

An Overview of the Twin Transformation Process in Türkiye

Emerging
Trends *in*

APO Members

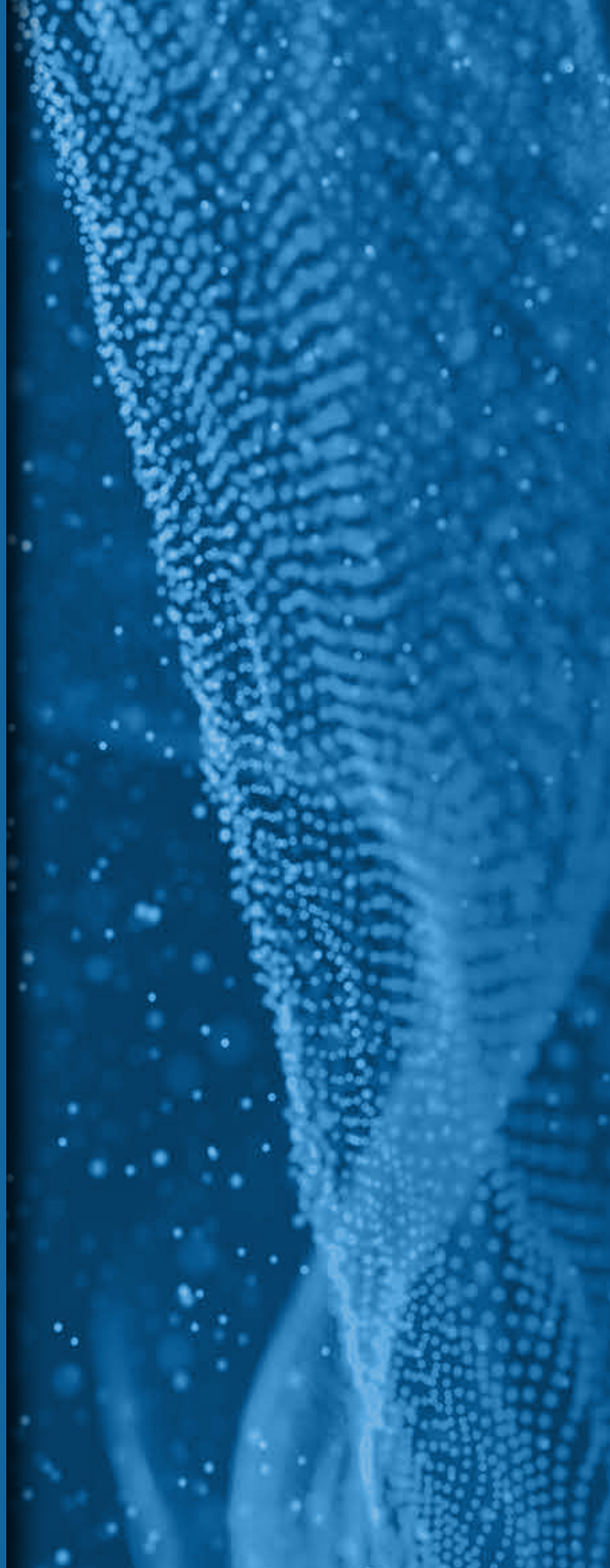
Asian Productivity Organization



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EMERGING TRENDS IN APO MEMBERS:

AN OVERVIEW OF THE TWIN TRANSFORMATION PROCESS IN TURKIYE

EMERGING TRENDS IN APO MEMBERS:
AN OVERVIEW OF THE TWIN TRANSFORMATION PROCESS IN TURKIYE

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PREFACE

This publication on *Emerging Trends in APO Members* is aimed at enabling better navigation of the volatility, uncertainty, complexity, and ambiguity (VUCA) landscape. In today's turbulent, unpredictable world, the APO adopts a country-specific approach to understand and analyze emerging trends and driving forces that will have significant effects on member economies in terms of productivity and competitiveness. This series of reports introduces several emerging trends with the potential to disrupt and transform markets, governments, and society now and in the near future. It is hoped that through these publications analyzing those impactful trends, governments, policymakers, and ordinary citizens from all walks of life will be able to harness those driving forces while coping with critical uncertainties.

Recommended approaches and methods to address the challenges ahead include political, economic, social, technological, legal, and environmental perspectives. Being future-ready requires such a comprehensive approach to informed decision-making by governments, enterprises, and individuals in the fast-changing environment in the Asia-Pacific region. For the APO, it is all about early identification of issues and prospects, which requires strengthening its role as a think tank and regional adviser on productivity in the region.

The APO thanks all contributors to the report. We hope that it will benefit those seeking to improve productivity and quality of life brought about by emerging trends in a rapidly changing world.

AN OVERVIEW OF THE TWIN TRANSFORMATION PROCESS IN TURKIYE

Abstract

Technological developments throughout history have introduced many new concepts, and these developments have impacted environmental, social, and economic life in diverse ways. Increasing environmental issues and innovations in digital technology are driving societies toward a more sustainable and productive future across various sectors. The climate crisis, which has been on the agenda for a number of years through international agreements and numerous panels, has become an inevitable reality worldwide. The EU's Green Deal (GD) of 2019 outlines the essential steps to address the climate crisis and aims for a zero-carbon target by 2050. The GD seeks to develop comprehensive and transformative strategies, supported by digitalization. At this point, the concept of "twin transformation", which integrates green and digital transformation, has emerged as a priority on national agenda in recent years. This approach impacts Turkiye, as it does other countries, prompting the development of a number of policies. With Turkiye's adoption of the GD, many sectors are expected to be affected by this transformation. As one of Turkiye's key export gateways, the EU transition is vital for Turkiye's competitiveness and economic balance. This study aims to examine the concepts of green, digital, and twin transformation and to provide important insights by evaluating their practices in Turkiye.

