

RESEARCH ARTICLE

The Perception of Employees About the Digital Transformation of Türk Telekom Company

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Abstract

This study examines the perception of Türk Telekom employees about the company's digital transformation based on human resources, technology, infrastructure, suppliers, users, and management parameters. Sub-parameters such as artificial intelligence, blockchain, IoT (Internet of Things), virtual/augmented reality, cryptocurrency, digital twin, machine learning, robotic systems, voice assistant systems, cybersecurity, big data, system integration, and cloud computing are also discussed within these main parameters. The research aims to assess the perception of digital transformation parameters in the telecommunications sector, using Türk Telekom as a case study. Findings suggest that system integration, big data, cybersecurity, and IoT are the most well-known digital transformation parameters, while digital twin technology emerged as the least familiar one. Türk Telekom employees also demonstrate only moderate awareness of key digital transformation components. In addition to training and workshop programs on digital transformation, it is suggested that enabling employees to observe the impacts of the digital transformation on tangible outcomes of their work, such as products or services, may serve as a motivational factor that enhances job performance.

Keywords: telecommunication, Türk Telekom, digital transformation, artificial intelligence, blockchain

Öz

Bu çalışmada, Türk Telekom çalışanlarının şirketin dijital dönüşümüne ilişkin algısı insan kaynakları, teknoloji, altyapı, tedarikçiler, kullanıcılar ve yönetim parametreleri temelinde incelenmiştir. Yapay zekâ, blok zinciri, IoT (nesnelerin interneti), sanal/artırılmış gerçeklik, kripto para, dijital ikiz, makine öğrenmesi, robotik sistemler, sesli asistan sistemleri, siber güvenlik, büyük veri, sistem entegrasyonu ve bulut bilişim gibi alt parametreler de bu ana parametreler kapsamında ele alınmıştır. Araştırma, Türk Telekom'u bir vaka çalışması olarak kullanarak telekomünikasyon sektöründe dijital dönüşüm parametrelerinin algısını değerlendirmeyi amaçlamaktadır. Bulgular, sistem entegrasyonu, büyük veri, siber güvenlik ve IoT'nin en bilinen dijital dönüşüm parametreleri olduğunu, dijital ikiz teknolojisinin ise en az bilinen teknoloji olarak ortaya çıktığını göstermektedir. Türk Telekom çalışanları ayrıca temel dijital dönüşüm bileşenlerine ilişkin yalnızca orta düzeyde farkındalık göstermektedir. Dijital dönüşüm konusunda eğitim ve atölye programlarına ek olarak, çalışanların dijital dönüşümün yürütmekte oldukları çalışmalara yönelik somut olumlu çıktıları üzerindeki etkilerini gözlemlenmelerini sağlamanın, iş performansını artıran bir motivasyon faktörü olarak hizmet edebileceği önerilmektedir.

Anahtar Kelimeler: Telekomünikasyon, Türk Telekom, dijital dönüşüm, yapay zeka, blokzincir

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Introduction

Human history has undergone various transformations—sociological, psychological, economic, cultural, and technologically driven by innovation, reform, war, and pandemics. In the 21st century, technology is one of the most significant areas of transformation. We are living in a new technological age, which has changed our daily routines, including the communication tools we use. As technology rapidly advances, these transformations have become inevitable. Since the early 21st century, these processes have been collectively termed *digital transformation*.

Digital transformation denotes the systematic adoption and integration of digital technologies within organizations, aimed at innovating or optimizing products, services, and operational processes through the digitization of traditional business workflows. It involves not only the implementation of technologies such as artificial intelligence (AI), the Internet of Things (IoT), big data analytics, robotics, and machine learning, but also a fundamental shift in organizational culture, strategy, and value creation models. Rather than being a purely technological shift, digital transformation represents a multidimensional change process that affects internal operations, customer engagement, decision-making processes, and competitive positioning. As such, it is increasingly viewed as a strategic imperative across industries, enabling organizations to enhance efficiency, agility, and resilience in the face of rapid technological and market changes (Mirzagayeva and Aslanov, 2022).

In the telecommunications sector, digital transformation has been extensively studied by researchers, who examine how companies leverage new technologies to enhance efficiency, improve customer experience, and increase revenue. Smith & Brown (2021), in their study, highlight that technologies such as cloud computing, AI, 5G, and IoT are reshaping service delivery and network management. AI-driven automation, in particular, optimizes network performance by improving predictive maintenance processes (Lee et al., 2020). Ellström et al. (2021), in their study on identifying dynamic capabilities for digital transformation in Sweden, emphasize that firms must clearly define adaptable digital transformation strategies, focus

on core competencies, and prioritize sustainability. Customer-centric digitalization has also emerged as a critical research area. García & Liu (2022) indicate that data analytics and machine learning help telecommunication companies personalize services and anticipate customer needs, thereby increasing customer loyalty.

