equilibrium between recognizing opportunities and acknowledging risks. These varied perspectives not only underscore striking differences in the perception of Türkiye's technology ecosystem but also offer valuable insights for policymakers.

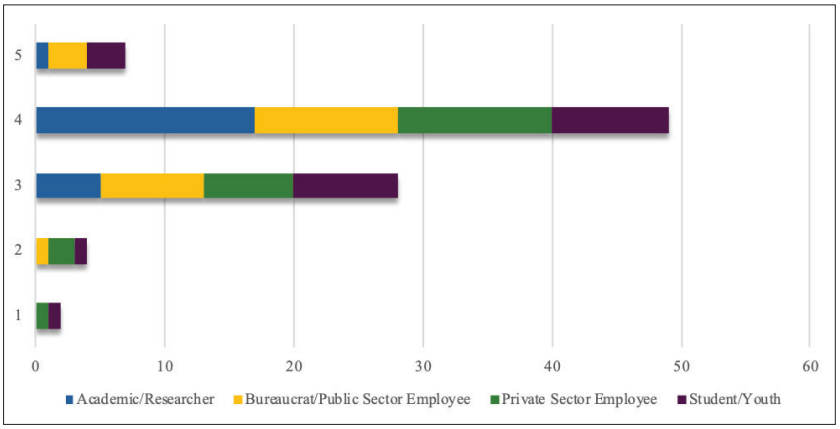
Figure 1: How would you rate Türkiye's technological ecosystem?



When asked to evaluate Türkiye's technological policies concerning overall technological developments (Figure 2), the survey results reflect a predominantly positive perception. The majority of respondents rated the policies as fair (3) or good (4), with 49 participants considering them good, 28 rating them as fair, and seven assessing them as very good. Academics/researchers and bureaucrats/public sector employees demonstrated the highest confidence, again most likely due to their direct involvement in research, policy-making, and national initiatives. The minimal number of low ratings (1 and 2) further reinforces the notion that Türkiye's policies are on the right track. However, further refinements – discussed in detail below – could enhance their impact on Türkiye's technological advancement and global competitiveness.

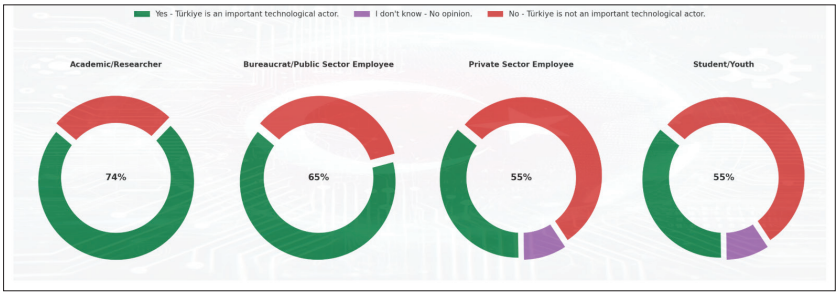
A comparison of responses to both the first and second questions – assessing the technological ecosystem and its supporting policies – reveals a strong correlation between the two. In both cases, the majority of respondents rated Türkiye's technological landscape as fair (3) or good (4), indicating that well-structured policies have been instrumental in driving technological progress. Additionally, the minimal rates of negative ratings in both charts reinforce Türkiye's strategic commitment to its technology policies, suggesting that the current policies effectively foster growth and innovation. These findings indicate that the development of the technology ecosystem is directly linked not only to infrastructure and investment policies but also to long-term strategic planning.

Figure 2: How do you rate Türkiye's policies regarding technological developments?



While Türkiye's domestic technological advancements are crucial, its global positioning is equally significant, aligning with its aspirations to become a regional leader and a key player in the global technology landscape. With this perspective, we asked participants whether they perceive Türkiye as an important technological actor on the international stage (Figure 3). The survey results indicate a majority (58%) affirming Türkiye's global technological significance. Academics/Researchers (74%) and bureaucrats/public sector employees (65%) demonstrated the strongest confidence, reflecting their direct involvement in research, policy initiatives, and national technology strategies. Meanwhile, private sector employees and students/youth showed a more balanced view (55% positive, 45% negative), suggesting opportunities to further strengthen global visibility, expand international partnerships, and enhance industry-driven innovation. These results align with the findings from Figure 1 and Figure 2 above, where Türkiye's technological ecosystem and policies received predominantly positive evaluations, reinforcing that Türkiye is on the right track, and strategic refinements can further elevate its global standing.

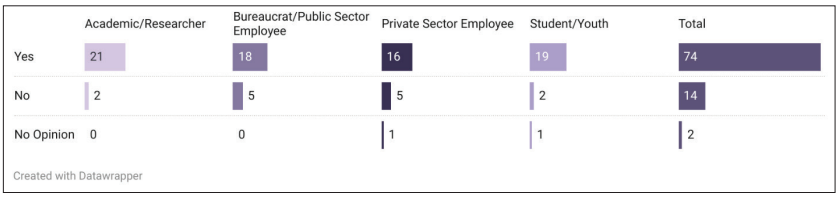
Figure 3: Do you see Türkiye as an important technological actor in the global arena?



As technology increasingly shapes global power dynamics, its role in foreign policy and economic diplomacy has become more significant than ever. Given Türkiye's strategic vision to establish herself as a regional leader and a key global technological actor, understanding the extent to which technology influences its international strategies is crucial. To assess this, we asked participants whether they believe technology is an important factor in Türkiye's foreign policy and economic diplomacy (Figure 4 and Figure 5). The survey results indicate overwhelming agreement on the crucial role of technology in Türkiye's foreign policy (83%) and economic diplomacy (82%), highlighting its strategic significance in global affairs. The minimal number of skepticism or uncertain responses suggests that technology's influence on Türkiye's global strategy is widely acknowledged. Concurrently, the low proportion of skeptical or uncertain responses indicates a broad confirmation of technology's decisive role in Türkiye's global strategy. This suggests that Türkiye can move forward in advancing its technology-driven diplomatic and economic strategies with extensive social and institutional support.

Figure 4: Do you think technology is an important factor in Türkiye's foreign policy?

Figure 5: Do you think technology is an important factor in Türkiye's economic diplomacy?

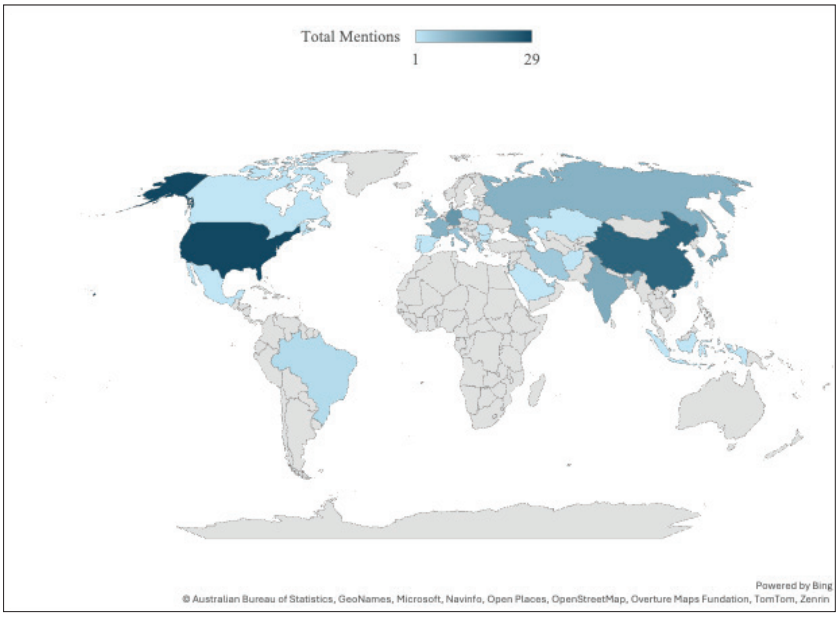


Türkiye's recognition as a significant technological actor on the global stage further underscores the importance of analyzing which countries it perceives as competitors. This perception offers critical insight into Türkiye's position within global technological competition and highlights the strategic priorities it sets amid evolving technological dynamics. As illustrated in Figure 6, survey results indicate that the United States (32%) and China (27%) are perceived as Türkiye's primary technological competitors. This finding reflects not only the ongoing U.S.-China technological rivalry at a global scale but also Türkiye's competitive positioning with these two states,

particularly in the fields of defense industries and unmanned aerial vehicle (UAV) technologies.

Alongside these two dominant actors, participants also identified Germany (17%), South Korea (15%), Israel (12%), France (10%), Japan (10%), and Russia (10%) as significant technological rivals. The perception of competition with Germany and France primarily stems from their robust defense and aerospace industries, whereas Israel is perceived as a rival in both geopolitical and technological contexts, particularly regarding military technologies. South Korea's comprehensive advancements in strategic fields like semiconductors, AI, and robotics also position it as a relative competitor for Türkiye. These findings indicate that a substantial number of respondents see Türkiye as an actor competing directly with the world's most technologically advanced nations, further solidifying its role within the global innovation ecosystem. Moreover, these results align closely with Türkiye's recent achievements in defense industries, artificial intelligence, and digital transformation, providing valuable insights into the country's future technological competitiveness.

Figure 6: According to you, with which states does Türkiye compete in the technological domain?



Considering the evolving international order and rapidly transforming technological ecosystem, the survey results highlight that technological competition should not be viewed merely as a race, but rather as a crucial catalyst for strategic cooperation and mutual growth. This perspective becomes clearer with responses to the question, "With which countries and in which fields should Türkiye cooperate in technology?" (Figure 7). Remarkably, the United States

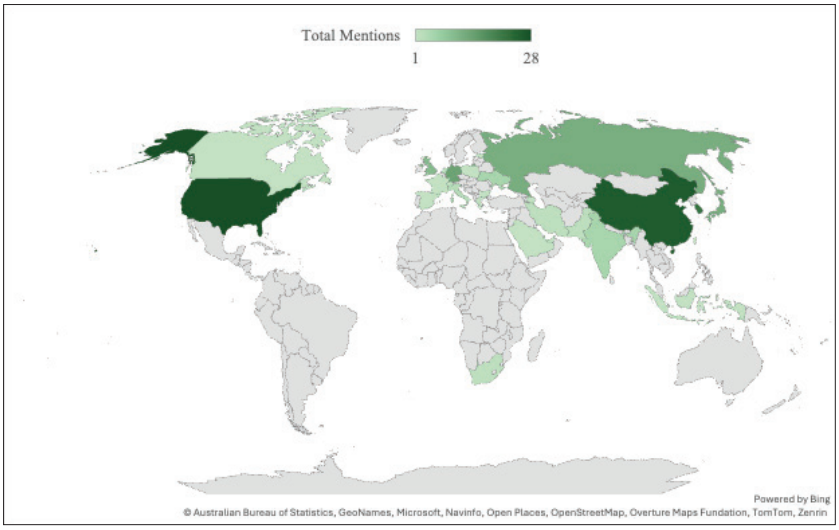
(32%) and China (29%), perceived as Türkiye's primary global competitors, are also identified as the most important partners for technological collaboration. This indicates that modern technological progress is shaped not solely through competition, but increasingly through joint projects and strategic synergies. While cooperation on globally critical issues like carbon emission reduction and green technologies is essential, each nation must also develop its capabilities to maintain competitive advantages, especially in information technologies. In this context, it remains strategically significant for Turkish technology companies to pursue international partnerships or acquire foreign technologies.

Upon examining responses regarding collaboration areas, AI emerges as the most frequently suggested field for cooperation with both the U.S. and China, underscoring AI's pivotal role in shaping future technological developments. Additional priority collaboration fields suggested with the U.S. include space, defense, semiconductors, electric vehicles, digitalization, and software, reflecting mutual interests in high-tech industries. With China, robotics, space, and electric vehicles are highlighted, along with batteries, wearable technologies, and semiconductors – areas benefiting Türkiye through China's technological advancements. Beyond the U.S. and China, South Korea (24%) ranks third among recommended partners due to its strong innovation-driven technology ecosystem, particularly emphasizing defense industries and digital transformation. In fourth place, Germany (16%) stands out prominently in renewable energy, aligning well with both countries' ambitious policies and initiatives in clean energy. Although collaboration in critical technologies may have certain boundaries, joint projects focusing on experience sharing and regulatory frameworks are evaluated positively.

A strategically valuable, though less frequently mentioned, area of cooperation involves collaboration with African countries, particularly concerning mining and rare earth elements. Rare earth elements are indispensable for modern technologies, and Africa remains one of the richest regions in these resources. Türkiye's recent discovery of one of the world's largest rare earth reserves positions it as a potential global actor in this field, creating mutually beneficial partnership opportunities with African nations. Such collaboration could secure critical raw material supplies for Türkiye's technology industry while simultaneously fostering economic and technological development across Africa, achieving a win-win scenario. Additionally, some respondents proposed regional cooperation frameworks rather than specific countries. Notably, 10% identified Turkic states as key technology partners, emphasizing that strengthening technological ties would accelerate Türkiye's domestic technological progress and support a robust regional technology ecosystem. Defense and energy were highlighted as priority fields, reflecting shared interests in security and sustainable energy innovation.

Overall, these findings demonstrate that Türkiye's technological diplomacy is defined by a balanced approach combining competition and cooperation within the global technology landscape. While competition perception with major powers such as the U.S. and China is strong, the necessity of cooperation in strategic domains is widely recognized. This reflects Türkiye's adoption of a multifaceted strategy aimed at simultaneously developing domestic technologies and enhancing balanced international cooperation, thus positioning itself as a competitive and innovative actor globally. Moving forward, strategic actions in priority sectors such as defense industries, AI, semiconductors, and renewable energy will further accelerate Türkiye's transformation into a leading country shaping technology regionally and globally.

Figure 7: According to you, with which states should Türkiye cooperate in the technological domain?

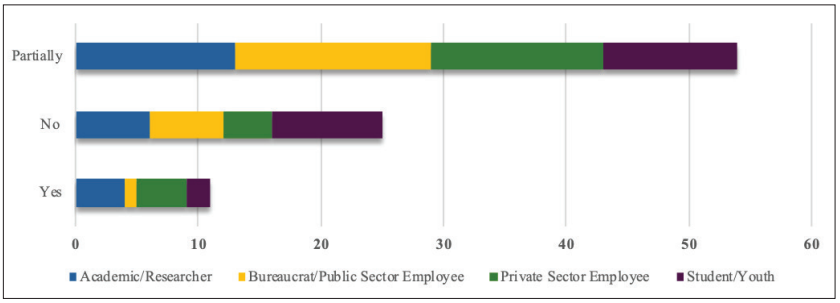


As Türkiye strengthens its position in the global technological landscape, both through competition and strategic cooperation, an important factor in sustaining this progress is public awareness and engagement with national technological initiatives. To assess this, we asked participants whether they believe the public is well-informed about Türkiye's technological advancements (Figure 8).

The survey results indicate that most respondents (60%) believe the public is only partially informed, with this category overwhelmingly surpassing other responses. This suggests that while Türkiye's technological advancements are recognized within certain circles, broader public awareness remains limited or inconsistent. A notable portion of respondents answered "no" (28%) indicating that a significant gap exists between Türkiye's technological progress and public knowledge about these developments. Conversely, the number of respondents who believe the public is well-informed

is minimal (12%), suggesting that more effective communication strategies, outreach programs, and public engagement efforts are needed to bridge this gap. Students/youth and private sector employees were the most represented groups in the "partially" and "no" categories, possibly highlighting a demand for greater accessibility to information and clearer communication of Türkiye's tech vision, policies, and achievements. Enhancing public awareness of technological advancements would not only foster greater national support for innovation but also encourage wider participation in Türkiye's growing tech ecosystem. Moreover, increasing digital awareness will empower our youth – the future guardians of our nation – to take ownership of our Digital Homeland.

Figure 8: Do you believe the general public is well-informed about Türkiye's technological initiatives?



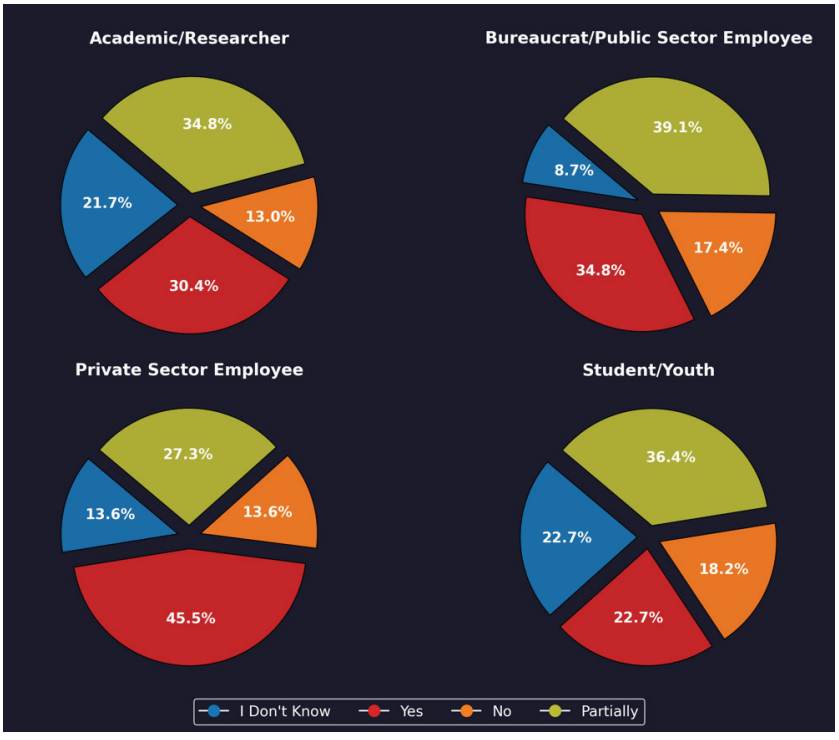
As public awareness of Türkiye's technological initiatives remains limited, another key indicator to understand the technological progress in Türkiye is the adoption of domestic software across different sectors. To assess this, we asked participants whether they observed an increase in the use of domestic software in their respective industries in 2024 (Figure 9). The survey results reveal a generally positive trend, with 33% of respondents confirming an increase in domestic software usage and 35% stating that the increase has been partial. This suggests that Türkiye is making strides in promoting locally developed software, though full integration remains an ongoing process. On the other hand, 16% of respondents stated that there has been no increase, while 17% were unsure, indicating that awareness and adoption still vary across industries.

When analyzing responses by sector, bureaucrats/public sector employees (39.1%) and academics/researchers (34.8%) had the highest percentage of respondents who believe there has been a partial increase in domestic software usage, reflecting government-backed digitalization efforts and academic research integration. However, private sector employees displayed the highest support, with 45.5% stating that there has been an increase in the use of the domestic softwares. Students/youth had a more balanced response, with

36.4% stating that there has been a partial increase, but 22.7% remained uncertain, suggesting that younger generations may not yet fully experience the transition toward domestic software in their fields.

These findings indicate that while Türkiye is making tangible progress in strengthening its domestic software ecosystem, adoption remains uneven across sectors. Public institutions appear more receptive than private enterprises, where concerns about functionality, scalability, or competitiveness with international solutions may slow down adoption. The relatively high percentage of "I don't know" responses (17% of the total) suggests that further awareness efforts are necessary to educate both businesses and individuals on the benefits and capabilities of domestic software solutions. Thus, Türkiye can accelerate its digital transformation by enhancing awareness among stakeholders, particularly regarding critical technologies such as cloud computing and data centers, which are essential for maintaining digital sovereignty and ensuring control over sensitive national data. Increasing awareness about these strategic technologies – especially cloud infrastructures and data management – is crucial to reinforce Türkiye's capability to keep its critical digital assets secure within national borders.

Figure 9: Is there an increase in the use of domestic software in your sector in 2024?

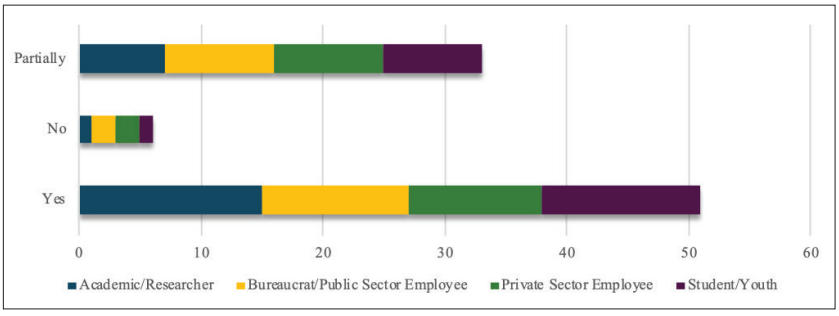


With Türkiye making significant strides in expanding the use of domestic software, ensuring strong user confidence and reliability is crucial for widespread adoption. While the previous section highlighted growing but uneven integration across industries, this section examines how much trust different professional groups place in these technologies (Figure 10).

The findings indicate that Türkiye has successfully established a strong foundation of trust in its domestic software industry, as evidenced by the majority of participants affirming their confidence with a resounding "yes." This widespread perception of trust, particularly among younger generations and public-sector professionals, highlights the growing reliability and competitiveness of local software solutions. However, a cautious outlook persists, notably among private sector entities and industrial enterprises, which maintain concerns regarding software performance, global competitiveness, and long-term sustainability. On the other hand, the proportion of participants who responded negatively ("no") remains relatively low across all occupational groups, reinforcing the overall positive stance toward domestic software.

These findings underscore Türkiye's potential to leverage this strong foundation of trust to accelerate the transition toward greater domestic software adoption. Yet, the presence of partial or cautious trust suggests that further efforts are necessary to address specific concerns, especially regarding software performance, sustainability, and competitiveness in international markets. Promoting independent assessments, international certifications, and robust user feedback mechanisms could further enhance trust and drive broader acceptance, particularly within industry and private-sector organizations. In summary, these insights suggest that while Türkiye has successfully built significant trust in domestic software, addressing the remaining areas of caution through targeted strategies will strengthen the country's competitive position globally.

Figure 10: Do you trust the domestic software?



Building on the previous analysis of public awareness, trust, and adoption of domestic technologies, it is crucial to identify actionable steps that will further

drive the development and widespread usage of Türkiye's domestic technological ecosystem. The survey responses highlight 10 key areas that stakeholders believe are essential for Türkiye's technological growth, spanning financial incentives, education reform, security enhancements, and market visibility (Figure 11).

At the forefront, financial and policy incentives emerged as the most critical factor, emphasizing the necessity of R&D support, funding opportunities, and tax benefits to encourage local companies to invest in technological innovation. Expanding Türkiye's current policies for promoting domestic technology and making them more targeted will accelerate this process.

Additionally, a significant portion of participants indicated their belief that the public lacks sufficient knowledge about Türkiye's technological advancements. Consequently, respondents emphasized prioritizing initiatives aimed at increasing public awareness to build greater trust in domestic technology. To bridge this gap, participants highlighted the importance of increasing conferences, panels, educational campaigns, media programs, and trust-building initiatives. Another prominent critical area identified was the promotion and marketing strategies for domestic products. Respondents suggested influencer collaborations, targeted campaigns, and strategic advertising activities to boost the visibility and adoption of local technology solutions.

An important strategic measure Türkiye has partially adopted is the widespread use of domestic technology within the public sector. This policy serves as a model for the private sector, facilitating broader adaptation. Prioritizing local software and hardware in public institutions will boost public trust and create a long-term ecosystem that stimulates industrial growth. Beyond financial and market strategies, structural and systemic improvements are also necessary to sustain technological growth. Survey participants stressed the importance of strengthening the education system and enhancing university-industry collaborations to build a competent workforce capable of meeting the demands of a technology-driven economy.

Accordingly, respondents recommended extending structured training programs, especially those focused on security, reliability, and usability, to both public and private sector employees. Additionally, integrating domestic software solutions into educational institutions, revising curricula, supporting university-driven research, organizing competitions, and providing incentives for students were highlighted as key steps. These actions will nurture a generation capable of contributing to Türkiye's technology-focused economy. Survey findings also indicate the necessity of developing security standards to enhance the global competitiveness of local technologies. Adhering to internationally

recognized security protocols and standards will accelerate the adoption of domestic technologies both nationally and internationally.

Furthermore, retaining domestic talent and preventing brain drain emerged as significant concerns. Competitive salary policies, attractive career opportunities, and innovation-oriented research ecosystems must be established to retain skilled professionals in Türkiye's technology sector. Increasing local technology firms' capacity to attract global investment is especially vital for domestic startups seeking international competitiveness. A common view among respondents was the necessity of promoting domestic technologies to wider audiences and enhancing their market visibility. Thus, local companies need to participate actively in global technology fairs, cultivate international collaborations, and increase investments in innovative projects.

Overall, these findings suggest that Türkiye requires a multidimensional approach to build a stronger domestic technology ecosystem. Elements such as financial incentives, regulatory frameworks, educational reforms, and talent management must be integrated to ensure sustainable technological advancement. Implementing these comprehensive measures will not only enhance Türkiye's competitiveness in the local market but also position the country as a leading actor in the global technology sector during its digital transformation process.

Figure 11: Top 10 Suggestions to Promote the Use of Domestic Technologies

1st	Financial and policy support for domestic tech
2nd	Boost public awareness & trust in domestic tech
3rd	Increase promotion & market visibility of domestic tech
4th	Expand local tech adoption in the public sector
5th	Enhance education quality for tech development
6th	Improve product standards and competitiveness
7th	Strengthen industry-academia partnerships
8th	Strengthen cyber and tech security standards
9th	Develop talent retention policies to prevent brain drain
10th	Implement policies to promote and expand domestic tech

As part of our survey, we sought to evaluate the effectiveness of Türkiye's technological policies in 2024 and identify areas that respondents believe

require greater attention (Figure 12). One of the most prominent findings is Türkiye's strong performance in defense technology, which emerged as the most recognized success story, garnering 86 mentions. Notably, all respondents from the academic/researcher group acknowledged this strength. Moreover, 51 respondents suggested that defense should remain a priority for further investment, indicating that Türkiye has already established a strong foundation in this sector. This aligns with previous findings, where defense was consistently regarded as Türkiye's most developed and globally competitive technological field.

Similarly, electric vehicles (EVs) and software received considerable recognition for success, reflecting Türkiye's progress in mobility and digital solutions. The achievements of TOGG, the country's first domestically produced electric vehicle brand, likely contributed to the positive perception of EVs. Being as such considered the second most successful area in 2024. However, despite these successes, respondents continued to emphasize the need for further focus, suggesting that sustained investment and development are crucial to ensuring long-term growth and competitiveness in these fields.

A key takeaway from this analysis is the variation between Türkiye's ongoing progress in AI, 5G, and other emerging technologies, and the expectations surrounding these fields. AI, in particular, stands out as an area of significant strategic importance. While 18 respondents recognized it as a success, 72 highlighted it as a priority for further investment. This underscores the growing awareness of AI's transformative potential and the importance of accelerating efforts to strengthen Türkiye's position in this domain. Similarly, 5G and Infrastructure, though acknowledged for their initial advancements, received only nine mentions as successes, while 36 respondents emphasized the need for greater investment. This suggests that Türkiye's efforts in 5G deployment are on the right path but could benefit from continued momentum to align with global developments.

Additionally, Large Language Models (LLMs) and semiconductors emerged as high-priority areas, with 32 and 18 recommendations, respectively, despite being less frequently cited as current strengths. This aligns with broader global technological trends, where AI-driven models and semiconductor innovation are pivotal for technological self-sufficiency and strategic growth. Strengthening Türkiye's capabilities in these sectors will not only enhance its competitiveness but also contribute to its long-term vision of becoming a leader in advanced technology industries.

Beyond AI and 5G, several other sectors stand out as both successful and requiring continued focus. Energy, Space Technologies, and AI Legislation

were frequently mentioned as key growth areas, underscoring Türkiye's expanding role in energy innovation, space exploration, and the governance of AI-driven systems. Notably, Space Technologies emerged as a particularly successful area among students, with approximately 50% ranking it as one of the top three most successful sectors in 2024. This strong recognition is likely tied to Türkiye's historic milestone of sending its first astronaut into space, along with significant advancements in implementing its National Space Strategy. The results suggest that these achievements resonated deeply with the younger generation, highlighting how national-level technological breakthroughs can inspire and influence public perception, especially among students who represent the future of Türkiye's tech ecosystem.

Additionally, the need for education and workforce training in technology fields emerged as a critical priority (28 mentions). This reinforces concerns about brain drain and the necessity of creating attractive career opportunities for local talent that we mentioned previously. Ensuring that Türkiye cultivates a skilled workforce will be fundamental to sustaining long-term innovation and competitiveness.

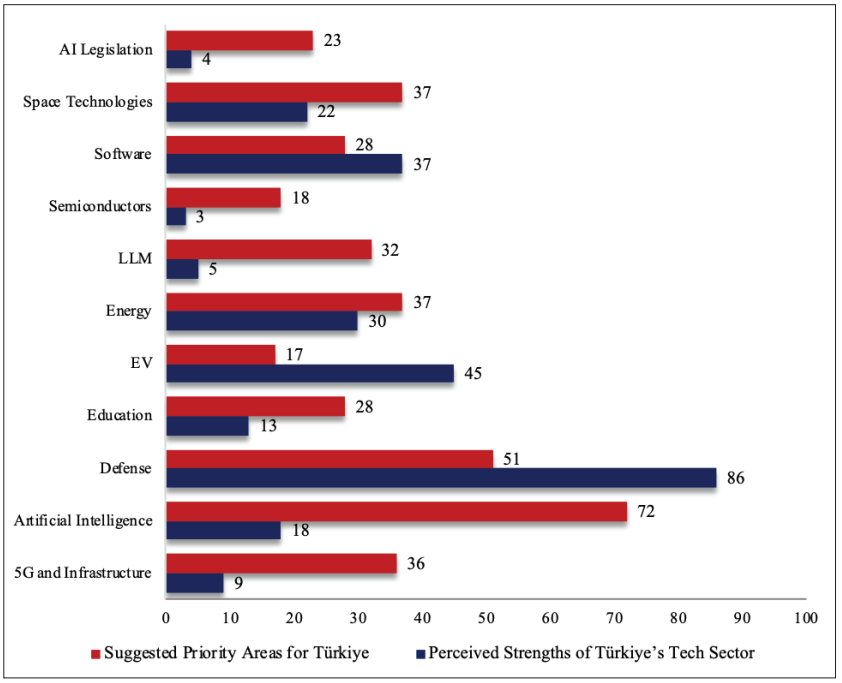
These insights point to several key strategic directions for Türkiye's future technological development.

1. The defense industry stands out as Türkiye's most prominent technological sector, recognized globally for its competitive edge. However, investments should be balanced across emerging fields such as AI, 5G, advanced manufacturing technologies, and semiconductors.
2. Electric vehicles, software, and space technologies have emerged as areas where Türkiye has achieved notable success recently but require further investments to reach their full potential.
3. Strengthening education and fostering university-industry collaborations are crucial for developing a skilled talent pool, addressing the needs of a technology-driven economy, and preventing brain drain.
4. Enhancing public awareness is vital for building confidence in domestic technologies and accelerating their adoption.
5. Strengthening the education system and promoting university-industry collaboration is crucial for reinforcing Türkiye's talent pool and preventing brain drain.

Recognizing these gaps, the Industry and Technology Ministry initiated targeted policies and financial mechanisms, particularly from mid-2024 onwards, focusing on strategic fields like AI and semiconductors. These steps underline Türkiye's proactive efforts to strengthen its technological ecosystem.

Ultimately, Türkiye's global technological position will depend on its ability to balance leadership in the defense sector with advancements in AI, communications, and software ecosystems.

Figure 12: Perceived Success vs. Recommended Focus Areas in Türkiye's Tech Sector (2024)



Based on our previous analyses of Türkiye's technological strengths and sectoral priorities, Figure 13 provides significant insights into how technological developments in 2024 have influenced various industrial sectors. Participants were asked to select and rank the top three sectors most positively impacted by technological advancement. Survey results confirmed that the defense industry is not only Türkiye's most advanced technological sector but also the most positively affected by recent technological progress, with 69 participants marking it as their top choice. This aligns with Türkiye's continuous investments in military technologies and its globally recognized innovations in defense. Notably, the defense industry's successes in drone technologies, unmanned aerial vehicles (UAVs), and AI-supported systems highlight that progress in this sector enhances not only national security but also Türkiye's global technological competitiveness.

Following the defense industry, the energy sector emerged as another area significantly influenced by technological advancements, receiving a total of 22 mentions across various rankings. This finding underscores the effectiveness

of Türkiye's strategies and investments in renewable energy, smart grids, and energy storage systems. Its efforts toward energy independence, clean energy transition strategies, and nuclear energy projects contribute significantly to technological progress within this sector. However, it is emphasized that relying solely on green technologies for energy security is not yet feasible globally, making it equally critical to increase societal awareness regarding energy efficiency and to support technological projects that enhance energy efficiency.

The education sector was identified as another key area, with survey findings emphasizing the need for stronger technological integration within educational institutions to cultivate a skilled workforce. Achieving notable recognition, particularly as the third-most-cited sector, education underscores the importance of digital transformation. AI-powered educational programs, remote learning platforms, and digital learning tools can significantly enhance Türkiye's capacity to develop a technology-oriented workforce, thereby boosting long-term economic competitiveness. Therefore, it is essential for Türkiye to proactively take measures today to develop crucial talent pools, including AI analysts, data analysts, and cybersecurity experts, to ensure adequate workforce availability in future digital technology sectors.