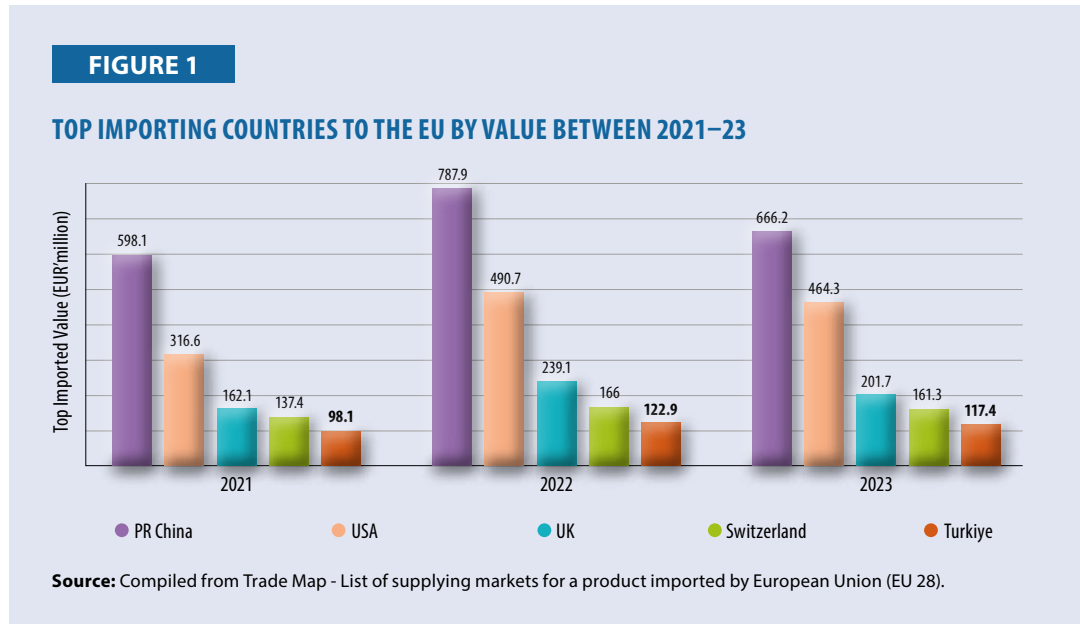
Introduction

The EU has embarked on a comprehensive transformation process in line with the goals of GD and digital transformation. These goals will impact not only EU member states but also its major trading partners, neighboring countries, and other international actors. The influence of these changes on the EU's economic and trade relations with other countries will significantly affect Turkiye [1]. There are increasing signs that this EU-led wave of change will have a global impact in the coming years. Public institutions, the private sector, NGOs, and international organizations around the world are discussing and preparing for ways to adapt to the GD [2].

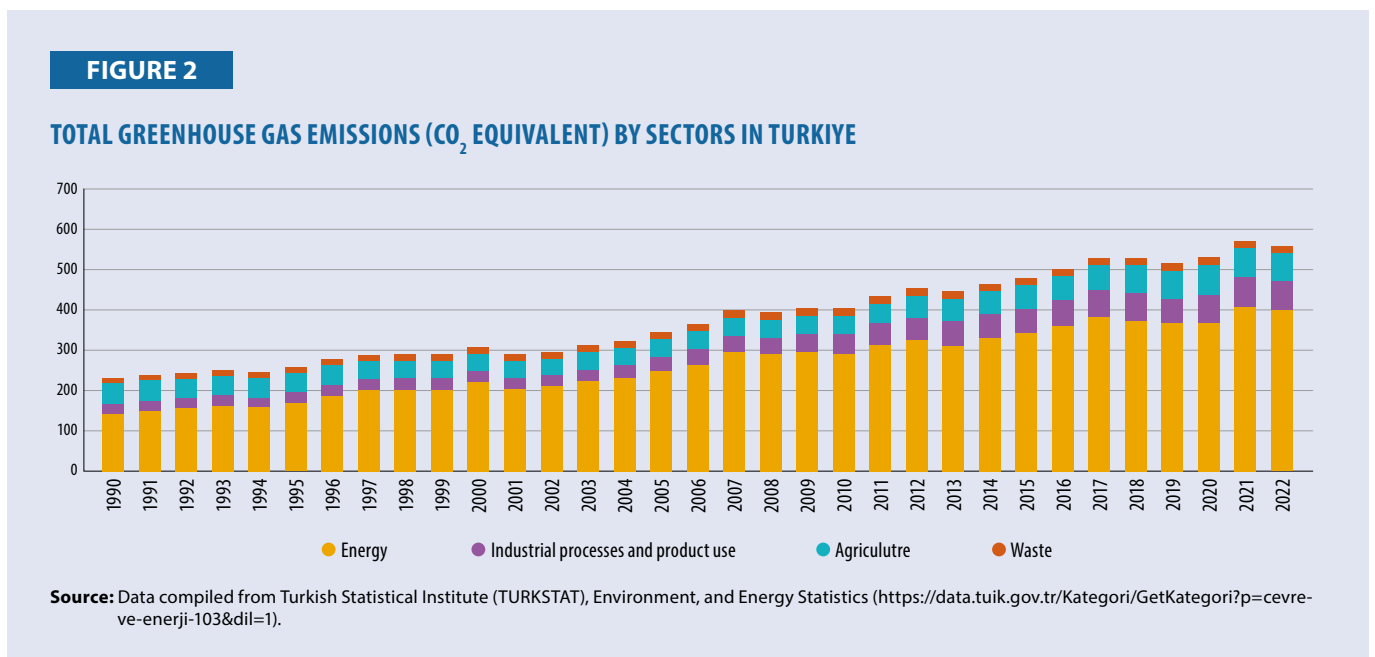
The GD includes comprehensive and transformative plans, requiring fast and effective solutions, especially with the support of digitalization. At this point, strategic planning of the transition is becoming crucial in order to ensure a successful transition for each country [3]. The green and digital transformation, referred to as the "Twin Transformation" within the GD framework, requires economic, social, and environmental adjustments. This transformation aims to adopt greener and more digital approaches across various sectors, especially industry, and reshaping value chains and creating new jobs and opportunities. While the EU plays a pioneering role in twin transformation, Turkiye is developing a parallel twin-transformation strategy and vision.