Additionally, blockchain technology has been explored for secure transactions and fraud prevention (Rahman & Singh, 2021). Despite the operational efficiency and new revenue streams of digital transformation, challenges such as high implementation costs, cybersecurity risks, and regulatory barriers persist (Patel et al., 2023). Williams (2022) also stresses that technology adoption must strategically align business objectives. Klein (2020) also explores the leadership dimension of digital transformation, highlighting the need for leaders to organize both their companies and transformation processes effectively.

Digital transformation has recently gained significant attention in Türkiye, with numerous researchers exploring its various dimensions. While some focus on digital transformation in the public sector (Hisoğlu-Koç, 2020; Göçoğlu, 2020), others investigate its impact on corporate branding and marketing (Yılmaz-Altuntaş, 2018; Koçak, 2019). Yankın (2019) examines digital transformation in the workplace, analyzing its social, economic, and demographic effects. Nuroğlu and Nuroğlu (2018) compare the digital transformation roadmaps of Germany and Türkiye in the industrial sector, noting that emerging challenges cannot be resolved immediately and emphasizing the importance of close collaboration with technology-producing firms. In telecommunications, Özkaya (2018) investigates the operational dynamics of digital transformation, focusing on differences between traditional and new business processes and their market impact. Gözükcük (2020) analyzes the relationship between digital transformation and economic growth, demonstrating that advancements in digital transformation parameters positively contribute to Gross Domestic Product (GDP). Yavuz (2019) examines blockchain technology and its applications within the context of economic digital transformation.

Previous studies reveal that digital transformation in the telecommunications sector has been

explored from multiple perspectives, but research incorporating perceptual measurements remains very limited. This study addresses this important gap by assessing telecommunications employees' perceptions of digital transformation parameters, specifically within Türk Telekom Company. It is also aimed that the findings and the recommendations of this study provide insights for other telecommunication companies about setting their future digital transformation strategies and policy-makers to enhance their digital visions.

Following the introduction, the second section of the study addresses the theoretical framework of digital transformation, differentiating between *digitization*, *digitalization*, and *digital transformation*. It also outlines sector-specific digital transformation parameters, focusing on telecommunications. Subsequently, the telecommunications sector is detailed, incorporating global and Turkish industry developments. The study also provides an overview of Türk Telekom, including its digital transformation initiatives and case applications. The methodology, data collection, and research framework are then presented, followed by an analysis of survey findings. The concluding section summarizes key findings and offers recommendations for the Türk Telekom Company and the telecommunications sector in general.

Digital Transformation in the Telecommunication Industry

In the 21st century, *digital transformation*, *digitalization*, and *digitization* have become increasingly important terms. Following the Industrial Revolution in the late 17th century, technological inventions advanced rapidly, gaining momentum in the 20th century and beyond. In the modern era, the management, control, and widespread dissemination of large-scale data have been made possible through technological advancements and the internet (Karagözoğlu-Aslıyüksek, 2016: 89). The shift from analog to digital processes has played a pivotal role in driving technological progress. The application of digitization to business and social life has given rise to digitalization, paving the way for broader digital transformation.

Today, most technologies referred to as *digital technologies* are widely used in economic and social life. While the unit costs of digital technologies have decreased in recent years, their overall utility has increased, leading to higher adoption and usage rates across society. The development of these technologies has accelerated and enhanced their added value (BSTB, 2018: 24). Although technological advancement is a key driver of digital transformation, the process should not be evaluated merely by the development and adoption of digital technologies. Digital transformation encompasses an integrated process in which all stakeholders, including industries, employees, educational institutions, and public agencies, undergo structural changes, resulting in new operational models and workflows.

Digital transformation technologies can be classified in various ways. According to the roadmap developed by TÜBİTAK (Scientific and Technological Research Council of Türkiye), digital technologies are grouped into three categories: *digitization*, *interaction*, and *factories of the future* (BSTB, 2018: 24). Virtualization, cybersecurity, big data, and cloud computing fall under digitization, while the Internet of Things (IoT) and sensor technologies are classified under interaction. Robotics, additive manufacturing, automation, and control systems are categorized as factories of the future.

The Telecommunications Sector

The telecommunications sector comprises companies that enable global communication through telephone, computer, and web-based network technologies. These firms build infrastructure that facilitates data transmission across the world. Key players include wireless service providers, satellite companies, cable operators, and internet service providers. For all industries worldwide, advancing technological infrastructure and ensuring high customer satisfaction are essential for maintaining competitiveness. In the telecommunications sector, the development of technology and supporting infrastructure is critical, as the quality and reliability of services directly impact users' daily lives and social interactions (KPMG Türkiye, 2018, p.4).

The Coronavirus Disease (COVID-19) pandemic in 2020, particularly due to lockdowns and reduced social interaction, accelerated digital transformation across all sectors. The telecommunications sector, however, adjusted more smoothly than many others, proving resilient and even advancing further throughout the pandemic (Beybur & Çetinkaya, 2020, p.148).

The shift to remote work and online education highlighted the need for robust technological infrastructure and uninterrupted internet access, significantly increasing demand for telecom services. During the pandemic, global data traffic increased by as much as 74% as a result of isolation measures. Unlike many industries that experienced setbacks in investment and growth, communication technologies rose in strategic significance (KPMG Türkiye, 2020, p.3).