The health and transportation sectors also received notable mentions, illustrating the increasing importance of digitalization and smart technologies in these fields. In healthcare, advancements such as telemedicine, AI-assisted diagnostic systems, and biotechnology were particularly impactful. In transportation, intelligent transportation systems, electric vehicle infrastructure, and autonomous driving technologies were highlighted as critical drivers of Türkiye's mobility transformation.

Public administration was frequently identified as either a second or third preference, highlighting the transformative impact of technology on governmental processes. E-government applications, digital public services, and AI-supported public management systems emerged as the most prominent components of transformation, reflecting the increasing adoption of digital solutions aimed at enhancing automation, transparency, and efficiency within public services.

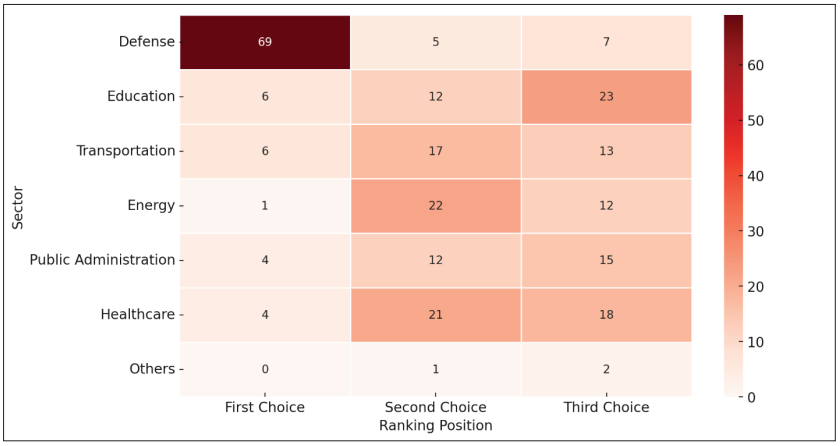
These findings identify sectors where Türkiye's technological investments have achieved the most visible progress, while also highlighting areas that require strategic focus to ensure long-term innovation and economic competitiveness:

1. Defense Industry: Continues to be Türkiye's most advanced sector, significantly enhancing its global competitive advantage in technology.
2. Energy Sector: Holds strong potential through advancements in renewable energy, energy efficiency, green energy, and smart-grid technologies, necessitating further investment.

3. Education: Requires deeper technological integration, emphasizing digital learning tools and AI-enhanced educational systems to sustain long-term economic development. Initiatives to train specialists in data analytics, artificial intelligence, and cybersecurity should be prioritized.
4. Health and Transportation: Accelerated digitalization and further investment in AI, big data, and biotechnology are essential for transformative growth in these sectors.
5. Public Administration: Must expedite digital transformation processes, leveraging e-government systems to offer more efficient and accessible public services.

As such, Türkiye's technological transformation strategy should be planned comprehensively across sectors, from education and health care to energy and transportation, to support sustained growth and global competitiveness. Strategic investment and effective use of technology will enable Türkiye to become a stronger player in the global technology landscape.

Figure 13: Which sectors in Türkiye were most positively impacted by technological advancements in 2024?



Given that our respondents represented four distinct societal groups, beyond the sectors analyzed earlier, we considered it valuable to assess how different segments of society were affected. This broader perspective would enable a more comprehensive evaluation of the overall situation. As illustrated in Figure 14, we asked each respondent whether their group or sector experienced a positive impact in 2024. The responses reflect a generally optimistic outlook: 42 respondents affirmed that Türkiye's technological advancements had a positive effect on their sector, while 36 participants acknowledged partial benefits. In total, 78 respondents (a significant majority) reported at least some level of positive impact,

reinforcing the idea that Türkiye's ongoing technological initiatives are delivering tangible benefits.

Among the different respondent categories, academics/researchers (21), bureaucrats/public sector employees (21), private sector employees (17), and students/youth (19) expressed positive sentiments regarding the impact of technological advancements. However, the Private Sector Employees had the highest proportion of negative responses (five out of 22), indicating that some industry representatives feel that Türkiye's technological progress has not yet translated into direct benefits for their sector.

The results align with earlier findings in the survey, which emphasized the need for greater awareness, policy support, and industry collaboration to enhance the widespread adoption of domestic technologies. The relatively high percentage of partial impact responses (36) suggests that while progress has been made, there are still areas where improvements and targeted policies are needed to ensure that technological advancements benefit all sectors equally. This reinforces the importance of bridging gaps between research, industry, and public sector initiatives to fully capitalize on Türkiye's technological potential.

With this in mind, to enhance the success and broaden the benefits of Türkiye's technology policies, the following measures can be recommended:

1. **Strengthening industrial collaborations:**
    - Increasing cooperation between private and public sectors is essential to ensure technological innovations spread across all sectors.
    - Expanding technology-transfer mechanisms, R&D support, and industry-university partnerships are necessary.
2. **Targeted policy supports:**
    - More targeted support programs should be introduced for private-sector and academic initiatives, modeled after successful strategies in defense, energy, and digital transformation.
    - Special incentive programs should be developed to facilitate technological adaptation, particularly for small and medium-sized enterprises (SMEs).
3. **Reaching broader segments of society:**
    - Education and awareness programs should be intensified to ensure technological advancements benefit diverse segments of society.
    - Students and young entrepreneurs should be more deeply integrated into the technological ecosystem.

4. **Enhancing adaptation of domestic technologies in the private sector:**
    - Sector-specific incentives should be provided to encourage the adoption of domestic software and digital solutions within the private sector.
    - Strategic guidance should be offered to private-sector representatives to facilitate their adaptation to domestic technologies.

Although Türkiye's technological advancements have had generally positive impacts, more comprehensive strategies are needed to ensure these benefits reach all sectors equally. Industrial collaborations, policy support, and educational reforms are especially critical for the sustainable growth of Türkiye's technology ecosystem. In this context, initiatives aimed at enhancing public-private sector cooperation, industrial incentives, and reforms that increase the effectiveness of technology policies will further strengthen Türkiye's competitive position within the global technology landscape.

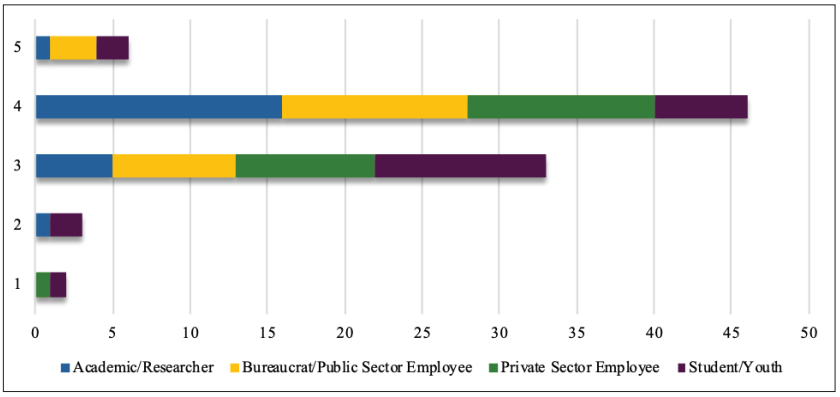
Figure 14: Do you believe Türkiye's technological progress in 2024 positively impacted your group/sector?

Although respondents were asked to evaluate technological advancements within their specific groups and sectors, they were also asked to assess Türkiye's overall technological progress in 2024 (Figure 15). Consistent with previous findings, the results of this chart reflect a predominantly positive perception, with the majority of participants rating Türkiye's progress as either "good" (4) or "fair" (3). The highest concentration of responses in these two categories indicates a widespread recognition of success, while also acknowledging the need for continued development. The "good" (4) rating received the most responses, demonstrating strong confidence in Türkiye's technological trajectory. This aligns with earlier analyses, where defense, EV, energy, and space technologies were frequently highlighted as areas of notable progress, reinforcing the perception that Türkiye has achieved significant advancements in these domains.

A smaller but notable proportion of respondents (rating 5 – "very good") reflects an optimistic outlook among certain professionals, particularly academics/researchers and bureaucrats/public sector employees. This suggests that individuals directly involved in policymaking and research have greater confidence in the impact of technological advancements. On the other

hand, the private sector employees and students/youth exhibited a more varied distribution across ratings, with a significant portion selecting "fair" (3). This aligns with earlier findings where private sector employees expressed concerns about the extent to which technological progress has directly benefited their industries, highlighting the need for further commercialization and industry adoption.

Figure 15: How would you rate Türkiye's overall success in technological advancements in 2024?



Building on our previous analyses of Türkiye's technological advancements, strengths, and areas for growth, it is equally important to consider the factors that may influence the sustainability of this progress. Given the rapid pace of technological development, even the most advanced nations, including global leaders such as the U.S. and China, face difficulties in keeping up with evolving trends. As a result, all countries are continuously working to navigate complexities related to funding, talent retention, and innovation. In Türkiye's case, while sectors like defense, electric vehicles, AI, and space technologies have made significant strides, survey responses indicate key areas that require further attention to sustain long-term growth. Strengthening these areas through strategic planning and investment will be essential in ensuring that Türkiye's technological momentum remains strong and its global competitiveness continues to rise. By proactively addressing these considerations, Türkiye can further solidify its position as an emerging leader in the digital economy and advanced technology landscape.

One of the most pressing areas for improvement identified by respondents (Figure 16) is the need for greater investment in R&D (55 mentions). This aligns with earlier findings emphasizing the importance of increased funding, tax incentives, and financial support to accelerate technological innovation. While Türkiye has made significant strides in key industries such as defense and electric vehicles, sustaining long-term growth in emerging sectors like

AI, semiconductors, and telecommunications requires a more robust commitment to R&D.

Similarly, limited access to investor financing (50 mentions) was widely recognized as an issue that needs to be focused on. This suggests that greater incentives beyond public funding are needed to encourage private-sector investment in technology. As highlighted earlier, increasing venture capital engagement, fostering startup accelerators, and strengthening industry-academia partnerships could help bridge this gap. Encouraging private sector participation in funding innovative initiatives is an area of focus not only for Türkiye but also for many other countries striving to enhance investment flows into their technology ecosystems.

Another key consideration is the need for further infrastructure development (44 mentions). This finding is particularly relevant in the context of sectors like 5G and AI, which were identified earlier as areas demanding focused investment. The expansion of critical infrastructure is an ongoing priority for many nations working to keep pace with digital transformation. Accelerating the rollout of digital and physical infrastructure will be essential in ensuring Türkiye's continued leadership in next-generation technologies.

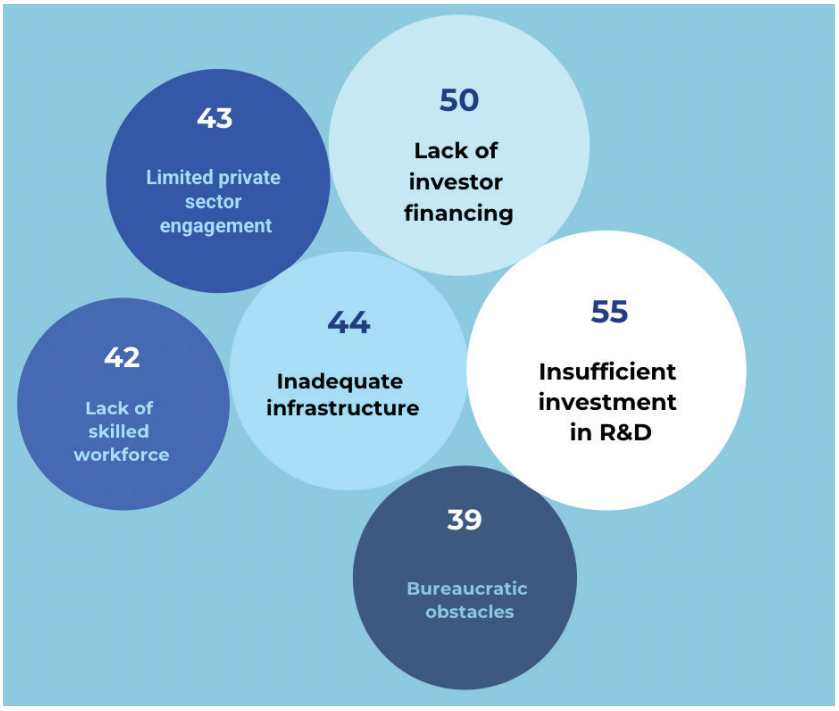
The availability of a highly skilled workforce (42 mentions) remains a crucial factor in driving technological progress. While Türkiye has made commendable efforts in AI legislation and technology-focused education, respondents highlighted a skills gap that could slow the pace of innovation. This is a shared concern across many countries, including leading technology hubs, which are actively working to strengthen STEM education, talent retention policies, and industry-academic collaboration. Expanding workforce development initiatives and creating incentives for skilled professionals to contribute to Türkiye's innovation ecosystem will be instrumental in maintaining technological momentum.

Finally, bureaucratic processes (39 mentions) were identified as an area where further refinements could enhance efficiency and innovation. This finding aligns with previous discussions on the importance of clear policies, streamlined regulations, and support mechanisms for startups. Many nations are continuously refining their regulatory frameworks to foster a more agile and competitive business environment, and Türkiye's ongoing efforts in this regard will contribute to a thriving innovation landscape.

By addressing these key areas strategically and holistically, Türkiye can build upon its existing technological achievements, ensuring that advancements in defense, AI, and space technologies are complemented by strong foundations in investment, infrastructure, and human capital. As other global play-

ers refine their approaches to these common considerations, Türkiye's proactive efforts will reinforce its position as an emerging leader in the global technology landscape.

Figure 16: What were the main areas that needed improvement in 2024?

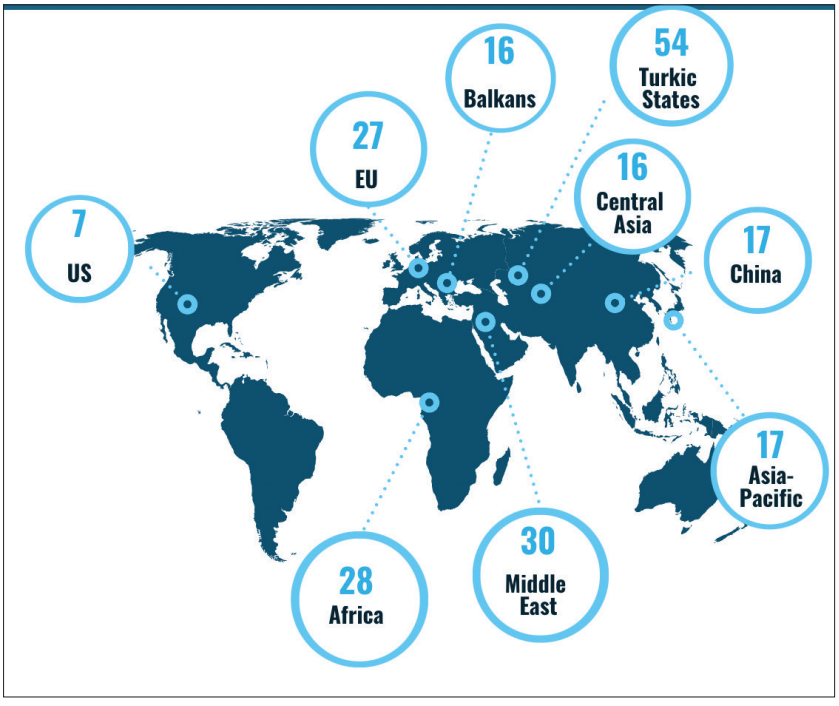


We now turn to an analysis of Türkiye's most effective international partnerships and the main technological areas of cooperation especially in 2024. To gain insight into this, respondents were asked to identify the regions or states with whom Türkiye collaborated most effectively and the key sectors driving these partnerships (Figure 17 and Figure 18). The responses to these two questions provide a comprehensive picture of Türkiye's regional alliances and sectoral focus, highlighting key economic, strategic, and technological priorities.

First of all, as can be seen from Figure 17, the Turkic States emerged as Türkiye's most significant international partners in 2024, with 54 responses, reflecting Türkiye's strong diplomatic and economic engagement within the Organization of Turkic States (OTS). It is also important to state that as we discussed above in Figure 7, Turkic states were also considered as the main region that Türkiye should cooperate with more in terms of technological development. Given this close collaboration, defense technologies, which received 64 responses as a key area of partnership, likely played a dominant role in Türkiye's engagements with these nations. Defense exports, joint military research, and technological collaboration have been critical aspects of Türkiye's

relationships with countries such as Azerbaijan, Kazakhstan, and Uzbekistan. In addition to defense industries, academic and research partnerships emerged as another critical area. Twenty-one participants emphasized that academic and scientific collaborations are a defining aspect of Türkiye's partnerships with Turkic states. In this context, inter-university exchange programs, joint research initiatives, and technology-development efforts have reinforced Türkiye's objective of contributing to the regional science and technology ecosystem. Furthermore, these academic collaborations hold significant potential for generating innovative solutions and fostering technology-driven economic growth within the region in the long term. These findings illustrate that Türkiye views cooperation with Turkic states not merely within an economic and political framework but also through a lens focused on technological advancement and academic development. Such an orientation reinforces Ankara's regional leadership role and paves the way for deeper strategic cooperation in crucial areas such as technology transfer and defense industries.

Figure 17: Which regions/states do you think Türkiye cooperated with most effectively in 2024?



Findings regarding Türkiye's international collaboration strategy in 2024 provide important insights into how the country positions itself in defense, energy, and emerging digital technology sectors. The Middle East and Africa also emerged as key regions of cooperation, with 30 and 28 mentions, respectively, suggesting a strong emphasis on both energy and defense collaborations. Energy

cooperation, which was identified as a main area of focus with 49 responses, has been a central pillar of Türkiye's regional engagement, particularly in renewable energy projects, infrastructure development, and resource trade agreements. Similarly, defense technologies, which also ranked highly in cooperation, underline Türkiye's expanding role as a defense supplier in these regions, particularly in drone technology and military modernization efforts.

"Nevertheless, certain areas such as defense technologies and collaborations in terms of space program with the U.S. could still play a role, though Türkiye's primary technological partnerships seem to have shifted toward regional and Asian allies."

The European Union remains an important partner as well but mostly in the energy sector. Given Türkiye's strategic position as an energy transit hub for Europe and its participation in EU-backed sustainability initiatives, the emphasis on energy aligns with broader geopolitical and economic trends. Furthermore, Türkiye's efforts to diversify its energy resources further enhance the importance of cooperation with the EU.

China and the Asia-Pacific region, which received 17 and 21 mentions respectively, are becoming increasingly significant partners for Türkiye, particularly in emerging digital and space technologies. Digital infrastructure and 5G, which had 12 responses, and AI and machine learning, with 15 mentions, reflect Türkiye's growing interest in leveraging Chinese and East Asian expertise in these high-tech fields and also Türkiye's cooperation with these states in terms of 5G or digital infrastructure.

Interestingly, the U.S. and the Balkans were mentioned less frequently as key cooperation partners, with only seven and 16 responses, respectively. While Türkiye maintains strategic and economic relations with both, the survey results suggest that technological cooperation may not have been as prominent in 2024. Nevertheless, certain areas such as defense technologies and collaborations in terms of space program with the U.S. could still play a role, though Türkiye's primary technological partnerships seem to have shifted toward regional and Asian allies.

These findings indicate that Türkiye's international cooperation strategy in 2024 was shaped by a balance of defense, energy, and emerging digital technologies, with a notable shift toward regional and Eurasian partnerships. The dominance of defense and energy cooperation suggests that Türkiye continues to leverage its strengths in these sectors to deepen strategic alliances, while its growing engagement in AI, 5G, and space technologies demonstrates an

ambition to expand its presence in high-tech innovation. This approach aligns with Türkiye's long-term objectives for technological self-sufficiency and global competitiveness, reinforcing its position as a rising innovation hub in Eurasia and beyond.

Figure 18: What was the main area of Türkiye's cooperation with these regions/states in 2024?

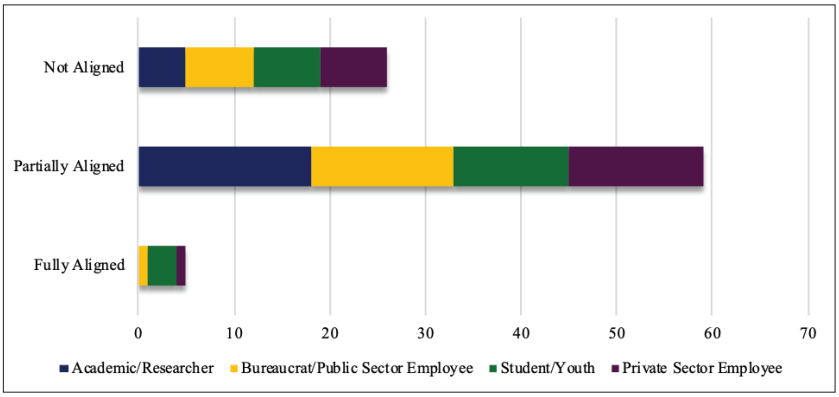
1st	Defense technologies
2nd	Energy
3rd	Academic and research partnerships
4th	Artificial intelligence and machine learning
5th	Digital infrastructure and 5G
6th	Space technologies

The alignment of Türkiye's technological policies with global trends and priorities is a critical factor in shaping the country's long-term innovation strategy. Previous analyses have underscored Türkiye's strengths in defense technologies, energy, and emerging fields such as AI and space technologies. However, ensuring that these advancements remain competitive on a global scale requires continuous assessment and strategic alignment with international technological developments.

As shown in Figure 19, the survey results reveal that the majority of respondents view Türkiye's technological policies as "partially aligned" with global trends. This suggests that while Türkiye has made significant progress in key areas, there remains room for further integration of global best practices and deeper alignment with international innovation frameworks. The distribution of responses across various professional groups – academics, public sector employees, and private sector representatives – indicates a broad consensus on this perspective.

It is important to note that this perception may also stem from Türkiye's increasingly independent foreign policy in recent years, which prioritizes national interests over strict alignment with global powers. Unlike other countries that align closely with either the U.S. or China amid the ongoing technological rivalry, Türkiye has strategically maintained balanced cooperation with both, leveraging its partnerships to serve its national agenda. Additionally, Türkiye's efforts in developing national LLMs, investing in semiconductor production, and advancing AI infrastructure can be seen as examples of policies that partially align with global technological priorities while maintaining a degree of strategic independence.

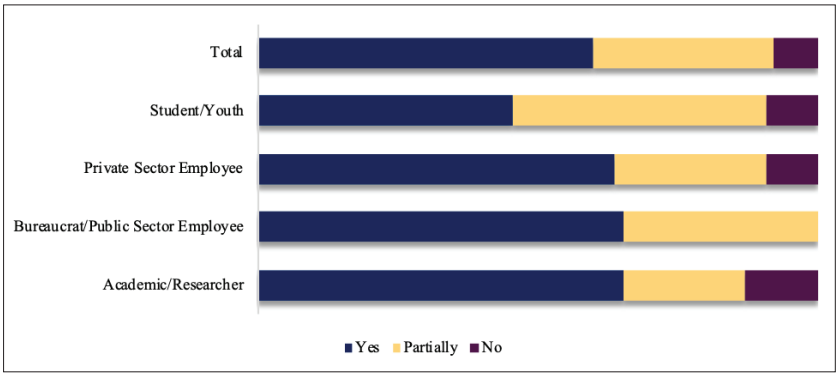
Figure 19: Do you think Türkiye's technological policies in 2024 are aligned with global trends and priorities?



The ongoing technological rivalry between the U.S. and China has significantly influenced global technology policies, and Türkiye is no exception. Given Türkiye's expanding role in the global tech landscape, analyzing the extent of this impact is essential (Figure 20). The survey results reveal that an overwhelming 88.5% of respondents believe the U.S.-China technological competition has shaped Türkiye's policies, with 61.4% stating it had a direct impact, and 27.1% recognizing a partial influence. In contrast, only 11.5% of respondents disagreed, highlighting a strong consensus on the geopolitical factors driving Türkiye's technological direction. Notably, bureaucrats and public sector employees unanimously acknowledged this influence, with 65.2% selecting "yes" and 34.8% choosing "partially." These findings reinforce the broader narrative that Türkiye is strategically maneuvering within this global tech rivalry while striving to maintain and strengthen its technological sovereignty.

Despite Türkiye's increasing pursuit of technological independence in recent years, the necessities of global competition continue to directly influence the country's strategic orientations. In this context, it is evident that while shaping its technological policies, Türkiye seeks to maintain balanced partnerships with both the U.S. and China, while also striving to build its own independent technology ecosystem. The U.S.' dominance in AI, semiconductors, and defense industries, along with China's advancements in digital infrastructure, 5G, and big data, present both opportunities and the need for strategic balancing for Türkiye. This dynamic necessitates that the country continues its pursuit of technological independence while also adopting a position that remains responsive to global developments.

Figure 20: Do you think that the U.S.-China race had a direct impact on Türkiye's technological policies and strategies in 2024?



Türkiye's ability to respond effectively to global technological developments is a crucial factor in its long-term innovation strategy. This survey question represented in Figure 21 aimed to assess how well Türkiye has adapted to key global technological trends in 2024, particularly in comparison to international benchmarks.

The survey results reveal a mixed yet predominantly positive perception of Türkiye's responsiveness to global technological developments. Among the assessed areas, renewable energy innovations, space exploration initiatives, and cybersecurity improvements garnered the highest approval ratings, with approximately 26-28% of respondents rating Türkiye's performance as "above expectations." When factoring in the "met expectations" responses, the overall positive perception rises to 61% for space exploration, 76% for energy, and 78% for cybersecurity. These findings align with Türkiye's notable advancements in its space program, including the launch of its first astronaut mission and the domestically produced TÜRKSAT 6A satellite, which reinforced confidence in the country's growing space capabilities. Similarly, cybersecurity has been a key governmental priority, particularly in strengthening national security against potential cyber threats. This focus culminated in the establishment of the Cybersecurity Directorate, directly linked to the Presidency, at the beginning of 2025, underscoring the state's commitment to fortifying its digital infrastructure.

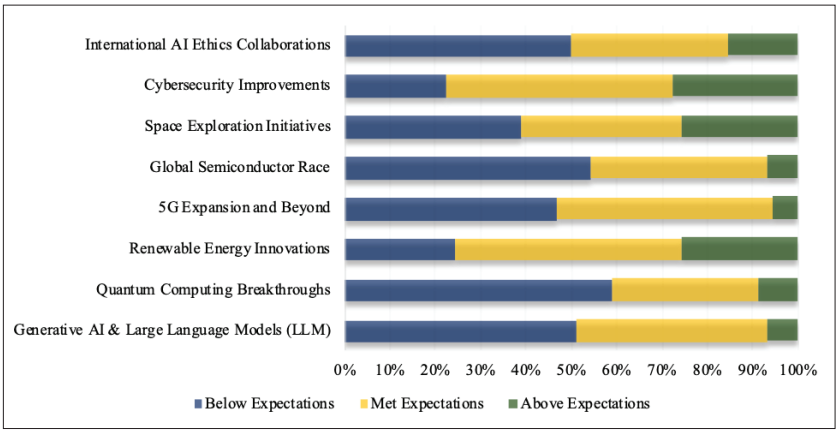
Another significant finding is related to 5G expansion, where 48% of respondents believe Türkiye met expectations, while 6% rated its performance as above expectations. This relatively positive perception is likely linked to Türkiye's international collaborations in 5G development. However, with 47% of respondents stating that progress in this area remains below expectations, there is a clear indication that further policy initiatives and investments will be necessary in 2025 to accelerate 5G deployment and enhance digital connectivity.

On the other hand, Quantum Computing Breakthroughs, the Global Semiconductor Race, and AI Ethics Collaborations received more "below expectations" responses. This reflects that Türkiye is still in the early stages of expanding its capabilities in these highly specialized and rapidly evolving fields. However, this also presents a significant opportunity for Türkiye to strategically position itself as an emerging player in next-generation computing and semiconductor development.

At this point, it is also important to highlight that a key reason why these areas remained below expectations is closely linked to the fact that the semiconductor and quantum technology sectors are currently dominated by a small number of global powers. However, at the same time, Türkiye's growing reputation as an important global tech player has naturally led to rising expectations for even greater success in these fields. This increasing anticipation reflects confidence in Türkiye's technological trajectory and its ability to expand its influence in high-tech industries.

Furthermore, Türkiye has significant potential to strengthen its role in these cutting-edge sectors through increased investment, research collaborations, and policy-driven initiatives. In particular, broadening international collaborations, fostering the domestic innovation ecosystem, and enhancing technological infrastructure can position Türkiye as a key player in these fields. By maintaining its current growth momentum and taking strategic steps in areas such as quantum computing, semiconductor manufacturing, and AI ethics, Türkiye can secure a stronger foothold in the global technology landscape in the long run.

Figure 21: How effectively did Türkiye respond to global developments influencing technological advancements in 2024?



After having analyzed the expectations and necessities for 2024, in our survey, we also focused on the path and policies that Türkiye should follow

in 2025. Within this context, we asked which areas should Türkiye focus in 2025 (Figure 22). The most recommended areas include AI R&D, promoting AI in public services, defense, and enhancing cybersecurity, each of which garnered a significant number of responses across all respondent categories. It is important to state that both AI R&D and defense were also among the two areas suggested where Türkiye should have focused the most during 2024 (Figure 12).

Artificial Intelligence R&D emerged as the most frequently suggested focus area, with respondents from all four categories – academia, public sector, private sector, and students –expressing strong support for increased investment and development in this domain. This aligns with previous findings emphasizing the gap between Türkiye's current AI development and the global race for AI dominance. Furthermore, promoting AI in public services emerges as a critical issue for enhancing efficiency in administrative processes, and modernizing, and optimizing public services. The increased use of AI in public administration can reduce bureaucracy, accelerate service delivery, and enable the adoption of data-driven approaches in decision-making processes.

Another area emphasized by the participants is the improvement of cybersecurity, which is becoming increasingly important for national security as digitalization accelerates. Establishing a resilient infrastructure against cyber threats has become a necessity for both government institutions and the private sector.

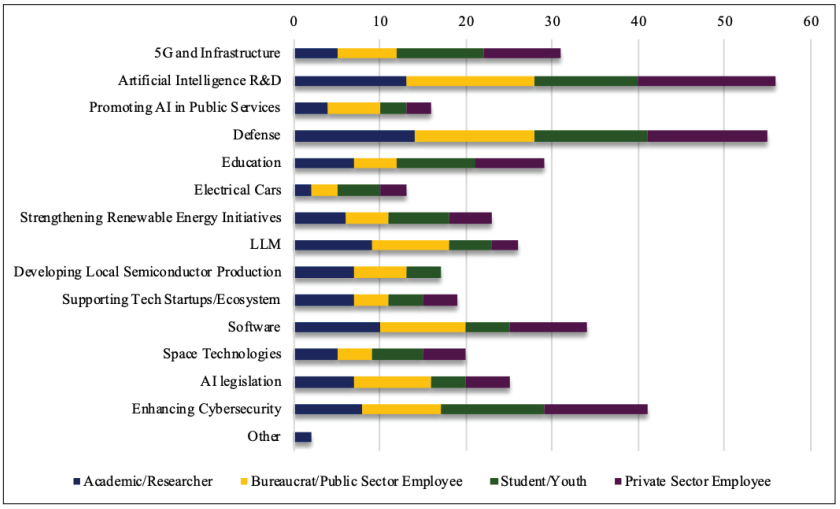
Among the infrastructure projects supporting Türkiye's digital transformation, the expansion of 5G, renewable energy initiatives, and semiconductor production have been identified as key investment areas by the respondents. The widespread adoption of 5G technology will establish a faster and more reliable digital connectivity network for both industrial production and individual users, allowing for more effective utilization of digitalization opportunities. Semiconductor production, on the other hand, can strengthen Türkiye's technological independence by reducing its reliance on foreign hardware technologies and enhancing the country's resilience against vulnerabilities in global supply chains.

Encouraging the entrepreneurial ecosystem and supporting technology startups were also highlighted as key findings of the survey. To enhance its innovation capacity and enable local startups to compete in international markets, Türkiye must establish a strong technology ecosystem. In this framework, financial support, R&D incentives, and startup accelerator programs can contribute to the growth of innovation-driven enterprises. Additionally, the need for regulatory frameworks in space technologies and

AI legislation was emphasized. This finding underscores the necessity of institutionalizing space policies as Türkiye's interest in space exploration and satellite technologies grows.

Overall, these priorities for 2025 outline the strategic steps Türkiye must take to become a stronger player in the global technology arena. Investments in critical areas such as AI, digital infrastructure, cybersecurity, and semiconductor production are vital for ensuring the sustainability of Türkiye's technology policy and enhancing its global competitiveness. In this regard, collaborative efforts from the government, private sector, and academic institutions will be instrumental in shaping Türkiye's technological future.

Figure 22: On which of these domains do you think that Türkiye should focus the most in 2025?



As we did for 2024, we also examined the sectors expected to benefit most from technological advancements in 2025 (Figure 23), alongside identifying the domains Türkiye should prioritize. Comparing these insights with the previous year provides a clearer understanding of shifting priorities and emerging trends in Türkiye's innovation landscape. While the overall focus remains relatively consistent, there are a few changes in emphasis compared to 2024. These trends provide important insights into which areas Türkiye should allocate more resources and policy support to achieve its goals of sustainable growth and technological independence.

