TURKEY'S DIGITAL TRANSFORMATION INDEX 2021

TÜBİSAD
INFORMATICS INDUSTRY ASSOCIATION

TUBISAD's study titled "Turkey's Digital Transformation Index", was prepared by Assoc. Prof. Ümit İZMEN, Prof. Dr. Yılmaz KILIÇASLAN and Prof. Dr. Yeşim ÜÇDOĞRUK GÜREL in order to reveal the state of Turkey's economy and society regarding digitalization in the transition to the Fourth Industrial Revolution.

The aim of this study is to contribute to taking correct, timely and target-oriented steps necessary for Turkey to adapt to digital transformation.

We would like to thank all industry representatives who supported the Index Survey.

Contents :

Resumes

Assoc. Prof. Ümit İZMEN

Assoc. Prof. Ümit İZMEN, previously taught at various universities such as Bilgi, Boğaziçi, Koç, and Özyeğin, is currently a faculty member of Namık Kemal University, Faculty of Economics and Administrative Sciences. She received her bachelor's and doctorate degrees from Boğaziçi University. Between 1990 and 2010, she served as assistant general secretary and chief economist at TÜSİAD. In addition to her academic studies, she worked as a consultant to the business' and non-governmental organizations, carried out many projects with development agencies and business organizations, and wrote columns for various newspapers and magazines. Her studies are focused on topics such as; Turkish economy, regional development, industrial policy, innovation economics, international political economy, and social capital.

Prof. Dr. Yılmaz KILIÇASLAN

After completing his primary, secondary, and high school education in Ankara, Assoc. Prof. Yılmaz KILIÇASLAN received his bachelor's degree from Anadolu University, Department of Economics in 1993 and his master's degree from Boston USA's Northeastern University, Department of Economics in 1997. Working as a research assistant at the METU Department of Economics between 1999-2005, Yılmaz Kılıçaslan carried out his doctorate studies in the same department. Kılıçaslan, who received his doctorate in 2005, was granted the position of assistant professor by Anadolu University Department of Economics the same year. He worked as a visiting scholar at London Metropolitan University in 2007-2008 and Rice University in USA Houston in 2013. He worked as a project manager and researcher in several scientific research projects supported by various national and international institutions. He has books and articles on productivity and efficiency, innovation, technology, workforce, economic growth, and development in different sectors, especially in the manufacturing industry. Kılıçaslan, who is still working as an academic member at Anadolu University Faculty of Economics, has been a member of the TÜBİTAK Advisory Board since 2018.

Prof. Dr. Yeşim ÜÇDOĞRUK GÜREL

She graduated from Middle East Technical University, Department of Economics in 1998. Prof. Dr. Yeşim Üçdoğruk Gürel received her master's degree in 2001 and her doctorate in 2005 from METU Department of Economics. She worked as a research assistant at the METU Department of Economics between 1998-2005. Gürel joined Dokuz Eylul Faculty of Business, Department of Economics in 2006 as a lecturer and still works as a faculty member in the same department. She teaches courses such as Microeconomics, Innovation and Technological Economics and Information Economics at Dokuz Eylül University. She worked as a researcher in scientific research projects supported by various national and international institutions. Gürel has academic studies published in the fields of industrial economics, technology and innovation economics, entrepreneurship, and corporate economics in Turkey and abroad.

Executive Summary

The coronavirus pandemic has shown the sheer importance of digitalization. Countries and companies that have been able to cope with the economic difficulties of the pandemic much more easily are those that have made the necessary investments in digital technologies, that have the appropriate skills, and an established infrastructure that is fast and widespread.

In addition, the disruptions seen in supply chains during the pandemic and the dominance of global companies in various digital technologies also pointed out the importance of strengthening local resources in the digital transformation process.

These developments have placed digital transformation at the center of economic, social and political achievements all over the world. Such a transformation should be fast, spread across the whole society and to all sectors and all types of companies, and incentivise local dynamics.

In this context, Turkey's Digital Transformation Index, prepared by TUBISAD and first published in 2020, provides a convenient tool for evaluating Turkey's digital transformation performance over time and in comparison with other countries.

The Turkey's Digital Transformation Index covers the legislation, infrastructure, usage and skills that are effective on digital transformation, and the economic and social impact facets of said transformation. Turkey's Digital Transformation Index is a composite index that has 4 sub-indexes and 10 pillars which makes up the 64 different indicators. For each indicator, pillar and sub-index, a relative index value was calculated using data from 139 countries. Therefore, the index value for any indicator is determined not only by Turkey's digitalization performance, but also by its relative position to other countries.

Turkey's Digital Transformation Index was calculated as 2.94, 3.03 and 3.24 out of 5 for the years 2019, 2020 and 2021, respectively. These datas can be interpreted as a further acceleration of digital transformation in 2021. It is pleasing that Turkey's rate of transformation has increased at a time when digital transformation is accelerating all over the world because of the coronavirus pandemic. However, this performance may not be enough for Turkey to realize the desired digital leap. Considering the ambitious targets set by the European Union for the 2030 Digital Decade, Turkey also needs to further increase its digital transformation performance.

Examining the pillars of the index also provides clues on how Turkey's digital transformation performance can be improved.

	2019	2020	2021
TURKEY'S DIGITAL TRANSFORMATION INDEX	2.94	3.06	3.24
ENVIRONMENT SUB-INDEX	2.87	2.95	3.09
1st pillar: Political and regulatory environment	2.76	2.82	3.01
2nd pillar: Business and innovation environment	2.98	3.09	3.17
READINESS SUB-INDEX	3.19	3.24	3.37
3rd pillar: Infrastructure	2.34	2.27	2.32
4th pillar: Affordability	4.54	4.54	4.63
5th pillar: Skills	2.69	2.89	3.17
USAGE SUB-INDEX	2.88	3.16	3.36
6th pillar: Individual usage	3.20	3.22	3.31
7th pillar: Business usage	2.77	3.32	3.41
8th pillar: Government usage	2.66	2.92	3.37
IMPACT SUB-INDEX	2.81	2.88	3.14
9th pillar: Economic impacts	2.36	2.18	2.25
10th pillar: Social impacts	3.26	3.58	4.03

All four sub-indexes of Turkey's digitalization score improved positively in 2021 compared to 2020. Among the four sub-indexes in 2021, the "Environment" sub-index lowered the digitization score, while the "Usage" sub-index raised it. A careful interpretation of the data is required given that a significant part of the data used in the index calculation belongs to the years before 2020.

The fact that the “Environment” is the most serious obstacle in Turkey's digitalization points to the importance of this area, which will have a positive impact on the entire economy. The “Environment” sub-index consists of two pillars as “ Political and regulatory environment” and “Business and innovation environment”. There is an improvement in both pillars compared to the previous year.

The "Readiness” sub-index shows how ready and sufficient the economy is for digitalization. The development rate of the readiness sub-index is lower than the other sub-indexes. The “Readiness” sub-index has three pillars: “Infrastructure”, “Affordability” and “Skills”.

Digitalization will undoubtedly develop on a strong infrastructure. However, the "Infrastructure" pillar is the pillar with the lowest performance after the "Economic Impacts" pillar. Also, the rate of improvement in “Infrastructure” is low. Performance in the “Affordability” pillar is strong, with the value increasing from 4.54 in 2020 to 4.63 in 2021. “Skills” is another pillar that needs improvement in order to increase Turkey's performance. Considering that digitalization can only be achieved with skills suited for this field, it would be beneficial for Turkey to take faster and more comprehensive steps in “Skills”.

The “Usage” sub-index is examined in three pillars : “Individual Usage”, “Business Usage” and “Government Usage”. The scores of all three pillars are close to each other. Among the 10 pillars, “Government Usage” has been the pillar with the fastest development in Turkey's Digital Transformation Index.

The "Impact" sub-index has two pillars: "Economic Impacts" and "Social Impacts". Both pillars have improved compared to last year. Of these two, the “Social Impact” score is quite strong with a value of 4. However, the "Economic Impact" was the pillar that pulled the Turkey Digital Transformation Index down the most, with its score of 2.25. This data indicates that the desire for change in the business world should be further supported.

The coronavirus pandemic has shown that digital technologies are of decisive importance in maintaining economic and social life with the least possible damage. In this context, in this year's report of the TUBİSAD Digitalization Index, a survey was conducted with the top managers of the leading companies in the ICT sector in order to evaluate the impact of the coronavirus pandemic on their sector.

According to the evaluations made out of 5, it is seen that the coronavirus epidemic does not have a significant negative impact on the sector.

- It has been observed that the sector did not benefit much from the aids announced during the coronavirus pandemic.
- The sector's adaptation to the changing business conditions during the pandemic has been strong.
- There was an increase in employment in the ICT sector during the pandemic.
- It is expected that the increase in the importance of ICT in terms of the activities of the companies will continue after the epidemic.
  Most of the companies will make new moves in the field of ICT for the post-pandemic period.
- With the acceleration of the need for digital transformation, the development in the ICT sector is expected to follow a positive course.

As a whole, index figures show that Turkey is open and willing to digital transformation, but infrastructure and skills need to be developed for this transformation to happen. It should be taken into account that the increasing use of digital technologies will make import-based solutions inevitable in the face of the insufficient development of the ICT sector with local dynamics.

Suggestions for accelerating Turkey's digital transformation can be summarized as follows:

Strengthening the Vision for Information and Communication Technologies

- Digitalization targets and policies should be updated with the acceleration in digital transformation and the targets of other countries in mind.
- Digitalization policies should be designed and implemented not only for the government but also for the whole country.
- Digitalization policies should be implemented in an integrated manner with resource efficiency in mind.
- Digital transformation should be embraced at the highest level and supported by a strong communication strategy to involve all segments of society in the process.
- Arrangements that are made so that companies do not fall into a disadvantageous position in international competition should comply with international standards.
- The distinctness of the Information and Communication Technologies sector should be taken into account in the regulations.

- A liberal approach should be adopted as much as possible, taking into account the confidentiality and security of personal data in accessing the Internet.