As of 2021, out of the world's 7.5 billion people, 5.3 billion own mobile phones, and over 4.6 billion are active internet users. Social media platforms have 3.9 billion registered users (Webrazzi, 2021), underscoring the telecommunications sector's massive scale.

The Telecommunications Sector in Türkiye

The history of Türkiye's telecommunications sector dates back to the Ottoman Empire, with the establishment of the *Postahane-i Amire* (Imperial Post Office) under Sultan Abdülmecid in the 1840s. The Telegraph Ministry was founded in 1855, and by 1871, it merged with the postal service to form the *Posta ve Telgraf Nezareti* (Ministry of Post and Telegraph) (Nolto Telecommunications, 2020). Mirroring global trends, Türkiye's telecommunications sector evolved gradually until the 2000s, when growth accelerated.

Today, Türkiye's communications sector holds significant potential, with companies leveraging advanced technologies and corporate structures to drive expansion. The industry can be categorized into mobile, fixed-line, broadband, and other services.

Mobile Market

As of December 2024, Türkiye has 94,321,270 mobile subscribers, representing a 110.11% penetration rate. Following the launch of 3G in July 2009, the number of subscribers reached nearly 66 million by March 2016. The launch of 4.5G in April 2016 prompted a rapid transition from 3G, with 4.5G users reaching 87,662,175 by December 2024, while 3G subscribers declined to 4,345,095 (BTK, 2024, p.59).

Table 1 compares 2G, 3G, and 4.5G subscriber numbers over the years.

Table 1. Number of Mobile Subscribers

Number of Mobile Subscribers (Millions)			
Year	2G	3G	4,5
2009	55,7	7,1	0
2011	33,9	31,4	0
2013	20,4	49,3	0
2015	9,4	64,3	0
2016	4,5	18,9	51,7
2018	2,1	6,6	71,3
2019	1,8	4,8	74,2
2021	2,0	4,2	80,2
2023	2,3	5,0	84,9
2024	2,3	4,3	87,7

Source: BTK, 2024

After the introduction of 3G and 4.5G technologies, the number of mobile subscribers accessing internet services via mobile devices and cell phones has reached 75.9 million. In addition, the number of mobile subscribers accessing internet services exclusively via 4.5G from mobile computers and cell phones reached 69.1 million. In the fourth quarter of 2024, the total volume of mobile internet data usage was recorded as 3,744,694 TBytes, and the total mobile internet data usage by 4.5G users alone reached 3,617,599 TBytes (BTK, 2024:60).

Table 2. Mobile Operators in Türkiye

Mobile Operators in Türkiye			
Operators	Market Share	Traffic Volume	ARPU
TÜRK TELEKOM	29,3%	22,8 Milyar/Dk	39,2 TL
VODAFONE	34,8%	27,1 Milyar/Dk	42,4 TL
TURKCELL	35,9%	28,0 Milyar/Dk	47,1 TL

Source: BTK,2024

As of the fourth quarter of 2024, based on the number of subscribers of mobile operators, Turk-

cell holds a market share of 40.6%, followed by Vodafone (30.4%), and Türk Telekom Mobile (29%) respectively (BTK, 2024:65). As of the last quarter of 2024, the total mobile traffic volume reached 77.9 billion minutes, representing the peak level of traffic observed.

Landline Market

Türkiye has 9 million landline telephone subscribers, corresponding to a penetration rate of approximately 10.6%, as of the end of December 2024. Considering the average household size in Türkiye, the landline telephone services still cover a significant portion of the population (BTK, 2024, p. 35). Türk Telekom's average voice traffic, which was 444 million minutes in the fourth quarter of 2023, declined to 410 million minutes in the same quarter of 2024. Compared to the same period in 2020 and 2021, voice traffic has decreased by approximately 19% and declined by about 2.8% compared to the previous quarter (BTK, 2024, p. 39).

Table 3. Landline Operators in Türkiye

Landline Operators in Türkiye	
Operators	Market Share (%)
SUPERONLINE	49,8
VODOFONENET	22,3
TTNET	11,7
ESER TELEKOM	2,2
COMPATEL	1,6
NETGSM	1,6
ÖZTEK	0,9
OTHERS	9,8

Source: BTK,2024

Table 3 shows the market shares of TTNET, VodafoneNet, Superonline, and other companies in terms of subscriber numbers as of December 2024 (BTK, 2024:35).

Broadband Market

The number of broadband internet subscribers, which was 7 million in 2008, has almost reached 96.4 million by 2024. The expansion of fiber infrastructure expedited the growth of internet subscribers (BTK, 2024:49).