Defense technology remains the most frequently selected sector, with 68% of respondents ranking it as their first choice. This is consistent with the 2024 findings, where defense was overwhelmingly recognized as the sector most positively impacted. The continued prioritization of defense highlights Türkiye's sustained investments in military technology, defense exports, and ad-

vancements in unmanned systems, cybersecurity, and aerospace defense, reinforcing its position as a global player in the defense sector.

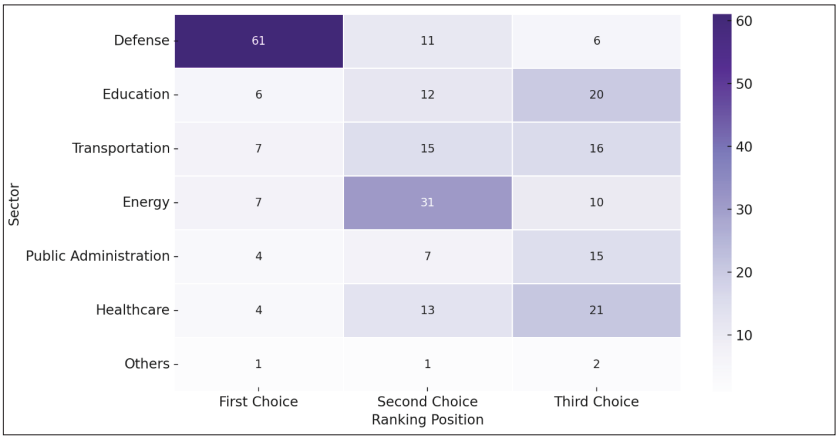
Energy, particularly renewable energy projects, has seen a significant rise in expectations for 2025. While it was already acknowledged as a positively impacted sector in 2024, it now ranks even higher, with second-choice selections increasing from 25% in 2024 to 35% in 2025. Additionally, when considering the total number of mentions across all ranking positions (first, second, and third choices), energy has seen a substantial increase in perceived importance. So, it can be said that while among the participants, there is a growing awareness of the importance of investing in domestic and sustainable energy sources, this is aligned with Türkiye's strategies and goals of energy security and reducing dependence on external resources. In this context, investments in renewable energy technologies will not only support economic sustainability but also enhance Türkiye's global competitiveness in the green transition process.

One notable shift is seen in education, which was the top third-choice selection in 2024 but has now been surpassed by health care in 2025. Health care now accounts for 24% of third-choice selections, signaling rising expectations for technological advancements in medical research, digital healthcare solutions, and AI-driven medical innovations. In particular, AI-powered medical solutions, digital health care services, and advancements in biotechnology demonstrate how technology is reshaping the health care sector. This shift in responses reflects a growing awareness of the need to modernize the health care system and make medical services more accessible. Türkiye's increased involvement in medical research and innovative health care solutions could accelerate sectoral advancements and enhance its global competitiveness.

In terms of education, despite this decline, investments in educational technologies, the expansion of digital learning platforms, and efforts to train the workforce of the future remain highly significant. Aligning the education system with technological transformation is crucial, particularly for cultivating skilled individuals in STEM (science, technology, engineering, and mathematics) fields. In this context, the necessity of sustaining innovation and digital integration in the education sector is strongly emphasized.

It is important to state that these evolving priorities and expectations suggest that Türkiye has to move toward a diversified technological strategy, balancing its strengths in defense with advancements in clean energy, education, and health care to drive long-term economic and social development. This transformation will enhance Türkiye's global competitiveness, not only in defense technologies but also in areas such as sustainable energy, health care innovations, and digitalization in education. A long-term technology strategy should strike a balance across different sectors, fostering both economic and social development.

Figure 23: Which sectors in Türkiye would be impacted most positively by technological advancements in 2025?



For 2025, we have also identified five key challenges that could significantly impact Türkiye's technological and economic progress. As illustrated in Figure 24, these challenges reflect critical structural and systemic barriers that must be addressed to sustain innovation and long-term development. The most pressing concern is insufficient investment in R&D, which remains a decisive factor in Türkiye's ability to compete in high-tech industries, drive innovation, and advance scientific research. Without substantial financial support for research and development, technological breakthroughs may be stifled, limiting future growth. However, as mentioned later in the report, initiatives such as HIT-30, TÜBİTAK (The Scientific and Technological Research Council of Türkiye) grants, and the HAMLE support program, among others demonstrate the Turkish government's commitment to addressing this issue. Expanding these efforts and fostering strategic partnerships with global tech companies could further enhance Türkiye's innovation ecosystem.

The second major challenge is considered to be the necessity for more infrastructure, which includes both physical and digital infrastructure necessary for advancing key sectors such as artificial intelligence, 5G, and semiconductor manufacturing. Strengthening infrastructure is critical to maintaining Türkiye's competitiveness in emerging technologies and ensuring the smooth adoption of next-generation innovations. Additionally, the adoption of cloud computing as a foundational pillar of digital technologies and the prioritization of domestic cloud providers, particularly for safeguarding critical infrastructure, is no longer merely an option but a necessity. In this context, the Public Cloud Strategy, expected to be released soon by the Presidency's Digital Transformation Office, is anticipated to be rapidly implemented across the public sector.

The lack of a skilled workforce ranks as the third most significant challenge, reinforcing earlier survey findings that emphasize the urgent need for enhanced education, talent retention strategies, and workforce training programs. Bridging the gap between Türkiye's technological ambitions and its human capital capabilities will be vital for sustaining growth in high-tech industries. The disparity between Türkiye's technology-driven growth ambitions and its existing human capital capabilities is bringing the demand for a highly skilled workforce to the forefront. Expanding STEM education, strengthening university-industry partnerships, and fostering young talent in the technology sector are essential measures for sustaining Türkiye's competitive edge.

Bureaucratic obstacles may pose a significant barrier, ranking fourth among the key challenges. Complex regulatory processes and administrative inefficiencies can hinder startups, deter investors, and slow down R&D initiatives, making it imperative to streamline policies and create a more agile and innovation-friendly ecosystem. To enhance the effectiveness of Türkiye's innovation ecosystem, regulatory processes must be streamlined, and entrepreneurship-friendly policies should be implemented. A more flexible and responsive regulatory framework will foster innovation and enable local startups to expand more easily into global markets.

Lastly, limited private sector engagement is identified as another issue, underscoring the need for stronger collaboration between the government and private enterprises. Encouraging greater participation from businesses in R&D, technology investments, and innovation efforts could accelerate commercialization, attract foreign investment, and enhance Türkiye's global competitiveness.

Together, these five challenges outline the key areas that policymakers, industry leaders, and stakeholders must focus on to not only sustain Türkiye's current technological momentum but also align it with global advancements in innovation, infrastructure, and workforce development. Addressing these issues proactively will be essential for securing Türkiye's position as a leading player in the global technology landscape.

Figure 24: Where should Türkiye focus the most in 2025?

1st	Insufficient investment in R&D
2nd	Inadequate infrastructure
3rd	Lack of skilled workforce
4th	Bureaucratic obstacles
5th	Limited private-sector engagement

While challenges are inevitable in the pursuit of becoming a significant technological player on the global stage, awareness of these challenges and, more importantly, taking proactive measures to address them, is even more critical. Recognizing this, our survey also sought to identify key government initiatives that respondents believe should be prioritized in 2025 to strengthen Türkiye's technological progress (Figure 25). These findings align closely with previously identified challenges and areas requiring increased investment. The most frequently selected priority is Increasing R&D Funding, with 36 respondents ranking it as their priority. Sustaining progress in high-tech manufacturing, AI, defense industry, and semiconductor development requires a significant increase in R&D investments. Therefore, to enhance Türkiye's global competitiveness, expanding incentives for technology-driven startups and academic research is of paramount importance.

The second most pressing initiative is building better digital infrastructure, which also reflects earlier concerns about inadequate infrastructure is a major hurdle for technological advancement. Digital infrastructure plays a crucial role in sectors such as 5G, AI, and semiconductor development, all of which were frequently mentioned as critical focus areas for Türkiye in 2025. With 25 respondents ranking this as their second priority, it was also emphasized that improving digital infrastructure would not only benefit the technology sector but also have a direct impact on the entire economic and public services ecosystem, accelerating Türkiye's digital transformation process. Strengthening digital infrastructure will speed up the integration of next-generation technologies and provide a solid foundation for the development of domestic technology solutions.

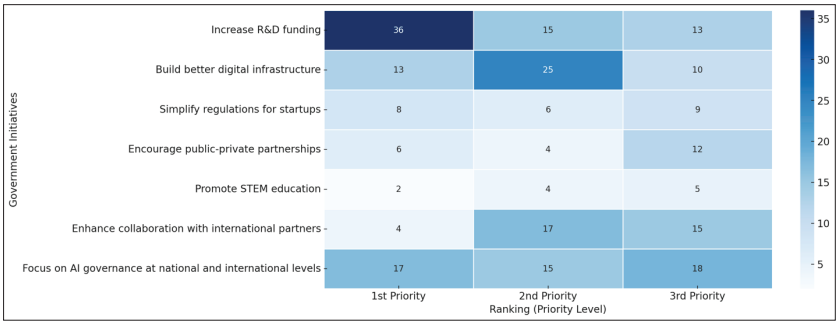
Fostering AI governance at the national and international levels also received strong support across all priority levels, indicating that respondents recognize the importance of ethical AI policies and regulations as Türkiye advances in AI and large language models. This corresponds with earlier discussions on Türkiye's partial alignment with global tech trends, where AI governance was seen as an area needing further strategic engagement.

Another notable priority is enhancing collaboration with international partners. The survey showed that in 2024 Türkiye had the most effective cooperation with Turkic states, the Middle East, and the EU, with a focus on defense, energy, and technological partnerships. Expanding international collaborations will likely be crucial for Türkiye's ambitions in space technologies, semiconductor manufacturing, and AI governance. International collaborations will help Türkiye establish a stronger position in global technology competition and accelerate technology transfer, contributing to the growth of its domestic technological ecosystem.

Additionally, simplifying regulations for startups and encouraging public-private partnerships were highlighted as key priorities. This ties into the challenge of limited private sector engagement, which was ranked as one of the top five barriers to Türkiye's technological progress. Addressing these regulatory and structural issues will be necessary to cultivate a stronger tech ecosystem, encourage investment, and accelerate innovation.

As can be seen, the key steps Türkiye needs to take in 2025 focus on increasing R&D investments, strengthening digital infrastructure, promoting AI governance, deepening international collaborations, and supporting the startup ecosystem. These strategic initiatives will enhance Türkiye's global competitiveness and position it as a strong player in the digital transformation process.

Figure 25: Which government initiatives should be prioritized in 2025?



Moving away from the domestic perspectives we focused also on Türkiye's collaborations with other regions and states for 2025. But as we continue our examination of Türkiye's global technological engagements, it is essential to compare past collaborations with future strategic priorities laid out in the survey. This way, the shift in perspectives between 2024 (17) and 2025 (Figure 26) reveals important insights into how Türkiye's technological partnerships may evolve.

One of the most significant findings from the survey is the increasing importance assigned to the U.S. and China as key technological partners. The fact that both countries ranked among the top choices for future cooperation highlights their dominance in the global tech ecosystem. However, beyond simply recognizing the U.S. and China as the two largest global technological powers, this also signifies Türkiye's own growing presence in the international tech landscape. Türkiye's ability to sustain meaningful collaboration with both of these competing powers underscores its strategic position as a rising technological actor. More importantly, this reinforces the necessity and the effectiveness of the current balanced approach followed by the Turkish government. Given the current geopolitical and economic rivalries between the U.S. and

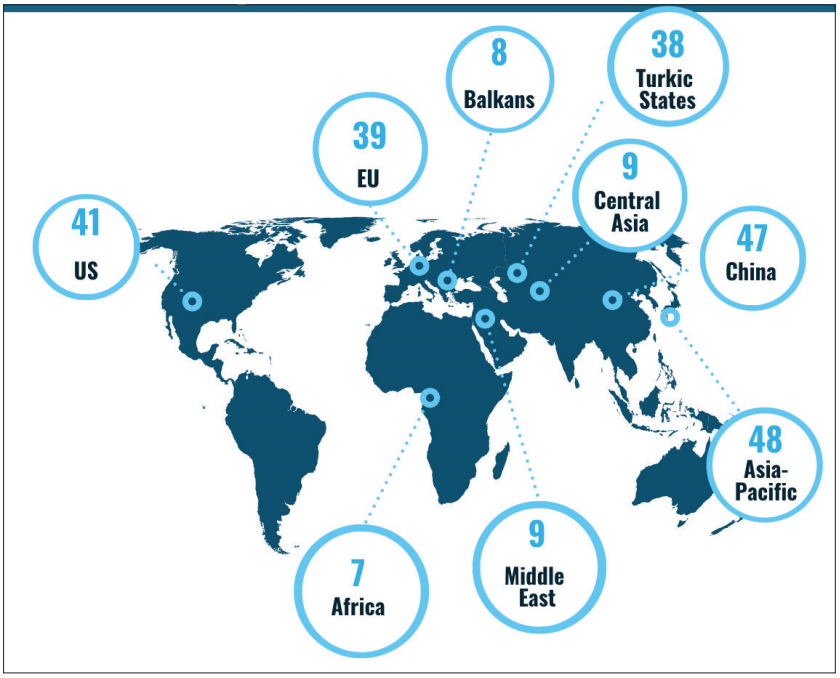
China, Türkiye's pragmatic strategy of maintaining strong relations with both will be crucial for its own technological ambitions. However, it is important to recognize that there are certain rational barriers to collaboration with these two globally competitive countries in the technology sector. Overcoming these challenges will largely depend on leveraging our own human capital and strengthening domestic capabilities.

At the same time, another important takeaway is the consistently strong ranking of the Turkic States. While they are not in the first place, their positioning in both 2024 and 2025 indicates that regional cooperation in the Turkic world remains a crucial aspect of Türkiye's technological vision. With organizations like the Organization of Turkic States gaining momentum, the Turkish government should seriously consider increasing its technological collaboration with these nations. Closer cooperation in AI development, semiconductor production, and cybersecurity could position the Turkic States as an emerging technological bloc, benefiting both Türkiye and its regional allies.

Another notable shift between 2024 and 2025 is the relative decline in prioritization for regions, such as the Middle East and Africa. While these regions played a prominent role in past collaborations, the survey suggests that respondents believe Türkiye should now focus more on high-tech economies, such as the U.S., China, and Asia-Pacific countries like Japan and South Korea. This does not necessarily indicate a diminishing interest in the Middle East or Africa, but rather a recalibration of strategic partnerships to align with Türkiye's high-tech ambitions. At this point, it is considered essential to inform the public and raise awareness. Emphasizing that the technologies developed in our country should be advanced within our sphere of influence through a win-win approach, sincerity, and a collaborative business model will be beneficial for both sides. This message, above all, needs to be effectively communicated to our domestic audience.

These findings indicate that Türkiye aims to strengthen its position in the global technology arena by pursuing higher value-added collaborations. Key factors shaping Türkiye's future international partnerships include technology transfer, R&D collaborations, and integration into next-generation industrial sectors. Developing balanced and strategic partnerships with both Western and Asia-Pacific countries in priority areas such as the defense industry, artificial intelligence, digitalization, and semiconductors will play a crucial role in enhancing Türkiye's long-term competitiveness.

Figure 26: Which regions/states do you think Türkiye should cooperate with the most in the technological domain in 2025?



As Türkiye refines its approach to international technological cooperation, it is crucial to assess not only which regions the respondents believe Türkiye should collaborate with but also the specific technological fields where such partnerships should be concentrated. Based on our survey AI and machine learning emerged as the dominant area of focus, receiving the highest number of mentions (67). This reflects the growing global emphasis on AI as a transformative force across industries and aligns with the above responses where the U.S. and China were considered as the two main actors Türkiye should cooperate with in 2025.

Defense Technologies remain a significant area of international cooperation, ranking second (51 mentions). Given Türkiye's already strong defense industry, this preference reinforces the country's commitment to maintaining and expanding its competitive edge in military technology. The survey findings indicate that Türkiye aims to maintain and further strengthen its international competitiveness in military technology. International partnerships in the defense industry can foster technology transfer, create joint production opportunities, and directly contribute to Türkiye's regional security strategies.

Energy, especially renewable energy projects, also ranked highly (46 mentions). The emphasis on energy cooperation suggests a growing recognition of Türkiye's need to align with global sustainability efforts and transition toward cleaner energy sources. This aligns with Türkiye's national energy policies, which have increasingly focused on expanding renewable infrastructure

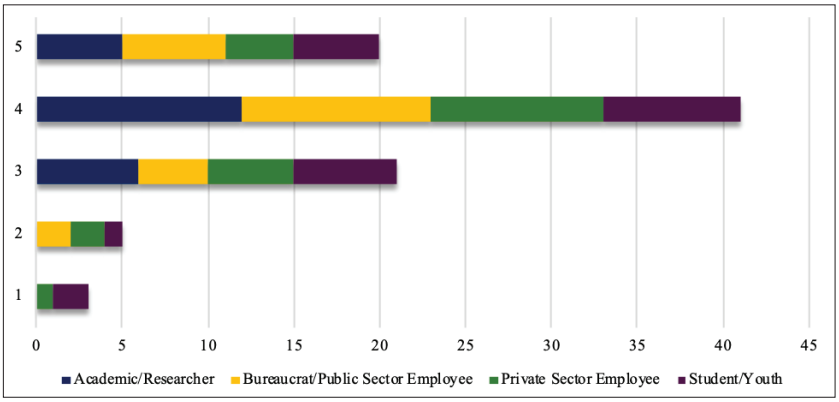
and fostering green innovation. Strengthening partnerships in this field with countries excelling in renewable energy technologies, such as those in Europe and Asia-Pacific, will not only promote technology transfer but also accelerate Türkiye's energy transition in line with its long-term sustainability goals.

Digital Infrastructure and 5G (27 mentions) represent another key area of expected collaboration. This highlights the importance of enhancing Türkiye's connectivity, network capacity, and technological competitiveness in telecommunications. Given that 5G was previously identified as a sector, where Türkiye has yet to fully realize its potential, forming strategic alliances with leading nations in 5G deployment, such as China and South Korea, could accelerate progress in this domain. Such strategic alliances could pave the way for a faster and more comprehensive digital transformation.

Lastly, space technologies (20 mentions) also stand out as a key area for collaboration. Türkiye's initiatives under the National Space Program, including its first human space mission and projects like Türksat 6A, reflect its long-term ambitions to enhance its capabilities in the space sector. However, given the highly competitive nature of this field, sustaining strategic partnerships with technologically advanced space agencies and leading countries is essential. Collaborating on joint projects with organizations such as NASA, ESA (European Space Agency), space programs in Asia, or private companies like SpaceX, could accelerate knowledge transfer and position Türkiye more competitively in the global space race.

Overall, the survey results indicate that as Türkiye strengthens its international technology collaborations, it should focus not only on traditional strategic sectors like defense and energy but also on emerging industries such as AI, digital infrastructure, and space technologies. By consciously shaping its international partnerships, Türkiye can accelerate technology transfer, enhance global competitiveness, and support its long-term development goals.

Figure 27: What is your level of optimism for Türkiye's technological progress in 2025?



The final question of the survey assesses the overall optimism surrounding Türkiye's technological progress in 2025 (Figure 27). The responses indicate a strongly positive outlook, with the majority of participants rating their optimism as four or five on the scale. This suggests a broad confidence in Türkiye's trajectory in technological advancements, despite any possible challenge.

The distribution of responses across different professional groups reflects a shared optimism, particularly among bureaucrats, private sector employees, and students, signaling faith in ongoing government initiatives, industry efforts, and academic contributions. Public sector employees, in particular, express their confidence in the consistency and long-term vision of Türkiye's technology policies, while private sector representatives highlight their expectations for the development of the innovation ecosystem. Additionally, students' generally optimistic outlook on technology underscores the interest and belief of future generations in Türkiye's digital transformation journey.

Looking ahead, this optimism aligns with the strategic priorities outlined in previous survey responses, emphasizing the importance of continued investment in R&D, enhanced cooperation with global tech leaders, and fostering innovation ecosystems. While challenges remain, the strong belief in Türkiye's ability to navigate these complexities and maintain a competitive edge in the global tech landscape underscores a promising future for the country's technological development.

TÜRKİYE'S TECHNOLOGICAL ECOSYSTEM: ROADMAPS, INVESTMENTS, AND GLOBAL POSITIONING

As the world navigates the Fourth Industrial Revolution, technology is advancing at an unprecedented pace. This rapid evolution presents both opportunities and challenges, particularly for states that must adapt their policies to keep up with these developments. Beyond the need to embrace technological progress, nations face mounting pressure to safeguard their technological sovereignty, fearing that others may surpass them in this critical domain.

In this shifting landscape, a new international order – which we refer to as the *technopolar order* – is emerging, with technology at its core. States are compelled to take strategic steps to enhance their technological capabilities, ensuring they remain competitive on the global stage. While great powers are accustomed to

such positioning, the widespread accessibility and transformative potential of emerging technologies have intensified the pressure on middle powers as well.

The growing accessibility and transformative potential of emerging technologies present both significant opportunities and new challenges for states. In this technopolar world, nations are striving to accelerate technological breakthroughs to secure a stronger position in the international system. Investments in AI, semiconductor manufacturing, data sovereignty, digital infrastructure, and defense technologies are no longer just economic growth drivers –they have become essential pillars of global power projection.

> "Currently, Türkiye boasts a robust and dynamic technology ecosystem that has been meticulously developed over the past two decades, serving as a critical foundation for driving the country's economic transformation toward high-tech industries."

In this context, techno-polarity differs from traditional power politics by establishing an order shaped not only by military and economic capacities but also by factors such as digital transformation, data sovereignty, and AI leadership. How states position their technology policies not only determines their place in global competition but also directly influences their alliances, geopolitical maneuverability, and national security strategies. Understanding the defining elements of this new order and developing effective strategies has become an unavoidable necessity for all actors seeking a strong voice in the global system.

Türkiye's technological advancement and position in global competition are largely determined by the strategic policies it adopts and the areas it invests in. In an era where technology is redefining global power dynamics, Türkiye is taking comprehensive steps to strengthen its innovation ecosystem and enhance its technological capacity, recognizing that such efforts are essential for establishing itself as a major global player. Currently, Türkiye boasts a robust and dynamic technology ecosystem that has been meticulously developed over the past two decades, serving as a critical foundation for driving the country's economic transformation toward high-tech industries. This well-established ecosystem comprises 102 technoparks, which collectively host over 10,000 technology companies, fostering innovation and entrepreneurship across various sectors. Additionally, Türkiye is home to more than 1,600 R&D and design centers, further strengthening its research and innovation capacity. With a workforce of 272,000 R&D professionals, the country continues to advance in critical areas such as AI, software development, and industrial technology. This extensive

infrastructure not only fuels Türkiye's digital transformation but also positions it as a key player in the global technology landscape, enhancing its competitiveness in high-tech production and innovation-driven growth.[4]

While Türkiye's technological progress has been ongoing for years, this report focuses specifically on the developments of 2024. To gain a comprehensive understanding of Türkiye's technological trajectory, it is essential to examine its standing in key global indexes and databases.

TÜRKİYE'S GLOBAL POSITIONING

Türkiye's innovation capacity and its position in global competition continue to strengthen, according to the Global Innovation Index 2024. Specifically, Türkiye ranks third among the top innovation economies in the Northern Africa and Western Asia region, following Israel and the United Arab Emirates (UAE). Similarly, when ranked by income group, Türkiye – a new entrant – also secures the third position in the upper middle-income category, following China and Malaysia.[5] This achievement serves as a tangible indicator of Türkiye's strategic investments in technology and innovation, reflecting the country's progress in R&D, entrepreneurship, and digital transformation. In recent years, R&D incentives, investments in technoparks, support for startups, and digital infrastructure projects have played a crucial role in advancing Türkiye's innovation ecosystem and elevating its position in global competition.

Türkiye's upward trajectory in the Global Innovation Index highlights the effectiveness of its technology-driven growth strategies and its potential to further integrate into the global innovation system. However, to sustain its innovation capacity and climb even higher in the rankings, it is essential to increase R&D investments, accelerate digital transformation processes, and expand international collaborations.

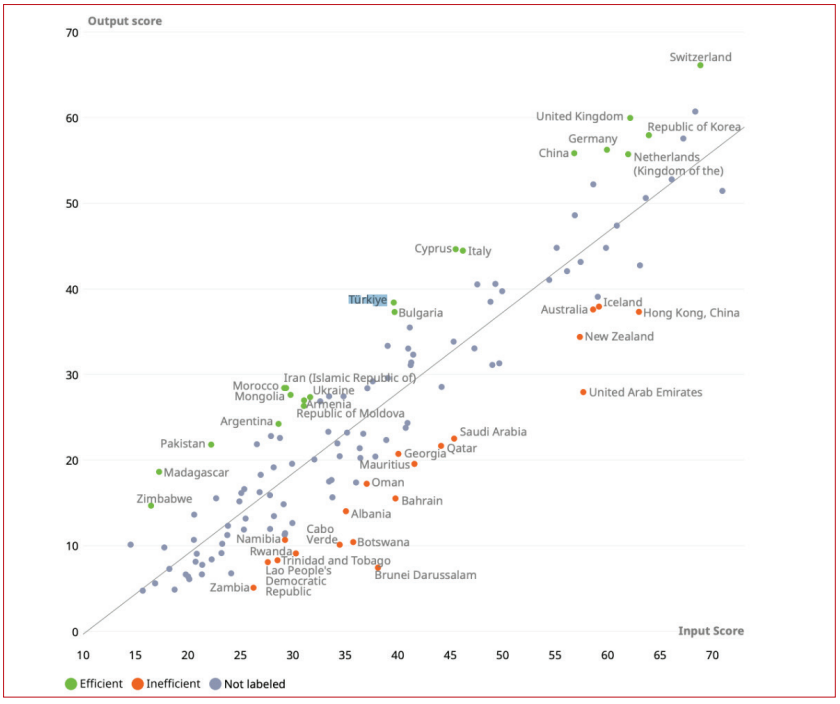
From a broader perspective, Türkiye ranks 37th out of 133 countries in the Global Innovation Index 2024, marking an improvement of two positions compared to the previous year. Indeed, according to the report, Türkiye is among the middle-income economies within the GII top 70 that have shown the most significant upward movement in the rankings since 2013. These rankings highlight Türkiye's growing role as an emerging innovation hub, reflecting its advancements in research, technology, and entrepreneurship.

4 Gökhan Yıldız, "Bakan Kacır: 102 Teknoparkımız, 1600'ün Üzerinde AR-GE ve Tasarım Merkezimiz, 272 Bin AR-GE Çalışanımız Var," *Anadolu Agency*, (July 18, 2024), retrieved from https://www.aa.com.tr/tr/bilim-teknoloji/bakan-kacir-102-teknoparkimiz-1600un-uzerinde-ar-ge-ve-tasarim-merkezimiz-272-bin-ar-ge-calisanimiz-var/3279110.

5Soumitra Dutta, Bruno Lanvin, Lorena Rivera León, and Sacha Wunsch-Vincent (eds.), *Global Innovation Index 2024: Unlocking the Promise of Social Entrepreneurship*, 17th ed., (Geneva: World Intellectual Property, 2024), p. 17.

Furthermore, the Global Innovation Index 2024 positions Türkiye as an efficient innovator, demonstrating strong performance in converting innovation inputs into tangible outputs. Türkiye is situated above the trendline in the Innovation Input to Output Performance graph (Graph 1), indicating that it generates higher-than-expected innovation outcomes relative to its investment levels. Ranked alongside countries like Bulgaria and Greek Cypriot, Türkiye outperforms several other middle-income economies, such as Ukraine, Iran, and Argentina, reinforcing its growing regional influence in innovation. When compared to other countries in the region that invest more in innovation, such as Saudi Arabia and the UAE, Türkiye outperforms them in efficiency, producing greater innovation output relative to its investment. Similarly, while China and Australia have significantly higher input scores, Türkiye's ability to convert resources into tangible innovation results places it in a competitive position among middle-income economies, demonstrating its strategic and effective approach to innovation-driven growth. This strong performance underscores Türkiye's rising role in global innovation, particularly within the Northern Africa and Western Asia region and the upper-middle-income group, positioning it as a key emerging player in technological advancement.

Graph 1: Innovation Input to Output Performance, 2024



Source: Global Innovation Index 2024[6]

6 Dutta, Lanvin, Rivera León, and Wunsch-Vincent (eds.), *Global Innovation Index 2024: Unlocking the Promise of Social Entrepreneurship*, p. 63.

According to another global index, Network Readiness Index (NRI) 2024, Türkiye ranks 58th out of 133 economies, positioning itself as a strong contender among upper-middle-income countries (Graph 2). Türkiye performs particularly well in technology access, ranking 9th globally, and excels in internet access in schools (1st place) and e-commerce legislation (1st place). However, it faces challenges in areas such as investment in emerging technologies (102nd), ICT skills in education (93rd), and gender gaps in internet use (89th). This situation highlights key areas for improvement that must be addressed to ensure the sustainability of the digital transformation process. In particular, a low ranking in ICT skills underscores the need for greater support in technology literacy and digital skills training.

Türkiye's 54th ranking in the governance category reflects the overall strength of its regulatory framework, while its 114th position in privacy protection laws highlights significant areas for improvement in data security and privacy. This underscores the need to enhance digital rights and cybersecurity regulations to strengthen Türkiye's digital governance framework.

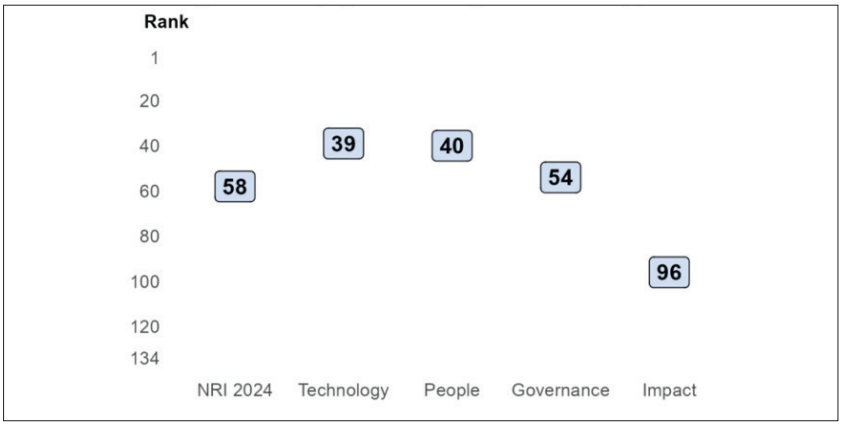
In terms of economic impact, Türkiye ranks 66th, with a domestic market scale of 11th place, highlighting its strong local market advantage in the digital economy. However, its 91st ranking in ICT exports reveals challenges in competing within the global technology market, emphasizing the need for greater strategic investments to enhance its international competitiveness. On the other hand, Türkiye's strong performance in AI talent concentration (10th place) and mobile broadband internet traffic (11th place) demonstrates its significant potential in digital infrastructure and technological capabilities. The high ranking in mobile broadband usage reflects the increasing role of digitalization in both daily life and business operations.[7] As Türkiye continues to enhance its digital infrastructure and network readiness, it is essential to increase investments in emerging technologies, prioritize ICT education, and improve regulatory frameworks. To support long-term innovation-driven growth and boost global competitiveness, Türkiye must adopt a holistic approach to its digital economy strategies.

The ICT Development Index (IDI) is another composite measure that evaluates the level of information and communication technology (ICT) development across countries, providing a comprehensive assessment of a nation's overall digital advancement. In 2024, Türkiye –analyzed within the Europe region and the upper-middle-income economies – scored 87.5 points, marking an increase from 85.8 in 2023. The report highlights Türkiye's strong performance in universal connectivity, driven by extensive mobile network coverage and growing internet penetration. Specifically, the report points out

7 Soumitra Dutta and Bruno Lanvin (eds.), *Network Readiness Index 2024*, (Portulans Institute, 2024), p. 204.

that 87.8% of individuals in Türkiye use the internet, 99.1% of households have internet access, and 99.3% of individuals own a mobile phone, reflecting a high level of digital connectivity and mobile adoption across the country.[8]

Graph 2: Türkiye's Global Ranking according to NRI Report, 2024



Source: Network Readiness Index 2024[9]

These data indicate that Türkiye's digitalization strategy is focused on supporting a broad-reaching and sustainable internet infrastructure. The near-universal internet access in households enables the more effective utilization of digital services in key areas such as remote education, e-commerce, digital banking, and public services. The high rate of mobile device ownership reflects the active engagement of individuals with digital platforms, making mobile technologies an integral part of daily life in Türkiye. However, to ensure the sustainability of Türkiye's progress in the ICT sector, continued efforts are needed to enhance digital skills, improve information security standards, and strengthen the digital economy ecosystem. In particular, the expansion of 5G technology and increased infrastructure investments in emerging technologies such as the Internet of Things (IoT) and AI will be critical factors in boosting Türkiye's competitiveness in digital transformation. Ultimately, Türkiye's high level of digital connectivity highlights the country's growth potential in ICT and establishes a strong foundation for further advancing its digital economy.