According to the European Commission's international trade data, Turkiye is the EU's fifth largest trading partner in 2023, accounting 4.1% of the EU's total trade in goods globally (up from 3.3% in 2022). In 2023, EU exports of goods to Turkiye totaled EUR111 billion while EU imports from Turkiye amounted to EUR95.5 billion [4].

As of 2021, when Turkiye signed the Paris Agreement, it stands out as one of the major trading partners of the EU, as shown in Figure 1. Turkiye’s high export potential to the EU indicates that it will be one of the countries most impacted by the EU's GD.



According to the World Bank's 2024 report [5], Turkiye needs to invest USD165 billion in 20 years to achieve net zero. However, green transformation could result in a net economic gain of USD146 billion in that period by increasing Turkiye's competitiveness, export potential, and reducing energy costs. Therefore, it is crucial for Turkiye to carry out green and digital transformations simultaneously. In this context, this study aims to provide an in-depth examination of Turkiye’s transformation process.



Turkiye's Green Transformation Process

In the fight against climate change, green transition policies have a major impact on industry, trade, technology, and employment. Therefore, the Climate Act and similar regulatory legislation play a critical role in defining Türkiye's future vision.

Figure 2 shows that Türkiye's total greenhouse gas emissions by sector contribute significantly to global emissions. This reveals the need for innovation and sector-wide solutions to combat climate change effectively. In this context, key policies, activities, and projects undertaken in Türkiye are summarized as the following:

i) **Development of National Life Cycle Assessment Database Project (2021)**

This project, carried out by the Ministry of Industry and Technology (MoIT) and the Scientific and Technological Research Council of Türkiye (TUBITAK) Marmara Research Centre Environment and Clean Production Institute, aims to establish the technical and statistical infrastructure to increase energy and resource efficiency in industry and reduce greenhouse gases. Data set studies for this project are ongoing [6].

ii) **GD Action Plan (2021) and Green Growth Technology Roadmap (2022)**

Türkiye accelerated its green transformation activities after ratifying the Paris Agreement in 2021. In this process, a GD Action Plan was created to guide industry toward green investments in order to comply with EU climate targets. In addition, a "Green Growth Technology Roadmap" was developed for the iron and steel, aluminum, cement, chemical, plastic, and fertilizer sectors, which aim to reduce carbon emissions. This roadmap identified the technologies and solutions required to enhance green production in industry [7].

iii) **Horizon Europe Programme**

This program supports science and innovation activities in various areas, such as public health, climate change, oceans, smart cities, soil health, and food. The program has a budget of EUR95.5 billion for the period 2021–27. In Türkiye, the program is coordinated by TUBITAK [8].

iv) **Türkiye Green Industry Project (2023)**

This project seeks to promote the green transformation of industrial companies in Türkiye, accelerate decarbonization, increase technical capacity, and strengthen export competitiveness. It is conducted by MoIT, Small and Medium Enterprises Development Organisation (KOSGEB), and TUBITAK, with support from the World Bank [9].

v) **Green Transformation Support Programme (2024)**

In Türkiye, "Green Transformation Support Programme" is implemented to drive green transformation in industry. This program is managed by MoIT, which supports investments that advance the circular economy, conserve natural resources, and achieve climate and sustainability goals, with a focus on resource-efficient, low-carbon production [10].