Table 4. Internet Providers in Türkiye

Internet Providers in Türkiye		
Companies	Subscribers (%)	Income (%)
TTNET	53,8	56,83
SUPERONLINE	15,23	13,04
VODAFONE NET	6,93	8,95
TURKSAT	6,89	3,14
TURKNET	5,82	6,97
MİLLENİCOM	1,94	2,1
OTHERS	9,4	8,97

Source: BTK,2024

As of December 2024, Türk Telekom TTNET, Turkcell Superonline, and Vodafone Net are the top three operators in terms of both the number of users receiving internet services and the market revenue share (BTK, 2024, p. 50). Moreover, 119 companies are regularly and continuously providing internet services (BTK, 2024, p. 51). Since the launch of mobile broadband services in July 2009, mobile internet subscribers have reached 75.9 million. The total mobile internet data volume has reached approximately 3.75 terabytes during the same period. In the fourth quarter of 2024, the total fixed broadband internet data volume, including cable internet services, was recorded as 16.9 million terabytes (BTK, 2024, p. 52).

Other Services

There are 14 authorized infrastructure operators in Türkiye. As of the end of 2024, the total fiber optic cable length deployed by various companies is approximately 605,000 kilometers. Türk Telekom alone accounts for around 400,000 kilometers, approximately 233,000 kilometers of which are allocated for backbone infrastructure, with the remainder designated for network distribution (BTK, 2024, p. 82).

Table 5. Satellite Communication Companies

The Number of Satellite Company Subscribers	
Companies	Subscribers (%)
ESER TELEKOM	43,5
TURKSAT	36,5
SUPERONLINE	8,3
İCT	5,4
İŞNET	5,1

Source: BTK,2024

Digital Transformation at Türk Telekom

Türk Telekom Company is one of the oldest and most well-known companies of Türkiye. With a history spanning 180 years, it is the country's first integrated telecommunications company. Its history dates back to 1840 with the establishment of the Post Directorate. Later, it continued under the PTT name until it was restructured as Türk Telekom A.Ş. in 1994. The company was privatized in 2005 and made its initial public offering (IPO) in 2008. In 2015, Türk Telekom entered the mobile communications sector by acquiring AVEA. In response to rapidly evolving communication and technological demands, Türk Telekom A.Ş., TT Mobil İletişim Hizmetleri A.Ş., and TTNET A.Ş. started providing integrated services in 2015, maintaining their legal entities and complying with relevant legislation and regulations. In January 2016, mobile, internet, telephone, and TV services merged under the single brand name, *Türk Telekom*.

Table 6. Türk Telekom Digital Transformation Parameters

DIGITAL TRANSFORMATION PARAMETERS	FIELDS OF ACTIVITY
HUMAN	Qualified Workforce – Human Resources Awareness – Digital Training Programs Artificial Intelligence Blockchain IoT (Internet of Things) Virtual/Augmented Reality (VR/AR)
TECHNOLOGY	Cryptocurrency Digital Twin Machine Learning Robotic Systems Voice Assistant Systems Cyber-Physical Systems
INFRASTRUCTURE	Cyber Security Big Data System Integration Cloud Computing Supporting local digital technology industry firms
SUPPLIERS	Enhancing capabilities in technology acquisition and development
USERS	Delivering digital transformation investments to end-users
MANAGEMENT	Institutionalizing digital transformation efforts, establishing relevant directorates and departments

As of March 31, 2021, Türk Telekom served 16.5 million fixed access lines, 13.7 million broadband users, 3.2 million TV subscribers, and 23.4 million

mobile subscribers. The Türk Telekom Group, aiming to introduce new technologies in Türkiye, has 34,963 employees in 81 provinces (Türk Telekom 2020 Annual Report, 2021, p.6).

In its roadmap for digital transformation of Türkiye, the Ministry of Industry and Technology of the Republic of Türkiye has categorized the digital transformation parameters under six categories (BSTB, 2018:118). As shown in Table 6, Türk Telekom's digital transformation activities are grouped under these six main parameters: *human resources, technology, infrastructure, suppliers, users, and management*.

Human at Türk Telekom

Türk Telekom aims to be the most human-centered and preferred company in the telecommunications sector, with a dynamic and innovative workforce. Emphasizing employees as its most valuable asset, the company integrates national digitalization strategies across its processes, especially through Human Resources (HR) practices. In 2020, Türk Telekom aligned all HR policies and systems with the human-centric principle, ensuring employees feel valued (Türk Telekom 2020 Annual Report, 2021, p.139).

During the COVID-19 pandemic, Türk Telekom maintained continuous development through the Türk Telekom Academy, providing interactive virtual training sessions to its employees. Modern online training methods in 2020 reflected the company's commitment to investing in human capital (Türk Telekom 2020 Annual Report, 2021, p.142).

Technology at Türk Telekom

With advanced physical infrastructure, diverse value-added services, and the ability to integrate technology swiftly, Türk Telekom ranks among the global leaders in big data and telecommunications. The company's digital transformation focuses on AI, blockchain, IoT, VR/AR, cryptocurrencies, digital twins, machine learning, robotics, and voice assistant systems (Türk Telekom 2020 Annual Report, 2021, p.135).

Artificial Intelligence (AI): Türk Telekom utilizes its proprietary AI solutions, such as the TT-ON

root cause analysis platform, to monitor dense wavelength-division multiplexing (DWDM) systems and fiber optic cable quality in real-time. This solution enhances automation and reduces manual operations, enabling staff to focus on higher-value tasks.