Developing an Entrepreneurial Environment

- The rule of law and the independence of the judiciary should be strengthened, the effectiveness of the legal system should be increased in the resolution of disputes, and the fair functioning of the judicial system should be enforced in disputes between government institutions and individuals, civil societies and companies.
- It should be aimed to improve the competitive environment and develop the entrepreneurial environment with incentives and regulations.
- Protection of intellectual property rights should be strengthened.
- The public procurement law isn't supportive of the Information and Communication Technologies sector.
- Increasing the share of R&D expenditures in GDP should be targeted and R&D policies should be reviewed to accelerate digital transformation.
- Access to financial resources, especially venture capital, should be improved.
- The government should give importance to activities that improve the competitive environment, not those that compete with the private sector.
- Tax rates should be determined in accordance with the international standards and in consultation with the sector.
- Business models that will bring SMEs together should be developed, and SMEs should be informed, guided and supported on digital transformation processes.
- Initiatives should be established to support and prioritize the use of domestic technology in all sectors.
- R&D and technopark incentives should be rearranged according to the remote working model.

Accelerating Infrastructure Investments

- Concrete goals should be set in order to ensure that the critical infrastructure, especially the fiber infrastructure, reaches the qualification required by the digital transformation as soon as possible.
- Imperfect competition conditions that make it difficult to make infrastructure investments should be improved.
- Firms should be enabled to act through platforms in order to reduce data storage and processing costs.

Development of Qualified Labor Resource

- Starting from basic education to tertiary education, the education system should be reviewed and the quality of the education system in providing ICT skills should be increased.
- University education curriculum should be changed and updated considering the needs of digital transformation and new programs should be opened in universities.
- Employment of women and disabled people in the field of ICT should be encouraged in order to meet the need for a qualified workforce.
- Training and human resource improvements should be made by considering the needs of not only Turkey but also the region.

- In terms of effective use of human resources, the needs of the government should be determined and resolved as a whole, not on a project basis, or a cooperation should be made with the private sector in this regard.
- Wage and migration policies should be developed to ensure that people with high digital competencies stay in the country and attract human resources from abroad.
- Joint projects should be developed with Turkish citizens working in the field of ICT abroad.
- Efficiency should be increased by providing the existing workforce with the skills to work with new technologies, and automation and artificial intelligence applications should be prevented from causing employment losses.
- Action should be taken to increase digital literacy for the entire population.

INTRODUCTION

Introduction

Digital transformation has been causing major changes for years in many sectors such as public services, education, health, finance, white goods, media, automotive, transportation, logistics, tourism, manufacturing industries, trade and even construction. The coronavirus pandemic has accelerated this process and made the importance of digitalization clearly visible. Digital transformation has become an indispensable necessity not only for the competitiveness of companies and countries, but also for the uninterrupted continuation of daily life. Countries and companies that have been able to cope with the economic difficulties of the pandemic much more easily are those that have made the necessary investments in digital technologies, that have the appropriate skills, and an established infrastructure that is fast and widespread.

Digital technologies and fast, widespread, powerful and cheap infrastructure have removed the dependence of many activities on location. In this way, working life continued, meetings were held, educational activities continued, banking and financial activities were carried out mainly in the online environment, shopping could be done without contact, digital technologies were used in health examinations, vaccination information, and processing of information that are critical for controlling the spread of the pandemic such as patient and contact follow-up has become possible thanks to digital technologies. Online platforms have provided opportunities in meeting the needs such as entertainment, art, culture and socialization that were unimaginable before. Taking advantage of all these opportunities has undoubtedly been parallel to the openness of the economy and society to digital transformation.

Economic and social segments that are not open to digital transformation, regions where the infrastructure is not strong and fast, people and companies that do not have the appropriate equipment and ICT skills have felt the burden of the pandemic much more heavily. In addition, the occasional disruptions in supply chains during the pandemic, the dependence on imports of some critical hardware and accessories, the increasing prices of imported products due to the decline in the value of the Turkish lira, and the dominance of global companies in some critical digital technologies also pointed to the importance of strengthening local opportunities in the digital transformation process.

Turkey carries out various studies about digital transformation in a number of fields such as e-Government, cyber security, national technologies, big data and artificial intelligence. In this framework, Ulusal Yapay Zekâ Stratejisi 2021-2025 (National Artificial Intelligence Strategy 2021-2025) was published. In the corporate sector, many companies have started various projects in order to keep up with the transformation in business and working models that have become evident especially during the coronavirus pandemic. However, projects for digital transformation are not synonymous with a holistic and comprehensive strategy implemented within the framework of a clear vision. In the absence of a clear vision and a holistic and comprehensive strategy, success in digital transformation cannot be achieved despite the size of the financial and human resources allocated. It is a problem to maintain competitiveness in the face of the changing world, businesses and working models, new products, sectors and professions. Securing competitiveness is not possible by digitalization of certain particular operations in some industries, but with a total change in how everything works, in other words, with digital transformation.

For this reason, all over the world digital transformation that embraces the whole society, spreads to all sectors and all types of companies, and activates local dynamics, is at the center of economic, social and political goals.

In this context, Turkey's Digital Transformation Index report, the first of which was published in 2020, has become a very important reference point for closely monitoring and accelerating the digitalization performance of the Turkish economy and society.

Turkey's Digital Transformation Index, prepared by TUBISAD, covers the legislation, infrastructure, usage and skills that are effective on digital transformation, and the magnitude of economic and social impact of said transformation. With this index, both a general index and separate digitalization index values for four sub-indexes and ten pillars are measured for Turkey. The Digital Transformation Index is prepared by making use of internationally comparable data, as well as the qualitative assessments of industry executives about Turkey's readiness and competences for digital transformation. With the update for 2021, the Digital Transformation Index values are calculated for the years 2019, 2020 and 2021. In the calculation of the index, data from 139 countries, including Turkey, are also used. Therefore, it is not only the digitalization of Turkey that determines the index value, but also the positions of other countries in the global digital transformation together with Turkey.

The use of international data in the calculation of the index causes some indicators to fall behind. This has become even more important due to delays in data collection during the coronavirus outbreak. The World Bank's Doing Business and the World Economic Forum's World Competitiveness Report studies used in the calculation of the index were not published in 2021. Hence, the index was calculated by using the values from the previous year's publication. Therefore, the interpretation of the data should be done with care. The impact of the coronavirus on digitalization will not be seen from this year's values, but from the index values to be calculated in the coming years. The fact that a significant part of the data used belongs to the years before 2020 makes it impossible to comment on the effect of the coronavirus on the calculated index values.

The plan of the report is as follows:
In the next section, descriptive analysis of some variables used in the calculation of the digital transformation index are presented in comparison with selected countries in order to determine Turkey's position in digital transformation. In the following section, Turkey's Digital Transformation index and all the components that make up the index are evaluated and the main constraints and solution proposals of Turkey's digital transformation are discussed. In Chapter 4, the results of a survey conducted to evaluate the impact of the coronavirus outbreak on the ICT sector are evaluated. Chapter 5 summarizes the results of this report.

WHERE TURKEY STANDS IN DIGITAL TRANSFORMATION?

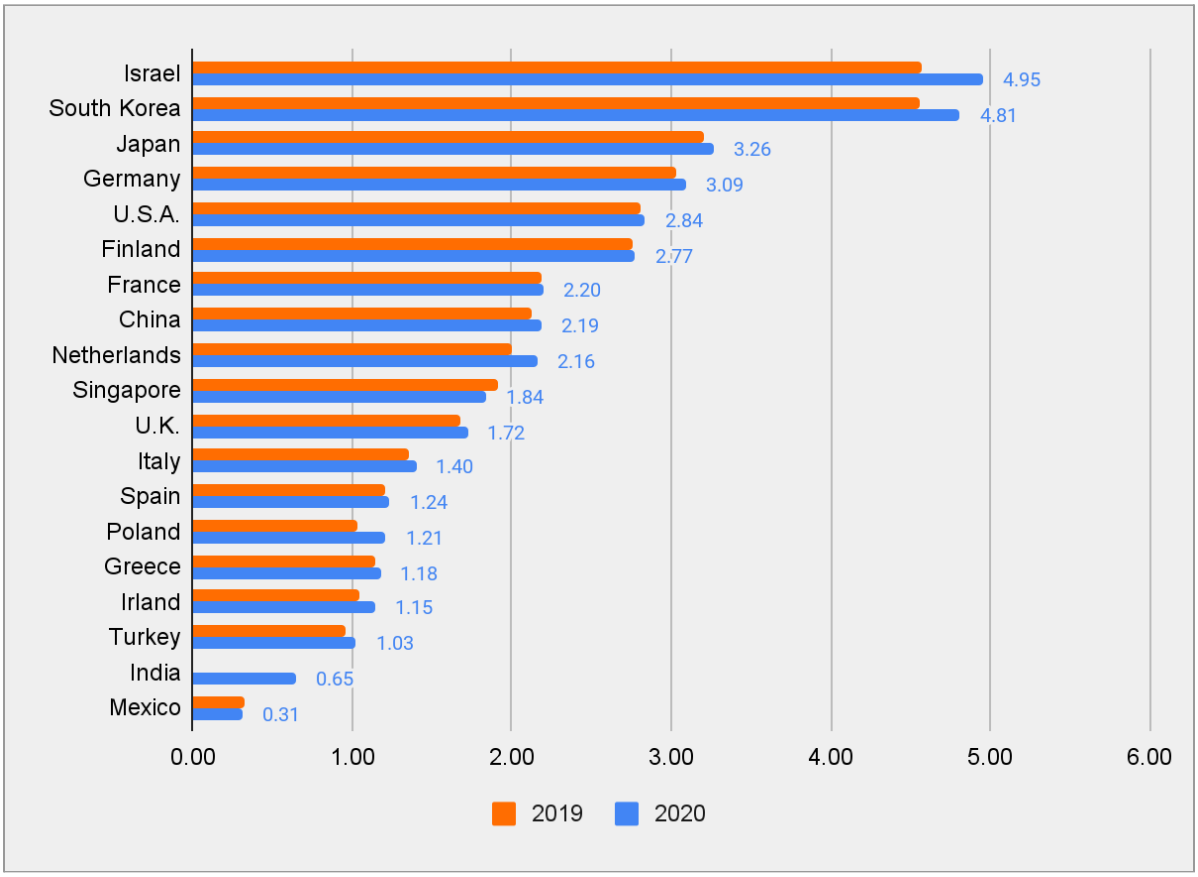
WHERE TURKEY STANDS IN DIGITAL TRANSFORMATION?