vi) **Climate Change Mitigation Strategy and Action Plan (2024–30)**

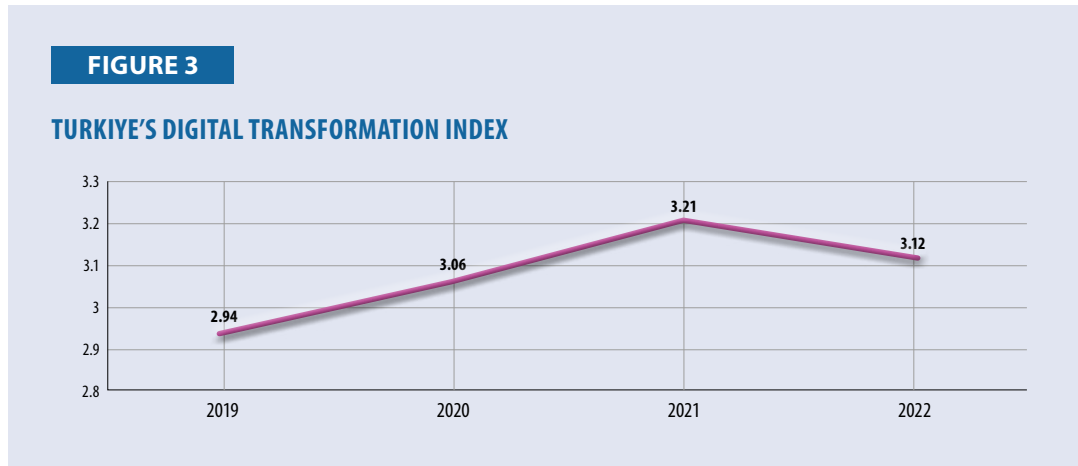
Prepared by the Ministry of Environment, Urbanisation and Climate Change, this action plan includes 49 strategies and 260 actions across sectors, such as industry, energy, buildings, transport, waste, agriculture, and forestry. Adopting a participatory approach, the plan provides a roadmap for relevant organizations with clear strategies and actions to reduce greenhouse gas emissions [11].

vii) Promoting Greenhouse Gas Reduction in the Steel Sector Project (2024)

This project, a collaboration between Japan International Cooperation Agency (JICA) and the General Directorate of Industry of MoIT, aims to promote greenhouse gas reduction efforts in the steel sector [12].

Turkiye's Digital Transformation Process

According to the Turkish Informatics Industry Association (TUBISAD) report [13], Turkiye's Digital Transformation Index scores were 2.94, 3.06, and 3.21 from 2019 to 2021, respectively. However, progress in digital transformation slowed down in 2022.



Key advisory services, policies, and projects to accelerate digital transformation in Turkiye are summarized as the following:

i) Turkiye's Digital Transformation Competence in Industry (2017)

The first comprehensive study on Turkiye's digital transformation process was conducted by the Turkish Industry and Business Association (TUSIAD). The study assessed the effects of digital transformation and the level of transformation readiness of the Turkish industrial sector [14].

ii) Istanbul Chamber of Industry Office (ISO) for Digital Transformation in Industry (ISO Digital) (2018)

ISO Digital provides digital maturity analyses, consultancy, and training services to ISO member companies. It also supports the transformation of the industry toward a technology-producing structure by collaborating with domestic technology business partners [15].

iii) Presidency Digital Transformation Office (2018)

The Digital Transformation Office, established under the Presidency of the Republic of Turkiye, aims to unite digital transformation (e-Government), cybersecurity, national technologies, big data, and artificial intelligence (AI) initiatives, which were previously managed separately under various institutions. This centralization aligns with developing technologies, social demands, and reform trends in the public sector [16].

iv) Digital Turkiye Road Map (2018)

This roadmap, prepared by the Ministry of Science, Industry and Technology, aims to increase the competitiveness of Turkiye's manufacturing industry and guide the digitalization process. The program envisages an extensive transformation impacting both the society and industry [17].

v) Istanbul Ready-to-Wear and Apparel Exporters' Association (IHKIB) Digital Transformation Centre (2018)

This project, funded as part of the Instrument for Pre-Accession Assistance (IPA) Project, was implemented within the scope of the Competitive Sectors Programme by MoIT and established a Digital Transformation Centre within IHKIB. The center carries out activities to create infrastructure and provide support to increase the digital skills of companies and entrepreneurs in Turkiye's ready-to-wear and textile sectors [18].

vi) Capability and Digital Transformation Centres (Model Factories) (2018–25)

The Model Factories, established by MoIT in Turkiye's major industrial hubs, offer hands-on training and guidance on lean production and digital transformation. These centers aim to become industry hub of excellence while serving the industry and aim to increase the productivity of companies [19].

vii) MEXT Technology Centre (2020)

MEXT, founded by the Turkish Metal Industrialists' Union (MESS), is the world's largest digital transformation and competence development center. Designated as the World Economic Forum (WEF) Fourth Industrial Revolution Centre by MoIT, the center provides comprehensive digital maturity assessments, which is the largest "digital transformation in industry" initiative in the world. The center leads pioneering studies in areas, such as mobility, AI, and talent transformation as well as generates highly specialized information [20].

viii) Technology-Focused Industrial Movement Programme (2021)

This special program is to consolidate the support and incentives provided by MoIT and its affiliated/related institutions on medium-high and high-tech sectors by managing them from a single platform, in line with the aim of increasing value-added production in Turkiye [21].

ix) National Artificial Intelligence Strategy (2021–25)

Jointly prepared by the Presidency's Digital Transformation Office and MoIT, this document serves as Turkiye's first national AI strategy. It outlines measures and a strong governance framework that will unify AI efforts across sectors for the 2021–25 period [22].

x) Middle East Technical University (METU) Digital Innovation Centre (2021–24)

The project, which is carried out within the scope of IPA, is conducted in cooperation with the Turkish Machinery Federation (MAKFED) and METU Teknokent and with the support of automotive sector NGOs. The project aims to boost R&D capacities of digital technologies and support the digital transformation of small and medium enterprises (SMEs) through the cooperation of academia and industry as well as to assist public institutions in policy making [23].