Blockchain: The company supports Blok-Z, a blockchain-based energy trading platform that enables direct peer-to-peer energy exchange among producers, suppliers, and consumers.

Internet of Things (IoT): Türk Telekom's IoT services support a network of interconnected devices, facilitating automated and remote control of processes, driven by the need for data-based decision-making.

Virtual/Augmented Reality: Türk Telekom collaborates with the startup Nara to integrate VR/AR technologies into education, enabling interactive, instructor-guided virtual classroom experiences.

Cryptocurrency: Two pilot projects—CryptoIndex-Series and Resardis—were accepted into Türk Telekom's innovation program. These initiatives offer AI-based tools and decentralized exchange platforms for crypto trading.

Digital Twin: Partnering with its subsidiary İnnova, Türk Telekom applies digital twin technology in smart city projects. The SkywaveCity platform enables centralized monitoring of urban health, traffic, and energy systems.

Machine Learning: Türk Telekom developed an open-source AI in the Operations system to reduce costs, minimize revenue loss from disruptions, and improve customer satisfaction.

Robotic Systems: Robotic process automation is used to enhance efficiency and reduce costs in sectors such as manufacturing, finance, e-commerce, and telecommunications.

Voice Assistant Systems: In the Türk Telekom Online Services app, users can send money using

voice commands via Apple's Siri, demonstrating how voice assistants improve service accessibility.

Infrastructure, Suppliers, Users, and Management

Türk Telekom's infrastructure includes cyber-physical systems, cybersecurity, cloud computing, system integration, and big data platforms. From the perspectives of suppliers, users, and management, the company emphasizes supporting domestic digital technology and industrial firms, enhancing technology acquisition and innovation capabilities, delivering digital transformation outcomes to end-users, and institutionalizing digital transformation by creating relevant departments and governance structures.

Methodology

The study aims to measure the perception of Türk Telekom Company employees about their knowledge and their company's activities on digital transformation processes. The study also hypothesized that young age groups (26-30) have the most knowledge on digital transformation processes due to their predisposition to digital technologies. In that context, we also aimed to test this hypothesis.

Thus, we designed a quantitative research strategy. Data was collected through a structured survey comprising two sections. The first section included 10 questions about demographic characteristics (gender, age, education, department, position, and experience). The second section assessed participants' awareness of their digital transformation level and that of their institution. To check whether the results are statistically different among age groups, t-tests were also conducted using the R statistical software program.

As shown in Table 7, the participants were asked to score the following questions on a Likert scale of 1 to 5. (1-lowest, 2-low, 3-moderate, 4-high, 5-highest)

Table 7. Survey Questions

Code	Questions
YZKBSD	Please evaluate your knowledge regarding artificial intelligence.
YZKSFD	Please evaluate your company's activities regarding artificial intelligence.
SGKBSD	Please evaluate your knowledge regarding virtual reality.
SGKSFD	Please evaluate your company's activities regarding virtual reality.
AGKBSD	Please evaluate your knowledge regarding augmented reality.
AGKSFD	Please evaluate your company's activities regarding augmented reality.
IOTKBSD	Please evaluate your knowledge regarding the Internet of Things (IoT).
IOTKSFD	Please evaluate your company's activities regarding the Internet of Things (IoT).
DJKBSD	Please evaluate your knowledge regarding digital twin technologies.
DJKSFD	Please evaluate your company's activities regarding digital twin technologies.
BZKBSD	Please evaluate your blockchain knowledge.
BZKSFD	Please evaluate your company's activities regarding blockchain.
KPKBSD	Please evaluate your cryptocurrency knowledge.
KPKSFD	Please evaluate your company's activities regarding cryptocurrency.
MLKBSD	Please evaluate your knowledge regarding machine learning.
MLKSFD	Please evaluate your company's activities regarding machine learning.
RSKBSD	Please evaluate your knowledge regarding robotic systems.
RSKSFD	Please evaluate your company's activities regarding robotic systems.
SASKBSD	Please evaluate your knowledge regarding voice assistant systems.
SASKSFD	Please evaluate your company's activities regarding voice assistant systems.
SGSKBSD	Please evaluate your knowledge regarding cybersecurity systems.
SGKSFD	Please evaluate your company's activities regarding cybersecurity systems.
BVKBSD	Please evaluate your knowledge regarding big data.
BVKSFD	Please evaluate your company's activities regarding big data.
SEKBSD	Please evaluate your knowledge regarding system integration.
SEKSFD	Please evaluate your company's activities regarding system integration.
BBSKBSD	Please evaluate your knowledge regarding cloud computing systems.
BBSKSFD	Please evaluate your company's activities regarding cloud computing systems.
IKDDKBSD	Please evaluate your knowledge regarding digital transformation in human resources.
SIKDDFD	Please evaluate your company's activities regarding digital transformation in human resources.
DDFKSKD	Please evaluate your contribution to your company's digital transformation efforts.