In this section, in order to determine where Turkey is in digital transformation, descriptive analysis of the variables used in the calculation of the digital transformation index are presented both in comparison with the selected countries and in a way to show the evolution of the countries with available data from 2019 to 2020. For these analyses, nineteen countries with different development levels and sizes were selected, including Turkey: U.S.A., Germany, Brazil, China, Finland, France, South Africa, South Korea, India, Netherlands, U.K., Ireland, Spain, Israel, Italy, Japan, Mexico, Poland, Singapore and Greece. This analysis will give important ideas about where Turkey is in digital transformation. Since statistics on some of the pillars used in the calculation of the Digital Transformation Index were not disclosed by the relevant institutions in 2021, they are not included in this 2021. These statistics include unlicensed software usage rates, the cost of enforcing contracts, the length of time commercial sales disputes are resolved through court, the total tax rate (as % of profits), the number of days required to start a company, and the number of procedures required to start a company. The 2019 information of these statistics can be accessed from **TÜBİSAD Turkey's Digital Transformation Index 2020** report. Descriptive analysis of other pillars used are presented below:

In Figure 1 below, the R&D expenditure statistics of selected countries for 2019 and 2020 are given. The best explanatory variable regarding R&D expenditures is the ratio of R&D expenditures to gross domestic product and it shows how much of that country's income is spent on research and development activities (TÜBİSAD, 2021). As of 2020, Israel has the highest share among the selected countries with 4.95%, followed by South Korea with 4.81%. Although both countries are leaders in this field, they significantly increased these rates in 2020 compared to 2019. Although Turkey has made significant strides in the ratio of R&D expenditures to gross domestic product in recent years, it ranks third from the last among the selected countries with 1.03%, after Mexico and India. In terms of ranking, there was no change in the transition from 2019 to 2020. However, we can say that in this one-year period, Turkey has increased its R&D expenditures, albeit slightly. Because this rate was 9.6 per thousand in 2019. Based on the fact that the ratio of R&D expenditures to gross domestic product has increased in 2020 compared to 2019, it can be said that R&D expenditures did not slow down despite the contraction in 2020. The only exception to this is Mexico. There was a contraction in R&D expenditures in this country in 2020. Although it is not correct to define R&D expenditures as the sole indicator of innovation, when evaluated together with the number of patent applications (if R&D expenditures are an input, patent applications are an output and can be interpreted as the efficiency of R&D expenditures), it allows us to comment on their efficiency.

Figure 1.

R&D Expenditure (% of GDP)



Source:

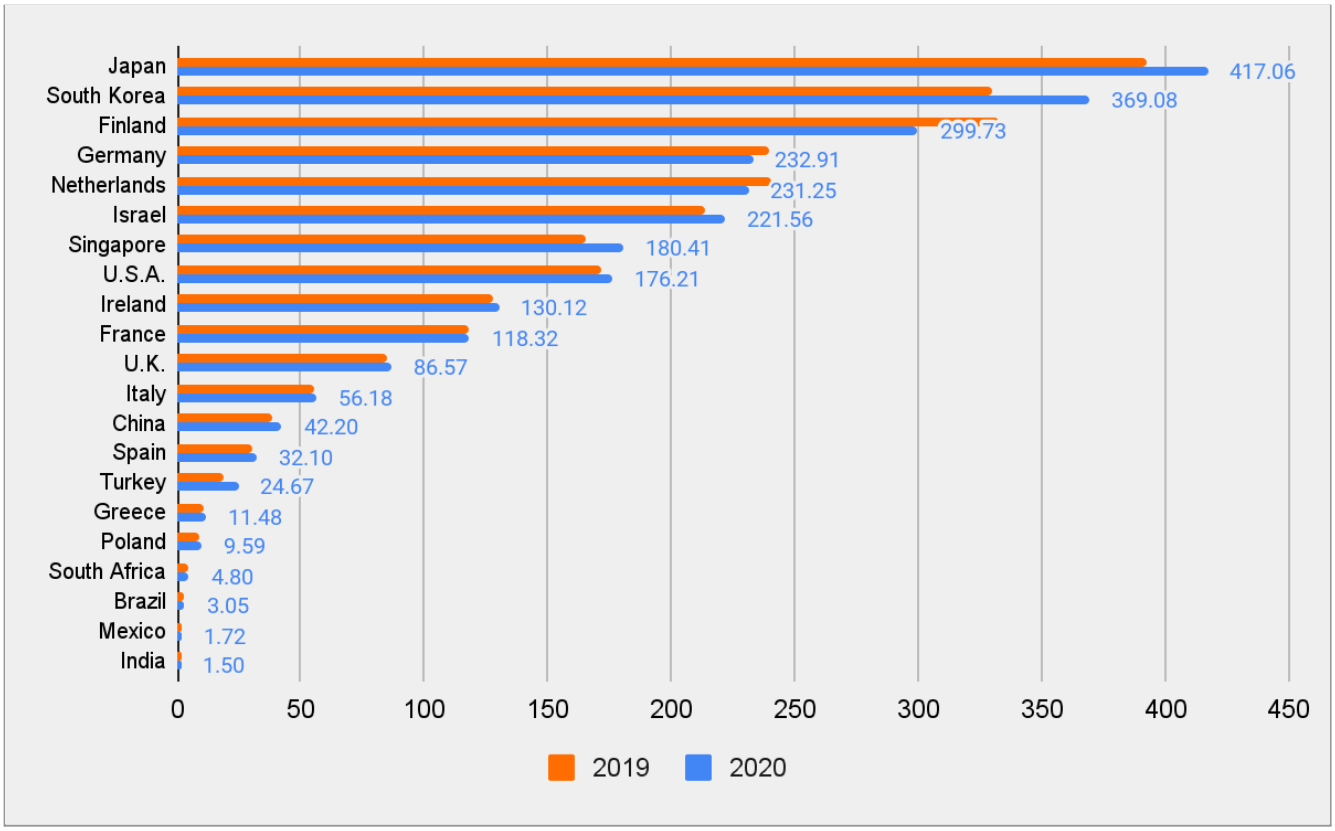
World Development Indicators, 2021

In Figure 2, patent application statistics under the PCT (Patent Cooperation Treaty) are given. The number of patent applications per million people in Turkey for 2020 is 24.67 (See Figure 2). Although an increase of 28% was observed in the number of patents compared to the previous year, this figure is quite low when compared to selected countries. It is noteworthy that the number of patent applications per capita in Japan, which is the country with the highest number of patent applications per million inhabitants, is approximately 17 times that of Turkey. On the other hand, Turkey's number of patent applications per million people within the scope of PCT is about 16 times that of India (1.50), which is the country with the lowest number of patent applications per million people. It is possible to observe the biggest effects of the coronavirus pandemic in 2020 and the resulting economic contraction on the number of patent applications in European countries. As a matter of fact, there was a decrease in the number of patent applications in Finland, Germany and the Netherlands compared to the previous year, and significant increases were not observed in Ireland, France, Greece and Poland (See Figure 2).

Figure 2.

Patent application under the Patent Cooperation Treaty

(Per one million people)



Source:

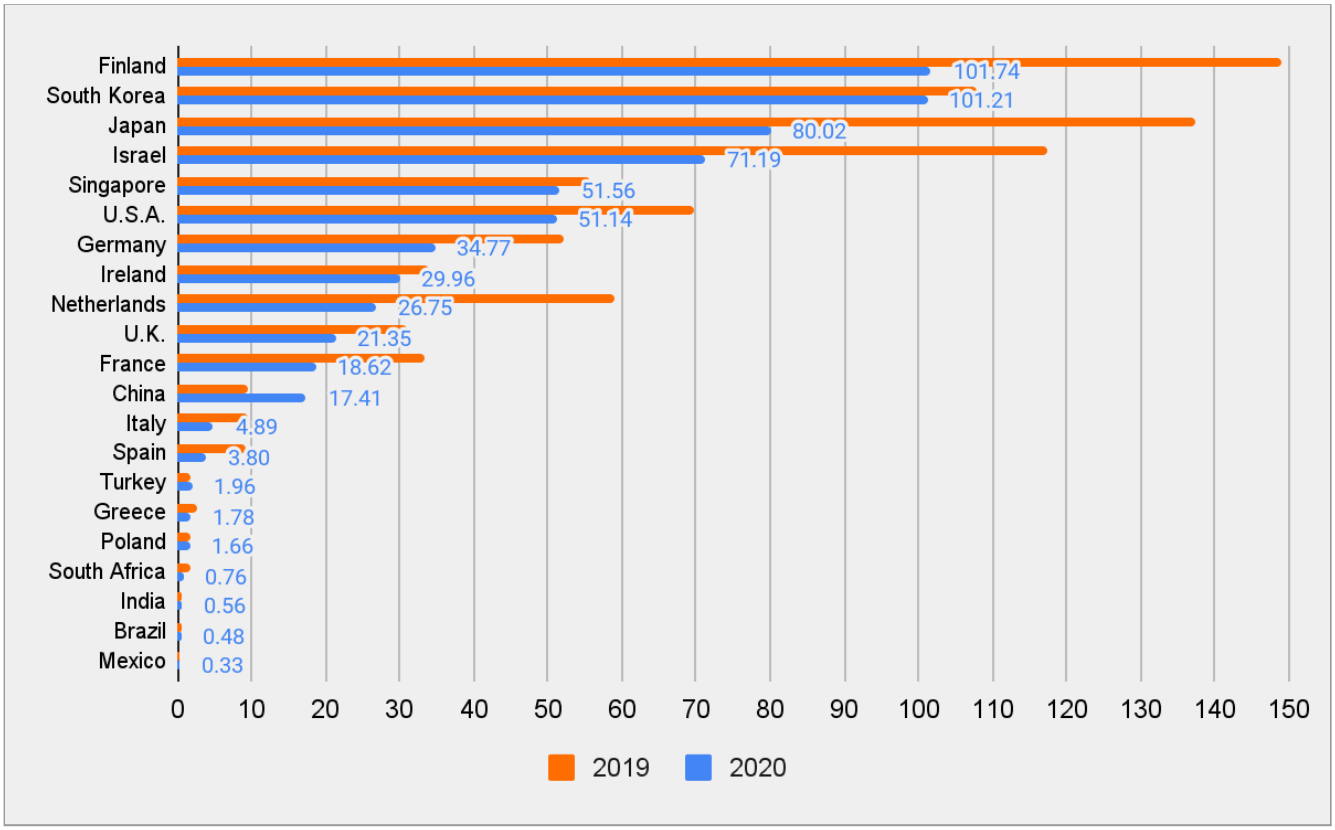
World Intellectual Property Organization (WIPO), 2021