Another global index that focuses only on the AI capacities of the states is the Global AI Index. Its latest edition, published in 2024, ranked Türkiye as 34 among 83 states. The index evaluates AI readiness based on several key factors, including infrastructure, operating environment, talent, development,

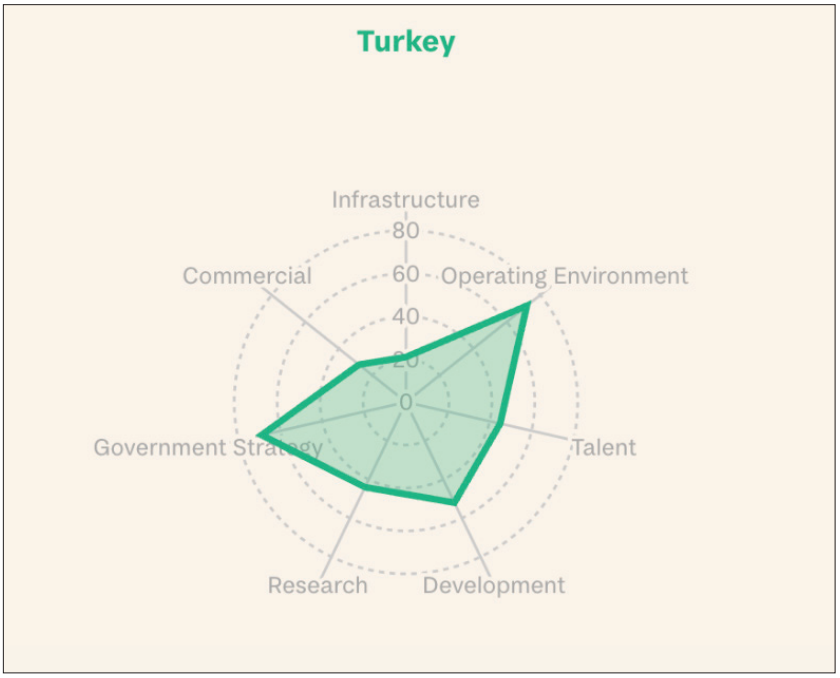
8 "Measuring Digital Development: The ICT Development Index 2024," *ITU*, (2024).

9 "Türkiye," *Network Readiness Index 2024*, retrieved from https://download.networkreadinessindex.org/reports/countries/2024/turkiye.pdf, p. 1.

research, government strategy, and commercial viability. As can be seen in Figure 28, Türkiye performs strongest in the operating environment, indicating a favorable regulatory framework and a supportive public perception of AI adoption. This is also supported by the fact that the country also ranks 14th in government strategy, demonstrating a solid national commitment to AI through policies, investments, and strategic initiatives.

Furthermore, Türkiye shows moderate progress in talent, development, and research suggesting a growing AI workforce and increasing work on AI platforms and algorithms. However, infrastructure and commercialization remain areas for improvement according to the report. Yet, considering the large number of AI startups emerging in Türkiye in recent years, it is likely that the country will improve its ranking in 2025, especially with continued investments, strategic support for innovation, and a rapidly developing AI ecosystem. With its strong regulatory environment and proactive government policies, Türkiye has the potential to rise significantly in future rankings by focusing on enhancing infrastructure, fostering AI-driven commercial initiatives, and strengthening research output, positioning itself as a regional AI leader.

Figure 28: Türkiye's Rank Positions for Each Sub-pillar of the Global AI Index



Source: Global AI Index 2024[10]

10 Joe White and Serena Cesareo, "The Global AI Index," *Tortoise*, retrieved from https://www.tortoisemedia.com/intelligence/global-ai#data.

In terms of patent filings, Türkiye has demonstrated notable progress. According to the Global Innovation Index 2024, while technologically leading nations such as China and the U.S. have experienced a decline in patent activity, Türkiye has seen substantial growth in Patent Cooperation Treaty filings, with an impressive 8.5% increase.[11] Such an upward trend does indeed highlight Türkiye's R&D and innovation ecosystem is strengthening and that its strategic investments in technological advancements are beginning to yield results. At the same time, it also emphasized Türkiye's expanding role in global innovation.

It is also important to state that the rise in patent applications reflects Türkiye's growing emphasis on intellectual property rights and its deliberate policy of commercializing technological innovations. This trend is expected to foster the emergence of more domestic technologies and enhance global competitiveness, particularly in strategic fields such as artificial intelligence, biotechnology, the defense industry, and renewable energy. To maintain this momentum in the coming years, it is crucial to further promote patent processes, raise awareness of intellectual property rights, and sustain R&D investments. In this regard, accelerated patent procedures strengthened academia-industry collaborations, and increased support for innovative startups will enable Türkiye to climb higher in global innovation rankings.

Analyzing a country's position in the startup ecosystem is crucial for understanding its innovation capacity, economic growth potential, and global competitiveness in emerging technologies. In Türkiye's case, its startup ecosystem has shown remarkable growth, particularly in AI, fintech, and deep-tech sectors. According to the Global Startup Ecosystem Index 2024, Türkiye climbed five positions globally, securing the 40th spot worldwide, marking one of the most significant upward shifts among the top 40 startup ecosystems. Furthermore, when seen regionally, in Europe, Türkiye advanced three spots to 24th place, following three consecutive years ranked 27th (Graph 3). This rise highlights Türkiye's progress toward becoming a regional innovation hub and the impact of strategic investments in its entrepreneurial ecosystem.

Additionally, Türkiye holds the 28th position globally in terms of the total impact of pantheons on the ecosystem.[12] This position indicates that Türkiye's startup ecosystem is rising as a significant player not only on a local scale but also internationally. In particular, venture capital (VC) investments, startup

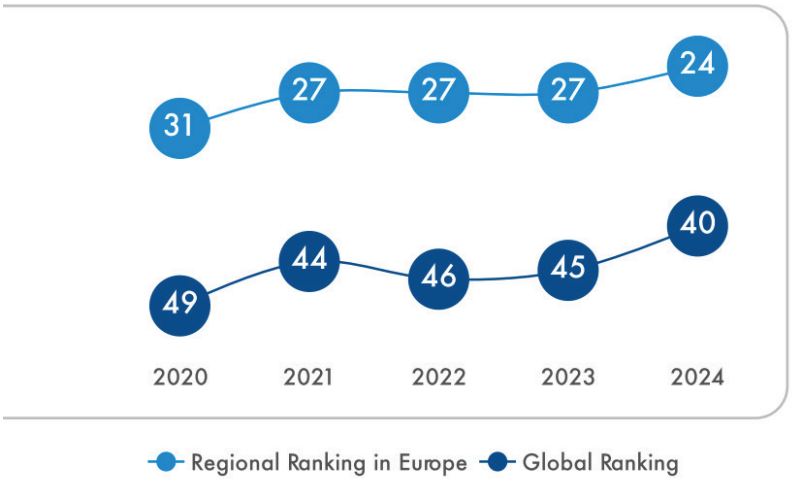
11 Dutta, Lanvin, Rivera León, and Wunsch-Vincent (eds.), *Global Innovation Index 2024: Unlocking the Promise of Social Entrepreneurship*, p. 38.

12 "Startup Ecosystem Report 2024," *Startup Blink*, retrieved from https://www.startupblink.com/startupecosystemreport, p. 170.

accelerator programs, and government-supported innovation incentives have played crucial roles in this ascent. However, access to international venture capital and global scaling remain key challenges for Türkiye's startup ecosystem. In 2025 and beyond, strengthening incentive mechanisms to boost VC investments, adopting policies that facilitate startups' expansion into global markets, and developing regulatory frameworks that improve access to financing will be of great importance.

In this context, the rise of Türkiye's startup ecosystem demonstrates an increase in innovation capacity and significant steps toward enhancing global competitiveness. In the coming years, focusing more on financing, infrastructure, talent management, and global collaborations will enable Türkiye to achieve its regional and global leadership goals in technology entrepreneurship.

Graph 3: Türkiye's Startup Ecosystem Ranking



Source: Global Startup Ecosystem Index 2024[13]

Furthermore, Türkiye now has five cities ranked among the global top 1,000 startup ecosystems, with İzmit entering the rankings for the first time. Four of these cities have improved their positions, highlighting a strong year for Türkiye's startup landscape. İstanbul remains the country's dominant startup hub, boasting nearly 10 times the total score of the second-ranked city, Ankara. Over the past four years, İstanbul's ranking has improved significantly, rising from 80th place in 2020 to 51st in 2024, placing it just outside Europe's top 10 startup ecosystems, where it currently ranks 11th, trailing Madrid (10th) by less than 5% in total score.

13 "Startup Ecosystem Report 2024," *Startup Blink*, p. 170.

Türkiye's startup ecosystem also demonstrates sectoral strengths in specific industries. İstanbul has established itself as a global powerhouse in the gaming industry, ranking seventh worldwide and second in Europe. In consumer electronics, Ankara surpasses İstanbul, securing the 24th spot in Europe, while İstanbul follows at 25th. Meanwhile, Antalya has emerged as a key player in web development, ranking 17th in Europe, making it the only Turkish city recognized in this sector (Table 1). These trends underscore Türkiye's growing influence in the global startup ecosystem, with various cities carving out specialized niches within the broader innovation landscape.

These trends indicate that Türkiye's entrepreneurial ecosystem is moving away from an İstanbul-centered model and establishing strong niche areas in various cities. The regional expansion of entrepreneurship and innovation culture strengthens the potential for more balanced growth in Türkiye's startup ecosystem and enhances its global competitiveness. In the coming period, increasing venture capital investments, expanding startup support mechanisms, and strengthening industry-focused collaborations will accelerate the technological growth of these cities. These efforts will contribute to Türkiye achieving greater international success in technology entrepreneurship.

Table 1: Türkiye's Country Ecosystem Ranking, 2024

National Rank & Change	City	Global Rank & Rank Change (from 2023)	Total Score	Top Industry Global Rank
1 -	Istanbul	51 +2	15.07	Gaming 7
2 -	Ankara	260 +16	1.60	Consumer Electronics 24
3 -	Izmir	534 -93	0.42	
4 -	Antalya	644 +4	0.29	Web Development 60
5 new	İzmit	803 new	0.19	
6 new	Gaziantep	1178 new	0.07	
7 new	Eskişehir	1233 new	0.06	
8 new	Bursa	1242 new	0.06	
9 new	Konya	1292 new	0.05	

Source: Global Startup Ecosystem Index 2024[14]

The index's country profile highlights Türkiye's strategic position as a startup hub bridging Europe, Asia, and the Middle East, offering access to a highly skilled entrepreneurial workforce. The country's startup culture is defined

14 "Startup Ecosystem Report 2024," *Startup Blink*, pp. 170-171.

by proactiveness, strong community-driven collaboration, and a clear ambition to scale internationally. Government initiatives and policies play a pivotal role in shaping the ecosystem's growth, with programs like Turcorn 100, spearheaded by the Industry and Technology Ministry, aiming to support high-growth startups with the potential to reach a $1 billion valuation. This initiative provides financial support, mentorship, a national and global accelerator program, and access to key ecosystem stakeholders. In addition, regional development agencies, such as the İstanbul Development Agency and İzmir Development Agency, continue to implement programs designed to strengthen local startup ecosystems, though increased investment and policy stability are essential for sustaining long-term growth. Complementing these efforts, major startup-focused events, including Hello Tomorrow Türkiye, Webrazzi Summit, and TEKNOFEST, serve as key networking platforms, fostering collaboration between entrepreneurs, investors, and policymakers. The report further asserts that with sustained public and private sector support, Türkiye has the potential to position İstanbul as a leading regional startup hub for the MENA region. If investment inflows increase, regulatory frameworks stabilize, and access to international funding expands, Türkiye could further solidify its status as a major innovation center in Europe and beyond.

Going into more detail, by the third quarter of 2024, the number of AI startups operating in Türkiye had reached 362, a remarkable increase compared to previous years. To provide perspective, the ecosystem started with just 24 startups in 2017 and expanded steadily, reaching 64 in 2018, 75 in 2019, 145 in 2020, 206 in 2021, 275 in 2022, and 325 in 2023. This represents a 15-fold growth over seven years, underscoring Türkiye's dynamic expansion in the AI domain.[15]

The development of an entrepreneurial culture, support from both the public and private sectors, the rise of accelerator programs, and increasing investment opportunities are among the key drivers of this growth. In particular, incentives provided by the Industry and Technology Ministry, TÜBİTAK, and private investment funds have encouraged entrepreneurs to develop innovative projects in the field of AI. The continuation of this trend could enhance Türkiye's global competitiveness in AI technologies, positioning it as a regional hub. In this regard, increasing venture capital investments, strengthening university-industry collaborations, and improving regulatory frameworks are critical for the sustainable growth of the ecosystem.

The primary focus areas of these startups reflect Türkiye's evolving AI ecosystem. The most prominent categories include computer vision (84 start-

15 "Yapay Zeka Girişimlerinin Sayısı 7 Yılda 15 Katına Çıktı," *Türkiye AI*, retrieved from https://turkiye.ai/trainin-yapay-zeka-girisimleri-haritasi-yayinlandi/.

ups), prediction and data analytics (66 startups), and machine learning (55 startups).

Computer vision stands out as one of the most concentrated fields in Türkiye's artificial intelligence startups. Image processing and object recognition technologies find extensive applications in the defense industry, health care, agriculture, and retail sectors. In particular, drone technologies, smart security systems, and industrial automation solutions have become focal points for startups in this field.

Forecasting and data analytics have also gained significant traction in Türkiye, driven by the rapid advancement of big data processing and predictive analysis techniques. Sectors such as finance, insurance, e-commerce, and the public sector are increasingly leveraging these technologies to optimize data-driven decision-making processes.

Machine learning-based solutions are being utilized across various domains, including automated process optimization, decision support systems, and personalized services. In Türkiye, machine learning-driven solutions are becoming increasingly widespread in education, health care, and logistics sectors. However, the fastest-growing area has been generative AI. While there were only 10 startups in this field in September 2022, this number surged to 29 by October 2024, marking a significant increase.[16] Generative AI technologies, advancing in areas such as text, image, and audio generation, are offering innovative solutions to Türkiye's content creation, media, design, and customer service industries.

These insights highlight that Türkiye's AI ecosystem is becoming increasingly diverse and sophisticated, aligning with global technological trends. The growth of generative AI, alongside computer vision and data analytics, presents strategic opportunities for technology entrepreneurs in the country. In this context, accelerator programs, investment incentives, and sectoral collaborations will play critical roles in enhancing the global competitiveness of Türkiye's AI startups.

On a global scale, Türkiye's AI ecosystem demonstrates a competitive edge. According to Stanford's 2024 AI Index Report, Türkiye's 325 AI startups in 2023 would place it ninth among countries with the highest number of newly founded AI startups, signaling its growing significance as an emerging AI hub (Table 2). With continued growth in 2024, this position is expected to rise, further solidifying Türkiye's standing in the global AI landscape.

16 "Yapay Zeka Girişimlerinin Sayısı 7 Yılda 15 Katına Çıktı," *Türkiye AI*.

With the continued growth trend in 2024, Türkiye is expected to climb higher in global rankings. The government's strategic policies, university-industry collaborations, accelerator programs, and increasing international investment interest are among the key factors supporting the sustainable growth of Türkiye's AI ecosystem. In this context, enhancing incentives for AI startups, strengthening ties with international investors, and supporting the commercialization of domestic AI solutions will further boost the ecosystem's global competitiveness. Beyond 2024, Türkiye's AI-focused startup ecosystem is increasingly positioning itself to expand into European, Middle Eastern, and Asian markets, presenting significant opportunities for global integration and growth.

TABLE 2: NUMBER OF NEWLY FUNDED AI COMPANIES BY GEOGRAPHIC AREA, (2013-2023, SUM)

Rank	Country	Number of AI Startups
1	US	5509
2	China	1446
3	UK	727
4	Israel	442
5	Canada	397
6	France	391
7	India	338
8	Japan	333
9	Germany	319
10	Singapore	193

Source: 2024 AI Index Report[17]

Lastly, it is noteworthy that the majority of these AI startups are based in İstanbul, which serves as the epicenter of Türkiye's AI ecosystem as seen also before. As of 2024, the size of Türkiye's artificial intelligence market has surpassed $600 million, with İstanbul accounting for over 80% of the market share.[18] This concentration stems from İstanbul being Türkiye's most developed city in terms of its entrepreneurial environment, investment attraction capacity, and technological infrastructure. The city offers a strong ecosystem with accelerator programs, technology parks, and innovation centers that attract international investors. İstanbul's leading position is also reinforced by

17 "Artificial Intelligence Index Report 2024," *Stanford University Human-Centered Artificial Intelligence*, retrieved from https://aiindex.stanford.edu/wp-content/uploads/2024/05/HAI_AI-Index-Report-2024.pdf, p. 252.

18 "İstanbul'un Yapay Zeka Pazarı 600 Milyon Doları Aştı," *TRT Haber*, (September 26, 2024), retrieved from https://www.trthaber.com/haber/bilim-teknoloji/istanbulun-yapay-zeka-pazari-600-milyon-dolari-asti-879412.html.

its logistical advantages, which facilitate startups' integration into global markets. The city's universities, R&D centers, and technoparks expand the talent pool, further supporting the growth of startups. To enhance Türkiye's global competitiveness in the AI sector, it is essential to leverage İstanbul's leadership by establishing similar innovation hubs in other cities, increasing R&D investments, and strengthening international collaborations. Beyond 2025, Türkiye's AI ecosystem is expected to expand further, positioning the country as an even stronger player in the global AI market.

Another critical factor in assessing a country's technological development is its AI talent-hiring trends. Analyzing data on AI talent hiring is crucial for understanding a country's technological capabilities, workforce readiness, and global competitiveness in the AI sector. It provides insights into the availability of skilled professionals, the demand for AI expertise across industries, and the effectiveness of education and training programs in producing a qualified AI workforce. Within this perspective, when we see the developments in Türkiye, as can be seen from Graph 4,[19] there is a steady upward trend in AI talent concentration, particularly in recent years, signaling the country's growing emphasis on cultivating AI expertise. Although Türkiye does not lead the rankings compared to countries like India or Hong Kong, its consistent growth rate highlights efforts in developing an AI-ready workforce, supported by the increasing availability of AI-related academic programs and industry initiatives. This trend reflects Türkiye's potential to enhance its competitiveness in the global AI landscape, provided it continues investing in education, training, and AI-driven industries to match the progress of more established ecosystems. However, for Türkiye to enhance its competitiveness, it must take further investments and strategic steps. In particular, development in the following areas is crucial:

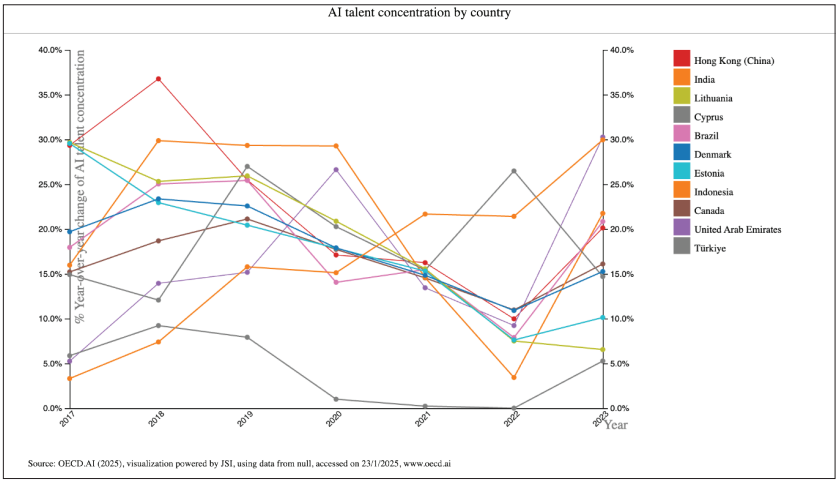
- **Strengthening Educational Programs**
    - Expanding undergraduate and graduate programs specializing in AI engineering and data science to train more experts
    - Broadening university-industry collaborations and promoting hands-on, application-based projects
- **Workforce Training and Skill Development**
    - Encouraging reskilling and upskilling programs to help the existing workforce gain AI competencies
    - Expanding certification programs in technoparks and innovation centers to support professional development

19 The graph illustrates the year-over-year changes in the concentration of AI talent across various countries, measured as the percentage of LinkedIn members with AI-related skills or occupations.

- **Attracting International Talent and Preventing Brain Drain**
  - Offering competitive salaries and attractive working conditions to retain AI professionals in Türkiye
  - Developing incentivized visa and work programs to attract international AI talent to Türkiye

These strategies will contribute to expanding Türkiye's AI talent pool, increasing its global competitiveness, and supporting sustainable growth within its AI ecosystem. If education and industry collaborations are further strengthened, Türkiye has the potential to become a regional hub for AI expertise.

Graph 4: AI Talent Concentration by Country



Source: OECD[20]

Focusing specifically on AI research, Türkiye ranked 16th globally in 2023 among more than 200 countries and regions for the number of AI-related publications, with a total of 11,085 papers according to the latest data from OECD (Table 3). This marks a steady increase from 10,738 publications in 2022 and 9,726 in 2021. In both 2021 and 2022, Türkiye held the 18th position globally, demonstrating consistent growth in AI research output and its rising influence in the field. This consistent growth reflects Türkiye's strong commitment to AI research and the academic institutions' increasing productivity in the field. In particular, the focused efforts of universities and research centers on AI have played a significant role in the global rise of AI-related publications.

20 "Live Data," *OECD.AI*, (2025), retrieved from https://oecd.ai/en/data?selectedArea=ai-jobs-and-skills&selectedVisualization=ai-talent-concentration-by-country.

Türkiye's key strengths in AI research include the rising number of academic publications, strong university-industry collaborations, and substantial government support. In recent years, TÜBİTAK and other public institutions have increased funding for AI research, driving growth in academic projects and industrial partnerships. However, there are still areas for improvement. While Türkiye's research output is expanding, it is crucial to increase the number of high-impact, frequently cited publications. Additionally, strengthening collaborations with global leaders such as the U.S., China, Germany, and the U.K. would enhance the international visibility of Turkish AI research. Furthermore, greater representation of Turkish researchers at prestigious AI conferences such as NeurIPS, ICML, CVPR, and AAAI should be actively encouraged.

To sustain its momentum in AI research, Türkiye must prioritize enhancing research quality and deepening its integration into global academic networks. With strategic initiatives in these areas, Türkiye has the potential to rank among the top five countries in AI research.

TABLE 3: TOP COUNTRIES IN AI PUBLICATIONS, 2023

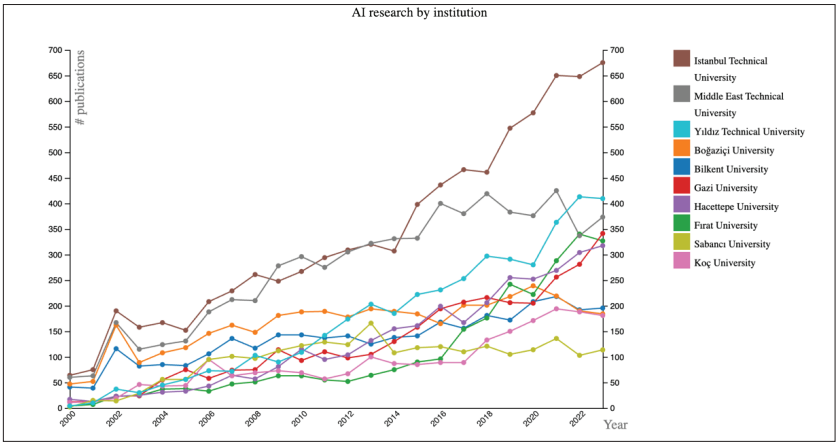
Ranking	Number of Publications	Country
1	215,165	China
2	108,706	US
3	56,411	India
4	39,000	UK
5	31,344	Germany
6	25,468	Indonesia
7	21,878	Italy
8	21,251	Canada
9	19,518	Japan
10	18,909	France
11	18,686	Korea
12	18,642	Australia
13	15,284	Spain
14	12,422	Russia
15	11,616	Netherlands
16	11,085	Türkiye

Source: Created by the authors with the data from OECD[21]

21 "Live Data," *OECD.AI*, (2025), retrieved from https://oecd.ai/en/data?selectedArea=ai-research&selectedVisualization=16719.

A closer analysis of AI research output in Türkiye highlights that İstanbul Technical University (İTU), Middle East Technical University (METU), and Yıldız Technical University (YTU) are the leading contributors to AI-related publications. İTU has consistently led the rankings, showing a significant increase in research output, followed closely by METU. YTU has also experienced substantial growth, surpassing many other institutions in recent years. Other notable universities with strong AI research contributions include Boğaziçi University, Bilkent University, and Gazi University, which have maintained steady growth (Graph 5). Given these trends, Türkiye's academic institutions are playing a crucial role in advancing AI research, with these universities leading the way in scientific output and technological innovation.

Graph 5: AI Research by Institution, 2023



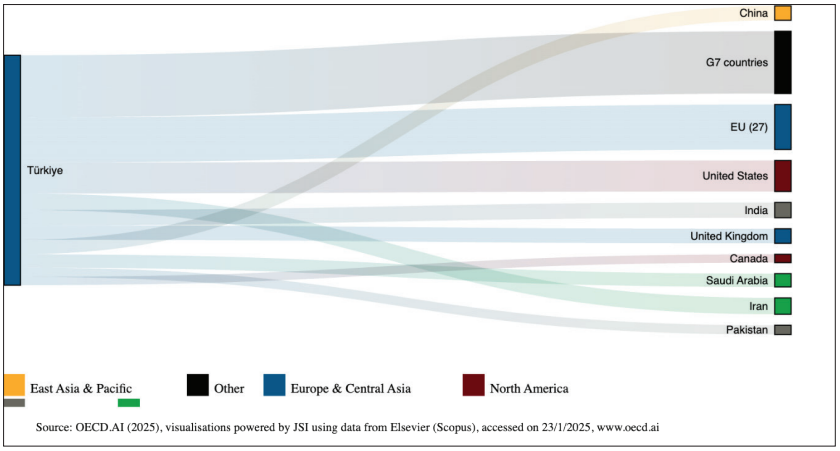
Source: OECD[22]

Remaining within the domain of research, it is also important to mention that international collaborations play a crucial role in advancing AI research, as they facilitate knowledge exchange, resource sharing, and the development of innovative technologies on a global scale. Graphs 6 and 7 illustrate Türkiye's international collaborations in AI scientific publications, based on data from Scopus and OpenAlex. The visualizations highlight that Türkiye's AI research is deeply integrated with European and North American networks, with G7 countries and the EU (27) being its primary collaborators. Additionally, China and India have emerged as significant partners, reflecting growing global cooperation in AI research. Türkiye also maintains notable academic ties with Saudi Arabia, Iran, and Pakistan, suggesting regional partnerships and shared research initiatives. Despite some variations, both datasets confirm

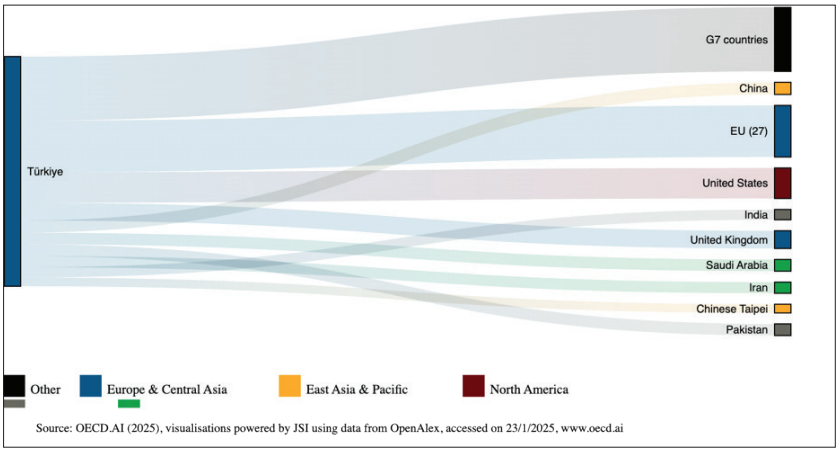
22 "AI in Türkiye," *OECD.AI*, (2025), retrieved from https://oecd.ai/en/dashboards/countries/Türkiye.

Türkiye's strong academic engagement in AI research with advanced economies and emerging AI hubs, underscoring the importance of strengthening international partnerships to enhance Türkiye's AI research impact and technological development.

Graph 6: International Collaboration in AI Scientific Publications from Scopus



Graph 7: International Collaboration in AI Scientific Publications from OpenAlex



In the field of robotics, Türkiye stands out as one of the countries with the highest growth in industrial robot installations. From 2021 to 2022, Türkiye achieved the second-highest growth rate globally, with a 22% increase in robot installations, adding to its stock 3,700 units and positioning it as the 13th largest industrial robot market.[23] By 2023, Türkiye's total installations grew by

23 "World Robotics 2023," *International Federation of Robotics*, (September 2023), retrieved from https://ifr.org/img/worldrobotics/2023_WR_extended_version.pdf.

another 15% with 4,400 units, elevating its rank to 11th place in the global market.[24] As a result, Türkiye has a total of approximately 27,000 robots in its stocks.[25] Although the data for 2024 is not yet available, Türkiye is expected to continue this upward trend, potentially joining the Top 10 countries in the robotics market.

An essential factor in the adoption of emerging technologies is the public's perception and attitude toward them, particularly in the case of AI. Understanding societal acceptance, concerns, and expectations can significantly influence policymaking, ethical considerations, and the pace of technological integration. According to the latest Ipsos report analyzing 32 countries in 2024,[26] 74% of people in Türkiye claim to have a good understanding of what AI is, while 67% of respondents state that they are aware of which types of products and services incorporate AI.[27] These figures indicate a relatively high level of AI awareness in the country, considering also that Türkiye's responses are above the global country averages in both instances, suggesting that the Turkish population is actively engaging with and recognizing AI-driven technologies in their daily lives. Furthermore, the same report reveals that while 53% of the population feels nervous about AI-powered products, an even greater 70% express excitement about their potential. This suggests that despite certain concerns, the overall sentiment toward AI in Türkiye leans more toward optimism and enthusiasm for its advancements (Graph 8). The Turkish public remains largely optimistic about AI products, with 69% believing that the benefits of AI outweigh its drawbacks. Furthermore, 41% of respondents expect AI to improve their jobs within the next three to five years. This positive outlook extends to concerns about job displacement, as only 21% consider it very likely and 42% somewhat likely that AI will replace their jobs in the future.[28] These figures suggest that while there are concerns, the prevailing sentiment in Türkiye leans toward AI as an enabler rather than a threat to the workforce.

24 "World Robotics 2024," *International Federation of Robotics*, (September 2024), retrieved from https://ifr.org/img/worldrobotics/Press_Conference_2024.pdf.

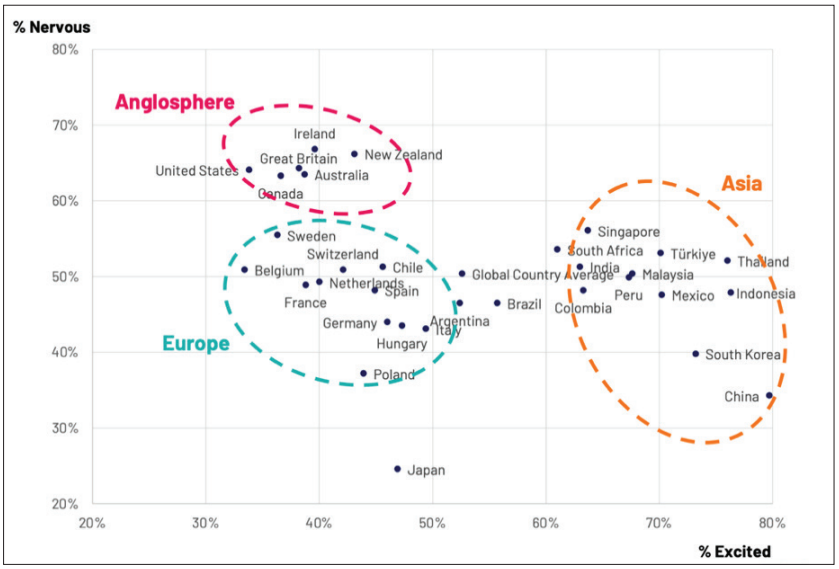
25 Nurullah Gür, Yasin Solak, and Murat Taşlı, "Akıllı Otomasyon Çağında Ulusların Rekabeti," *İstanbul Ticaret Odası*, (İstanbul: İTO, 2024), retrieved from https://itosam.org.tr/itosam/media/publications/pdf/CTo2kqdkhQ3WkIq3u7RGpejUZMyvpQZ0ekxz889L3aJR67F78STR.pdf.

26 "The Ipsos AI Monitor 2024," *IPSOS*, (June 2024), retrieved from https://www.ipsos.com/sites/default/files/ct/news/documents/2024-06/Ipsos-AI-Monitor-2024-final-APAC.pdf.

27 It is important to state that the report also states that "Samples in Brazil, Chile, China, Colombia, Indonesia, Ireland, Malaysia, Mexico, Peru, Singapore, South Africa, Thailand, and **Türkiye** are more urban, more educated, and/or more affluent than the general population. The survey results for these countries should be viewed as reflecting the views of the more "connected" segment of their population.

28 "The Ipsos AI Monitor 2024," *IPSOS*.