SYTVSFDDFND	Please evaluate your company's support for local technology and industrial firms in their digital transformation efforts.
SDDFSKTEKBSD	Please evaluate your knowledge regarding the end-user impact of your company's digital transformation activities.
BMVSKOSDDSKD	As a customer or user, please evaluate the end-user side of your company's digital transformation activities.
SDDFNYKKBSD	Please evaluate your knowledge regarding how your company's digital transformation activities are conducted.
SMDABBAOV-DOSSM	Please rank your company's current perspective and prioritization on the following topics from 1 to 7.
TDEAACVDDD-FOED	Please evaluate the impact of the global COVID-19 pandemic on digital transformation efforts.
TDE-AACVDTSDDFED	Please evaluate the impact of the global COVID-19 pandemic on digital transformation efforts in the telecommunications sector.
TDEAACVDTT-DDFOED	Please evaluate the impact of the global COVID-19 pandemic on digital transformation efforts within Türk Telekom.

Data

The research focused on Türk Telekom, one of Türkiye's leading and long-established telecommunications firms. The aim was to assess employee awareness regarding digital transformation parameters and identify areas of strength and improvement within the organization. A total of 288 Türk Telekom employees participated in the survey. Surveys were distributed via email, and responses were collected accordingly.

Findings

Demographic data from participants are shown in Tables 8–14. Eighty-two respondents (28.47%) were between 36 and 40 years old, followed by 76 participants (26.39%) aged 41 and above, and 71 (24.65%) aged 31–35, respectively. The number of respondents in the 26–30 age group was 48 (16.67%), while 11 participants (3.82%) were aged 18–25.

Table 8. Age Distribution

Age Groups	Rate (%)	Responses
18-25	3,82	11
26-30	16,67	48
31-35	24,65	71
36-40	28,47	82
41 and older	26,39	76
Total	%100	288

On the other hand, the number of male participants was 217, with a rate of 75.35%, while only 71 participants (24.65%) were female.

Table 9. Gender Distribution

Gender	Rate (%)	Responses
Female	24,65	71
Male	75,35	217
Total	%100	288

The participants' educational background indicates that the majority, 169 individuals (58.68%), held an undergraduate degree from a university. This group was followed by 71 participants (24.65%) with a master's degree, while only 3 participants (0.69%) held a Ph.D. degree.

Table 10. Education Levels

Education Levels	Rate (%)	Responses
High School	3,47	10
Associate degree	12,50	36
Undergraduate	58,68	169
Graduate	24,65	71
Ph.D. degree	0,69	2
Total	%100	288

The respondents were asked to mention their experience in the telecommunication sector. Seventy-five respondents (26.04%) had 11 to 15 years of experience in the telecommunications sector, while 78 participants (27.08%) had more than 15 years of experience. Additionally, 135 participants (46.87%) had less than 10 years of experience in the sector.

Table 11. Industry Experience

Experience (Years)	Rate (%)	Responses
0-2	13,54	39
3-7	18,40	53
8-10	14,93	43
11-15	26,04	75
16-20	12,50	36
21-29	13,54	39
30 and More	1,04	3
Total	%100	288

The responses indicated that 74 participants (25.59%) have an experience within Türk Telekom for 11 to 15 years. While 48 participants (16.66%) have over 15 years of experience, more than half of the respondents—166 individuals (57.65%)—have less than 10 years of within-organization experience.

Table 12. Company Experience

Company Experience (Years)	Rate (%)	Responses
0-2	20,49	59
3-7	21,18	61
8-10	15,97	46
11-15	25,69	74
16-20	9,72	28
21-29	6,25	18
30 and more	0,69	2
Total	%100	288

On the other hand, 108 individuals held specialist positions, followed by 86 individuals in senior specialist roles. Only 31 participants held managerial or higher-level positions. Additionally, 39 technicians, 23 assistant specialists, and one intern responded to the survey.

Table 13. Company Positions

Positions	Rate (%)	Responses
Intern	0,35	1
Technician	13,54	39
Assistant Expert	7,99	23
Expert	37,50	108
Senior Expert	29,86	86
Executive	3,47	10
Manager	5,21	15
Group Manager	1,04	3
Director	1,04	3
Total	%100	288

One hundred eighty-seven participants responded to the survey of those who work in the Technology Department. Although we sent them the questionnaire, no responses were received from the Internal Audit Department and the Corporate Risk and Business Continuity Department.

Table 14. Departments

Departments	Rate (%)	Responses
Finance	4,51	13
Support Services and Procurement	1,04	3
Individual Sales	2,43	7
Corporate Sales	4,17	12
Technology	64,93	187
Strategy, Planning, and Digital	4,86	14
Human Resources	2,43	7
Law and Regulation	0,69	2
Wholesales	2,78	8
Regional	8,68	25
Other	3,47	10
Total	%100	288

Based on the results of the analysis, the most well-known digital transformation parameter was

identified as *system integration*. Employees demonstrated an above-average level of knowledge on this topic, which may be attributed to their frequent involvement in related projects and tasks.

System integration was followed by *big data*, *cybersecurity*, and the *Internet of Things (IoT)* in terms of awareness. Conversely, *digital twin* technology emerged as the least known digital transformation parameter.