In order to be able to interpret the number of patent applications correctly, it is of great importance from which sectors these applications are made. For this reason, while evaluating patent applications per million people, it is necessary to evaluate applications made in the field of ICT (Information and Communication Technologies). Because the most important sector in the transition to the information society is the Information and Communication Technologies sector. The number of patent applications in the field of ICT per million people in Turkey is 1.96. With this statistic, Turkey ranks seventh last among the selected countries. In other words, less than 10% of Turkey's patent applications are made in the field of ICT. Looking at Finland (101.74) and South Korea (101.21), which are the leading countries in ICT-based patent applications per million people, as of 2020, patent applications made in the field of ICT account for approximately 34% and 27% of the total patent applications, respectively. When the data for 2019 and 2020 are compared, it has been observed that the number of patent applications made in the field of ICT per million people varies greatly. In particular, the number of patent applications in the field of ICT in Finland, Japan, Israel, the Netherlands, Germany and the USA showed a large decrease compared to 2019. Countries with a high number of patent applications per capita in the field of ICT are among the developed countries. Among the selected countries within the scope of this study, the two countries that increased patent applications in the field of ICT in the pandemic year are Turkey and China.

Figure 3.

Patent applications in the field of Information and Communication Technologies

(Per one million people)



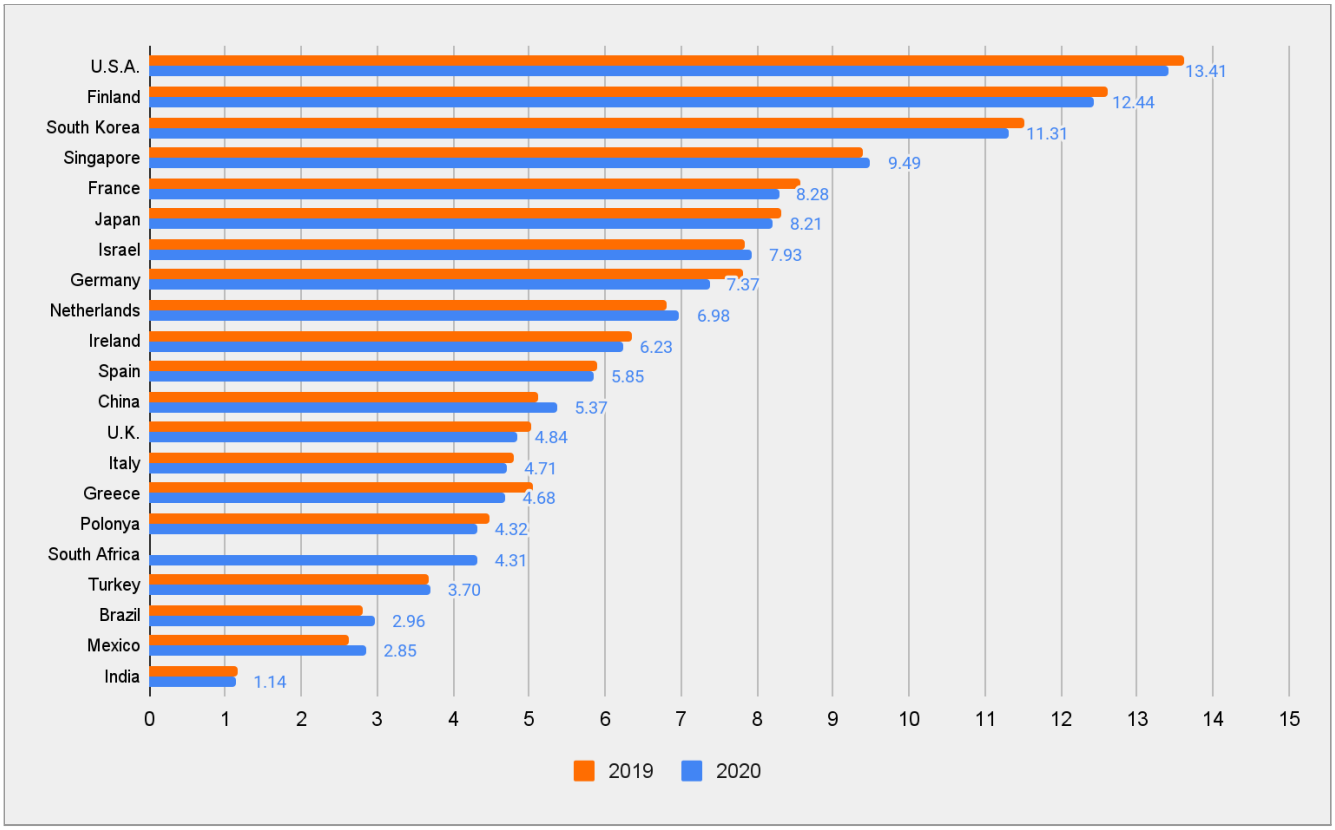
Source :

World Development Indicators, 2021

Another variable we use in the calculation of the Digital Transformation Index is electricity production. It is accepted that the countries with strong electricity production have more developed infrastructures for the transition to the digital economy (TÜBİSAD, 2020). In addition to hydroelectric, coal, oil, gas and nuclear power generation, electricity generation statistics also cover geothermal, solar, wind, tidal and wave energy, as well as generation from combustible renewable energy and waste, at kilowatt-hours (kWh) per capita. With 3700 kWh per capita, Turkey ranks among the countries with the lowest per capita electricity production among selected countries, along with Brazil (2960 kWh), Mexico (2850 kWh) and India (1140 kWh) (See Figure 4). Looking at the USA, which is the country with the highest electricity production per capita, is 3.6 times (13410 kWh) in comparison with the per capita production in Turkey. When the data in 2019 and 2020 for selected countries are compared, it is observed that there is a decrease in electricity production per capita as a result of the contraction in 2020 in countries except Singapore, Israel, Netherlands, China, Turkey, Brazil and Mexico. Electricity production in Turkey has not changed much in 2020.

Figure 4.

Electricity production (mWh/person)



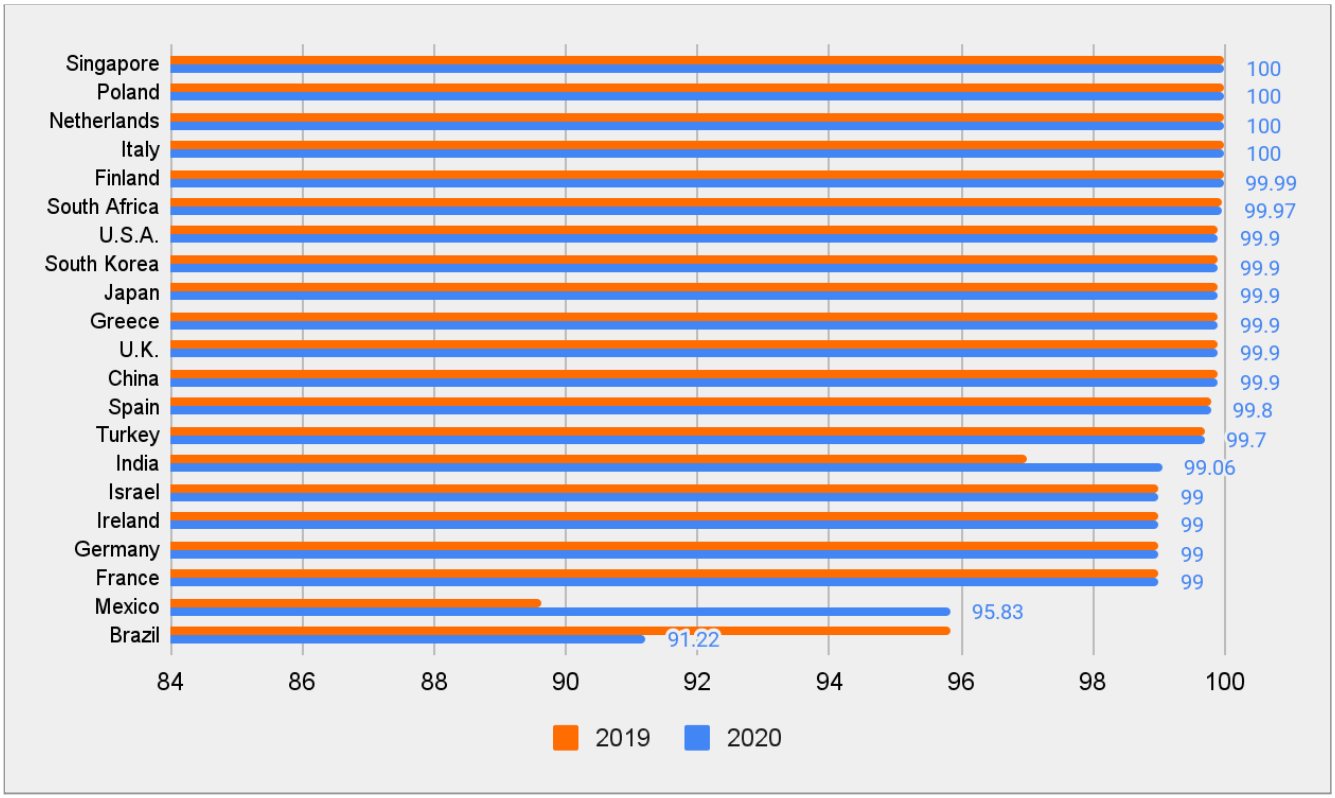
Source:

BP Statistical Review of World Energy, 2021

In Figure 5, mobile network coverage of selected countries, including Turkey, for 2019 and 2020 is given. Mobile network coverage measures the percentage of residents covered by any mobile cellular signal, regardless of whether they are subscribed to it or not (TÜBİSAD, 2020). This statistic is the ratio of the number of residents in any mobile cellular signal range to the total population. 99.7% of Turkey's population is in a mobile network coverage area (See Figure 5). This rate was almost the same in 2019. To make a comparison among the selected countries, the top 4 countries in terms of mobile coverage network are Singapore, Poland, Netherlands and Italy where 100% of the population is covered by a mobile network. Comparing the data for 2019 and 2020, it was observed that while there were no striking changes in the vast majority of countries, the mobile network coverage of India and Mexico increased greatly, while the mobile network coverage of Brazil surprisingly decreased significantly (See Figure 5).