xi) Turkiye's Digital Transformation Index (2022)

This study, prepared by TUBISAD, covers the legislation, infrastructure, usage, and skills related to digital transformation as well as the economic and social impacts of transformation. It assesses Turkiye's readiness and performance in digital transformation and identifies areas that need improvement [13].

xii) Beyond Recovery through Digitalization of SMEs (Digital Road) Project (2022)

Developed in collaboration with MoIT, General Directorate of Development Agencies, and UNDP, this project aims to increase the digitalization level of SMEs in the manufacturing industry and tourism sector in Turkiye and contribute to the digital transformation ecosystem. Within the scope of the project, SME Digitalization Platform was established to provide various

services, such as online digital maturity model, awareness content, digitalization supplier recommendation system, and financing support programs [24].

xiii) National Technology Movement

As part of Türkiye's 2023 Industrial and Technology Strategy, the National Technology Movement consists of five main components, which are: (i) high technology and innovation; (ii) digital transformation and industrial move; (iii) entrepreneurship; (iv) human capital; and (v) infrastructure. This strategy aims to accelerate the industry's digital transformation, increase high technology production, expand the role of research and development (R&D), invest in skilled manpower, and establish an economic order based on digitalization [25].

xiv) Digital Europe Programme

On 1 January 2023, Türkiye joined the EU's Digital Europe Programme through IPA. The program aims to enhance digital capacities and disseminate technology adoption across Europe. In Türkiye, the Digital Transformation Office of the Presidency and MoIT coordinate the program as well as support the digital transformation of SMEs, public institutions, and other stakeholders by establishing European Digital Innovation Centres [26].

xv) OZUBEX Industrial Transformation Centre (2023)

This project, developed through IPA in cooperation with the White Goods Suppliers Association, Ozyegin University, and TUSIAD, focuses on improving the digital transformation skills of SMEs within the white goods and subindustries sectors to increase their global competitiveness. In addition, the center assesses the digital maturity levels of SMEs and provides solutions to industry challenges through transformation roadmaps [27].

xvi) DDX Digital Transformation Evaluation Model (2023)

Developed by the Turkish Industrial Transfer and Administration Institute (TUSSIDE) under TUBITAK, the DDX model is an important tool for analyzing the current industrial landscape and creating a transformation roadmap. It connects businesses with Digital Transformation Consultants in the DDX Consultant Pool¹, guiding them through their digital transformation journey [28].

xvii) KOSGEB SME Digital Transformation Support Programme (2024)

This support program aims to improve the business processes of SMEs in Türkiye by supporting their digital transformation processes, increase their competitiveness, and strengthen their economic role [29].

Turkiye's Twin Transformation Process

The green and digital transformation initiatives described above have facilitated the transition toward twin transformation in Türkiye. Key studies initiated in Türkiye in this area are summarized as the following:

i) 14th Competition Congress 2022

The event brought together sector representatives, experts, and public organizations to assess the impact of twin transformation on competitiveness and provided a platform to discuss important strategies for the sustainable development of the country [30].

¹ The pool established by TUSSIDE for selecting consultants to apply the DDX Digital Transformation Assessment Model comprises individuals who have successfully completed the DDX Digital Transformation Consultant Development Programme and have been certified.

ii) Twin Transformation Product Development Project in Machinery Sector

This project, developed by the Association of Machinery and Components Exporters (MAIB), covers the period of 2022–25. It provides various training and consultancy services to companies in order to encourage and support green and digital transformation in the machinery sector. It also serves as a pilot study in this field [31].

iii) Medium Term Programme (MTP) (2023–25)

The MTP outlines 297 policies and measures under 10 main categories: growth, employment, financial stability, price stability, balance of payments, disaster management, public finance, business and investment environment, green transformation, and digital transformation. Among these categories, green and digital transformation are highlighted for their significant roles in combating climate change and fostering economic development [32].

iv) Ankara Chamber of Industry (ASO) (2023)

A cooperation protocol was signed between ASO and TUBITAK to facilitate ASO members' access to TUBITAK's digital and green transformation support. The protocol also aims to provide guidance and support in project development for industrialists [33].

v) 12th Development Plan (2024–28)

Turkiye's 12th Development Plan outlines twin transformation policies and targets under the theme "Competitive Production with Green and Digital Transformation". The plan emphasizes developing a skilled workforce and increasing export capacity through value-added production by adopting an approach focused on digitalization and green transformation [34].

vi) 100 SMEs' Twin Transformation Journey Project (2024)

This project, implemented in cooperation with İşbank and MEXT Technology Centre, aims to improve the production efficiency of 100 SMEs and accelerate their digital and green transformation processes. Within the scope of the project, MEXT will conduct transformation analyses for each SME and provide tailored roadmaps. When the project is completed, it is expected to provide important insights into the country's industrial transformation [35].

vii) Climate Change Mitigation Strategy and Action Plan (2024–30)

The document highlights the impact of twin transformation on investment, production, foreign trade, competition, and employment policies. It emphasizes the risks to sustainable and secure supply of raw materials, therefore stressing the importance of the National Strategic/Critical Raw Materials Strategy [11].

viii) Coordination Board for Improvement of Investment Environment (YOIKK) (2024)