Graph 8: Public Sentiment toward AI Products



Source: Ipsos, 2024[29]

ROADMAPS AND INITIATIVES

During 2024, Türkiye made significant strides in its technology landscape through two major initiatives: the AI National Strategy Action Plan (2024-2025) and the HİT-30 High Technology Investment Program. The AI National Strategy Action Plan was revised to align with the 12th Development Plan and address recent advancements in AI. It focuses on six core priorities:

- Developing AI expertise and expanding employment opportunities,
- Supporting research and innovation,
- Ensuring access to quality data and technical infrastructure,
- Regulating AI for socioeconomic adaptation,
- Enhancing international cooperation
- Accelerating structural and labor transformation.[30]

This strategy aims to bolster Türkiye's global competitiveness in AI, strengthen its talent pool, and solidify its technological infrastructure. Concurrently, it seeks to ensure sustainable and inclusive growth by shaping the societal and economic impacts of AI through well-defined regulatory policies.

29 "The Ipsos AI Monitor 2024," *IPSOS*, p. 17.

30 "Ulusal Yapay Zekâ Stratejisi 2021-2025," *Türkiye Cumhuriyeti Cumhurbaşkanlığı Dijital Dönüşüm Ofisi*, retrieved from https://cbddo.gov.tr/uyzs.

Key initiatives under this plan include the TechVisa Program, launched to attract top AI talent. This program aims to bring highly skilled AI professionals to the country, strengthening Türkiye's technological ecosystem and enhancing its global competitiveness. Additionally, Türkiye is developing local AI models, including LLMs, introducing a Trusted AI Seal to ensure ethical compliance, and increasing funding for AI workforce development and research programs.[31] Moreover, funding for AI workforce development and research programs is being increased. By expanding support mechanisms for both academic and industrial AI projects, Türkiye aims to cultivate a highly skilled talent pool and foster innovative AI research that drives long-term technological advancement.

> During 2024, Türkiye made significant strides in its technology landscape through two major initiatives: the AI National Strategy Action Plan (2024-2025) and the HİT-30 High Technology Investment Program.

To enhance AI governance and security, the government has announced the establishment of a Risk Management System Certification Program for AI products while strengthening intellectual property protections. This system is designed to ensure the security and ethical compliance of AI applications, promoting responsible and accountable technological advancements. Moreover, Türkiye aims to integrate AI across public institutions, drive sectoral AI adoption, and foster a collaborative AI ecosystem through global engagements. Expanding venture capital and alternative financing sources for AI startups is also a key priority, with a strong focus on strengthening partnerships, particularly within the EU. Through these measures, Türkiye envisions a globally competitive AI ecosystem that fuels technological and economic growth.

Another landmark initiative in 2024 was the HİT-30 High Technology Investment Program, launched by the Ministry of Industry and Technology with a $30 billion budget. This strategic program aims to transform Türkiye into a global hub for high-tech production by 2030, with a focus on key sectors such as semiconductors, mobility, green energy, advanced manufacturing, digital technologies, and space exploration. To achieve this, HİT-30 provides comprehensive incentives, including project-based funding, tax benefits, and R&D support, encouraging both domestic innovation and foreign direct

31 Ahmet Erarslan, "Türkiye's AI strategy: Roadmap for 2025," *Türkiye Today*, (September 11, 2024), retrieved from https://www.turkiyetoday.com/business/turkiyes-ai-strategy-roadmap-for-2025-51646/.

investment. Flagship projects under this initiative include HİT-Electric Vehicles, HİT-Battery, and HİT-Chip, which aim to boost Türkiye's production capacity and technological independence in critical industries.[32]

This program is pivotal for Türkiye's green and digital transformation, reinforcing economic competitiveness and technological sovereignty. By leveraging its strategic location, skilled workforce, and expanding R&D ecosystem, Türkiye seeks to position itself at the forefront of global innovation. The program also supports global problem-solving efforts in areas such as renewable energy, energy storage, and AI-driven digital transformation, ensuring Türkiye's integration into the global high-tech landscape. If successfully implemented, HİT-30 will mark Türkiye's transition from a technology consumer to a major global producer, securing its long-term leadership in critical industries.[33]

In parallel with these initiatives, Türkiye's 2024-2028 Strategic Plan and National Technology Entrepreneurship Strategy Action Plan outline a roadmap to expand high and medium-high technology production and significantly increase the number of technology startups. This comprehensive plan aims to position Türkiye among the world's leading technology hubs by providing targeted support to entrepreneurs and startups. As part of this roadmap, the Türkiye TechVisa Program, mentioned in the AI National Strategy Action Plan and officially launched in September 2024, is expected to support 50 AI-focused entrepreneurs in its first year, with this number increasing to 425 by 2028.[34] The Technology and Innovation Fund is also being actively utilized in this process, with an initial nine companies receiving investment in 2024. At present, 10 technology-driven startups, including WeBee, Virasoft, Kuartismed, CY Vision, Mindsite, Wask, Delivers.AI, Cellsway, Vispera, and Syntonym, have received direct funding. Additionally, the fund has made indirect investments through venture capital firms such as Revo Girişim Sermayesi Yatırım Fonu, ScaleX Girişim Sermayesi Yatırım Fonu, and 500 İstanbul Girişim Sermayesi Yatırım Fonu.[35]

32 "Bakan Kacır, HIT-30 Yüksek Teknoloji Yatırım Programı'nın detaylarını paylaştı," *Anadolu Ajansı*, (July 29, 2024) retrieved from https://www.aa.com.tr/tr/enerjiterminali/genel/bakan-kacir-hit-30-yuksek-teknoloji-yatirim-programinin-detaylarini-paylasti/42689; "Yüksek Teknoloji Yatırım Programı HIT-30," *Hit-30*, retrieved from https://hit30.sanayi.gov.tr/.

33 Fatih Sinan Esen, "Türkiye Yüzyılının Yeni Teknoloji Atılımı: Yüksek Teknoloji Yatırım Programı HİT-30," *Kriter*, No. 93, (September 2024), retrieved from https://kriterdergi.com/yazar/fatih-sinan-esen/turkiye-yuzyilinin-yeni-teknoloji-atilimi-yuksek-teknoloji-yatirim-programi-hit-30.

34 "Türk Teknoloji Girişimlerinde 2028 Rotası Çizildi," *TRT Haber*, (March 16, 2024), retrieved from https://www.trthaber.com/haber/bilim-teknoloji/turk-teknoloji-girisimlerinde-2028-rotasi-cizildi-844615.html; "Türkiye Tech VISA Programı Başlıyor," *T.C. Sanayi ve Teknoloji Bakanlığı*, (September 16, 2024), retrieved from https://sanayi.gov.tr/medya/haber/turkiye-tech-visa-programi-basliyor.

35 "Anasayfa," *Teknoloji ve İnovasyon Fonu*, retrieved from https://teknolojiinovasyonfonu.com.tr/.

One of the most ambitious initiatives within this framework is the Turcorn 100 Program, which aims to increase the number of Turkish unicorns – startups valued at over $1 billion. The program expects to support 30 startups in 2024, expanding to 80 in 2025, and reaching 100 by 2026. Currently, Türkiye has seven Turcorns, and in 2024, some 15 additional startups were identified as potential unicorns.[36] Through these efforts, Türkiye is not only fostering entrepreneurial innovation but also reinforcing its position as a leader in technology-driven economic growth. By accelerating AI adoption, expanding venture capital opportunities, and strengthening its innovation ecosystem, Türkiye is taking decisive steps toward becoming a key player in the global technology landscape.

Beyond the flourishing investments and policies that are shaping Türkiye's technology landscape, 2024 has also been marked by numerous influential technology gatherings that have reinforced the country's position as a hub for innovation and digital transformation. Among these, the most significant event last year was the TEKNOFEST 2024, Türkiye's largest technology and innovation festival. TEKNOFEST plays a crucial role in fostering an entrepreneurial spirit among young generations, providing them with early hands-on experience and sustaining their motivation in technology and innovation. The festival enables participants to develop projects in cutting-edge fields, including aviation, space, artificial intelligence, robotics, and energy, while bringing together national and international stakeholders to strengthen Türkiye's innovation ecosystem. Moreover, by increasing students' and entrepreneurs' interest in technology, TEKNOFEST contributes to nurturing the country's future engineers, scientists, and technology leaders. As one of the main pillars of Türkiye's National Technology Initiative, the festival plays a direct role in building an ecosystem that supports technological independence.[37]

In 2024, TEKNOFEST was held in Adana from October 2 to October 6 at Şakirpaşa Airport, serving as the central event of the festival. Leading up to this grand gathering, a series of technology competitions took place across 11 different cities, including Kocaeli, İstanbul, Ankara, Aksaray, Mersin, İzmir, Antalya, İsparta, Kahramanmaraş, and Erzurum, between August and September. These competitions covered 49 main categories and 127 subcategories, attracting an unprecedented 1.65 million participants from 790,000 teams nationwide, further cementing TEKNOFEST's status as a cornerstone of

36 "TURCORN 100 Ekosistemi," *TURCORN*, retrieved from https://www.turcorn.gov.tr/tr/turcorn-100-programi-ekosistemi; Zeynep Duyar, "Scale-up'lara Sağlanacak Destekler Yeni 'Turcorn'ların Önünü Açacak," *Anadolu Ajansı*, (September 11, 2024), retrieved from https://www.aa.com.tr/tr/bilim-teknoloji/scale-uplara-saglanacak-destekler-yeni-turcornlarin-onunu-acacak/3327217.

37 Gloria Shkurti Özdemir and Ferhat Pirinççi, "Milli Teknoloji Hamlesi: İlkeler, Araçlar ve Amaçlar," in Burhanettin Duran, Ferhat Pirinççi, and Gloria Shkurti Özdemir (eds.), *Türkiye'nin İstiklali: Milli Teknoloji Hamlesi*, (İstanbul: SETA, 2023), p. 47.

Türkiye's technological advancement and innovation ecosystem.[38] The competitions covered a wide range of critical fields, including aviation, space, AI, autonomous systems, biotechnology, energy technologies, and environmental innovations, providing a vital platform for nurturing Türkiye's future technology leaders. The scale of participation further underscores TEKNOFEST's role as a cornerstone of Türkiye's technological advancement and innovation ecosystem. Furthermore, beyond national participation, TEKNOFEST extends its reach globally, bringing together technology enthusiasts, academics, entrepreneurs, and industry leaders from around the world, fostering international collaboration and knowledge exchange. As mentioned above, by reinforcing Türkiye's National Technology Initiative, TEKNOFEST 2024 has taken a significant step toward building a thriving innovation ecosystem, paving the way for a more competitive and technology-driven future.

> "If successfully implemented, HİT-30 will mark Türkiye's transition from a technology consumer to a major global producer, securing its long-term leadership in critical industries."

At this point it is important to mention that TEKNOFEST has witnessed an extraordinary surge in participation over the years, reflecting Türkiye's growing interest in technology and innovation. From its inception in 2018 with 20,000 participants and 4,333 teams, the festival has expanded exponentially, reaching a record-breaking 1.65 million participants and 790,000 teams in 2024. Furthermore, since 2018 TEKNOFEST has hosted approximately 4 million applications to date.[39] The continuous growth of TEKNOFEST each year is directly linked to the expansion of Türkiye's technology ecosystem, the strengthening of its entrepreneurial culture, and the increasing interest of young people in science, engineering, and innovation. This ongoing process plays a crucial role in positioning Türkiye as a key player in technology production, reinforcing its status as a global innovator and leader in technological advancement.

This rapid growth, particularly after 2020, highlights the increasing enthusiasm among young innovators, researchers, and technology enthusiasts.

38 "TEKNOFEST Adana Kapılarını Ziyaretçilere Açtı," *Anadolu Ajansı*, (October 2, 2024), retrieved from https://www.aa.com.tr/tr/info/infografik/41487; "TEKNOFEST 2025 Teknoloji Yarışmaları Başvuruları Başladı!" *TEKNOFEST*, (January 4, 2025), retrieved from https://www.teknofest.org/tr/content/announcement/teknofest-2025-teknoloji-yarismalari-basvurulari-basladi/.

39 "TEKNOFEST Adana Kapılarını Ziyaretçilere Açtı," *Anadolu Ajansı*; "TEKNOFEST 2025 Teknoloji Yarışmaları Başvuruları Başladı!" *TEKNOFEST*.

The festival's expansion beyond İstanbul to cities like Gaziantep, Samsun, Ankara, İzmir, and Adana, as well as its international presence in Baku, has played a crucial role in fostering a nationwide and even global engagement with cutting-edge technology. The impact of this participation is significant, as it cultivates a culture of scientific inquiry, technological entrepreneurship, and R&D-focused initiatives, ultimately strengthening Türkiye's position as a hub for aerospace, defense, and digital transformation. By encouraging young talent and fostering collaboration between academia, industry, and government, TEKNOFEST has evolved beyond being merely a technology festival, it has become a transformative ecosystem shaping Türkiye's future. This event inspires future engineers and scientists, while also laying the groundwork for innovative projects, supporting entrepreneurship, and contributing to the development of domestic technologies. By providing valuable opportunities for students, academics, and entrepreneurs, TEKNOFEST enhances Türkiye's scientific and technological capabilities, accelerating its global competitiveness. Moreover, TEKNOFEST serves as a strategic platform that brings together different sectors, strengthening collaboration between academia, industry, and public institutions. As a result, Türkiye's R&D and innovation capacity continues to expand, while its progress toward becoming a technologically independent nation accelerates.

> "Beyond the flourishing investments and policies that are shaping Türkiye's technology landscape, 2024 has also been marked by numerous influential technology gatherings that have reinforced the country's position as a hub for innovation and digital transformation."

Another important event was the 6th DevOpsDays İstanbul, bringing together professionals from software development and operational infrastructure management. The event aimed to foster a stronger software culture, facilitate the exchange of best practices, and provide valuable networking opportunities for Türkiye's growing tech community. This year's edition witnessed an increased presence of international participants, further elevating the event's status as a global platform for DevOps professionals. Key highlights included roundtable discussions and a series of short yet insightful talks, where experts delved into cutting-edge developments, shared experiences, and examined the latest trends shaping the DevOps landscape. The discussions not only addressed national advancements but also incorporated international perspectives, positioning Türkiye as an emerging player in

the global DevOps ecosystem.[40] Similarly, the SDN Summit in İstanbul, brought together technology leaders, entrepreneurs, and innovators to explore Türkiye's evolving technology ecosystem, R&D advancements, and entrepreneurial landscape. The summit served as a platform to discuss strategic priorities such as fostering support for electric vehicles, accelerating renewable energy initiatives, and strengthening the domestic startup ecosystem. Moreover, the event underscored Türkiye's expanding influence in the global technology and investment sectors, reinforcing its potential as a key destination for innovation-driven enterprises. By highlighting the country's advancements in deep tech, AI, and digital infrastructure, the SDN Summit demonstrated how Türkiye is positioning itself as a significant player in the international technology landscape, with ambitions to lead in sustainability, high-tech entrepreneurship, and digital transformation.[41]

> "By encouraging young talent and fostering collaboration between academia, industry, and government, TEKNOFEST has evolved beyond being merely a technology festival, it has become a transformative ecosystem shaping Türkiye's future."

As Türkiye strives to establish itself as a key regional and global technological powerhouse, it places great emphasis on strategic regional collaborations that enhance its innovation-driven growth. In this context, collaborative programs, such as the EU's Horizon Europe grants demonstrated Türkiye's ability to contribute to and benefit from global scientific and technological advancements. These partnerships reflect the country's growing influence in shaping international digital transformation agendas. Industry and Technology Minister Mehmet Fatih Kacır announced that Türkiye has secured 243 million euros ($266.32 million) in grant funding through the Horizon Europe program. This funding supports 1,107 Turkish-led projects, aiming to solidify Türkiye's role in scientific research and technological innovation. Minister Kacır emphasized that this achievement represents a significant step in boosting Türkiye's global competitiveness, further enhancing its standing in the fields of science and

40 Emirhan Yılmaz, "Yazılım Dünyası İstanbul'da Bir Araya Geldi," *Anadolu Ajansı*, (April 24, 2024) retrieved from https://www.aa.com.tr/tr/bilim-teknoloji/yazilim-dunyasi-istanbulda-bir-araya-geldi-/3200791.

41 "Teknoloji Liderleri ve Girişimciler İstanbul'daki SDN Zirvesi'nde Buluştu," *Türkiye Cumhuriyeti Cumhurbaşkanlığı Yatırım Ofisi*, (April 30, 2024), retrieved from https://www.invest.gov.tr/tr/news/news-from-Türkiye/sayfalar/tech-leaders-and-innovators-gather-at-sdn-summit-in-istanbul.aspx.

technology.[42] Through programs like Horizon Europe, Türkiye is seizing the opportunity to develop globally competitive technologies, deepen industry-academia collaborations, and promote knowledge transfer in strategic fields. In key areas such as renewable energy, AI, big data analytics, and 5G, Türkiye's collaborative projects with international partners are enhancing its technology production capacity and strengthening its position in the digital economy. These efforts have the potential to transform Türkiye from a mere technology consumer into a key regional innovation hub, driving forward its influence in cutting-edge technological advancements.

> "These initiatives reinforce Türkiye's ambition to lead in advanced industries, particularly in AI, defense, and space technologies, while ensuring a cohesive and self-sufficient technological ecosystem across the Turkic world."

Furthermore, another notable milestone of 2024 was the 1st Industry, Science, Technology, and Innovation Ministers' Meeting of the Organization of Turkic States (OTS), held in İstanbul in October. This meeting marked a historic step toward strengthening scientific and technological integration among Turkic nations, positioning Türkiye as a catalyst for regional innovation and industrial transformation. As emphasized by Minister Kacır in his opening speech, İstanbul remains a critical global hub for economy, finance, and innovation, and this gathering signaled the beginning of a new era of collaboration in industry, science, and technology. The discussions at the meeting laid the groundwork for long-term cooperation, with key focus areas including R&D, scientific research and scholarships, industrial AI and digital transformation, innovation ecosystems, investment funds and entrepreneurship, small and medium enterprises (SMEs), metrology and industrial product safety, standardization and conformity assessment, industrial collaboration, and space technology development.[43]

42 Fatma Eda Topcu, "Bakanı Kacır: 1107 Türk Yürütücünün Dahil Olduğu 243 Milyon Avro Hibe Desteğini Türkiye'ye Kazandırdık," *Anadolu Ajansı*, (April 25, 2024), retrieved from https://www.aa.com.tr/tr/ekonomi/bakani-kacir-1107-turk-yurutucunun-dahil-oldugu-243-milyon-avro-hibe-destegini-turkiyeye-kazandirdik/3202202#:~:text=Sanayi%20ve%20Teknoloji%20Bakan%C4%B1%20Mehmet,T%C3%BCrkiye'ye%20kazand%C4%B1rd%C4%B1k%22%20dedi.

43 Serap Doğan, "Bakan Kacır: Atacağımız Adımlar, Sanayi, Bilim, Teknoloji ve İnovasyon Alanlarında Dayanışmayı Pekiştirecek," *Anadolu Ajansı*, (October 26, 2024), retrieved from https://www.aa.com.tr/tr/bilim-teknoloji/bakan-kacir-atacagimiz-adimlar-sanayi-bilim-teknoloji-ve-inovasyon-alanlarinda-dayanismayi-pekistirecek/3375430.

By addressing strategically interlinked fields, Türkiye and its regional partners are not only strengthening their collective technological capabilities but also enhancing their competitiveness in the global landscape. These initiatives reinforce Türkiye's ambition to lead in advanced industries, particularly in AI, defense, and space technologies, while ensuring a cohesive and self-sufficient technological ecosystem across the Turkic world. With this meeting, Türkiye has taken a significant diplomatic and technological step toward becoming a regional leader in innovation, solidifying its role as a bridge between emerging technological economies and global innovation hubs.

In conclusion, Türkiye's remarkable progress in technology, innovation, and entrepreneurship reflects its commitment to establishing itself as a key player in the new emerging technopolar order. The country's advancements in AI, startup ecosystems, and digital infrastructure, supported by robust national strategies and international collaborations, have positioned it as an emerging technological hub. However, it is important to emphasize that sustaining this momentum will require continued investment in high-tech industries, regulatory stability, and strategic policy adjustments to address existing challenges. By fostering a culture of innovation, strengthening regional partnerships, and enhancing AI-driven initiatives, Türkiye has the potential to not only consolidate its position in the global technology landscape but also drive forward its ambition of becoming a leading digital powerhouse. Building on this foundation, the next section of this report will focus on sector-specific developments in Türkiye for 2024, providing a detailed analysis of key industries shaping the country's technological landscape.

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

The year 2024 has been pivotal for the development and application of artificial intelligence (AI) across various domains. Nations worldwide have taken significant strides, not only by increasing investments and R&D efforts but also by integrating AI into their core national strategies. Türkiye is among the countries that fully recognize the transformative potential of AI and have developed a strategic vision in this field. It demonstrates a strong commitment to the effective and responsible use of AI in line with economic growth, social development, and national security interests. To this end, investments, regulatory frameworks, and international partnerships, supported through collaborations between the public and private sectors, aim to position Türkiye's AI ecosystem as a globally competitive force.

In this context, Türkiye has prioritized the growth of AI initiatives and startups throughout 2024, which has been a landmark period for LLMs. Since the introduction of ChatGPT in 2022, LLMs have become the centerpiece of AI advancements. While many private companies globally have ventured into developing their own systems, the market continues to be dominated by Western tech giants, particularly U.S.-based companies such as OpenAI, Meta,

Google DeepMind, and Anthropic. In this competitive landscape, Türkiye has taken significant steps to develop its own LLMs, aiming not only to address its national interests but also to challenge the existing monopolies and offer a uniquely Turkish perspective to the AI ecosystem. Two major developments marked Türkiye's progress in this area in 2024.

In February 2024, HAVELSAN announced the launch of its AI platform, MAIN. This groundbreaking platform is designed to enhance institutional efficiency by operating securely on either closed data networks or the internet, leveraging a proprietary Turkish language model.[44] As Türkiye's first large-scale Turkish Language Model, MAIN incorporates advanced capabilities, including:

i. Large Turkish Language Model (LLM): Designed to address the complexities of the Turkish language, this model captures linguistic nuances in advanced text-based communication and excels in natural language processing (NLP) tasks. With high accuracy in understanding Turkish morphology and contextual structures, it is highly applicable in text analysis, machine translation, and language modeling.

ii. A large vision model for image analysis: Equipped with image analysis and visual data processing capabilities, this model leverages computer vision techniques to excel in tasks such as object recognition, facial analysis, geographic image processing, and scene understanding. It plays a critical role in applications across security, defense, health care, and industry.

iii. A large audio model for speech recognition: Specialized in speech recognition and natural language processing, this AI-powered solution enables voice command comprehension, text-to-speech (TTS), and speech-to-text (STT) conversion. It is expected to significantly enhance various fields, including call center automation, assistant technologies, and accessibility solutions.

iv. An Open-Source Intelligence Model (OSINT): Developed for data collection and analysis, this AI model is designed to extract and interpret large-scale data from open sources such as the internet, social media, and public datasets. It provides critical advantages in fields like security, intelligence, and media analytics, enabling organizations to derive strategic insights from vast amounts of information.[45]

44 "HAVELSAN, Yapay Zeka Platformu 'MAIN'i Tanıttı," *TRT Haber*, (February 1, 2024), retrieved from https://www.trthaber.com/haber/bilim-teknoloji/havelsan-yapay-zeka-platformu-maini-tanitti-833729.html.

45 "Main," *HAVELSAN*, retrieved from https://www.havelsan.com/tr/urunler/main-kurumsal-yapay-zeka-platformu.

MAIN offers a wide array of features, such as question answering, content generation, and language translation, enabling organizations to optimize workflows and make informed decisions. Its unique architecture ensures both security and scalability, making it an indispensable tool for institutions embracing AI-driven innovation. By prioritizing data security and leveraging advanced AI technologies, MAIN underscores Türkiye's ambition to become a key player in the global LLM landscape while addressing local needs and perspectives.

A few months after its launch, several government institutions began adopting the MAIN platform to enhance the quality of their services and harness the opportunities offered by AI in their operational processes. One of the first adopters was the Public Procurement Authority (*Kamu İhale Kurumu*), which implemented the platform to streamline administrative workflows, systematize data management and reporting operations, and integrate AI-driven technological infrastructure into the institution's organizational culture. This step marked a significant move toward embedding AI within public sector operations to drive efficiency and innovation.[46]

Shortly after, the Turkish Technology Team Foundation (T3 Vakfı) announced its own Large Language Model, named T3 AI'LE, designed specifically for the Turkish language. The primary goal of T3 AI'LE is to play a pivotal role in the global digital transformation, break down language barriers, ensure the free flow of information, and foster unity among societies in the spirit of peace.[47] Recognized as a significant milestone in natural language processing (NLP), T3 AI'LE is designed to best capture the structural and semantic richness of Turkish. During its development, specialized solutions were crafted to address the morphological and syntactic complexities of Turkish, enabling the model to achieve more natural and fluent language understanding and generation. This initiative represents a crucial step in Türkiye's national AI strategy, accelerating efforts to develop domestic LLMs. Furthermore, T3 AI'LE enables innovative AI applications in key areas such as preserving language and cultural heritage, enhancing AI-driven education and public services, and strengthening digital content production.

As Türkiye's first indigenous LLM, T3 AI'LE represents a significant step forward in positioning the country among technologically advanced nations. This achievement not only strengthens Türkiye's national AI strategy

46 Göksel Yıldırım, "Kamu Alımlarında Yapay Zeka Dönemi Başlıyor," *Anadolu Ajansı*, (September 11, 2024), retrieved from https://www.aa.com.tr/tr/bilim-teknoloji/kamu-alimlarinda-yapay-zeka-donemi-basliyor/3327318.

47 Muhammet Yiğit Özdemir, "T3 AI'LE: Türkiye'nin Büyük Dil Modeli," *Savunma TR*, (February 25, 2024), retrieved from https://www.savunmatr.com/t3-aile-turkiyenin-buyuk-dil-modeli/.

but also establishes it as a globally competitive player in AI development. More importantly, it aims to elevate Türkiye's presence on the international stage, enabling the country to assert its influence in this critical domain. Additionally, T3 AI'LE seeks to challenge the dominance of Western-centric content and discourse that has characterized existing LLMs, offering an alternative perspective that aligns with Türkiye's cultural, social, and linguistic identity.[48] By strengthening the domestic AI ecosystem, T3 AI'LE aims to unlock new opportunities in academia, public services, digital content creation, and education. This development reinforces Türkiye's transition from a mere consumer of AI technology to a leading producer, shaping its role in the AI-driven digital transformation.

> As Türkiye's first indigenous LLM, T3 AI'LE represents a significant step forward in positioning the country among technologically advanced nations.

Another significant milestone for Türkiye in the field of artificial intelligence was achieved in May 2024 when the National Security Council (*Milli Güvenlik Kurulu*, NSC) included AI in its official statement. As the primary institution responsible for outlining decisions, evaluations, and recommendations on Türkiye's national security policies, defense strategies, and pressing issues, the NSC declared:

> It has been emphasized that advancements in the field of artificial intelligence offer great opportunities that could usher in a new era in human history. However, it was also noted that this potential brings certain challenges and new threats emerging in cyberspace. The importance and priority of Türkiye being prepared for the scientific, military, economic, and social outcomes of artificial intelligence research and developing advanced capabilities in this field have been highlighted.[49]

This announcement is particularly noteworthy as it marks the first time the Turkish government has directly communicated its stance on AI in the context of military and security applications. By elevating AI to a matter of national security, the NSC underscored its strategic significance and signaled Türkiye's commitment to leveraging AI advancements while addressing their associated risks. This statement reflects a pivotal moment in aligning AI with Türkiye's broader national security and development agenda.

48 "SETA TECHTALKS: Büyük Dil Modelleri ve T3 AI'le - Küresel Trendler, Yerel Etkiler," *Youtube*, retrieved from https://www.youtube.com/watch?v=uWNaneNQ8Cs.

49 "28 Mayıs 2024 Tarihli Toplantı," *Türkiye Cumhuriyeti Cumhurbaşkanlığı Milli Güvenlik Kurulu Genel Sekreterliği,* retrieved from https://www.mgk.gov.tr/index.php/28-mayis-2024-tarihli-toplanti.

A significant development shows the rising importance of AI within the Turkish government on Oct. 2, 2024, when the Turkish Parliament decided to establish an Artificial Intelligence Commission.[50] This newly created entity will operate in coordination with the Digital Media Commission, serving as a dedicated body to address AI-related matters. The commission will comprise 22 members and have an initial working period of three months, starting from the election of its chairperson, vice chairperson, spokesperson, and clerk.[51]

> By elevating AI to a matter of national security, the NSC underscored its strategic significance and signaled Türkiye's commitment to leveraging AI advancements while addressing their associated risks.

The commission is designed to function as an open forum, welcoming contributions from a wide range of participants, including experts and professionals with globally recognized achievements in information technology, as well as stakeholders such as TÜBİTAK, the Digital Transformation Office, the Presidency, and the Communications Directorate. In addition, experts from universities and field specialists will also participate. These discussions will culminate in a comprehensive report that evaluates all aspects of AI, including its advantages and disadvantages.[52]

Another noteworthy development took place in November 2024 when Türkiye unveiled its first quantum computer, QuanT, marking a significant step toward technological independence and global competitiveness. Developed at TOBB ETÜ Technology Center, QuanT positions Türkiye among the 15 nations with quantum computing capabilities, a field expected to reach a $2 trillion market by 2035. Quantum technology, which can solve complex

50 The decision taken by the Grand National Assembly of Türkiye, as published in the Official Gazette dated October 5, 2024, and numbered 32683, is written as follows: "A Parliamentary inquiry has been initiated in accordance with Article 98 of the Constitution and Articles 104 and 105 of the Rules of Procedure, with the aim of determining steps to be taken to capitalize on the benefits of artificial intelligence, establishing the legal framework for this field, and identifying measures to prevent the risks associated with the use of artificial intelligence. The inquiry will be conducted by a Commission composed of 22 members, with a working period of three months starting from the date of election of the Chairperson, Vice Chairperson, Spokesperson, and Clerk. The Commission is also authorized to conduct its work outside of Ankara if necessary. This decision was made during the 2nd Session of the General Assembly on October 2, 2024."

51 "TBMM Kararı," *Resmi Gazete*, (October 5, 2024) retrieved from https://www.resmigazete.gov.tr/eskiler/2024/10/20241005-1.pdf.

52 "Yapay Zeka Komisyonu İçin Geri Sayım! Kanun Çalışması Gündeme Gelecek...." *A Haber*, (August 24, 2024), retrieved from https://www.ahaber.com.tr/gundem/2024/08/24/yapay-zeka-komisyonu-icin-geri-sayim-kanun-calismasi-gundeme-gelecek?paging=5.

problems in minutes rather than decades, is set to revolutionize fields like cryptography, AI, energy optimization, and cybersecurity. The country is also establishing a Superconducting Chip Fabrication Facility, ensuring domestic production of key quantum components.[53] This milestone reduces foreign dependency, strengthens national security, and accelerates Türkiye's leadership in deep technologies and digital transformation.

While the Turkish government spearheaded major technological advancements, several notable independent innovations also emerged. One such breakthrough was Stockimg AI an innovative platform developed by three Turkish students, enabling users to generate AI-powered images and videos.[54] The platform quickly gained global traction, attracting millions of users worldwide. Within just 10 months, Stockimg AI reached 2 million users and achieved a valuation of $3.5 million, highlighting the potential of Turkish innovation in the rapidly growing AI industry. This success underscores Türkiye's emergence as a key player in artificial intelligence, driven by the ingenuity of its researchers and entrepreneurs. Türkiye's advancements extended beyond traditional sectors, with remarkable breakthroughs in AI-driven entrepreneurship. The global success of platforms like Stockimg AI, developed by Turkish innovators, highlights the country's emerging role as a hub for AI innovation.

53 Mertkan Oruç and Seda Tolmaç, "Türkiye'nin İlk Kuantum Bilgisayarı "QuanT" Tanıtıldı," *Anadolu Ajansı*, (November 21, 2024), retrieved from https://www.aa.com.tr/tr/bilim-teknoloji/turkiyenin-ilk-kuantum-bilgisayari-quant-tanitildi/3400083.

54 "Türk Öğrenciler Geliştirdi: 10 Ayda 2 Milyon Kullanıcıya Ulaştılar," *TRT Haber*, (January 3, 2024), retrieved from https://www.trthaber.com/haber/bilim-teknoloji/turk-ogrenciler-gelistirdi-10-ayda-2-milyon-kullaniciya-ulastilar-825878.html.

AEROSPACE TECHNOLOGIES

As technology continues to evolve and proliferate, the space domain has re-emerged as a competitive arena. Unlike the Cold War era, which saw competition primarily between two superpowers – the U.S. and the Soviet Union – today's space race includes new emerging states and non-state actors playing increasingly significant roles. Türkiye is among these emerging powers, recognizing the strategic importance of space in both civilian and military domains and taking decisive steps to establish itself in this arena.