Figure 5.

Mobile network coverage (% of population)



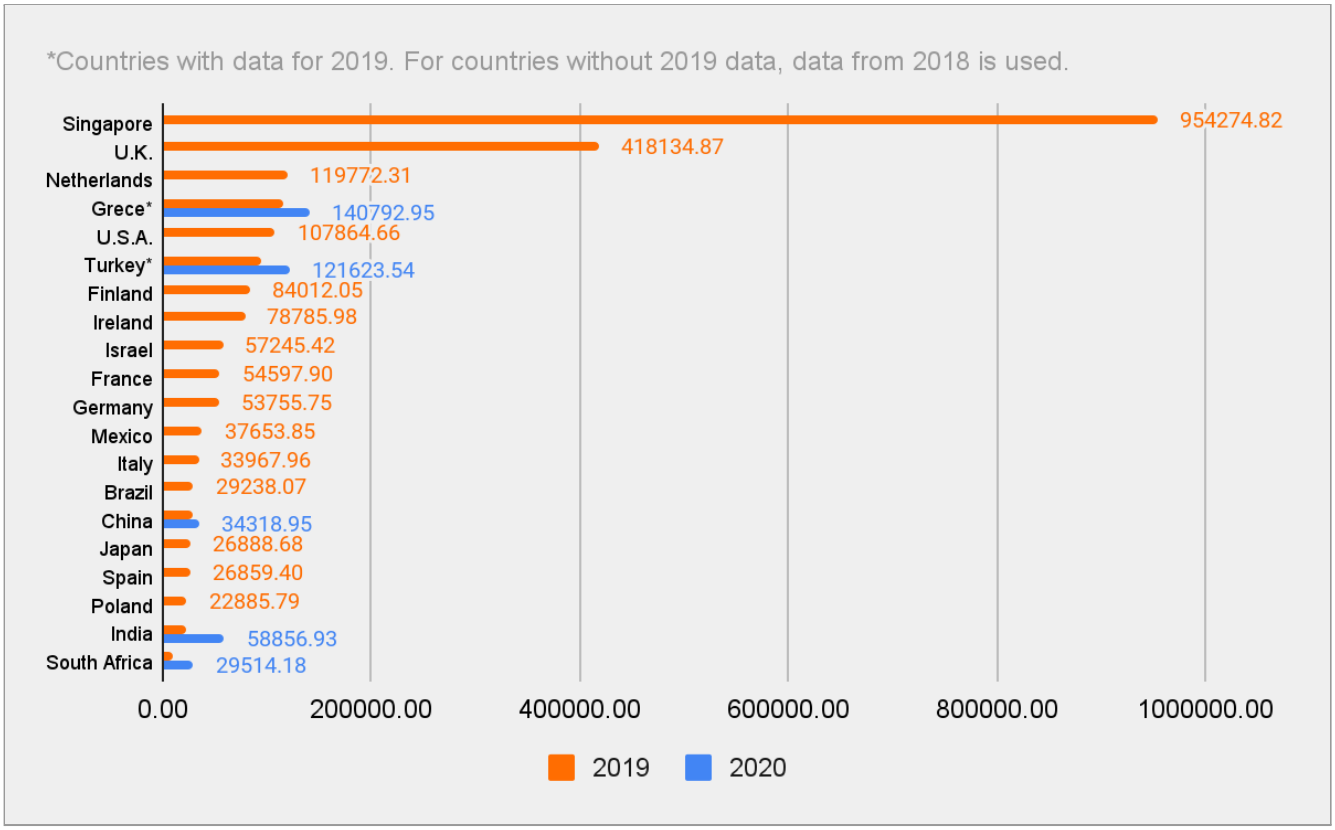
Source:

International Telecommunication Union (ITU), 2021

The 2020 data of international internet bandwidth, which is one of the pillars used in the calculation of the Digital Transformation Index, has not been disclosed for most of the countries we examined. In this regard, only the data of Turkey, Greece, China, India and South Africa for the year 2020 have been reached. Frankly, we do not think that the rankings between countries have changed much from 2019 to 2020. In 2019, Singapore (954 thousand kb/s), England (418 thousand kb/s) and Netherlands (119 thousand kb/s) took the first three places in the list, while Poland (22 thousand kb/s), India (21 thousand kb/s)) and South Africa (10 thousand kb/s) took the last place (TÜBİSAD, 2020). In 2019, with 95 thousand kb/s per user per second, Turkey was the 6th country with the highest international internet bandwidth per user among the selected countries (See Figure 6). This rate has increased to 121 thousand kb/s in 2020. The international internet bandwidth of Greece, which is 4th in the ranking, has increased to 140 thousand kb/s in 2020. India is the country that has increased its internet bandwidth the most proportionally from 2019 to 2020 with an increase of almost 3 times in a one year period.

Figure 6.

International internet bandwidth, (kbps)



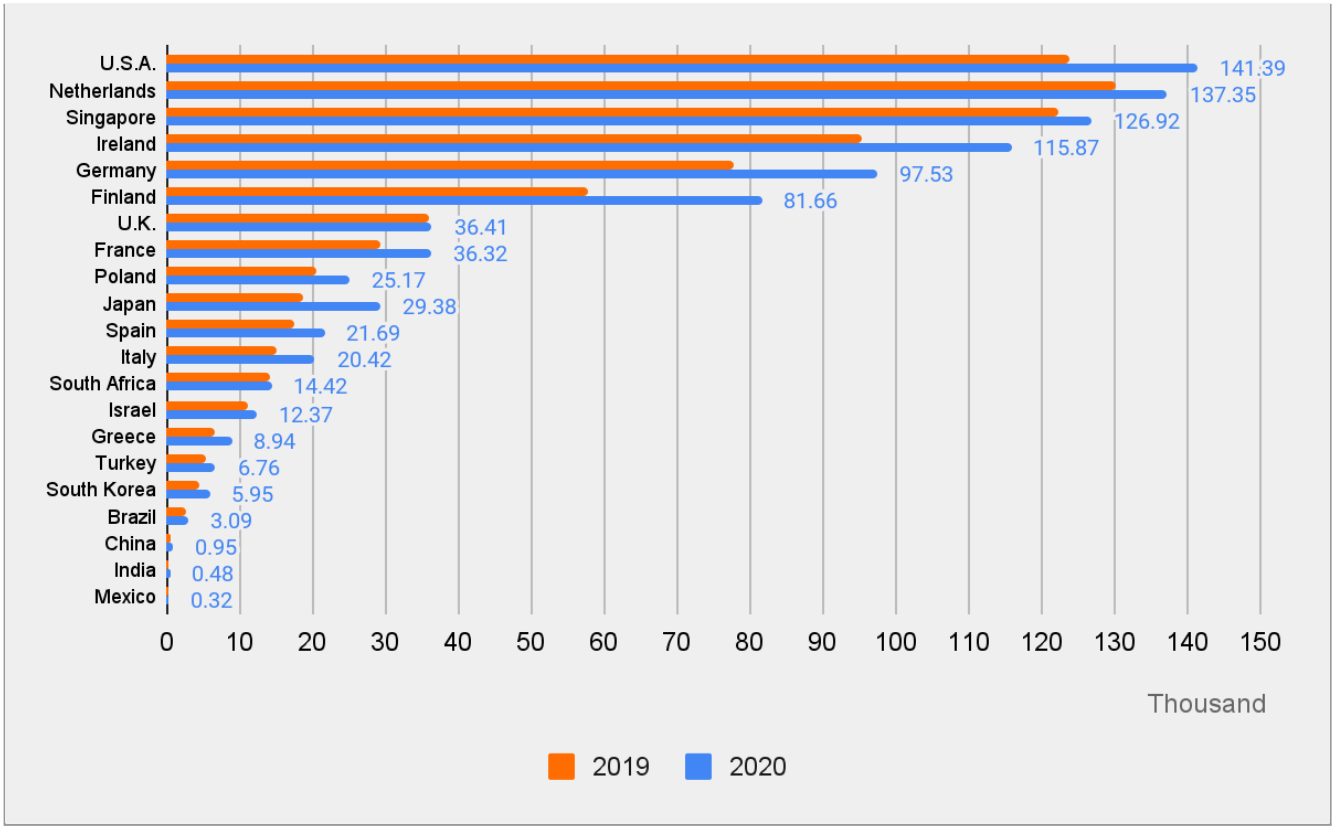
Source:

International Telecommunication Union (ITU), 2021

In digital transformation, besides the prevalence of ICT infrastructure, its quality and cost are also important. The quality of an economy's infrastructure is an important factor in investment decisions for both domestic and foreign investors. The increasing number of ICT technology users has increased the need for secure internet servers. For this reason, the number of secure internet servers per one million population is considered a very important statistic (TÜBİSAD, 2020). In addition, one of the biggest effects of the coronavirus pandemic is the increase in internet shopping. Although there has been a decrease in many statistics worldwide or at least in a group of countries, there has been an increase in the number of secure internet servers per capita in all selected countries with the establishment of secure internet networks required by the increasing e-commerce volume. The number of secure internet servers per one million people in Turkey is 6,760 (See Figure 7). This number was 5,438 in 2019. When compared with selected countries, Turkey is below the average, with South Korea (5,950), Brazil (3,090), China (950), India (480) and Mexico (320) at the bottom of the list. Looking at the countries at the top of the list, it is seen that the USA has 141 thousand and the Netherlands has over 137 thousand secure internet servers for each million population (See Figure 6).

Figure 7.