In its Action Plan, YOIKK has placed digital and green transformation at its core, outlining the following actions [36]:

- Completion of labor force needs analysis while taking into account the effects of twin transformation
- Identification of skills in the occupations needed within the scope of twin transformation
- Development of training contents/modules that take into account the skills identified in the professions needed within the scope of twin transformation, realizing on-the-job training programs and vocational training courses
- Implementing incentive mechanisms to accelerate the green and digital transformation of the industry

ix) Twin Transformation Web Portal²

Within the framework of the National Technology Movement, the Directorate General for National Technology of MoIT is responsible for Türkiye's digital transformation while the Directorate General for Strategic Research and Productivity manages green transformation. A new platform has been developed to integrate these two transformation processes. The platform provides users with access to the latest information as well as includes calls for green and digital transformation support programs. The portal is designed to serve a broad audience who are interested in keeping up with transformation initiatives and taking advantage of new developments.

Twin Transformation: Green and Digital Transformation

Green Transformation

The concept is based on the Green Deal (GD) adopted by the EU in 2019. The agreement aims to combat the climate crisis and develop policies promoting clean energy and environmental sustainability across various sectors. Digitalization is one of the key players in achieving efficiency, which is a core theme of GD [3].

Green Transformation is an approach that focuses on environmental sustainability and resource efficiency, encompassing goals, such as reducing greenhouse gas emissions, improving energy efficiency, enhancing waste management, and promoting sustainable use of natural resources. At this point, green transformation not only creates positive impact on the environment but also supports economic growth [37]. In other words, green transformation is defined as a set of actions aimed to create a balance between economic growth and environmental protection based on the effective and rational use of available resources [38].

Green transformation relies on the realization and spread of innovations in technology, economics, social, behavior, and business models [39]. This makes it possible for green transformation to positively impact the society, the environment, and the economy. The key benefits for businesses, which play a critical role in green transformation, include [37]:

- Encourage the development of environmentally friendly products and processes, and provide innovation and competitive advantage
- Offer long-term cost savings through improved energy efficiency, waste reduction, and natural resources optimization
- Facilitate the transition to meet legal requirements and regulations by increasing compliance with environmental regulation standards
- Enhance the reputation of businesses committed to environmental responsibility
- Attract environmentally conscious customers to such businesses, thus ensuring customer loyalty

Digital Transformation

Digital Transformation is a way of enhancing business processes, services, and activities of an enterprise or a sector by adopting a more efficient, faster, and innovative approach based on digital technologies [40]. In other words, digital transformation is defined as the integration of digital technologies by enterprises into business operations, thereby renewing ways of doing business and customer interaction [41].

² The portal carried out by MoIT was opened for use on 5 August 2024 and will provide service via <https://ikizdonusum.sanayi.gov.tr/>.

Digital transformation has a major impact on many sectors, including education, healthcare, banking, and retail. For countries, this transformation is critical for development and economic strength. Effective use of digital technologies provides a competitive advantage and strengthens a country's position in the global market. These technologies include AI, Internet of Things (IoT), smart factories, big data, virtual and augmented reality, 5G, digital twins, 3D printing, cloud computing, e-commerce, blockchain, cybersecurity, remote working, drones, and digital payment systems [42].

Digital transformation is not only a process of rapid implementation of technological components; it is also a complete process of adaptation, involving a serious disengagement of social, cultural, political, economic, and environmental factors in the background [43]. When this process is well managed, digital transformation can bring many positive effects in terms of social, environmental, and economic domains. Digital transformation creates positive impacts on businesses with the advantages it provides, including [44]:

- Optimizes business processes, enables automation, and increases efficiency
- Enables more work to be done with less labor and increases operational profitability
- Minimizes human errors through software and robotic automation
- Frees up employees to create more value by reducing or eliminating unnecessary workload
- Reduces paper usage and optimizes energy and resource consumption, resulting in cost savings
- Ensures continuous operations since digital technologies can function without interruption
- Facilitates fast archiving, data access, data analysis, and reporting through use of software systems
- Improves sales and creates more effective marketing strategies with customer data insights
- Supports business growth by providing low-cost, high-efficiency solutions

Twin Transformation: Strong Unity

Within the framework of the GD, the “twin transformation” approach refers to “inbound and simultaneous green and digital transformation” that enables companies to produce sustainable solutions in production, management, and technology through digital transformation, and in climate and environmental sectors through green transformation. It is projected that by 2030, more than 70% of new economic value creation will be linked to digital platforms [45], and digital solutions could reduce global emissions by up to 20% by 2050 [46]. Therefore, countries must intensify their efforts in this field to leverage the positive effects of twin transformation. This transformation can benefit not only businesses but also society as a whole. As a result, industrial policies in the future should be designed to align with the twin transformation process, where green and digital transformation take place simultaneously and complement each other [47].

Green and digital transformation have a mechanism that supports and enhances one another. Green transformation addresses climate change by reducing carbon emissions while digital transformation makes processes more efficient, cleaner, and environmentally friendly through technological advancements. Digital technologies enable the monitoring of environmental parameters and improve prediction accuracy. For example, real-time monitoring and tracking resources improve management and support a circular economy. Digital twins, simulations, and online platforms play crucial role in saving energy and reducing environmental footprints [48].