Over the years, Türkiye has made notable advancements, such as establishing the Turkish Space Agency (TUA) in 2018 and unveiling its ambitious National Space Program in 2021.[55] However, 2024 was a particularly pivotal year for Türkiye, marked by tangible progress toward achieving the goals outlined in its national space strategy. In January 2024, Türkiye achieved a historic milestone in space exploration by sending its first astronaut, Alper Gezeravcı, to the Interna-

55 For more information on Türkiye's space program see: Gloria Shkurti Özdemir, "Assessing Türkiye's Role in the Global Space Competition," *SETA Analysis*, No. 87, (January 2024), retrieved from https://www.setav.org/en/assets/uploads/2024/01/A87En.pdf.

tional Space Station (ISS). At that time, this accomplishment positioned Türkiye among an elite group of 22 nations that had successfully sent astronauts to the ISS. Beyond its symbolic significance, this achievement reflects Türkiye's advancing capabilities in space technology and solidifies its standing as an emerging power within the global space community. Furthermore, it is important to state that Gezeravcı, during his two-week stay in the ISS had the chance to conduct 13 different experiments focusing on areas such as genetic research, investigations into metal alloys and particles, and studies on propolis and algae.[56]

> "2024 was a particularly pivotal year for Türkiye, marked by tangible progress toward achieving the goals outlined in its national space strategy."

In June 2024, Türkiye launched its second astronaut, Tuva Cihangir Atasever, on a space mission. Unlike the first mission, this was a shorter suborbital research flight. The entire journey lasted approximately an hour, during which Atasever conducted seven scientific experiments in a microgravity environment during the roughly three-minute freefall phase.[57] This mission also marked a significant milestone in Türkiye's space program, showcasing its growing capabilities in space exploration and research. Furthermore, it has reinforced Türkiye's commitment to becoming an active player in space research while advancing its scientific capabilities. As an essential part of Türkiye's space strategy, this second astronaut mission aims to lay the groundwork for more extensive and long-term space research initiatives in the future.

In particular, microgravity experiments – which are crucial for biotechnology, materials science, and human spaceflight – demonstrate Türkiye's efforts to expand its space research capacity. This mission represents a significant step toward strengthening Türkiye's position in space exploration and scientific innovation. Conducting experiments in a microgravity environment during a cost-effective suborbital flight contributes valuable scientific insights with potential applications in fields like medicine and technology. At the same time, it

56 Zeynep Duyar, "Alper Gezeravcı, Uluslararası Uzay İstasyonu'ndaki Son Deneyini Yaptı," *Anadolu Ajansı*, (February 2, 2024), retrieved from https://www.aa.com.tr/tr/bilim-teknoloji/alper-gezeravci-uluslararasi-uzay-istasyonundaki-son-deneyini-yapti/3126131#:~:text=Astronot%20Gezeravc%C4%B1%2C%20M%C4%B0YELO%C4%B0D%20deneyiyle%20galaktik,yap%C4%B1m%C4%B1%20s%C3%BCrecini%20nas%C4%B1l%20etkiledi%C4%9Fini%20ara%C5%9Ft%C4%B1rd%C4%B1.

57 "Türkiye'nin 2'nci Uzay Misyonu Tamamlandı: Tuva Cihangir Atasever'in İçinde Bulunduğu Araç Dünya'ya İniş Yaptı," *NTV*, (June 8, 2024), retrieved from https://www.ntv.com.tr/galeri/turkiye/turkiyenin-2nci-uzay-misyonu-tamamlandi-tuva-cihangir-ataseverin-icinde-bulundugu-arac-dunyaya-inis-yapti,Oti366UIcUK1WmWM4so_eQ/l_wSBtZbHkCrjtEJdWyrKw.

can be said that the mission, enhances Türkiye's international reputation and fosters opportunities for global collaboration.

Another key goal of Türkiye's national space program is to enhance ground-based observation and tracking of space objects, vital for national security, especially given the threat of spy satellites. To support this, in 2024, Türk Hava Kurumu (THK) University developed an AI-powered deep learning model to accurately determine satellite orbits.[58] This initiative strengthens national security by monitoring potential satellite threats and advances Türkiye's technological capabilities in space. Furthermore, by integrating AI, Türkiye aligns with global trends, paving the way for broader applications like debris tracking and space traffic management, further cementing its position in the global space arena.

Concurrently, Türkiye has made notable progress in satellite technologies, strengthening its position in the international space arena. With 25 active satellites in orbit, Türkiye ranks 21st globally among all entities, including agencies and nongovernmental organizations. When considering only nations, Türkiye is sixth in Europe, following the United Kingdom, France, Germany, Italy, and Spain, and stands as the leader in the Middle East. This reflects Türkiye's robust and growing satellite infrastructure.[59] Not only that but in 2024, Türkiye achieved another historic milestone by becoming one of only 10 countries capable of independently developing and producing satellites, exemplified by the TÜRKSAT 6A project. In July 2024, the TÜRKSAT 6A communications satellite was successfully launched into orbit aboard SpaceX's Falcon 9 rocket. This advanced satellite extended coverage to a population of 5 billion, enabling connectivity across regions in South Asia, including India, Thailand, Malaysia, and Indonesia.[60] This achievement underscores Türkiye's technological self-reliance and strengthens its strategic position in the global space industry. Enhancing communication capabilities also opens new opportunities for economic growth, international partnerships, and the delivery of essential services to previously underserved regions.

One other significant advancement in this area was the integration of Türkiye's unmanned aerial vehicles (UAVs) with the TÜRKSAT satellites for communication and control. This development is particularly crucial for UAVs operating abroad,

58 "Türkiye Üzerinden Geçen Casus Uyduları Yapay Zeka Yakalayacak," *TRT Haber*, (April 24, 2024), retrieved from https://www.trthaber.com/haber/bilim-teknoloji/turkiye-uzerinden-gecen-casus-uydulari-yapay-zeka-yakalayacak-853000.html.

59 "Satallites by Countries and Organizations," *N2YO.com*, retrieved from https://www.n2yo.com/satellites/?c=&t=country.

60 "Uzayda Türk İzi! Milli Uydumuz TÜRKSAT 6A Uzaya Fırlatıldı: İşte O Tarihi Anlar | Başkan Erdoğan'dan Video Mesaj," *A Haber*, (July 8, 2024), retrieved from https://www.ahaber.com.tr/gundem/2024/07/08/uzayda-turk-izi-milli-uydumuz-turksat-6a-uzaya-firlatildi-iste-o-tarihi-anlar-baskan-erdogandan-videomesaj?paging=11.

as it enhances the security and reliability of their connections.[61] By leveraging satellite communication, Türkiye ensures secure and encrypted channels for data transmission, significantly reducing the risk of unauthorized access or interference. This capability not only strengthens the operational effectiveness of its UAV fleet but also bolsters Türkiye's strategic autonomy in defense, enabling more robust and independent deployment of its assets in international missions or conflict zones. This integration underscores the importance of satellite infrastructure in modern warfare and positions Türkiye as a key innovator in the global defense landscape.

"By leveraging satellite communication, Türkiye ensures secure and encrypted channels for data transmission, significantly reducing the risk of unauthorized access or interference."

Beyond government-funded initiatives, Türkiye has also achieved significant advancements in the commercial satellite sector. Notable projects include satellites like Connecta T2.1 or Connecta IOT (four of the later satellites were launched in 2024)[62] highlighting the country's expansion into private-sector space endeavors. Additionally, Türkiye is actively contributing to the rapidly growing field of CubeSats, a category of smaller, cost-effective satellites. Projects such as KILIÇSAT and İTÜPSAT1 demonstrate Türkiye's innovative approach to space technology and its commitment to diversifying its satellite portfolio.

In 2024, within this framework, TÜRKSAT introduced its PeycON mobile satellite antenna systems, designed for versatile use across land, air, and sea platforms. These advanced systems developed entirely with domestic and national resources, are compatible with all satellites and meet international standards. PeycON antennas have been deployed for various institutions, including AFAD, the Turkish Red Crescent, the Gendarmerie General Command, and the Coast Guard Command, among others.[63] They are actively utilized, particularly in defense applications, showcasing Türkiye's commitment to leveraging cutting-edge, locally developed technologies to strengthen its operational capabilities in critical sectors.

61 "İHA'ların Kontrolü Türksat Uyduları ile Daha Güvende," *TRT Haber*, (February 12, 2024), retrieved from https://www.trthaber.com/haber/bilim-teknoloji/ihalarin-kontrolu-turksat-uydulari-ile-daha-guvende-836398.html.

62 Zeynep Duyar, "Türkiye'nin Uzay Ekosistemini Güçlendirecek 4 Uydu Daha Uzaya Fırlatıldı," *Anadolu Ajansı,* (August 17, 2024), retrieved from https://www.aa.com.tr/tr/bilim-teknoloji/turkiyenin-uzay-ekosistemini-guclendirecek-4-uydu-daha-uzaya-firlatildi/3306307.

63 "Türksat'ın Milli Anten Sistemleri ile İletişim Kesintisiz Sağlanıyor," *TRT Haber*, (January 17, 2024), retrieved from https://www.trthaber.com/haber/bilim-teknoloji/turksatin-milli-anten-sistemleri-ile-iletisim-kesintisiz-saglaniyor-829691.html.

DEFENSE TECHNOLOGIES

The defense sector stands out as one of Türkiye's most remarkable success stories over the past decade. Once reliant on importing defense industry necessities, Türkiye has transformed into a key player in the global defense sector through technological advancements achieved under its National Technology Initiative. As a result, it has emerged as one of the leading exporters in the defense industry. Over the past decade, investments in defense technology, the development of domestic and national systems, and strategic partnerships based on technology transfer have significantly accelerated Türkiye's arms exports. Advanced unmanned aerial vehicles (UAVs and armed drones), armored vehicles, missile systems, and electronic warfare solutions have positioned Türkiye as a highly competitive force on the international stage. This transformation has strengthened Türkiye's military and economic independence, establishing its defense industry as a powerful global player. The rise in defense exports not only meets Türkiye's own security needs but also enhances the defense capabilities of its allied nations, solidifying its role as a strategic partner in global security.

According to SIPRI data from 2025, Türkiye's share of the global arms export market rose from 0.8% to 1.7% between 2020-2024 compared to the 2015-2019 period – an impressive 103% increase – making it the

world's 11th largest arms supplier. Simultaneously, comparing the imports in the same periods, arms imports declined by 33%, with Türkiye's share of global imports decreasing from 1.7% in 2025-2019 to 1.1% in 2020-2024, ranking 22nd globally.[64] Additionally, three Turkish defense companies – Baykar, Turkish Aerospace Industries (TAI), and ASELSAN – were listed in SIPRI's latest report on the Top 100 arms-producing and military services companies, with all three improving their rankings compared to the previous year.[65] This progress underscores Türkiye's growing self-reliance and innovation, especially in terms of technology and influence in the global defense industry.

Within this framework, Türkiye has developed and produced several advanced missile systems and technologies that showcase its growing capabilities in defense innovation. Among these is the LGK-81 Laser Guidance Kit, a cutting-edge precision guidance system designed to transform conventional general-purpose bombs into highly accurate laser-guided munitions. Produced by ASELSAN, this system was successfully integrated into the HÜRKUŞ-C aircraft in early 2024, marking a significant milestone in enhancing the operational effectiveness and precision strike capabilities of Türkiye's domestically produced defense platforms. This achievement highlights Türkiye's ability to combine technological innovation with indigenous production to strengthen its defense infrastructure.[66]

Similarly, Türkiye completed the testing of its indigenously developed missiles at the beginning of 2024, including Gökdoğan, a beyond-visual-range air-to-air missile, and Bozdoğan, a within-visual-range air-to-air missile. These advanced systems represent a significant step in Türkiye's efforts to achieve self-sufficiency in defense technologies. Both missiles entered the military inventory in July 2024, further enhancing the country's air combat capabilities and reducing dependence on foreign suppliers. This accomplishment underscores Türkiye's growing expertise in missile technology and its commitment to bolstering its strategic and tactical defense infrastructure.[67]

64 Katarina Djokic, Mathew George, Zain Hussain, Pieter D. Wezeman, and Siemen T. Wezeman, "Trends in International Arms Transfers, 2024," *SIPRI Fact Sheet*, (March 2025), retrieved from https://www.sipri.org/sites/default/files/2025-03/fs_2503_at_2024_0.pdf.

65 Lorenzo Scarazzato, Nan Tian, Diego Lopes Da Silva, Xiao Liang, and Katarina Djokic, "The Sipri Top 100 Arms-Producing and Military Services Companies, 2023," *SIPRI Fact Sheet*, (December 2024), retrieved from https://www.sipri.org/sites/default/files/2024-11/fs_2412_top_100_2023_0.pdf.

66 "HÜRKUŞ Milli Pençelerle Donatılıyor," *TRT Haber*, (January 2, 2024), retieved from https://www.trthaber.com/haber/bilim-teknoloji/hurkus-milli-pencelerle-donatiliyor-825656.html.

67 Rıfat Öncel. "2024'te Savunma Sanayii," in Cem Duran Uzun and Faruk Taşçı (eds.), *2024'te Türkiye*, (İstanbul: SETA, 2024), pp. 167-173.

A significant milestone was achieved in February 2024, when Türkiye's first national combat aircraft, KAAN, successfully completed its maiden flight. This fifth-generation aircraft represents a groundbreaking achievement in Türkiye's defense capabilities, offering superior air dominance through its high-performance and integrated avionics system, which incorporates advanced artificial intelligence and heterogeneous computing technologies. TÜBİTAK, a key player in Türkiye's technological ecosystem, is spearheading critical domestic projects to enhance KAAN's capabilities further. These include developing software to achieve radar invisibility, vital life support systems, and explosion prevention mechanisms. Such advancements ensure the aircraft's stealth and operational safety. They also solidify Türkiye's position as a leader in next-generation aerospace technology.[68]

Similarly, Türkiye is advancing its aerospace capabilities with the development and production of its first indigenous jet trainer and light attack aircraft, HÜRJET, designed by Turkish Aerospace Industries (TAI). Developed to replace aging trainer aircraft, HÜRJET serves as a versatile platform for various mission capabilities while also preparing pilots for Türkiye's next-generation KAAN fighter jet. After successfully completing its maiden flight in 2023, HÜRJET achieved a significant milestone in 2024 by surpassing the speed of sound, reaching Mach 1.01, with an expected maximum speed of Mach 1.4. This achievement underscores Türkiye's growing expertise in military aviation and its commitment to technological self-sufficiency in the defense sector.[69]

Another significant achievement for Türkiye in 2024 was the development and operational advancements of the Bayraktar TB3 Unmanned Combat Aerial Vehicle (UCAV). This state-of-the-art UCAV integrates advanced technologies, including AI, to enhance its operational efficiency and autonomy.[70] Throughout the year, the TB3 underwent rigorous testing. In November 2024, it successfully performed take-off and landing operations on the drone-carrying amphibious assault ship, TCG Anadolu, marking a milestone in Türkiye's naval aviation. Notably, the TB3 is equipped with domestically designed and produced ASELFLİR-500 cameras by ASELSAN, significantly reducing reliance on foreign sources and underscoring Türkiye's progress in self-sufficient defense manufacturing.[71]

68 "TÜBİTAK Teknolojileriyle KAAN'ı Benzersiz Kılacak," *TRT Haber*, (February 26, 2024), retrieved from https://www.trthaber.com/haber/bilim-teknoloji/tubitak-teknolojileriyle-kaani-benzersiz-kilacak-840160.html; "Milli Uçak 'KAAN' İlk Uçuşunu Yaptı," *TRT Haber*, (February 21, 2024), retrieved from https://www.trthaber.com/haber/gundem/milli-ucak-kaan-ilk-ucusunu-yapti-838998.html.

69 "ANKA III Bu Kez Hedefi "TOLUN" ile Vurdu," *TRT Haber*, (November 21, 2024) retrieved from https://www.trthaber.com/haber/savunma/anka-iii-bu-kez-hedefi-tolun-ile-vurdu-883642.html.

70 "Bayraktar TB3," *Baykar*, retrieved from https://www.baykartech.com/en/uav/bayraktar-tb3/.

71 Hülya Ömür Uylaş, "Bayraktar TB3, TCG Anadolu'ya İki Kez Daha Başarıyla İniş Kalkış Gerçekleştirdi," *Anadolu Ajansı*, (November 26, 2024), retrieved from https://www.aa.com.tr/tr/savunma-sanayisi/bayraktar-tb3-tcg-anadoluya-iki-kez-daha-basariyla-inis-kalkis-gerceklestirdi/3404382.

Another critical technology integrated with the TB3, as well as the TB2 and Akıncı UAVs, is the Bayraktar Imaging Package, a system designed for rapid and high-resolution mapping of vast areas.[72] Equipped with 14 cameras, this advanced system can map approximately 4,000 square kilometers per day (1544.41 square miles), providing imagery detailed enough to detect vehicles and individuals. Once the mapping is complete, the collected data can be analyzed using advanced AI techniques, including object detection, area segmentation, and other AI-driven analytics tailored to specific operational needs. This capability significantly enhances reconnaissance, surveillance, and strategic planning, further strengthening Türkiye's technological edge in defense and intelligence operations.

When a state seeks to enhance its defense industry independence, it is crucial not only to focus on the production of military vehicles and missiles but also to achieve self-reliance in advanced technologies and components used within these systems. This is particularly significant given the complexity and high technological demands of such assets. In this context, the ASELFİR-500 camera, developed by ASELSAN, plays a pivotal role in advancing Türkiye's defense capabilities and bolstering its autonomy. Equally noteworthy is the TF6000 engine, produced by TUSAŞ Engine Industries (TEI) in 2024, which is planned for use in the KIZILELMA and ANKA-3 unmanned aerial vehicles.[73] These developments represent critical milestones in Türkiye's journey toward achieving full technological independence in its defense sector. It is also worth noting that KIZILELMA will incorporate various domestically developed technologies, further strengthening Türkiye's defense industry. Among these innovations is T3 AI'le, Türkiye's national LLM, which will enable voice-command control, reducing reliance on manual inputs and enhancing operational efficiency.[74]

Another notable example of domestically developed systems aimed at enhancing Türkiye's defense sector independence is the ALP 300-G, the country's longest-range early warning radar system. Equipped with cutting-edge technology, it positions Türkiye among the leading nations in radar production,

72 Ayşe Böcüoğlu Bodur, "Yüksek Çözünürlüklü Haritalama Yapabilen "Bayraktar Görüntüleme Paketi" SAHA EXPO'da Tanıtıldı," *Anadolu Ajansı*, (October 24, 2024), retrieved from https://www.aa.com.tr/tr/savunma-sanayisi/yuksek-cozunurluklu-haritalama-yapabilen-bayraktar-goruntuleme-paketi-saha-expoda-tanitildi/3373331.

73 "TF6000 Motoru İlk Kez Çalıştırıldı: KIZILELMA'ya Güç Verecek," *SavunmaSanayist.com*, (March 9, 2024), retrieved from https://www.savunmasanayist.com/tf6000-motoru-ilk-kez-calistirildi-kizilelmaya-guc-verecek/.

74 Ömer Faruk Doğan, "İnsansız Savaş Uçağı KIZILELMA, Sesli Komut ile Kontrol Edilecek! Selçuk Bayraktar Duyurdu," *TGRT Haber*, (December 13, 2024), retrieved from https://www.tgrthaber.com/teknoloji/insansiz-savas-ucagi-kizilelma-sesli-komut-ile-kontrol-edilecek-selcuk-bayraktar-duyurdu-2987813?s=1.

surpassing others in resolution, range, and accuracy. This advanced radar features active electronic scanning, operates in a stationary position, and integrates over 4,000 transmit-receive modules, ensuring operational continuity even in the event of module failures. Its development marks a significant step toward Türkiye's self-sufficiency in high-tech defense systems.[75]

Building on these advancements, Türkiye aims to integrate its domestically produced radar, missile, electronic warfare systems, and other technologies such as the ALKA Directed Energy Weapon System (ALKA YESS)[76] into the *Çelik Kubbe* (Iron Dome) Project, designed to neutralize aerial threats against the country. This AI-powered defense system is set to become an unparalleled shield, significantly enhancing Türkiye's defensive capabilities and strategic autonomy. A key factor in further strengthening the country's position in next-generation defense technologies is the development and integration of comprehensive air defense systems. These systems are capable of countering a wide range of threats, including drone attacks, cruise missiles, ballistic missiles, and fighter jets. Under Türkiye's multi-layered air defense strategy, domestically developed systems not only enhance the efficiency of the defense industry but also aim to maximize national security. Notably, the Hisar, Siper, and Korkut air defense systems are designed to neutralize threats at various range and altitude levels, significantly bolstering Türkiye's air defense capabilities. Additionally, these systems are integrated with advanced radar and early warning technologies, which will enhance strategic deterrence on both a regional and international scale. The development of these cutting-edge air defense systems not only cements Türkiye's role as a major player in the global defense industry but also presents a strong export opportunity for allied and partner nations.[77]

Another example of Türkiye harnessing AI advancements in the defense sector is the Heliport-Sim Project, developed by HeliPLAT and Junosis, which aims to revolutionize helicopter landing and takeoff training through cutting-edge simulation and AI technologies. Designed for both military and civilian avia-

75 "Erken İhbar Radar Sistemlerinin İlk Teslimatı Yapıldı," *TRT Haber*, (May 20, 2024), retrieved from https://www.trthaber.com/haber/bilim-teknoloji/erken-ihbar-radar-sistemlerinin-ilk-teslimati-yapildi-858630.html.

76 The ALKA Directed Energy Weapon System (YESS), developed by ROKETSAN, will be used to counter drone threats effectively. This advanced system employs high-energy laser technology and electromagnetic capabilities to neutralize drones and other airborne threats, providing a critical layer of defense in Türkiye's *Çelik Kubbe* air defense system. For more see: "Dron Tehditleri "ALKA Lazer Silahı" ile Önlenecek," TRT Haber, (September 19, 2024) retrieved from https://www.trthaber.com/haber/bilim-teknoloji/dron-tehditleri-alka-lazer-silahi-ile-onlenecek-878405.html.

77 Serhat Tutak and Mustafa Çalkaya, "Türkiye'nin Yerli ve Milli Silahları "Çelik Kubbe"yi Eşsiz Yapacak," *Anadolu Ajansı*, (August 8, 2024), retrieved from https://www.aa.com.tr/tr/savunma-sanayisi/turkiyenin-yerli-ve-milli-silahlari-celik-kubbeyi-essiz-yapacak/3298379.

tion, this system leverages advanced simulation and modeling technologies to provide realistic environmental modeling, offering significant advantages in training, crisis management, and operational readiness. With comprehensive simulation capabilities in air traffic coordination, emergency scenarios, and crisis management training, the system enhances both security and operational efficiency. Its integration with air defense systems, pilot training programs, and airspace management solutions ensures the seamless and secure execution of military and civil aviation operations. Additionally, AI-powered analysis systems enable forecasting and optimization of flight scenarios, improving airspace utilization efficiency. This, in turn, supports strategic decision-making in air traffic management, emergency response, and mission planning. By enhancing Türkiye's technological expertise in aviation and defense, this innovative system strengthens the country's global competitiveness, positioning Türkiye as a stronger player in international markets.[78] By digitizing and modernizing helicopter training, Heliport-Sim significantly improves flight safety, reduces operational risks, and enhances coordination in high-traffic airspaces. This innovative approach not only strengthens Türkiye's aviation capabilities but also serves as a model for other nations seeking to advance their pilot training programs through AI-driven solutions.

Building on Türkiye's advancements in aerospace technology and helicopter development, the country has reached a significant milestone with the T625 GÖKBEY, a general-purpose helicopter designed and manufactured by Turkish Aerospace Industries (TUSAŞ). By the end of 2024, GÖKBEY officially entered the inventory of the Gendarmerie General Command with its first delivery, marking a pivotal step toward Türkiye's self-reliance in rotary-wing aircraft production.[79] Equipped with 34 advanced avionics systems developed by ASELSAN, GÖKBEY integrates cutting-edge technologies that enhance its operational efficiency, situational awareness, and mission versatility.[80] Beyond being a domestically produced helicopter, its development highlights Türkiye's capability to engineer not only the aircraft itself but also the sophisticated subsystems essential for modern aviation, further reducing reliance on foreign suppliers. This achievement, coupled with AI-driven training innova-

78 Göksel Yıldırım, "Helikopterler Teknoloji Desteğiyle daha Güvenli İnip Kalkacak," *Anadolu Ajansı*, (October 28, 2024), retrieved from https://www.aa.com.tr/tr/savunma-sanayisi/helikopterler-teknoloji-destegiyle-daha-guvenli-inip-kalkacak/3376753.

79 "İlk 'GÖKBEY' Jandarma Genel Komutanlığı'na Teslim Edildi," *TRT Haber*, (October 29, 2024), retrieved from https://www.trthaber.com/haber/gundem/ilk-gokbey-jandarma-genel-komutanligina-teslim-edildi-885126.html.

80 Göksel Yıldırım, "GÖKBEY Helikopteri ASELSAN'ın Yerli ve Milli Çözümleriyle Uçacak," *Anadolu Ajansı*, (October 29, 2024), retrieved from https://www.aa.com.tr/tr/bilim-teknoloji/gokbey-helikopteri-aselsanin-yerli-ve-milli-cozumleriyle-ucacak/3378468.

tions like Heliport-Sim, underscores Türkiye's strategic vision of establishing a fully independent, technologically advanced aviation ecosystem, reinforcing both its military and civilian aerospace capabilities on a global scale.

As AI and emerging technologies become integral to modern warfare, states worldwide are leveraging them for strategic advantage. Countries like the U.S. and China have developed new military doctrines to harness AI's potential. The U.S. Joint All-Domain Command and Control (JADC2) system exemplifies this shift, integrating AI, machine learning, data analytics, and secure communications to enhance decision-making and seamlessly connect soldiers, vehicles, aircraft, ships, and unmanned systems across all domains. Similarly, Türkiye has embraced this transformation with HAVELSAN's "Digital Unity" project, which enables unmanned aerial, land, and sea vehicles to operate collaboratively through an integrated command and control system, forming the foundation of future combat systems.[81] Expanding on this, in 2024, HAVELSAN completed CENGAVER, a "digital soldier" system designed to enhance battlefield situational awareness and optimize security forces' effectiveness. Developed within the Digital Unity framework, CENGAVER ensures continuous real-time tracking of soldiers' locations, even in GPS-denied environments, using Ultra-Wideband (UWB) technology with 1-meter (3.29 feet) indoor and 6-meter outdoor precision. One of CENGAVER's standout features is real-time health and performance monitoring through a wearable smartwatch, tracking oxygen levels, heart rate, body temperature, movement, fatigue, and stress. This allows commanders to assess soldiers' well-being instantly, ensuring informed decision-making in the field. HAVELSAN has designed the system with a minimalist approach, ensuring it enhances operational efficiency without restricting mobility.[82] Together, Digital Unity and CENGAVER exemplify Türkiye's commitment to integrating AI and digital technologies into modern defense strategies, strengthening its military capabilities and autonomy.

Lastly, one of the most significant technological and military developments of 2024 was Türkiye's announcement of the establishment of the Directorate of Cyber Security to counter emerging cyber threats.[83] This initiative, crucial for Türkiye's national security, was officially realized in early 2025 with the for-

81 Gloria Shkurti Özdemir, *Artificial Intelligence Arms Dynamics: The Case of the US and China*, (İstanbul: SETA, 2024), pp. 82-83.

82 Metin Akpınar, "Türkiye'nin İlk Dijital Askeri: CENGAVER Sahaya Çıkmaya Hazır," *Donanım Haber*, (November 30, 2024), retrieved from https://www.donanimhaber.com/turkiye-nin-ilk-dijital-askeri-cengaver-sahaya-cikmaya-hazir--184780.

83 Kemal Karadağ, "Siber Güvenlikte "Başkanlık" Modeli Devreye Alınacak," *Anadolu Ajansı*, (December 14, 2024), retrieved from https://www.aa.com.tr/tr/bilim-teknoloji/siber-guvenlikte-baskanlik-modeli-devreye-alinacak/3424377.

mal launch of the Directorate,[84] marking a decisive step toward strengthening the country's cyber defense capabilities and safeguarding critical infrastructure against digital threats, especially taking into consideration the developments in Ukraine and Gaza that showed once more the importance of security in the cyber domain. This new framework aims to establish a comprehensive national security mechanism to protect critical infrastructure, government institutions, the private sector, and individuals from cyberattacks. The Cybersecurity Directorate will work to strengthen Türkiye's digital sovereignty, prevent cyber threats, enhance real-time response capabilities, and develop AI-powered cybersecurity solutions. The directorate will be responsible for:

- Defining national cybersecurity strategies,
- Strengthening public-private sector collaborations,
- Managing international threat intelligence
- Ensuring rapid and coordinated responses to cyberattacks.

Additionally, it will lead the development of domestic and national cybersecurity technologies, aiming to reduce Türkiye's dependence on foreign solutions and position the country as an active player in the global cybersecurity ecosystem. This initiative not only reinforces Türkiye's defense industry but also plays a crucial role in its goal of becoming a regional leader in cybersecurity. It represents a significant step toward making Türkiye a more resilient nation against global cyberthreats.

84 "Türkiye Establishes Cybersecurity Directorate to Combat Cyber Threats," *Directorate of Communications*, (January 9, 2025), retrieved from https://www.iletisim.gov.tr/english/dis_basinda_turkiye/detay/turkiye-establishes-cybersecurity-directorate-to-combat-cyber-threats.

SEMICONDUCTORS AND RARE-EARTH MINERALS

Microchips have long been a cornerstone of technological progress, but as advancements accelerate at an unprecedented pace, their strategic significance has become more apparent than ever. Beyond powering everyday electronics such as smartphones, laptops, and cars, semiconductors are critical to military technology, directly shaping defense capabilities and national security. Their widespread applications make even the most basic chips instrumental in influencing entire industries and global power dynamics, underscoring their essential role in economic and geopolitical stability. The COVID-19 pandemic's impact on global supply chains, combined with the technological decoupling between the U.S. and China, has intensified the push for "semiconductor nationalism," emphasizing trade protectionism and self-sufficiency in chip manufacturing.[85] Leading technology powers like the United States and China are adopting aggressive policies to reduce dependence on semiconductor supply chains, investing in domestic production, and imposing restrictions

85 Gloria Shkurti Özdemir, "Türkiye'nin Yerli ve Milli Çip Üretimi Atılımı," *Kriter*, No. 92, (July-August 2024), retrieved from https://kriterdergi.com/yazar/gloria-shkurti-ozdemir/turkiyenin-yerli-ve-milli-cip-uretimi-atilimi.

on international chip exports. This transformation is reshaping global trade policies, presenting both significant opportunities and challenges for countries competing in semiconductor manufacturing.

From Türkiye's perspective, this shift offers a critical opportunity to strengthen its national semiconductor industry and reduce reliance on foreign technologies. A well-structured semiconductor strategy, supported by strategic investments, public-private sector collaborations, and international partnerships, could position Türkiye as a key player in the global technology landscape. Within this framework, Türkiye has begun prioritizing chip design and manufacturing to safeguard its technological sovereignty and reduce dependency on foreign suppliers.

> "Several institutions and private companies are pioneering Türkiye's semiconductor development, including TÜBİTAK BİLGEM, YİTAL, UEKAE, ASELSAN, YONGATEK, and Electra IC."

Chips are fundamental to Türkiye's key industries, including automotive, defense, healthcare, and consumer electronics. Türkiye's semiconductor advancements are evident in various indigenous technologies, including the TOGG electric vehicle, Anka and KIZILELMA UAVs, military jets, and other defense systems. Recognizing its strategic value, Türkiye has intensified efforts to design and manufacture domestic chips, positioning itself as an emerging player in the global semiconductor landscape.

Within this framework, several institutions and private companies are pioneering Türkiye's semiconductor development, including TÜBİTAK BİLGEM, YİTAL, UEKAE, ASELSAN, YONGATEK, and Electra IC. Notable initiatives include (i) TÜBİTAK BİLGEM and ASELSAN developed Çakıl, Türkiye's first domestic processor; (ii) TÜBİTAK BİLGEM started YONCA Project which aims to build a fully indigenous processor, expand Türkiye's semiconductor ecosystem, and transition to 16nm (nanometer) FinFET technology, with aspirations for sub-7nm production; (iii) YONGATEK's semiconductor projects such as ÇENTİK (a microcontroller chip, produced in 2024, replacing foreign-made chips in white goods such as washing machines, dishwashers, and refrigerators; exported to Dubai),[86] KIRMIK (a video processing chip), and SAKA (a hardware-programable chip).

86 "Milli Çip ÇENTİK'te Kritik Eşik," *TRT Haber*, (January 22, 2024), retrieved from https://www.trthaber.com/haber/bilim-teknoloji/milli-cip-centikte-kritik-esik-831009.html.