Table 15. T-Test Results for the Age Groups 26-30 years old vs. others)

Parameters	T-test	df	p-value
YZKBSD	-0,86296	218	0,8054
SGKBSD	-0,2898	218	0,6139
AGKBSD	0,054995	218	0,5219
IOTKBSD	-0,53351	218	0,7029
DJKBSD	-0,15839	218	0,5629
BZKBSD	-0,368	218	0,6434
KPKBSD	-0,06513	218	0,5259
MLKBSD	1,9664	218	0,02526
RSKBSD	-0,28958	218	0,6138
SASKBSD	-0,36519	218	0,6423
SGSKBSD	-1,704	218	0,9551
BVKBSD	-0,49005	218	0,6877
SEKBSD	0,29148	218	0,3855
BBSKBSD	-0,21615	218	0,5855
IKDDKBSD	0,58464	218	0,2797

It was hypothesized that employees between 26 and 30 years old would have a better knowledge level of digital transformation processes due to their aptitude for digital tools. The study also examined whether there were statistically significant differences in digital transformation knowledge levels among employees aged 26–30 compared to other age groups. No significant differences in knowledge levels related to artificial intelligence, virtual reality, augmented reality, IoT, digital twin, blockchain, cryptocurrency, robotic systems, voice assistant systems, cybersecurity, big data, system integration, cloud computing, and digital transformation in human resources. However, participants aged 26–30 were found to have a higher knowledge level regarding *machine learning* than other age groups.

Regarding the perception of the respondents on the digital transformation activities of the company they work for, *cybersecurity* was ranked first, followed by *big data* and *system integration*. *Digital twin* and *cryptocurrency* were the least known

parameters among employees. Table 16 exhibits the summary of responses.

Table 16. Summary of Responses

Technology/Area	Knowledge Levels	Awareness of Company Activities
Artificial Intelligence (AI)	38% moderate, 32% low, 21% high	25% unaware
Virtual Reality (VR)	35% low, 6% none, 18% high	65% low
Augmented Reality (AR)	33% low, 16% none, 17% high	45% low
Internet of Things (IoT)	17% low, 13% none, 38% high	45% low
Digital Twins	64% none, 17% low, 7% high	77% none
Blockchain	30% low, 17% none, 22% high	79% low
Cryptocurrency	28% low, 8% none, 29% high	87% low
Machine Learning	34% low, 18% none, 25% high	70% low
Robotic Systems	34% low, 12% none, 24% high	69% low
Voice Assistants	30% low, 15% none, 29% high	44% low, 36% high
Cybersecurity	4% none, 26% low, 35% moderate, 33% high	70% high
Big Data	28% low, 11% none, 31% high	45% high
System Integration	15% low, 10% none, 50% high	57% high
Cloud Computing	18% low, 6% none, 42% high	60% high
HR Digital Transformation	28% low, 25% none, 20% high	54% low

The impact of COVID-19 on the future of digital transformation was also examined among the participants. 82% of respondents believed the pandemic would accelerate digital transformation and lead to permanent change. Only 5% thought everything would return to pre-pandemic norms, while 3% had no knowledge, 7% expected minimal impact, and 3% anticipated no effect.

When examining the pandemic's effect specifically on the digital transformation of the telecommunications sector, 83% of participants responded that the pandemic would accelerate and sustain transformation. Regarding Türk Telekom, 72% of participants believed the pandemic would accelerate and entrench the company's digital transformation efforts.

Survey results thus indicate that employees widely perceive COVID-19 as a significant catalyst for digital transformation, with an expectation of long-term changes. The pandemic was the only topic on which approximately 80% of all participants shared a common perspective, likely due to

its profound effects on both personal and professional lives.

Discussion and Conclusion

Digital transformation has progressed from a basic necessity to a strategic imperative across all sectors. Nevertheless, the processes of transformation must be examined within the context of each specific industry, as the parameters guiding such transformation differ according to sectoral characteristics and requirements. Consequently, organizations seeking to implement digital transformation initiatives must first identify the sector-specific parameters relevant to their operations and determine the components to be employed. On this basis, a comprehensive needs assessment for digital transformation can then be developed.

Artificial intelligence, blockchain, the Internet of Things (IoT), virtual/augmented reality, cryptocurrency, digital twin technology, machine learning, robotic systems, voice assistant systems, cybersecurity, big data, system integration, and cloud computing are important digital transformation parameters for many industries, including the telecommunication sector.

This study identified the most well-known digital transformation parameter among Türk Telekom employees as system integration, followed by big data, cybersecurity, and IoT. On the other hand, digital twin technology emerged as the least familiar parameter.

Regarding awareness of company activities related to digital transformation, cybersecurity was the most acknowledged domain among Türk Telekom employees, followed by big data and system integration. Conversely, digital twin and cryptocurrency were employees' least known areas of corporate activity.

The findings of the study indicated similar results both for the knowledge level of the employees and their awareness of the company's digital transformation activities. Furthermore, the findings of the survey related to the impact of the COVID-19 pandemic on the future of digital transformation are consistent with the findings of previous studies by Nalbantoğlu (2021) and Budak & Korkmaz (2020), which suggest that the pandemic

has accelerated digital transformation and that these changes are likely to become permanent.