For green and digital transformation to be successful, dynamic and integrated management support is necessary. Although the private sector plays a leading role in the transition to digital technology, the contribution of government and civil society is also essential to increase environmental sustainability and mitigate negative impacts [49]. Given the growing importance and potential benefits of twin

transformation, it is critical to ensure that both green and digital transformations are realized simultaneously. The EU's Joint Research Centre (JRC) report elaborates on the economic, social, and political requirements for a successful twin transformation. These elements need to be carefully considered for an effective transition [48].

i) Economic factors

- **Cost assessments:** Assessing the financial implications of green and digital technologies, including initial investments and long-term costs
- **Economic opportunities:** Identifying and assessing opportunities for economic growth and employment in sectors driven by green and digital innovations
- **Labor market changes:** Managing employment transitions in sectors undergoing technological changes
- **Financing needs:** Providing adequate funding and investment for the deployment of necessary technologies and infrastructure

ii) Social factors

- **Public acceptance:** Ensuring widespread acceptance and support for green and digital initiatives through effective communication, education, and engagement
- **Justice and equity:** Addressing socioeconomic inequalities and distributing the benefits and burdens of transitions fairly
- **Behavior change:** Promoting behavioral change among individuals, businesses, and communities to adopt sustainable practices and digital solutions

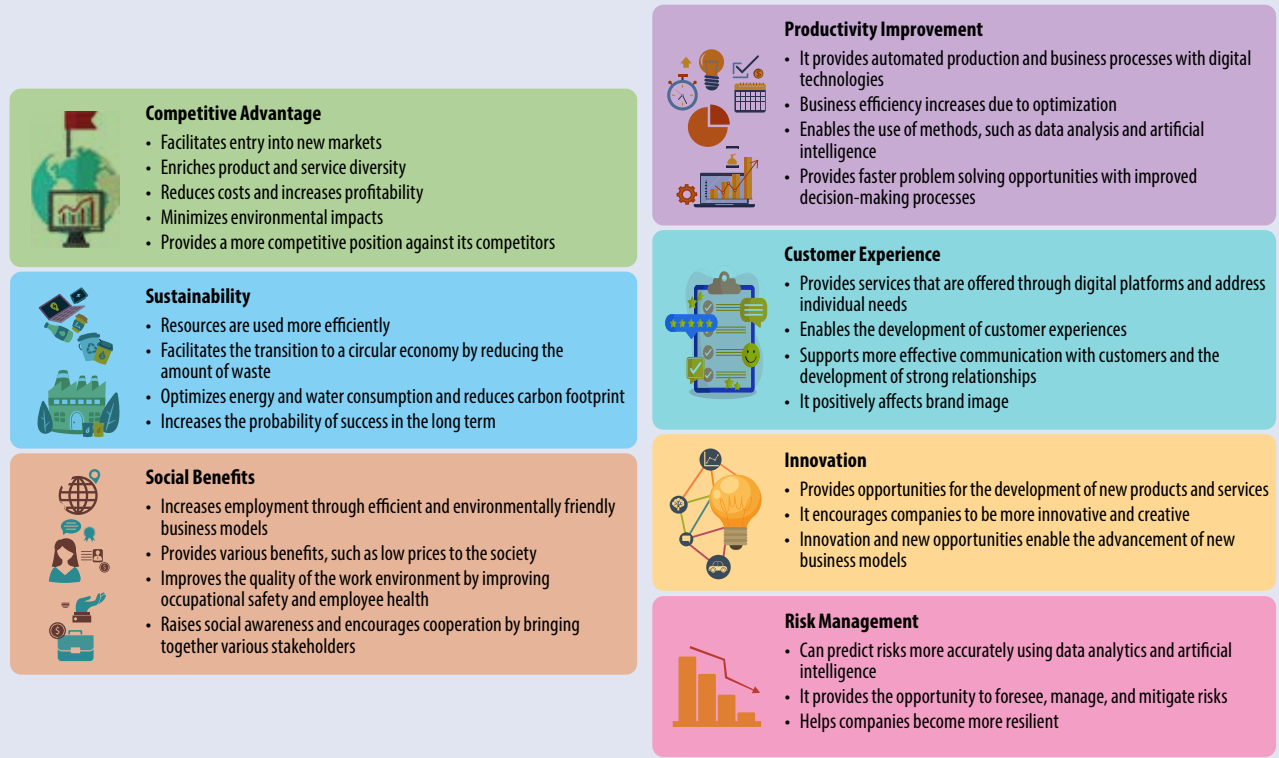
iii) Political factors

- **Regulatory frameworks:** Developing and enforcing policies and regulations that facilitate the adoption of green and digital technologies
- **Standards and certification:** Establishing standards and certification processes to ensure the quality, compatibility, and safety of technologies used in the transition process
- **Geopolitical considerations:** Managing international cooperation, trade agreements, and geopolitical dynamics that influence the adoption of green and digital technologies

Figure 4 illustrates the significant advantages of green and digital transformation together [50].

FIGURE 4

BENEFITS OF TWIN TRANSFORMATION FOR COMPANIES



Challenges and Opportunities in Turkiye

Turkiye is significantly affected by physical risks, such as drought, forest fires, extreme rainfall, and floods, all of which are driven by climate change. These risks can lead to agricultural inefficiency, biodiversity loss, and declines in quality of life. In addition, the transition risks faced by Turkiye are also crucial. The GD and Border Carbon Regulation Mechanism standards, in line with the EU's 2030 and 2050 climate targets, are at a level that may impact Turkiye's export competitiveness. Furthermore, economic instability and currency fluctuations pose threats to the conversion process. For these reasons, Turkiye must expedite its green and digital transformation efforts [51].