In the military sector, ASELSAN has been a key player in designing and producing domestic chips, collaborating with MKR-IC, TÜYAR, and Bilkent University to develop radar and electronic warfare chips. In 2024, ASELSAN began mass production, further reducing Türkiye's reliance on foreign suppliers and reinforcing its defense industry autonomy.[87]

Recognizing the critical role of semiconductors, the Turkish government has introduced direct funding to support domestic chip design and production. In 2024, under the HIT-30 High-Tech Investment Program, the Ministry of Industry and Technology financed Arçelik and YONGATEK to develop an indigenous chip for home appliances, consumer electronics, small household appliances, and kitchen accessories.[88]

It is important to state that the HIT-30 Program includes six specialized calls focused on advancing Türkiye's technological capabilities, with HIT-Chip specifically dedicated to strengthening the country's semiconductor industry and chip production. This initiative highlights Türkiye's awareness of its technological gaps and its commitment to developing a self-sufficient semiconductor ecosystem.[89]

A critical challenge in semiconductor manufacturing is the availability of rare earth minerals, a topic that gained significant attention in Türkiye throughout 2024. Türkiye is home to what is believed to be the world's second-largest single rare earth mineral reserve, after Bayan Obo in China, with an estimated 694 million tons of raw capacity. With this vast resource, Türkiye aims to become one of the top five global producers of rare earth elements, positioning itself as a key player in the international supply chain for these strategic materials.[90]

Although Türkiye's rare earth deposit was officially inaugurated in 2023, the country made significant strides in 2024 by signing a Memorandum

87 Abdulkadir Günyol and Tolga Yanık, "ASELSAN Genel Müdürü Ahmet Akyol: Çipleri Kendimiz Tasarlıyor, 2024 İtibarıyla Binlercesini Seri Üretebiliyoruz," *Anadolu Ajansı*, (April 24, 2024), retrieved from https://www.aa.com.tr/tr/savunma-sanayisi/aselsan-genel-muduru-ahmet-akyol-cipleri-kendimiz-tasarliyor-2024-itibariyla-binlercesini-seri-uretebiliyoruz/3200577.

88 Maşallah Dağ, "Sanayi ve Teknoloji Bakanlığının Desteğiyle Arçelik ve YongaTek İşbirliğinde Yerli Çip Tasarımına Başlandı," *Anadolu Ajansı*, (July 26, 2024), retrieved from https://www.aa.com.tr/tr/bilim-teknoloji/sanayi-ve-teknoloji-bakanliginin-destegiyle-arcelik-ve-yongatek-isbirliginde-yerli-cip-tasarimina-baslandi/3286422.

89 Tolga Yanık, "Yerli Çip Üretimi Teknoloji İhracatını ve İstihdamı Destekleyecek," *Anadolu Ajansı*, (August 14, 2024), retrieved from https://www.aa.com.tr/tr/bilim-teknoloji/yerli-cip-uretimi-teknoloji-ihracatini-ve-istihdami-destekleyecek/3303279.

90 Gloria Shkurti Özdemir, "Türkiye'nin ABD-Çin Nadir Toprak Elementleri Güç Mücadelesindeki Stratejik Hamlesi," Kriter, No. 94, (October 2024), retrieved from https://kriterdergi.com/yazar/gloria-shkurti-ozdemir/turkiyenin-abd-cin-nadir-toprak-elementleri-guc-mucadelesindeki-stratejik-hamlesi.

of Understanding (MoU) with China for bilateral cooperation in natural resources and mining, indicating potential joint efforts in processing and refining these deposits.[91] At the same time, despite the lack of an official announcement, Türkiye has reportedly joined the Mineral Security Partnership (MSP)—a U.S.-led initiative aimed at securing global critical mineral supply chains.[92] This move signals Türkiye's intent to diversify its rare earth partnerships, reduce dependency on China, and strengthen cooperation with the U.S., the EU, and other international allies in securing sustainable and resilient supply chains for key industries, including semiconductors, defense, and green technologies. Rare earth elements are essential raw materials for high-tech industries, particularly in semiconductor manufacturing, renewable energy, defense, and electric vehicles, making them critical to strategic sectors. Although China currently dominates the global supply, rising geopolitical tensions and supply chain vulnerabilities have heightened the need for alternative sources. Türkiye possesses the significant potential to become a major global supplier of these vital resources by effectively leveraging its rare earth deposits. Investments in extraction, refining, and advanced manufacturing processes could significantly enhance Türkiye's competitiveness in this field. The strategic utilization of these resources would not only strengthen Türkiye's technological sovereignty but also increase its influence in the evolving global economy. Moreover, establishing a domestic supply chain based on local production could position Türkiye as a strong contender in the global technology landscape.

> "Türkiye is home to what is believed to be the world's second-largest single rare earth mineral reserve, after Bayan Obo in China, with an estimated 694 million tons of raw capacity. With this vast resource, Türkiye aims to become one of the top five global producers of rare earth elements, positioning itself as a key player in the international supply chain for these strategic materials."

91 "Türkiye, China Sign MoU on Natural Resources and Mining," *Anadolu Agency*, (October 16, 2024), retrieved from https://www.aa.com.tr/en/energy/general/turkiye-china-sign-mou-on-natural-resources-and-mining/43972.

92 Ragıp Soylu, "Türkiye Joins Western Critical Minerals Club Amid EU-China Rivalry," *Middle East Eye*, (September 20, 2024), retrieved from https://www.middleeasteye.net/news/Türkiye-joins-western-critical-minerals-club-amid-eu-china-rivalry.

DIGITAL TRANSFORMATION

Türkiye's digital transformation in 2024 exemplifies its strategic vision of integrating advanced technologies to secure economic growth, enhance national security, and assert its position as a global technological leader. By investing in foundational infrastructure, fostering innovation, and emphasizing domestic development, Türkiye has demonstrated that digital transformation is not merely a goal but a pivotal instrument in achieving technological sovereignty and international competitiveness. Türkiye's dedication to digital transformation has been demonstrated through substantial investments and strategic initiatives aimed at integrating advanced technologies across various sectors. Key areas of focus have included AI, the Internet of Things (IoT), and cybersecurity – technologies recognized as pivotal for modernizing the nation's digital infrastructure and enhancing economic competitiveness.

The establishment of the Digital Transformation Office (DTO) in 2018 marked a significant milestone in Türkiye's digital transformation vision. Tasked with managing and coordinating the country's digital transformation strategies, the office has played a central role in fostering a cohesive and forward-looking approach to integrating digital services working upon digital infrastructure in the

public sector. The DTO, as a leading institution responsible for implementing digital technology services, aims to lead the implementation of the digital transformation ecosystem by increasing the performance of public institutions in e-services, AI strategy, and data governance with a pubic cloud strategy. DTO has a national mission to take the country to a pioneering level in digital global economy and international order which will only be possible by adopting an agile management approach that understands contemporary developments well, can make quick decisions, and develops the capacity to produce innovative technological solutions.

> Overcoming historical challenges, Türkiye has positioned its automotive sector as a symbol of national pride and technological progress, underlining the broader aspirations of technological sovereignty and global competitiveness.

Furthermore, at the opening of Amadeus' İstanbul R&D Center, the Industry and Technology Mehmet Fatih Kacır emphasized the pivotal role of technological innovation and digital transformation in achieving sustainable and competitive growth stating "In today's environment, digital transformation and technological innovation are no longer options but necessities for companies aiming to lead in innovation and achieve sustainable, competitive growth. In Türkiye, we have witnessed how technology-driven disruptions in various sectors create opportunities for innovation and success."[93]

Throughout 2024, significant developments took place in Türkiye's digital transformation realm. The automotive sector provided a compelling case for Türkiye's digital transformation journey. The unveiling of the TOGG T10F Sedan model exemplified how strategic investments in technology and innovation have transformed domestic industries. Overcoming historical challenges,[94] Türkiye has positioned its automotive sector as a symbol of national pride and technological progress, underlining the broader aspirations of technological sovereignty and global competitiveness. From the first national car "Devrim" in 1961, fast forward, to December 27, 2019, President Recep Tayyip Erdoğan

93 Gökhan Yıldız, "Bakan Kacır: 102 Teknoparkımız, 1600'ün Üzerinde AR-GE ve Tasarım Merkezimiz, 272 bin AR-GE Çalışanımız Var," *Anadolu Agency*, (July 18, 2024), retrieved from https://www.aa.com.tr/tr/bilim-teknoloji/bakan-kacir-102-teknoparkimiz-1600un-uzerinde-ar-ge-ve-tasarim-merkezimiz-272-bin-ar-ge-calisanimiz-var/3279110.

94 Türkiye's first domestically produced car, Devrim (Revolution), developed in 1961, despite its technical success, was discontinued due to internal and external obstacles. This left a lingering sense of unfulfilled potential within the Turkish nation. For more read: Shkurti Özdemir and Pirinççi, "Milli Teknoloji Hamlesi: İlkeler, Araçlar ve Amaçlar."

inaugurated the TOGG project in Gebze's Informatics Valley, describing it as a pivotal step in achieving complete independence through domestic and national development.[95] Since then, TOGG has continued to make strides in innovation and production. Following the successful launch of the T10X model, which has been on the roads since 2022, the company officially introduced the T10F Sedan model, further expanding its lineup and providing consumers with new options.[96] This new model will undoubtedly enhance the company's competitiveness, reinforcing its position in the market. The T10F Sedan not only highlights Türkiye's progress in the electric vehicle sector but also supports TOGG's ambition to compete on a global scale. With its aerodynamic design, extended range, and advanced smart technologies, the new model has been developed in alignment with the brand's strategic vision for sustainable mobility. This expansion will not only increase TOGG's production capacity but also propel Türkiye's domestic electric vehicle industry forward, positioning the country as a leader in the transformation of the automotive sector.

It is also noteworthy that in 2024, Türkiye witnessed a significant surge in fully electric vehicle (EV) sales, which rose by 51.7% year-on-year, reaching 99,489 units by December 2024. This growth expanded EVs' market share from 6.8% to 10.1%, reflecting the country's accelerating shift toward sustainable mobility. Most notably, TOGG emerged as the market leader, closing the year with 30,093 units sold, securing a 30% market share. TOGG's dominance positioned it 18,559 units ahead of its closest competitor, TESLA, solidifying Türkiye's domestic automotive industry's competitiveness in the growing EV sector.[97] This development underscores Türkiye's growing competitiveness in the domestic automotive industry and its strong foothold in the expanding electric vehicle sector. TOGG's success serves as clear evidence of the increasing demand for electric vehicles while also proving that Türkiye, with its automotive brand, has become a formidable competitor on the global stage.

At the same time, Türkiye has emerged as a key market for global electric vehicle (EV) manufacturers. Reflecting this trend, in 2024, the Chinese automotive giant and one of the world's largest car manufacturers, BYD, announced plans to

95 "A Dream Come True: Türkiye Reveals Prototype of First Domestic Car," *Daily Sabah*, (December 27, 2024), retrieved from https://www.dailysabah.com/automotive/2019/12/27/a-dream-come-true-Türkiye-reveals-prototype-of-first-domestic-car.

96 Abdulselam Durdak, "TOGG, Yeni Sedan Modelinin İlk Görüntüsünü Paylaştı," *Anadolu Ajansı*, (January 7, 2024), retrieved from https://www.aa.com.tr/tr/ekonomi/togg-yeni-sedan-modelinin-ilk-goruntusunu-paylasti/3102715.

97 Mücahitcan Avcıoğlu, "Türkiye Saw Bearly 100,000 Electric Car Sales in 2024," *Anadolu Ajansı,* (January 8, 2024), retrieved from https://www.aa.com.tr/en/economy/turkiye-saw-nearly-100-000-electric-car-sales-in-2024/3444908.

invest $1 billion to establish a new manufacturing plant in Türkiye. The facility will produce both electric and plug-in hybrid vehicles, with operations expected to begin by the end of 2026.[98] This investment is a major milestone for Türkiye's automotive sector, driven not only by the increasing tariffs on Chinese EVs in European markets but also by Türkiye's rapidly expanding EV market and strategic geographical position. As a bridge between Europe, Asia, and the Middle East, Türkiye is ideally positioned to become a regional hub for electric vehicle production and exports. The country's growing role as an automotive manufacturing center, combined with its rising domestic demand for EVs, makes it an attractive destination for global automotive investments, further strengthening its position in the global electric mobility landscape.[99]

> "In the field of signalization, where only five countries globally can manufacture their systems, Türkiye has once again demonstrated its capabilities in production and branding."

Success in the EV industry hinges not only on vehicle manufacturing but also on battery production, a critical component of the ecosystem. Recognizing this, Türkiye has taken significant steps to strengthen its domestic battery industry. One of the most notable developments is the establishment of Siro, a joint venture between TOGG and Chinese battery manufacturer Farasis. The foundation for Siro's battery production plant was laid in 2023, with mass production set to begin in 2026. The plant is expected to reach a capacity of 20 GWh/a by 2031, and 50 GWh by 2035.[100] Beyond Siro, Türkiye already hosts two active battery cell production facilities and nearly 100 lithium-ion battery manufacturing plants of various scales. With ongoing investments in new battery plants, Türkiye aims to exceed 80 GWh of battery production capacity by 2030, positioning itself as a key player in the global energy storage and EV battery supply chain.[101] To accelerate these developments, the Turkish government has committed $4.5 billion under the HIT-30 High-Tech Investment Program in 2024 to support

98 "BYD: Türkiye'ye Yaklaşık 1 Milyar Dolar Yatırım Yapacak Çinli Otomotiv Devi Hakkında Neler Biliniyor?" *BBC*, (July 8, 2024), retrieved from https://www.bbc.com/turkce/articles/cglkg5pev4ko.

99 Gloria Shkurti Özdemir, "Geleceği Yakalamak: BYD'nin Türkiye Yatırımı ve Stratejik Etkleri," *Sabah*, (July 20, 2024), retrieved from https://www.sabah.com.tr/yazarlar/perspektif/gloria-shkurti-ozdemir/2024/07/20/gelecegi-yakalamak-bydnin-turkiye-yatirimi-ve-stratejik-etkleri.

100 "Türkiye Launches Construction of 1st Battery Plant," *Daily Sabah*, (April 24, 2023), retrieved from https://www.dailysabah.com/business/automotive/turkiye-launches-construction-of-1st-battery-plant.

101 "Türkiye Batarya Üretimde Yatırım Üssü Olmayı Hedefliyor," *TRT Haber*, (September 25, 2024), retrieved from https://www.trthaber.com/haber/bilim-teknoloji/turkiye-batarya-uretimde-yatirim-ussu-olmayi-hedefliyor-879261.html.

battery production.[102] This investment reflects Türkiye's ambition to become a regional leader in battery technology, ensuring energy security, technological self-sufficiency, and competitiveness in the global EV market.

Lastly, a robust charging network is essential for the widespread adoption of EVs, and Türkiye has made significant progress in this area as well. Following the launch of TOGG, the country has witnessed a surge in charging infrastructure, reflecting the growing demand for EVs. As of November 2024, Türkiye has a total of 26,000 charging sockets, including both AC and DC chargers.[103] While further expansion is necessary to meet the increasing number of EVs, Türkiye already leads Europe in charging network density, with one charging socket for every six EVs, compared to the EU average of 13 per socket.[104] Moreover, the charging service sector has experienced rapid growth. While only five companies were providing charging services in April 2022, the number has since risen to 169 licensed providers.[105] Some of these companies, such as Aspower, have even expanded their operations internationally, exporting charging solutions to Gulf states and Europe.[106]

The importance of this rapid expansion becomes even clearer when considering projections from the Energy Market Regulatory Authority (EPDK). By 2030, Türkiye is expected to have 1.3 million EVs on the road and a total of 142,000 charging points. By 2035, the number of EVs is projected to reach 3.3 million, with 273,000 charging points.[107] These developments highlight Türkiye's strategic vision for EV infrastructure, ensuring that its charging network keeps pace with rising demand, while also positioning the country as a regional leader in sustainable mobility and clean energy solutions.

As part of Türkiye's ongoing digital transformation, the development of domestic and national railway signaling systems in 2024 marked a significant milestone in enhancing transportation safety and reducing reliance on foreign technol-

102 "Türkiye Introduces High Incentives for EV, Battery, Semiconductor Investments," *S&P Global*, (July 29, 2024), retrieved from https://cilive.com/commodities/metals-mining/news-and-insight/072924-Türkiye-introduces-high-incentives-ev-battery-semiconductor-investments#:~:text=Türkiye%20will%20also%20offer%20a,an%20EV%20battery%20production%20plant.

103 "Enerji Dönüşümü Şarj Hizmeti Piyasası İstatistikler Listesi," *Enerji Piyasası Düzenleme Kurumu*, retrieved from https://www.epdk.gov.tr/Detay/Icerik/3-0-222-1040/enerji-donusumusarj-hizmeti-piyasasi--istatistik.

104 "Türkiye Leads Europe in Electric Vehicle Fast-charging Network," *Hürriyet Daily News*, (December 15, 2024), retrieved from https://www.hurriyetdailynews.com/turkiye-leads-europe-in-electric-vehicle-fast-charging-network-203617.

105 "Türkiye Leads Europe in Electric Vehicle Fast-charging Network," *Hürriyet Daily News*.

106 Göksel Yıldırım, "Yerli Şarj İstasyonu Avrupa Kapısını Açtı," *Anadolu Ajansı*, (December 5, 2024), retrieved from https://www.aa.com.tr/tr/bilim-teknoloji/yerli-sarj-istasyonu-avrupa-kapisini-acti/3414172.

107 "Türkiye Leads Europe in Electric Vehicle Fast-charging Network," *Hürriyet Daily News*.

ogy. This initiative, spearheaded by the Transport and Infrastructure Ministry, in collaboration with ASELSAN and Turkish State Railways (TCDD), aims to improve train traffic safety, lower operational costs, and foster local expertise. By investing in homegrown railway technology, Türkiye is strengthening its technological sovereignty in the transportation sector while positioning itself as a leader in advanced railway infrastructure. These collaborative initiatives in producing signalization systems underscore Türkiye's capability to achieve self-reliance in critical technological areas. Nonetheless, in the field of signalization, where only five countries globally can manufacture their systems, Türkiye has once again demonstrated its capabilities in production and branding.[108]

> "Recognizing the strategic importance of cloud technologies, Türkiye is actively expanding its cloud ecosystem, leveraging both domestic and international investments to strengthen its digital infrastructure and technological sovereignty."

A similar advancement was done also in terms of air traffic safety. Specifically, in 2024, Türkiye's Transport and Infrastructure Ministry introduced İRADE, the country's first domestically developed air traffic monitoring software, created by the General Directorate of State Airports Authority (DHMİ). Deployed at İstanbul Atatürk and Çukurova airports, İRADE enhances airspace safety by consolidating real-time radar, weather, and navigation data into a unified interface, streamlining operations for air traffic controllers. Minister Abdulkadir Uraloğlu highlighted that this breakthrough reduces foreign dependency, bolsters Türkiye's aviation technology sector, and ensures seamless integration with the expanding global aviation industry.[109]

In the realm of digital transformation, cloud computing stands as a critical pillar for enhancing data security, infrastructure efficiency, and AI capabilities. In 2023, Türkiye's cloud computing market was valued at approximately $1.48 billion, with projections indicating growth to $1.69 billion by 2024 and a Compound Annual Growth Rate (CAGR) of 13.94% from 2023 to 2031.[110] Recognizing the strategic importance of cloud technologies, Türkiye is actively

108 "Demiryollarında 'Yerli ve Milli' Sinyalizasyon," *T.C. Ulaştırma ve Altyapı Bakanlığı*, (February 15, 2024), retrieved from https://sgb.uab.gov.tr/haberler/demiryollarinda-yerli-ve-milli-sinyalizasyon.

109 Mustafa Çalkaya, "Hava Trafiği Milli 'İRADE' Yazılımıyla Kontrol Edilecek," *Anadolu Ajansı*, (November 17, 2024), retrieved from https://www.aa.com.tr/tr/bilim-teknoloji/hava-trafigi-milli-irade-yazilimiyla-kontrol-edilecek/3396032.

110 "Türkiye Cloud Computing Market: Analysis 2019-2032," *DataCube Research*, retrieved from https://www.datacuberesearch.com/Türkiye-cloud-computing-market.

expanding its cloud ecosystem, leveraging both domestic and international investments to strengthen its digital infrastructure and technological sovereignty.

While Türkiye is not yet a global leader in cloud computing, it is making notable advancements, particularly in sovereign cloud solutions, data localization, and AI-driven cloud services. In this context, Türkiye is preparing to launch the Türkiye Public Cloud Computing Strategy, a national initiative aimed at accelerating cloud adoption in the public sector, reducing the need for government agencies to develop and maintain their IT infrastructure.

On a practical level, Türkiye has been actively expanding its cloud technology landscape through both local initiatives and international partnerships. The country has agreements with major global cloud providers, including Huawei Cloud, Google Cloud, Microsoft Azure, Amazon Web Services (AWS), and Alibaba Cloud. At the same time, local cloud providers, such as Turkcell, Türk Telekom, Vodafone Türkiye, and ATP, are investing in expanding their data centers and cloud offerings, further reinforcing Türkiye's digital resilience and competitiveness in the global cloud market.[111]

In 2024, one of the most significant advancements in cloud technologies and digital transformation took place in Türkiye's defense and security sectors with the development of the Turkish Armed Forces (TAF) Cloud Computing System. This domestically developed cloud infrastructure is set to play a crucial role in ensuring data security across TAF's entire IT ecosystem, including critical defense projects like *Çelik Kubbe*. Key features of this system include: (i) Secure private cloud infrastructure: All military data will be stored on a highly secure, domestically developed private cloud; (ii) Redundant and high-availability storage: Cloud architecture will ensure uninterrupted data flow, enhancing operational resilience; (iii) AI-driven automation and security monitoring: Trained AI models will be integrated to automate processes and strengthen cybersecurity; (iv) Advancing Local Defense and Tech Sectors: The project will provide valuable expertise in server infrastructure, storage systems, and network security for Türkiye's defense and technology industries.[112] This initiative marks a significant step in Türkiye's technological self-sufficiency, strengthening national cyberse-

111 Mehmet Selçuk Güçlü, "ATP, Alibaba Cloud ile Türkiye Bulut Pazarındaki Rekabet Gücünü Artıracak," *Anadolu Ajansı*, (January 15, 2025), retrieved from https://www.aa.com.tr/tr/isdunyasi/genel/atp-alibaba-cloud-ile-turkiye-bulut-pazarindaki-rekabet-gucunu-artiracak/692838; Arife Yıldız Ünal, "Yapay Zeka Bulut Teknolojisi Türkiye'de Dijital Dönüşümü Hızlandıracak," *Anadolu Ajansı*, (June 4, 2024), retrieved from https://www.aa.com.tr/tr/bilim-teknoloji/yapay-zeka-bulut-teknolojisi-turkiyede-dijital-donusumu-hizlandiracak/3239410.

112 Yusuf Akbaş, "TSK Yerli ve Milli Bulut Sistemine Geçiyor: İmzalar Atıldı!" *Donanım Haber*, (December 5, 2024), retrieved from https://www.donanimhaber.com/tsk-yerli-buluta-geciyor-tsk-bulut-bilisim-sistemi-nedir--184967; Mustafa Çalkaya, "TSK Bulut Bilişim Sistemi Projesi için imzalar atıldı," *Anadolu Ajansı*, (December 4, 2024), retrieved from https://www.aa.com.tr/tr/bilim-teknoloji/tsk-bulut-bilisim-sistemi-projesi-icin-imzalar-atildi/3413277.

curity while laying the foundation for future AI-powered cloud solutions in both military and civilian applications. It not only enhances data protection and operational efficiency for Türkiye's armed forces but also reinforces the country's strategic leadership in secure cloud computing technologies.

Along with Türkiye's groundbreaking steps for transforming the country into a technology powerhouse for the next century, as a result, many big tech companies have started to heavily invest in Türkiye to meet the visionary approach of the country for the next century. Within this framework, Microsoft Türkiye has unveiled plans to substantially increase its investments in the country and the company is aiming to expand local data centers and cloud infrastructure to support Türkiye's digital transformation. Additionally, Microsoft is set to broaden its R&D activities in Türkiye to develop AI-driven solutions and host a major artificial intelligence event in 2024.[113]

As Türkiye heavily invests in groundbreaking technological breakthroughs, quantum computing is one of the critical goals it has set sail to achieve. To that end, the Presidency of Defense Industries (SSB) has announced the establishment of the Türkiye Quantum Technologies Development Center, a landmark decision made during the Defense Industry Executive Committee (SSİK) meeting chaired by President Recep Tayyip Erdoğan on Aug. 6, 2024. This center will focus on: (i) Establishing essential infrastructure for quantum technologies; (ii) Developing a skilled workforce specialized in quantum research; (iii) Enhancing the domestic quantum technology ecosystem and advancing technological expertise; (iv) Conducting targeted research in domestic quantum technologies; (v) Strengthening national and international collaborations in the field. The initiative underscores Türkiye's commitment to becoming a global leader in cutting-edge quantum technology, fostering both innovation and cooperation.[114]

Türkiye's comprehensive approach to digital transformation in 2024 has established a robust foundation for long-term growth, innovation, and global competitiveness. By aligning infrastructure development with technological innovation and strategic governance, Türkiye not only meets the demands of the digital age but also sets a precedent for emerging economies aiming to secure their place in the global technological hierarchy. Through its commitment to digital transformation, Türkiye is reshaping its economy, strengthening its sovereignty, and charting a path toward sustained leadership in the international system.

113 Abdulselam Durdak and Hülya Ömür Uylaş, "Microsoft Türkiye Yatırımlarını Misliyle Artırmayı Planlıyor," *Anadolu Ajansı*, (April 27, 2024), retrieved from https://www.aa.com.tr/tr/bilim-teknoloji/microsoft-turkiye-yatirimlarini-misliyle-artirmayi-planliyor/3203750.

114 Tolga Yanık, "Türkiye Kuantum Teknolojileri Geliştirme Merkezi kuruluyor," *Anadolu Ajansı*, (August 21, 2024), retrieved from https://www.aa.com.tr/tr/bilim-teknoloji/turkiye-kuantum-teknolojileri-gelistirme-merkezi-kuruluyor/3309243.

TELECOMMUNICATION AND 5G

Türkiye's telecommunications advancements in 2024 reflected a strategic pursuit of technological sovereignty and digital innovation. By prioritizing 5G development and emphasizing local manufacturing, the nation is not only enhancing its digital infrastructure but also asserting itself as a proactive and competitive force in global telecommunications. These initiatives underscore Türkiye's commitment to leveraging cutting-edge communication technologies to drive economic growth, bolster national security, and position itself as a key player in shaping the future of global connectivity. Türk Telekom, as a pioneering actor, played a central role by conducting comprehensive 5G trials and spearheading innovative projects that highlighted Türkiye's growing readiness for next-generation communication technologies. Key milestones included the establishment of the country's first smart factory application, the creation of the first private industrial mobile network, and the successful execution of the first live 5G sports broadcast.[115] These achievements underscored Türkiye's ability to adopt and inte-

115 "Türkiye transmits 1st 5G signal from homegrown portable network," *Daily Sabah*, (September 23, 2024), retrieved from https://www.dailysabah.com/business/tech/turkiye-transmits-1st-5g-signal-from-homegrown-portable-network.

grate advanced telecommunications solutions effectively. Furthermore, the company prioritized the expansion of its fiber-optic infrastructure to ensure robust and widespread internet accessibility. By 2024, Türk Telekom successfully extended its optical fiber network to an impressive 459,000 kilometers, reaching approximately 32.7 million households nationwide.[116] This extensive network not only improved connectivity but also laid the essential groundwork for future technological advancements, including the deployment of 5G services. Türkiye's progress in these areas underscores its vision to position itself as a leading actor in the global digital economy. By investing in foundational infrastructure and embracing emerging technologies, the country is taking decisive steps toward achieving technological sovereignty and fostering a sustainable, innovation-driven future.

> In alignment with the National Strategic Plan for 2024-2028, Türkiye prioritized the widespread integration of 5G technology as a critical component of the nation's digital transformation agenda.

In alignment with the National Strategic Plan for 2024-2028,[117] Türkiye prioritized the widespread integration of 5G technology as a critical component of the nation's digital transformation agenda. A notable feature of this strategic vision was the emphasis on the local production of 5G equipment. By fostering domestic manufacturing capabilities, Türkiye aims to reduce its reliance on foreign technologies, strengthen technological sovereignty, and stimulate the growth of its domestic technology industry. This commitment to self-reliance and technological sovereignty marks a significant step toward ensuring the nation's strategic independence in critical technological domains.

Furthermore, the strategic plan outlined the importance of investing in research and development (R&D) for 6G technologies, positioning Türkiye as a proactive and forward-looking participant in global telecommunications advancements. By laying the groundwork for next-generation networks, Türkiye not only enhances its digital infrastructure but also reinforces its role as a key player in shaping the future of global connectivity.

116 "Türk Telekom'dan Güçlü Faaliyet Performansıyla 2024'e Hızlı Başlangıç: Mobil ve Fiberdeki Büyüme İvmesi Sürüyor," *Türk Telekom*, (June 6, 2024), retrieved from https://medya.turktelekom.com.tr/turk-telekom-dan-guclu-faaliyet-performansiyla-2024-e-hizli-baslangic-mobil-ve-fiberdeki-buyume-ivmesi-suruyor.

117 "Twelfth Development Plan (2024-2028)," *Presidency of Strategy and Budget*, retrieved from https://www.sbb.gov.tr/wp-content/uploads/2024/06/Twelfth-Development-Plan_2024-2028.pdf.

Private sector contributions played a vital role in driving these advancements. Turkish GSM companies are accelerating their efforts for the transition to 5G technology, with plans to launch services by 2026. These efforts include modernizing infrastructure, developing domestic 5G applications, and focusing on R&D activities. The adoption of 5G is expected to boost efficiency and productivity in key sectors such as automotive, health care, and logistics. Furthermore, the integration of local technologies aims to enhance national technological independence, marking a significant step toward self-reliance in telecommunications.[118]

As mentioned in the previous section, Türkiye has taken important steps in terms of EVs, and within this framework it is gearing up to develop "V2X" (Vehicle-to-Everything) technology, enabling vehicles to communicate with each other and surrounding infrastructure. This cutting-edge technology aims to enhance vehicle safety, improve traffic efficiency, and support autonomous driving. Furthermore, this strategic move, which supports Türkiye's transformation in the automotive sector, is seen as a pivotal step toward shaping the future of the mobility ecosystem, led by TOGG. Developed by ULAK Communication, V2X is being tested in collaboration with vehicle manufacturers in Türkiye. This technology promises significant advancements in areas such as smart intersections, collision prevention, and traffic light optimization. With the integration of 5G and beyond, machine-to-machine communication is expected to become even more widespread.[119] These developments underscore Türkiye's proactive approach to integrating cutting-edge telecommunications technologies into everyday life.

A significant breakthrough by ULAK Haberleşme A.Ş. in 2024 was its advancements in 5G and portable base stations. The company continued to drive innovation in domestic and national communication technologies, collaborating with industrial organizations and operators. A major milestone was the mobilization of 4.5G base stations, enhancing network coverage and accelerating Türkiye's digital transformation. Additionally, ULAK Haberleşme is actively working on a seamless transition from 4.5G to 5G, conducting field tests on high-speed air interfaces, 5G radio technologies, and massive MIMO. The company is also focusing on standalone 5G base stations for private networks, reinforcing Türkiye's technological self-sufficiency. Looking ahead, ULAK Haberleşme is taking strategic steps toward 6G, securing international patents, and fostering a robust local ecosystem to position Türkiye as

118 Fatma Eda Topcu and Arife Yıldız Ünal, "GSM Şirketleri 5G'ye Geçiş için Çalışmalarını Sürdürüyor," *Anadolu Ajansı*, (April 5, 2024), retrieved from https://www.aa.com.tr/tr/bilim-teknoloji/gsm-sirketleri-5gye-gecis-icin-calismalarini-surduruyor/3184165.

119 "Milli Teknoloji, Araçları "Konuşturmak" için Yola Çıkmaya Hazırlanıyor," TRT Haber, (June 15, 2024), retrieved from https://www.trthaber.com/haber/bilim-teknoloji/milli-teknoloji-araclari-konusturmak-icin-yola-cikmaya-hazirlaniyor-863724.html.

a global leader in next-generation telecommunications.[120] These developments hold immense significance, as they strengthen the country's technological sovereignty, reduce dependence on foreign technology, and bolster cybersecurity, economic resilience, and strategic autonomy in critical sectors. The deployment of portable base stations further enhances Türkiye's disaster response capabilities, ensuring reliable communication in emergencies. Moreover, advancements in 5G and 6G will accelerate innovation in smart cities, autonomous systems, and IoT, driving economic growth and global competitiveness.

> "Türkiye has taken important steps in terms of EVs, and within this framework it is gearing up to develop "V2X" (Vehicle-to-Everything) technology, enabling vehicles to communicate with each other and surrounding infrastructure."

The resilience of Türkiye's telecommunications infrastructure was evident during the February 6, 2022, earthquakes, when the Gendarmerie Integrated Communication and Information System (JEMUS), developed by ASELSAN, proved critical in disaster management and emergency response. Deployed across all 81 provinces by the end of 2024, JEMUS plays a pivotal role in providing secure communication and enhancing search and rescue operations, highlighting the sector's contributions to national security and disaster resilience. Beyond providing secure communication, the system plays a vital role in search and rescue operations during disasters, significantly enhancing emergency response capabilities.[121]

In all, Türkiye's advancements in telecommunications and 5G technology reflect a cohesive vision for a digitally empowered future. By aligning its strategic goals with local innovation, infrastructure modernization, and international competitiveness, Türkiye is not only addressing the immediate challenges of the digital age but also establishing itself as a leader in global telecommunications. These developments underscore the nation's commitment to fostering sustainable growth, enhancing security, and driving technological progress in an interconnected world.

120 Arife Yıldız Ünal, "ULAK Haberleşme "Yerli ve Milli 5G" için Teknolojik Altyapıya Odaklandı," *Anadolu Ajansı*, (August 21, 2024), retrieved from https://www.aa.com.tr/tr/bilim-teknoloji/ulak-haberlesme-yerli-ve-milli-5g-icin-teknolojik-altyapiya-odaklandi/3309137.