Malunga (2023) underlines the importance of digital leaders exerting both direct and indirect influence on the organizational digital transformation. Specifically, leadership within the telecommunications sector must foster a digital mindset, broaden its sensing capabilities across diverse value chains, and pursue cross-industry integration as a means of ensuring long-term sustainability and competitive advantage. Thus, it is recommended that Türk Telekom enhance its internal communication and information sharing regarding its digital transformation initiatives. In this context, as Yurdakul et al. (2017) suggest, it would be beneficial to implement informative training modules and workshops through the Türk Telekom Academy to raise awareness among employees and underline the importance of digital transformation on business success. Such initiatives would help employees better understand how their work contributes to digital transformation and allow them to find greater meaning and purpose in their roles, ultimately enhancing productivity.

In addition, it would be valuable to organize promotional activities that inform employees about the services Türk Telekom provides to end-users, customers, and firms operating in domestic production, manufacturing, and industrial sectors. Managers of each unit should also communicate and emphasize the aspects of digital transformation relevant to their respective departments. Enabling employees to observe the tangible outcomes of their work, such as products or services, may serve as a motivational factor that enhances job performance. Moreover, employees outside of technology departments should also be provided with targeted briefings to raise their awareness of how digital transformation is being integrated into their work.

One limitation of this study is that the survey was conducted only with Türk Telekom employees. Therefore, the findings cannot be generalized to the entire telecommunications sector. Additionally, considering the company's total number of employees and the survey's sample size, the results may not fully represent the organization as a

whole. Nonetheless, future studies that include other key players in the industry, such as Turkcell and Vodafone, could yield more generalizable and sector-wide insights. Expanding the scope of digital transformation parameters and examining them in greater detail would further enrich the study's outcomes, providing valuable guidance for both researchers and practitioners in future strategic planning.

While this study concentrates specifically on Türk Telekom employees' perceptions regarding their knowledge and the company's digital transformation initiatives, the insights derived may offer valuable guidance for the telecommunications sector more broadly and support policymakers in formulating effective digitalization strategies.

The survey findings underscore the uneven distribution of knowledge across different digital technologies. Company managers and policymakers should therefore prioritize sector-wide capacity-building initiatives aimed at improving digital literacy and technical competencies. Structured training programs would ensure that employees at all organizational levels are equipped with the necessary skills to engage with advanced technologies such as artificial intelligence, blockchain, and digital twins.

Given that telecommunications functions as a backbone for other industries, policies should encourage the integration of telecom services with critical sectors such as finance, healthcare, education, and manufacturing. Establishing innovative ecosystems and collaborative platforms would foster the co-development of digital applications, thereby creating new value chains and reinforcing national competitiveness.

The advancement of digital transformation requires sustained investment in research and development. Policymakers could facilitate this process by offering fiscal incentives, such as tax relief and targeted grants, to telecommunications firms investing in emerging technologies. Particular attention should be directed toward fostering domestic capabilities in cybersecurity, cloud services, and system integration, reducing dependence on foreign technology providers and strengthening digital sovereignty.

A notable finding of this study was the limited employee awareness of ongoing corporate digital

transformation initiatives. To address this gap, policies should require telecommunications companies to develop comprehensive communication frameworks that systematically inform employees of ongoing projects, objectives, and outcomes. Enhancing internal transparency will strengthen employee engagement and align organizational culture with strategic digital goals.

To sustain and accelerate digital transformation, regulatory authorities should design frameworks tailored to the unique requirements of the telecommunications industry. These should include standards for interoperability, robust cybersecurity protocols, and ethical guidelines for the deployment of artificial intelligence and the Internet of Things. Such frameworks would not only safeguard users but also provide clarity and stability for firms investing in digital innovation.

The pandemic has acted as a catalyst for digital adoption, particularly in remote services and cloud-based applications. Policymakers should embed these gains into long-term digital strategies by supporting projects that enhance network resilience, scalability, and inclusivity. Institutionalizing pandemic-driven innovations would ensure that the sector remains adaptive to future disruptions while maintaining momentum in digital transformation.

These recommendations, while derived from the perceptions of Türk Telekom employees, extend to the broader telecommunications sector. By addressing skill gaps, promoting innovation, and ensuring regulatory alignment, policymakers can strengthen the sector's role as a central enabler of national digitalization agendas.

Declarations

Funding: *No funding was received for conducting this study.*

Conflicts of Interest: *The authors declare no conflict of interest.*

Ethical Approval: *The study involved survey research with 288 employees of Türk Telekom. Data were collected on a voluntary basis, and confidentiality and anonymity were strictly maintained. If required, details of ethical approval can be provided by the authors.*

Informed Consent: *Informed consent was obtained from all participants prior to the survey.*

Data Availability: *The datasets generated and analyzed during the current study are not publicly available due to privacy and confidentiality restrictions but are available from the authors on reasonable request.*

Authors' Contributions: *All authors contributed to the design, implementation, analysis, and writing of the study. The first author coordinated the research process, the second author contributed to data collection, and the third author supported the analysis and manuscript preparation.*

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