TABLE 1

CHANGE IN TURKIYE'S GLOBAL DIGITAL COMPETITIVENESS RANKING (2019–23)

Years	Ranking
2019	52
2020	44
2021	48
2022	54
2023	53

Source: IMD World Digital Competitiveness Ranking (TR_digital.pdf (widen.net).

According to the International Institute for Management Development's (IMD) 2023 World Digital Competitiveness Ranking [52], Türkiye has shown a fluctuating ranking among more than 60 countries over the past six years, and has experienced a recession in recent years. It is evident that Türkiye must increase its digital capabilities to catch up with other developed countries.

In addition, the twin transformation process may encounter challenges, such as integration of existing systems, budget and resource insufficiency, and employee cohesion. The right strategies and methods are needed to overcome these obstacles. In summary, Türkiye's environmental, political, economic, and financial conditions emerge as key factors that will directly influence the transition process.

Türkiye's geopolitical position, combined with growing awareness and commitment, can facilitate a positive transition in the twin transformation process. As a strategic bridge between Asia and Europe, Türkiye offers supply chains and cooperation opportunities due to its proximity to Europe. High export-oriented production and large employment potential also reinforce its advantages. Moreover, Türkiye has the appropriate practices, policies, and support mechanisms in place to successfully manage this process.

Limitations of the Study

Although twin transformation practices are becoming increasingly common in Türkiye, the majority of these initiatives are still relatively new, which means there is insufficient historical data to assess their impact. This lack of data makes it challenging to evaluate the outcomes of these practices and presents a significant limitation for the study. Additionally, there is no systematic framework or enforcement mechanism in place to compare the before-and-after results of twin transformation-oriented practices. Therefore, in order to fully assess their effects, it is essential to gather sufficient data and allow time for the practices to mature and adapt.

Conclusions and Recommendations

Significant developments on the world stage have led to profound changes and transformations in many countries. Today's world is simultaneously experiencing digital transformation along with various challenges, such as economic fluctuations, climate change, pandemics, migration, and social mobility. These simultaneous changes increase the risk of conflict, uncertainty, and instability, forcing countries to review and harmonize their existing policies.

The twin transformation, combining green and digital transformation, can reinforce the effects of these processes and offer new opportunities to combat instability. The speed at which countries adapt to this process is critical for positive future outcomes. Global transformations can create unforeseen opportunities for countries if they are approached with a robust strategy. The future will be shaped by how successfully green and digital transformations are integrated. The success of the twin transformation process depends on long-term planning, R&D, and effective coordination of the private sector and government agencies. Several policy steps are recommended to support and accelerate this process. These are [47, 51]:

- Investments should be made in digital infrastructure, and bureaucracy should be simplified to support twin transformation in Türkiye
- Regulations and support mechanisms should be improved
- The role of twin transformation in industrial policy should be increased
- Digitalization and green transformation should be evaluated holistically, and comprehensive road maps should be created

- Twin transformation areas should be identified with sector-specific targets and performance indicators defined and monitored
- Twin transformation-focused R&D and innovation activities should be encouraged
- Education curricula should be designed with a long-term perspective to support the transformation
- Public policy should be developed in a holistic manner, and interinstitutional coordination should be ensured
- Interactions between sectors, enterprises, and individuals should be taken into account and results should be anticipated

As a result, Türkiye's economic, industrial, and technology policies, incentives, and financial support programs should be revised with a focus on twin transformation. Türkiye's competitiveness will be directly impacted by actively participating in other countries' standard-setting efforts on similar issues.

In conclusion, the inclusion of twin transformation-oriented approaches in various policy documents in Türkiye clearly demonstrates the country's determination and strategic vision in this field. This process encourages the development of comprehensive preparations, plans, and practices in critical areas, such as digital and green transformation. These steps taken by Türkiye go beyond strengthening the existing economic structure and aim to build an innovative and sustainable future. The twin transformation strategies are designed to appeal to and benefit all segments of society, not only through their economic dimensions but also through their social and environmental advantages. At the same time, reviewing Türkiye's economic, industrial, and technology policies as well as its incentive and financial support programs from a twin transformation perspective, will directly affect the country's competitiveness. These efforts will support Türkiye's goal of increasing its competitiveness by accelerating economic development in the long run.

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ABBREVIATIONS AND ACRONYMS

AI	Artificial intelligence
ASO	Ankara Chamber of Industry
EU	European Union
GD	Green Deal
IHKIB	Istanbul Ready-to-Wear and Apparel Exporters' Association
IMD	International Institute for Management Development
IPA	Instrument for Pre-Accession Assistance
KOSGEB	Small and Medium Enterprises Development Organisation
METU	Middle East Technical University
MoIT	Ministry of Industry and Technology
MTP	Medium Term Programme
NGOs	Nongovernmental organizations
R&D	Research and development
SMEs	Small and medium enterprises
TUBISAD	Turkish Informatics Industry Association
TUBITAK	Scientific and Technological Research Council of Türkiye
TUSIAD	Turkish Industry and Business Association
UNDP	United Nations Development Programme
YOIKK	Coordination Board for Improvement of Investment Environment