Secure internet servers (per million population)



Source:

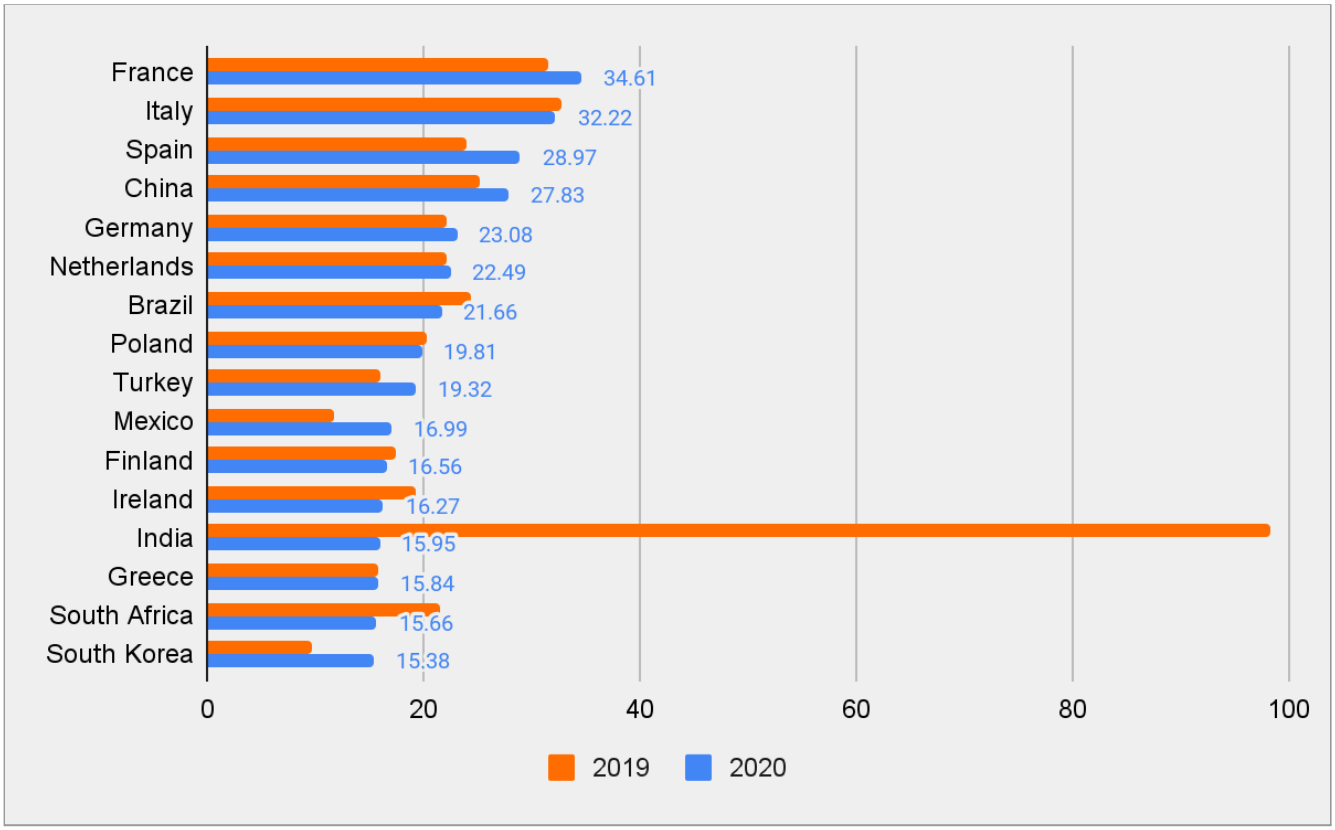
World Development Indicators, 2021

Another important indicator in digital transformation is how much of the telecommunication revenues are reused as telecommunication investments, shown in Figure 8. The share of Turkey's telecommunication investment in telecommunication service revenues, which was 15.9% in 2019, increased significantly to 19.32% in 2020 (See Figure 8). Especially in European countries and Turkey, there have been significant increases in telecommunication investments in 2020. We think that at least one of the reasons for this increase is the pandemic. Compared to selected countries, Turkey (19.32) is at the middle along with Brazil (21.66), Poland (19.81) and Mexico (16.99) while being ahead of South Korea (15.38), South Africa (15.66) and Greece (15.84) and behind of France (34.61), Italy (32.22) and Spain (28.97). In 2019, India, which is at the top of the ranking, evaluated almost all of its annual telecommunications revenues (98.28%) as telecommunications services investments, but the share of investment in revenue decreased to 15.95% in 2020 (See Figure 8).

Figure 8.

Share of annual investment in telecommunications services in revenue

(% Telecommunications revenue) (kb/s)



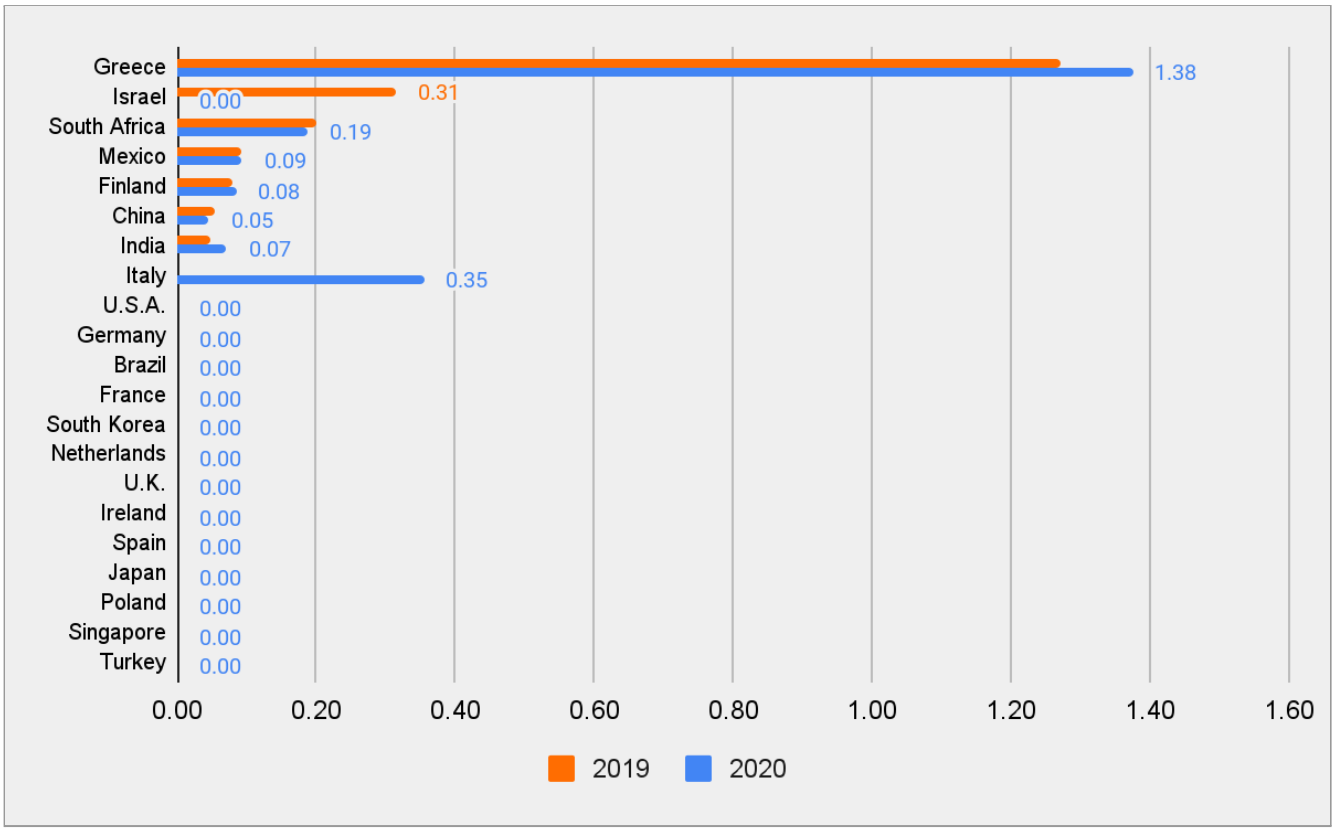
Source:

International Telecommunication Union (ITU), 2021

Average mobile cellular tariffs are given in Figure 9. The average 1-minute purchasing power parity (PPP) dollar cost of mobile cellular tariffs in Turkey is close to zero together with many countries (See Figure 9). The countries with the highest cost of a one-minute local call are Greece (PPP$1.38), Italy (PPP$0.35) and South Africa (PPP$0.20) respectively. Israel (PPP$0.31), the country with the second highest cost of one-minute local calls in 2019, brought its costs closer to zero in 2020, while in Italy, which is one of the countries with a near-zero one-minute local call cost, this cost increased to PPP$0.35 in 2019.

Figure 9.