121 Sertaç Aksan and Cansu Kurukahvecioğlu, "Depremde Ayakta Kalan Tek Sistemdi: Türkiye'nin Tamamına Kuruluyor," *TRT Haber*, (June 12, 2024), retrieved from https://www.trthaber.com/haber/gundem/depremde-ayakta-kalan-tek-sistemdi-turkiyenin-tamamina-kuruluyor-863183.html.

EDUCATION

The year 2024 marked a transformative period for Türkiye's educational sector, where technological advancements became the cornerstone of reforms aimed at enhancing accessibility, quality, and relevance. Recognizing education as a critical driver for national and global competitiveness, Türkiye leveraged its strategic investments in technology to bridge the digital divide and prepare its population for the demands of the modern, digitally-driven global economy. These developments position Türkiye as a proactive participant in the international system, highlighting the interconnectedness of education, technology, and economic progress. The educational sector in Türkiye experienced significant reforms aimed at integrating digital tools and methodologies to enhance both the accessibility and quality of education. Recognizing the transformative potential of technology, the Education Ministry launched a series of initiatives to modernize classrooms across the country.[122] These initiatives provided students with digital resources and ensured that teachers received comprehensive training in utilizing modern educational technologies effectively.

Moreover, collaborative partnerships between educational institutions and technology companies played a crucial role in advancing Türkiye's digital education

122 Ravale Mohydin, "The Role of Education in Türkiye's Technological Transformation," *TRT World*, retrieved from https://researchcentre.trtworld.com/wp-content/uploads/2024/10/The-Role-of-Education-in-Turkiye.pdf.

agenda.[123] These partnerships facilitated the development of specialized programs in key areas such as AI, cybersecurity, and data analysis. The introduction of these programs reflects a forward-thinking approach aimed at equipping students with the critical skills required to thrive in a digitally transformed economy. By aligning educational outcomes with the demands of the evolving global job market, Türkiye is strategically preparing a future-ready workforce capable of driving innovation and economic growth. These reforms not only bridge the digital divide but also underscore Türkiye's commitment to fostering a knowledge-based economy, where technology and education converge to create sustainable development opportunities.

> "The year 2024 marked a transformative period for Türkiye's educational sector, where technological advancements became the cornerstone of reforms aimed at enhancing accessibility, quality, and relevance."

To further bolster its educational infrastructure, the National Technology Academy, an institution under the Industry and Technology Ministry, initiated specialized training programs in cutting-edge fields, including AI, autonomous driving technologies, and chip design. Announced by Minister Mehmet Fatih Kacır, this initiative aims to equip a new generation of experts to drive forward Türkiye's National Technology Initiative, ensuring the country's continued leadership and innovation in cutting-edge technologies.[124]

It is also important to highlight that, as part of Türkiye's efforts to advance scientific research and foster a culture of innovation, the country has established numerous science centers aimed at making science and technology more accessible and comprehensible to society. These centers bring together individuals from diverse age groups and backgrounds, promoting scientific education and engagement. Many of them operate with the support of TÜBİTAK and local municipalities. In 2024, five new science centers were inaugurated, bringing the total to 40 nationwide, with 12 located in İstanbul, further strengthening Türkiye's commitment to scientific outreach and innovation.[125]

123 "Türkiye Made Digital World List with Its Distance Education Statics," *T.C. Milli Eğitim Bakanlığı*, (June 19, 2020), retrieved from https://www.meb.gov.tr/Türkiye-made-digital-world-list-with-its-distance-education-statistics/haber/21158/en.

124 Zeynep Duyar, "Milli Teknoloji Hamlesi'nin Yeni Neferleri "Akademide" Yetişecek," *Anadolu Ajansı*, (August 29, 2024), retrieved from https://www.aa.com.tr/tr/bilim-teknoloji/milli-teknoloji-hamlesinin-yeni-neferleri-akademide-yetisecek/3316039.

125 "Türkiye to Expand Science Outreach with 40 Centers Nationwide," *Daily Sabah*, (November 17, 2024), retrieved from https://www.dailysabah.com/turkiye/turkiye-to-expand-science-outreach-with-40-centers-nationwide/news.

Higher education institutions in Türkiye also took notable strides in integrating AI into research and curriculum development. Over 20 universities launched AI-supported projects targeting agricultural efficiency and sustainability, demonstrating the far-reaching implications of AI technologies in addressing global challenges like food security and water conservation. These projects highlight the alignment of Türkiye's academic and technological priorities with sustainable development goals. The Council of Higher Education (YÖK) announced that more than 20 universities in Türkiye are conducting AI-supported projects aimed at advancing the agricultural sector. These projects focus on increasing productivity in agricultural products, ensuring water conservation, and fostering sustainable farming practices. The AI-driven initiatives implemented in higher education institutions are expected to play a critical role in enhancing agricultural efficiency and sustainability, contributing significantly to the sector's growth and modernization.[126]

Another important step in 2024 was achieved through the "AI and Technology Academy" initiative officially inaugurated during TEKNOFEST. This initiative aims to enhance the development of skilled AI professionals and provide advanced AI training for young talents. The project is a collaboration between the Industry and Technology Ministry, the Presidential Digital Transformation Office, Google Türkiye, the T3 Enterprise Center, and the Entrepreneurship Foundation (GİRVAK). It is designed to support Türkiye's growing AI ecosystem and empower the next generation of innovators.[127]

Türkiye's commitment to fostering international collaboration in education and technology was evident in its participation in the "Turkic States Organization Artificial Intelligence Forum" held in Kyrgyzstan in October 2024. This forum underscored the importance of knowledge sharing and joint innovation among regional partners, emphasizing AI as a tool for shared development and progress. The "Turkic States Organization Artificial Intelligence Forum" held in Kyrgyzstan underscored the significance of international cooperation and knowledge sharing in the field of AI. Officials from Türkiye, Kazakhstan, Uzbekistan, and Azerbaijan emphasized the importance of fostering collaboration and ensuring a continuous flow of information to advance AI technologies within the region. The forum highlighted the collective commitment of Turkic states to leverage AI innovation as a tool for shared development and

126 Buğrahan Ayhan, "YÖK, tarımda 20'den fazla üniversitenin yapay zeka destekli proje yürüttüğünü bildirdi," *Anadolu Ajansı*, (September 10, 2024), retrieved from https://www.aa.com.tr/tr/bilim-teknoloji/yok-tarimda-20den-fazla-universitenin-yapay-zeka-destekli-proje-yuruttugunu-bildirdi/3326516.

127 Emirhan Yılmaz, "Google Türkiye'nin "Yapay Zeka ve Teknoloji Akademisi"nin Açılışı TEKNOFEST'te Gerçekleştirildi," *Anadolu Ajansı*, (October 2, 2024), retrieved from https://www.aa.com.tr/tr/teknofest/google-turkiyenin-yapay-zeka-ve-teknoloji-akademisinin-acilisi-teknofestte-gerceklestirildi/3349409.

technological progress.[128] Within this framework, it is important to state also that in November 2024, the T3 Foundation and the Turkish Cooperation and Coordination Agency (TİKA) collaborated on the establishment of the Science Bishkek Innovation Center in the Kyrgyz capital.[129]

> "Türkiye's commitment to fostering international collaboration in education and technology was evident in its participation in the "Turkic States Organization Artificial Intelligence Forum" held in Kyrgyzstan in October 2024."

The private sector played a pivotal role in advancing Türkiye's educational agenda, as seen in initiatives like the "Coding Marathon," organized by the Information and Communication Technologies Authority (BTK) and Huawei Türkiye. This program provided university students with hands-on training in cloud computing, enabling them to achieve internationally recognized certifications and enhancing their competitiveness in the global technology landscape. The "Coding Marathon," organized in collaboration between the Information and Communication Technologies Authority (BTK) and Huawei Türkiye, provided university students with the opportunity to showcase their innovative projects. Participants received online training in cloud computing, after which those who successfully passed an evaluation exam were awarded the Huawei Cloud Computing Certificate, an internationally recognized credential. This initiative aims to enhance students' technical skills and prepare them for global technology standards in cloud computing.[130]

Türkiye's educational advancements in 2024 not only bridged existing gaps but also redefined the role of education as a strategic pillar in its broader technological vision. By fostering innovation, enhancing digital literacy, and prioritizing international collaboration, Türkiye demonstrated its commitment to leveraging education as a tool for national development and global influence. This multifaceted approach ensures that Türkiye remains a dynamic player in the international system, where education and technology converge to shape sustainable, inclusive, and competitive growth.

128 Nazir Aliyev Tayfur, "Kırgızistan'daki Türk Devletleri Teşkilatı Yapay Zeka Forumu'nda Uluslararası İşbirliğinin Önemi Vurgulandı," *Anadolu Ajansı*, (Ocotber 9, 2024), retrieved from https://www.aa.com.tr/tr/dunya/kirgizistandaki-turk-devletleri-teskilati-yapay-zeka-forumunda-uluslararasi-isbirliginin-onemi-vurgulandi/3356919.

129 "Emine Erdoğan, Bilim Bişkek İnovasyon Merkezi'nin Açılışını Yaptı," *TRT Haber*, (November 6, 2024), retrieved from https://www.trthaber.com/haber/bilim-teknoloji/emine-erdogan-bilim-biskek-inovasyon-merkezinin-acilisini-yapti-886808.html.

130 Arife Yıldız Ünal, "Üniversite Öğrencileri "Kodlama Maratonu"nda Projelerini Vitrine Çıkardı," *Anadolu Ajansı,* (October 9, 2024), retrieved from https://www.aa.com.tr/tr/bilim-teknoloji/universite-ogrencileri-kodlama-maratonunda-projelerini-vitrine-cikardi/3356086.

ENERGY

Growing energy demand globally and zero emission targets are creating two contradictory situations. Türkiye has set primary goals in line with the 2053 zero-emission targets, both to ensure energy supply security and meet the increasing electricity demand from sustainable and clean energy sources. On the other hand, to manage the gradual transition to clean energy with digital transformation and technological innovation, Energy and Natural Resources Minister Alparslan Bayraktar said that the energy transformation should be carried out equitably, considering the conditions of each country, and summarized the necessary strategy for Türkiye in the Smart Energy Transformation Strategy.[131]

Since energy demand increased by 8% in 2024, compared to 2023, the national energy strategy needs to be implemented more sensitively. At this point, there is a need for smart policies that provide a competitive ground that prioritizes people providing more innovation and technological development ground.[132]

131 "H.E. Alparslan Bayraktar on Türkiye's Energy Security, Regional Energy Dynamics, and Attracting FDI," *S&P Global CERAWeek Conversations SoundCloud*, (2021), retrieved from https://soundcloud.com/ceraweek-conversations/he-alparslan-bayraktar-on-Türkiyes-energy-security-regional-energy-dynamics-attracting-fdi.

132 "Dijital Teknolojilerle Entegre Bir Dönüşüm Sürecine İhtiyacımız Var," *PetroTurk*, (March 4, 2022), retrieved from https://www.petroturk.com/yenilenebilir-enerji-haberleri/dijital-teknolojilerle-entegre-bir-donusum-surecine-ihtiyacimiz-var.

There are five main pillars of the energy strategy for Türkiye to manage these complicated challenges coming with climate change and growing energy demand. These pillars are:

- Increasing renewable energy capacity,
- Increasing supply and demand-side energy efficiency and its awareness in the country,
- Accelerating new technologies such as hydrogen, electricity storage, and carbon capture capacity in the country,
- Ensuring the security of critical mineral supply required for these technologies and
- Expanding our nuclear energy capacity.[133]

> "Türkiye has set primary goals in line with the 2053 zero-emission targets, both to ensure energy supply security and meet the increasing electricity demand from sustainable and clean energy sources."

The year 2024 has been a period in which significant technological developments were implemented in Türkiye's energy sector. The installed electricity capacity increased from 109,500 MW to 115,000 MW by the end of 2023. While 57.3% of the installed capacity consists of renewable energy sources, natural gas stands at 22.4%, domestic coal at 10.6%, and imported coal at 9.7%.[134] The state's share in the electricity sector continues to decrease. While Electricity Production Inc. (EÜAŞ) was responsible for 48.9% of production in 2010, this figure decreased to 19% in 2024. The most important item in the energy transition in recent years is the acceleration of the transition to renewable energy. Solar energy investments have a large share here. On the other hand, 6.5% of the 8% increase in energy demand is due to renewable energy. The place of natural gas in the installed capacity has also decreased by 1%.[135]

When we assess the resource rates in electricity generation in installed power capacity, renewable energy resources reached 66% in the first monthly figures in 2024. Around 18% of this comes from solar and wind, whereas this rate

133 "Bakan Bayraktar, COP29'da Türkiye'nin Enerji Dönüşümü Hedeflerini Anlattı," *T.C. Enerji ve Tabii Kaynaklar Bakanlığı*, (November 12, 2024), retrieved from https://enerji.gov.tr/haber-detay?id=21399.

134 "Electricity," *Republic of Türkiye Ministry of Energy and Natural Resources*, (January 12, 2025), retrieved from https://enerji.gov.tr/infobank-energy-electricity.

135"Bakan Bayraktar, COP29'da Türkiye'nin Enerji Dönüşümü Hedeflerini Anlattı," *T.C. Enerji ve Tabii Kaynaklar Bakanlığı*.

was 16% in 2023. In contrast, the share of imported resources decreased to 34%. There is also a sufficient market for the development of domestic solar technologies in Türkiye.[136]

In 2024, Türkiye introduced its National Energy Efficiency Action Plan (2024-2030), designed to guide efforts from 2024 to 2030. The plan outlines 61 strategic actions and 265 specific activities across key sectors, including buildings, industry, transportation, and agriculture. A strong emphasis is placed on technology, digital transformation, and innovation throughout the plan. In particular, digital transformation plays a pivotal role in the "Energy Transformation in the Public Sector" initiative, which includes measures such as IoT integration, incentives for big data platforms, and the establishment of specialized renewable energy clusters.[137]

In the field of natural gas, a localization process commenced in the data control, monitoring, and management systems of Türkiye's National Gas Transmission Company (BOTAŞ). The National SCADA system has been localized in Batman Dörtyol Crude Oil Pipeline, with ASELSAN's assistance. The vision is to localize the national SCADA system of the entire national gas infrastructure.[138] Also, to reach more efficient business processes, BOTAŞ has been commissioned a national ERP system, KOVAN – a domestic and national Enterprise Resource Management developed by HAVELSAN. In this context, purchasing management, material management, stock management, and warehouse management modules have been put into operation as of October 2024.[139] KOVAN is a new-generation business management system developed for public institutions, military institutions, and the private sector. It ensures that internal business processes are managed in a reliable, easy, and traceable manner under an integrated system. Thanks to its unique platform structure, it eliminates dependence on foreign licenses and ensures that strategic data is stored on domestic systems.[140]

Furthermore, ambitious targets have been set in the Renewable Energy Program in the 2024-2028 strategic plan. It is planned to increase the current

136 "Electricity," *Republic of Türkiye Ministry of Energy and Natural Resources*.

137 "Yenilenebilir Enerjide 2035 Yol Haritası," *T.C. Enerji ve Tabii Kaynaklar Bakanlığı*, (October 21, 2024), retrieved from https://enerji.gov.tr/haber-detay?id=21380.

138 Göksel Yıldırım, "BOTAŞ'ın Petrol ve Doğal Gaz Şebekeleri ASELSAN'a Emanet," *Anadolu Ajansı*, (March 2, 2024), retrieved from https://www.aa.com.tr/tr/bilim-teknoloji/botasin-petrol-ve-dogal-gaz-sebekeleri-aselsana-emanet/2161579.

139 "Yerli Kurumsal Kaynak Planlama (ERP) Sistemi KOVAN'ı Devreye Aldık!" *BOTAŞ*, (November 4, 2024), retrieved from https://www.botas.gov.tr/Icerik/yerli-kurumsal-kaynak-planlama/1041.

140 "Anasayfa," *Havelsan Kovan*, retrieved from https://kovan.works.

installed power of 30,000 MW in solar and wind to 120,000 MW by 2035 and to create an investment ecosystem of $80 billion for this purpose.[141]

Türkiye has significantly expanded its domestic solar panel production capacity, reflecting a growing commitment to renewable energy. The number of solar panel manufacturers has surged from just 5 in 2015 to 37 in 2024, highlighting the sector's rapid development and increased local manufacturing capabilities.[142]

> "In the field of natural gas, a localization process commenced in the data control, monitoring, and management systems of Türkiye's National Gas Transmission Company (BOTAŞ)."

As a key pillar of Türkiye's renewable energy strategy, wind energy continues to gain momentum with significant advancements in domestic production and export capacity. To enhance its global competitiveness, Türkiye has accelerated domestic wind turbine production, expanding its reach to international markets, particularly in the Balkan countries. As of 2023, wind energy exports reached $2.2 billion, and this figure is expected to grow further in 2024, reinforcing Türkiye's position as a key player in the renewable energy sector. [143]

There has also been a notable increase in collaborations on energy storage systems, particularly in battery technologies. New facilities have been established through partnerships between ASELSAN and TÜBİTAK to support the domestic production of lithium-ion batteries. These advancements play a crucial role in integrating renewable energy sources into the grid, enhancing energy sustainability and efficiency.[144]

As part of its commitment to clean energy transformation, Türkiye is actively advancing its efforts in hydrogen energy research and development. The Türkiye Hydrogen Technologies Strategy and Roadmap is currently in progress, reflecting the country's recognition of hydrogen as a strategic pri-

141 "Dijital Teknolojilerle Entegre Bir Dönüşüm Sürecine İhtiyacımız Var," *PetroTurk*.

142 "Türkiye'de Güneş Paneli Üretici Sayısı 37'nin Üzerinde," *Yeşil Haber*, (August 29, 2024), retrieved from https://yesilhaber.net/turkiyede-37-gunes-paneli-ureticisi-var/#:~:text=Enerji%20Piyasası%20Düzenleme%20Kurumu%20(EPDK, this%20number is%20above%2037.

143 Gülşe Çağatay, "Türkiye Rüzgar Sanayisinden Ekonomiye 2,2 Milyar Dolarlık Katkı," *Anadolu Ajansı*, (July 24, 2024), retrieved from https://www.aa.com.tr/tr/enerjiterminali/finans/turkiye-ruzgar-sanayisunu-ekonomiye-2-2-milyar-dolarlik-katki/42622.

144 "Sanayi ve Teknoloji Bakanı Mustafa Varank ASPİLSAN Enerji'yi Ziyaret Etti," *Aspilsan*, (February 7, 2023), retrieved from https://www.aspilsan.com/aspilsan-enerji-silindirik-lityum-iyon-pil-tesisi/#:~:text=Tesis%20Ocak%202022'de%20faaliyete,ile%20Temmuz%202022'de%20gerçekleştirildi.

ority. With a focus on expanding green hydrogen production capacity, this roadmap outlines a comprehensive plan to drive innovation and sustainability in the sector.[145]

In the field of nuclear energy, equipment was supplied from Türkiye within the scope of supporting domestic manufacturing, and the development of domestic products was encouraged. It was also stated that new support could be provided in 2025 for the development of domestic products at the plant, where a total of $664 million worth of domestic product equipment was supplied.[146]

> "In today's rapidly evolving landscape, "energy transition" and "digital transformation" are not merely options, but necessities for those striving to remain competitive and complicated conditions in the global arena."

Energy and Natural Resources Minister Alparslan Bayraktar said they aim to commission all four reactors of Akkuyu Nuclear Power Plant (NPP) by 2028 and that the power plant will meet 10% of Türkiye's electricity needs.[147] The final stage of turbine plant installation in the first unit of the power plant has already been reached.[148]

Lastly, it is crucial to highlight the importance of cybersecurity in the energy sector, which is recognized as a critical infrastructure essential to national security. Strengthening cybersecurity solutions and enhancing human resources for the effective use of domestic technologies remain key priorities for the Energy and Natural Resources Ministry, ensuring resilience and protection against emerging threats.[149] As mentioned earlier, BOTAŞ, for instance, has been working with ASELSAN to localize cybersecurity critical infrastructure in the national SCADA system.

145 "2024-2028 Stratejik Planı," *T.C. Enerji ve Tabii Kaynaklar Bakanlığı*, retrieved from https://enerji.gov.tr/Media/Dizin/SGB/tr/Kurumsal_Politikalar/ETKB_2024-2028_Stratejik_Plani.pdf; "Türkiye Hidrojen Teknolojileri Stratejisi ve Yol Haritası," *T.C. Enerji ve Tabii Kaynaklar Bakanlığı*, retrieved from https://enerji.gov.tr/Media/Dizin/SGB/tr/Kurumsal_Politikalar/HSP/ETKB_Hidrojen_Stratejik_Plan2023.pdf.

146 Ayşe Böcüoğlu Bodur, "TSE, Akkuyu NGS'de 664 Milyon Dolarlık Yerli Ürün Kullanılmasını Sağladı," *Anadolu Ajansı*, (September 20, 2024), retrieved from https://www.aa.com.tr/tr/ekonomi/tse-akkuyu-ngsde-664-milyon-dolarlik-yerli-urun-çokilmasini-sagladi/3335690.

147 "Bakan Bayraktar'tan Akkuyu Nükleer Güç Santrali Açıklaması," *Hürriyet*, (September 8, 2024), retrieved from https://www.hurriyet.com.tr/gundem/bakan-bayraktartan-akkuyu-nukleer-guc-santrali-aciklamasi-42524680.

148 "Erdoğan ve Putin, Akkuyu Nükleer Santrali Töreni'ne Canlı Bağlantı ile Katıldı," *BBC*, retrieved from https://www.bbc.com/turkce/live/haberler-turkiye-65407863.

149 Alparslan Bayraktar, *X*, 1:08 AM, (October 8, 2024), retrieved from https://x.com/aBayraktar1/status/1843593813425553609.

In conclusion, as of 2024, Türkiye made significant strides in advancing domestic energy technologies, driven by strategic ministry initiatives, R&D projects, and university collaborations. This progress aimed to enhance competitiveness in both domestic and international markets, fostering innovation and sustainability. These developments are expected to play a crucial role in strengthening energy independence and economic growth. In today's rapidly evolving landscape, "energy transition" and "digital transformation" are not merely options, but necessities for those striving to remain competitive and complicated conditions in the global arena.

CONCLUSION AND POLICY RECOMMENDATIONS

As Türkiye continues its ascent as a formidable player in the global technology landscape, 2024 stands as a defining year in its journey. Our survey results confirm that Türkiye is performing well in various technological domains, reinforcing its strong foundation and potential for further growth. The high expectations for 2025 reflect the confidence in Türkiye's ability to drive innovation and expand its leadership in emerging technologies. While significant progress has been made in artificial intelligence, 5G, and cybersecurity, continued strategic investments and policy initiatives will be crucial in maintaining this momentum.

Türkiye's impressive R&D spending of TL 1 trillion ($127.5 billion) over the past decade highlights its unwavering commitment to fostering innovation across diverse sectors. This investment underscores the country's strategic focus on sustainable development and global competitiveness, ensuring that Türkiye remains at the forefront of technological and scientific advancements. As the nation embarks on its second century, it must embrace renewed am-

bition, setting high standards to become a transformative force in cutting-edge technologies. Türkiye's influence extends beyond its borders, and its technological advancements resonate with brotherly nations, partners, and regions that share a common history and culture. Through resilience, unity, and innovation, Türkiye stands as a beacon of strength, driving progress not only for itself but also for the global community. To sustain this momentum and ensure continued progress, Türkiye must implement comprehensive policy measures that further strengthen its digital ecosystem.

> "The high expectations for 2025 reflect the confidence in Türkiye's ability to drive innovation and expand its leadership in emerging technologies. While significant progress has been made in artificial intelligence, 5G, and cybersecurity, continued strategic investments and policy initiatives will be crucial in maintaining this momentum."

1. **Increasing investment** in research and development is essential. Expanding funding programs through institutions such as TÜBİTAK and KOSGEB to support artificial intelligence, semiconductors, and emerging technologies will accelerate domestic innovation. HIT-30 is a perfect example of this and more initiatives like this will provide the necessary incentives for innovation. Specifically, sector-driven innovation funds and establishing related ecosystems in critical infrastructures may accelerate the contribution of the private sector in prior projects. Providing tax benefits and subsidies to companies investing in local technology development will encourage private sector participation while establishing more AI-focused venture capital funds can further stimulate technological growth.
2. Türkiye's technological development is strong across multiple sectors and the outlook for 2025 remains highly positive. While defense is considered the primary area of success and will remain a key focus in 2025, Türkiye should adopt a **holistic approach**, ensuring that advancements across various sectors complement and reinforce one another.
3. As Türkiye advances its AI programs and technological developments, **establishing an AI Directorate**, similar to that of Cybersecurity, will provide a structured and coordinated approach to AI governance, development, and ethical implementation.
4. Türkiye must establish its own **AI Safety Institute** to ensure it remains at the forefront of global AI governance and security. In recent years, numerous countries, including the United States, United Kingdom, Aus-

tralia, Canada, and Japan, have founded similar institutes (with some variations in name, such as the U.K.'s rebranding from the AI Safety Institute to the AI Security Institute). These institutes play a crucial role in assessing and mitigating the risks posed by advanced AI systems.

One of the most significant aspects of these organizations is their collaborative efforts, which greatly influence global AI regulations. For instance, in April 2024, the AI Safety Institutes of the U.K. and the U.S. signed a landmark agreement to jointly test advanced AI models, share research insights, and facilitate expert talent exchanges. Additionally, on Nov. 20–21, 2024, AI safety institutes and government-mandated offices from Australia, Canada, the European Commission, France, Japan, Kenya, South Korea, Singapore, the U.K., and the U.S. convened in San Francisco for the inaugural meeting of the International Network of AI Safety Institutes. This initiative marks a pivotal step toward enhanced international cooperation on AI safety. Given these global developments, Türkiye must establish its own AI Safety Institute. Doing so would not only strengthen national AI security but also position Türkiye as an active participant in shaping international AI safety standards and policies.

5. A crucial component of Türkiye's digital strategy is **strengthening its AI and digital infrastructure**. In order to develop AI-driven progress, prioritizing 5G deployment and expanding fiber-optic networks will enhance connectivity, while developing a national AI cloud infrastructure will provide critical support for startups and research initiatives. Additionally, investing in supercomputing centers dedicated to AI and semiconductor research will bolster Türkiye's technological capabilities and competitiveness on the global stage.
6. Our survey clearly highlighted the need to **improve public awareness** through the significance of digital transformation **and the adoption of domestic technologies**. National campaigns promoting Turkish-made software and AI solutions will increase public trust and engagement. At this point, Türkiye can leverage influencers and social media platforms to enhance outreach. Organizing conferences and panels through various institutions, starting from high schools and universities, will help build a culture of technological innovation. Government procurement of domestic technologies, particularly in the public sector, should set an example for the private sector, demonstrating the viability and efficiency of local innovations. Additionally, organizing technology summits, fairs, and public demonstrations will further showcase Türkiye's advancements and encourage the integration of digital solutions into everyday life. This

will increase public confidence in domestic technologies and help build a stronger foundation for Türkiye's digital ecosystem.

7. **Enhancing collaboration between academia and industry** is another key priority. Establishing university-led innovation hubs and tech incubators will bridge the gap between research and commercial application. Mandating internship programs for students in AI, robotics, and digital industries will prepare a skilled workforce ready to meet industry demands. Incentivizing private-sector partnerships with universities for AI research projects will further solidify Türkiye's position as a leader in technological innovation. Türkiye can also introduce programs to attract Turkish students studying abroad or create initiatives to maintain strong connections with them. These incentives, designed to reverse brain drain, will expand Türkiye's highly skilled workforce, strengthening its position in the global technology landscape and providing a significant competitive advantage.

> "Through resilience, unity, and innovation, Türkiye stands as a beacon of strength, driving progress not only for itself but also for the global community."

8. To bridge the gap between the government and private sector in fostering innovation, Türkiye should **establish dedicated institutions that facilitate closer cooperation between the government and private sector**. Drawing inspiration from successful international models such as the Defense Innovation Unit (DIU) in the U.S.**,** such institutions can serve as a crucial link between policymakers and technology developers. These entities would not be limited to military advancements but would focus on accelerating innovation in diverse sectors, including AI, cybersecurity, and digital transformation. By fostering stronger government-industry collaboration, Türkiye can ensure that cutting-edge technological solutions are effectively integrated into national development strategies and public services.

9. **Building a skilled workforce and retaining talent** is critical for sustaining Türkiye's technological progress. Revamping STEM education to align with the needs of emerging technologies will ensure that graduates possess the skills required for the digital economy. Offering competitive salaries and research grants will help prevent brain drain, while government-backed scholarships and fellowships for students specializing in AI and semiconductors will cultivate the next generation of innovators.

10. From an international perspective, Türkiye is increasingly recognized as an important technological actor on the global stage. For this reason,

technology diplomacy should become one of the main pillars of its foreign policy, reflecting the rising significance of technology in international relations.

11. In connection with its technological diplomacy, expanding **international technology partnerships** will further enhance Türkiye's global standing. For instance, developing joint R&D projects with South Korea and Japan in robotics and space technologies will enhance Türkiye's capabilities in high-tech industries. Based on our survey results, Türkiye is expected to maintain a balanced approach to technological cooperation with both the U.S. and China.

    Furthermore, **strengthening regional cooperation** is a strategic move that will accelerate Türkiye's technological advancement. Our research highlights Turkic states as the most promising region for mutually beneficial technology partnerships. Türkiye's strong defense industry provides a key advantage in deepening collaboration with regional partners. Expanding cooperation in digital infrastructure, artificial intelligence, renewable energy, and semiconductor technologies will help establish a comprehensive and sustainable partnership ecosystem. Beyond defense sector alliances, initiatives such as academic exchange programs, joint R&D centers, and technology transfer projects will foster a robust innovation ecosystem among Turkic states. Building a more integrated technology network will enable the region to gain greater influence in the global tech landscape. By amplifying regional partnerships, Türkiye can not only enhance its own technological capabilities but also empower its partners, solidifying its role as a leading regional technology hub in global competition.
12. **Boosting domestic semiconductor production and data centers** is another critical step. Establishing semiconductor manufacturing plants through public-private partnerships will reduce import dependency and enhance self-sufficiency in critical technologies. Incentivizing chip design startups and supporting R&D initiatives in semiconductor technologies will further develop Türkiye's role in the global technology supply chain.
13. **Commissioning new data centers** within the country should be a top priority to safeguard critical data and ensure the security of our digital infrastructure. In this context, raising awareness about the potential risks associated with unrestricted cross-border data flows, as well as the benefits of national data governance, is essential. To this end, policymakers should prioritize concepts such as data independence, data privacy, and data sovereignty, while also leading efforts to enhance literacy and awareness regarding the Digital Homeland, ensuring a deeper understanding of its importance and implications.

14. **Encouraging innovation in the energy sector** is essential for positioning Türkiye as an important actor in the global green energy transition. In particular, advancing smart grid technologies and integrating renewable energy resources into the National SCADA System should remain key priorities. To accelerate this transformation, the Energy Market Regulatory Authority's R&D incentives, national cloud companies, and the initiatives of cybersecurity firms in protecting critical infrastructure and developing strategic projects will play a crucial role. Investments in smart grids, AI-driven energy optimization, demand forecasting models, and predictive maintenance projects for natural gas and electricity distribution will enhance policy efficiency, operational effectiveness, and long-term sustainability. Additionally, supporting public-private initiatives focused on green AI and energy-efficient technologies will ensure that Türkiye's digital transformation is aligned with global environmental objectives.

Türkiye's digital transformation is not merely an option but a necessity in the evolving global order. To maximize the benefits of the digital economy while protecting national sovereignty, Türkiye must continue to embrace innovation with a strategic and forward-thinking approach. By fostering a resilient digital ecosystem, strengthening its AI and technology sectors, and ensuring sustainable and inclusive growth, Türkiye is well-positioned to lead the next wave of global technological advancements. Under the visionary leadership of President Erdoğan, and with steadfast determination, Türkiye's rise as a hub for advanced technologies will not only affirm its technological independence as a great power but also catalyze global digital transformation and innovation. It is important to state that every technological advancement within Türkiye will create a positive ripple effect throughout the region and among its allies and brother nations, further solidifying its influence in the global technology landscape.

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2025 Techpulse Türkiye
Tracking Technological Innovation and Trends

Gloria Shkurti Özdemir, Erman Akıllı, Safa Uslu

The 2025 TechPulse Türkiye provides a comprehensive analysis of Türkiye's technological advancements, policies, and strategic positioning in the global innovation landscape during 2024. This report evaluates the country's progress across key sectors, including artificial intelligence (AI), defense technologies, digital transformation, semiconductors, telecommunications, energy, and education. It highlights Türkiye's efforts to enhance its technological ecosystem through national initiatives such as the National Technology Initiative, the National AI Strategy, Public Cloud Computing Strategy, and large-scale investments in R&D, infrastructure, and digitalization.

Focusing on the technological developments of 2024 and projections for 2025, the report examines Türkiye's innovation trajectory, the impact of global technological developments, and the country's regional and international collaborations in fields such as AI, 5G, and defense technology. Through expert interviews and surveys, it provides insights into Türkiye's strengths and areas for growth in the evolving global technology landscape.

By offering strategic insights and policy recommendations, the 2025 TechPulse Türkiye serves as a critical resource for policymakers, industry leaders, and researchers seeking to navigate the country's evolving tech landscape and global positioning.

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