Average mobile cellular tariffs (PPP$/minute)



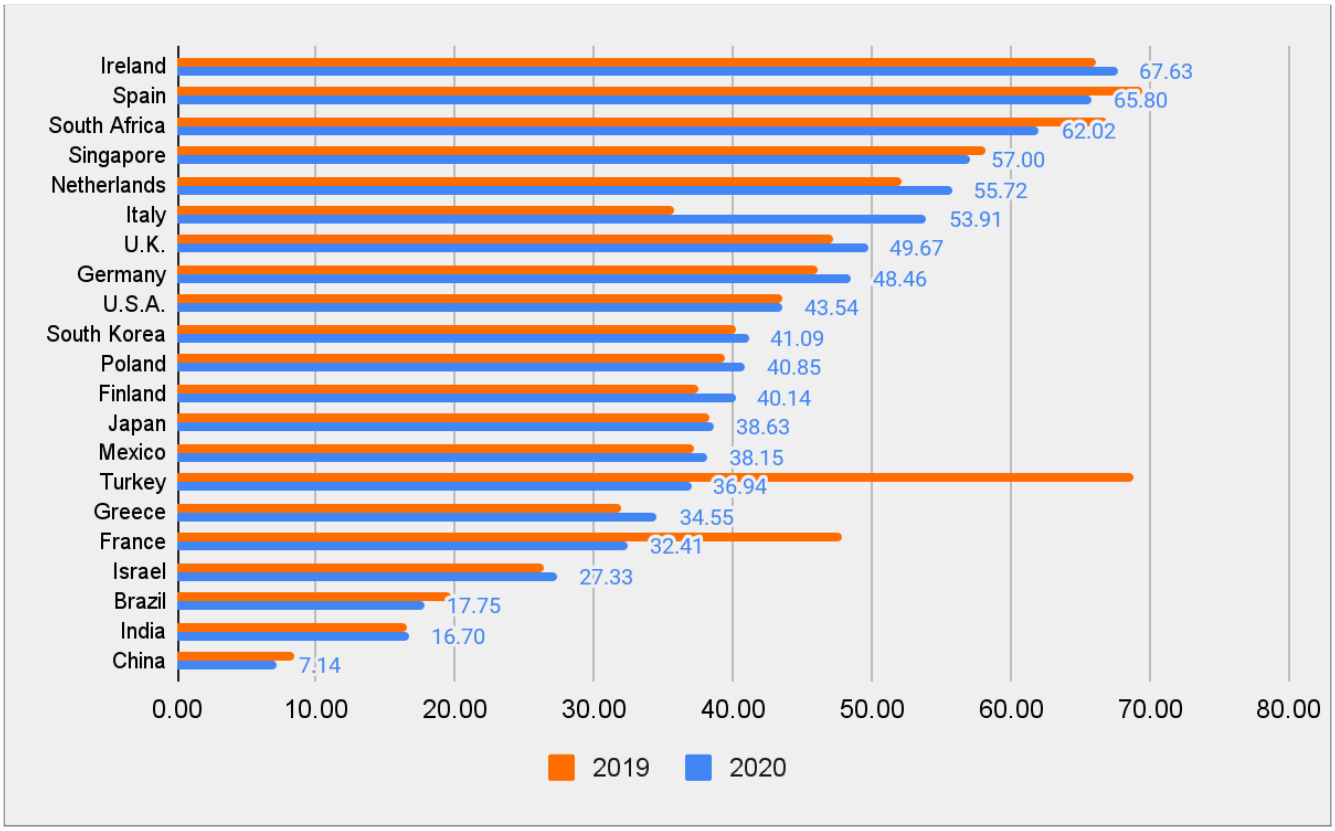
Source :

International Telecommunication Union (ITU), 2021

In 2019, Turkey ranked second with PPP$ 68.87 after Spain (PPP$69.49), the country with the highest monthly fixed broadband internet tariff (See Figure 10). However, by 2020, it is seen that these fees have decreased to PPP$36.94. With this decrease, Turkey, along with France, is the country with the highest decrease in fixed broadband internet tariff fees in 2020. In Italy, on the other hand, the situation was reversed, with fixed broadband internet tariff fees rising from PPP$35.67 to PPP$53.91. As of 2020, the countries with the lowest monthly fixed broadband internet tariffs are China (PPP$7.14), India (PPP$16.70) and Brazil (PPP$17.75). It should be taken into account that the high populations of China and India may cause the fixed costs per user to be very low, allowing internet tariff fees to decrease (TÜBİSAD, 2020).

Figure 10.

Fixed broadband internet tariffs (SGP $/minute)



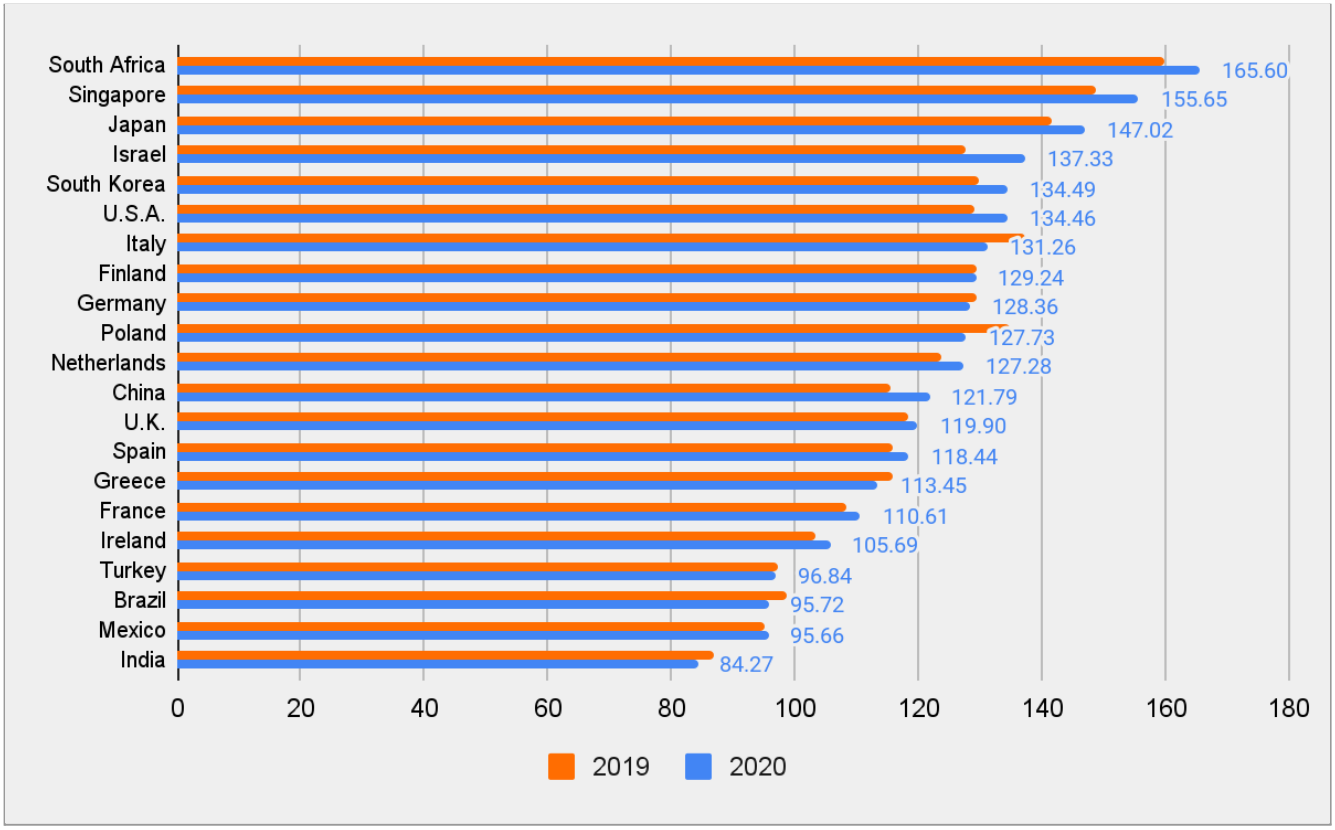
Source:

International Telecommunication Union (ITU), 2021

Today, a significant portion of digital transactions, including banking and online shopping, can also be carried out via mobile phones. Therefore, mobile phone subscription has an important place in digital transformation. The countries with the highest number of mobile phone subscriptions per 100 people in the selected countries shown in Figure 11 are South Africa (165.60), Singapore (155.65) and Japan (147.02), respectively. The number of mobile phone subscriptions per 100 people in Turkey is 96.84 (See Figure 11). With this number, Turkey is in the last few of the selected countries along with Brazil (95.72), Mexico (95.66) and India (84.27). When comparing 2019 and 2020, while the number of mobile phone subscriptions per 100 people increased in many countries, this number decreased in Italy, Poland, Greece, Turkey, Brazil and India.

Figure 11.

Mobile phone subscription (Per 100 people)

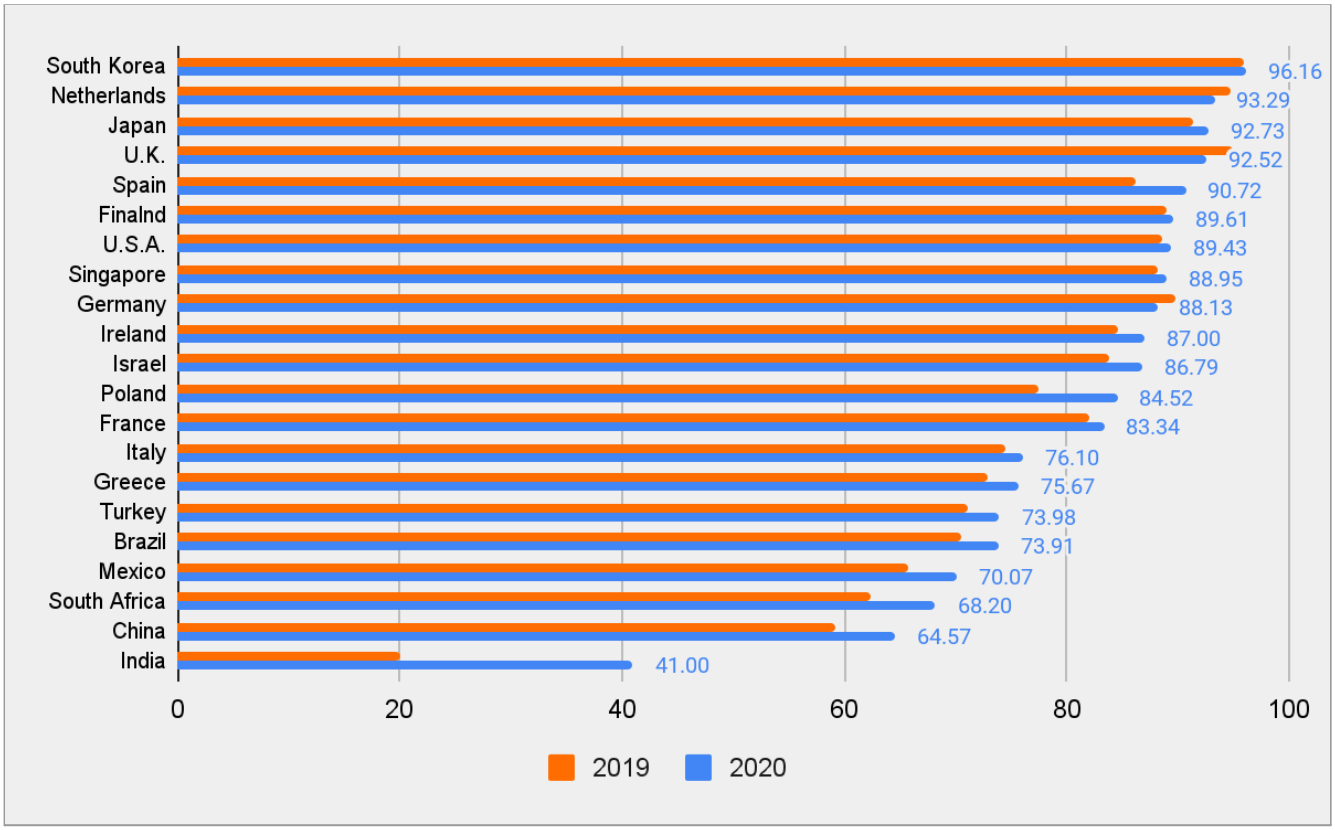


Source:

International Telecommunication Union (ITU), 2021

One of the important elements of the transition to the digital economy is the use of digital technologies by individuals on the side of demand. In this respect, the high level of individual internet use is an important indicator. Individual internet use refers to the ratio of people using the internet in the last 12 months to the total population (TÜBİSAD, 2020). The rate of individual internet usage in Turkey in 2020 is 73.98% (See Figure 12). This rate was 71.04% in 2019. With this ratio, Turkey is below the average of selected countries and ranks sixth from the last. The countries with the highest percentage of individual internet use are South Korea (96.16), Netherlands (93.29) and Japan (92.73) (See Figure 12). When comparing 2019 and 2020, although there were no dramatic decreases in the rate of individual internet use in selected countries, significant increases were observed in countries such as Poland, Mexico and Spain. India is the country with the highest proportional increase in personal internet use in 2020. We see that in India internet usage, which was 20% in 2019, increased to 41% in 2020.

Figure 12.
Individual internet use(%)

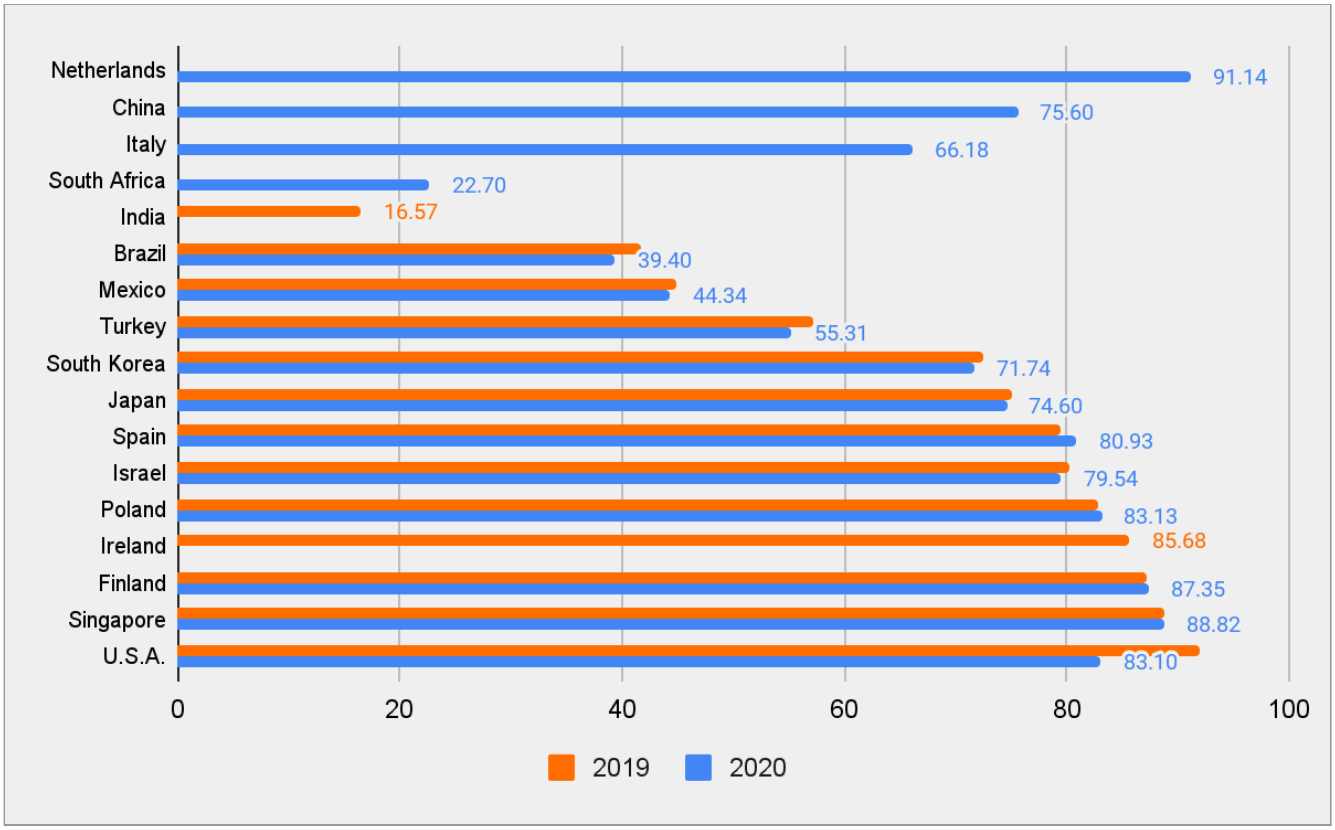


Source:
International Telecommunication Union (ITU), 2021

Having a computer in a household, together with internet access, is an important factor that enables individuals in that household to access information and technology more easily. The importance of this was witnessed in 2020, especially with the pandemic. Because many children that were getting education could not attend online training because they did not have a computer at home. Computer ownership in households is calculated by dividing the number of households with computers (a desktop or laptop computer) by the total number of households (TÜBİSAD, 2020). When a comparison is made with the selected countries, Turkey is below the average of selected countries with a rate of 57.25%, followed by India (16.57%), South Africa (22.7%), Brazil (41.76%) and Mexico (44.88%) (See Figure 13). It is observed that computer ownership in Turkey decreased from 2019 to 2020. This may be due to the replacement of computers with other ICT devices (tablets, phones, etc.). In the USA, the country with the highest household rate in 2019 (92.02%), there was a significant decrease in computer ownership in 2020. The countries with the highest computer ownership as of 2020 are the Netherlands (91.14%) and Singapore (88.74%).) (See Figure 13).

Figure 13.

Computer ownership in households (%)



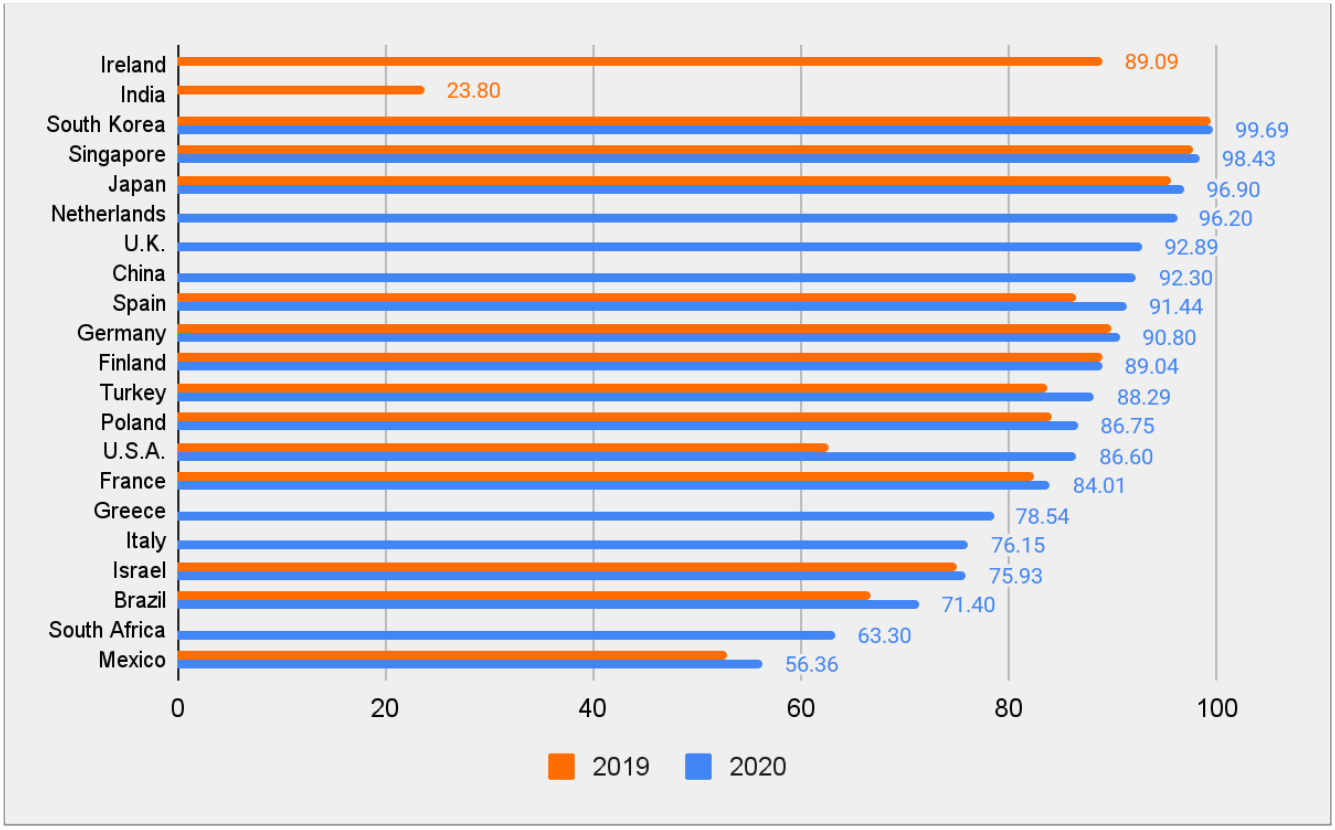
Source:

International Telecommunication Union (ITU), 2021

Another thing that is as important as computer ownership is internet access. The proportion of households with internet access is calculated by dividing the number of households(at least one household member aged 15-74) covered by the internet by the total number of households (TÜBİSAD, 2020). 88.29% of households in Turkey have internet access (See Figure 14). Compared to 2019, there has been an improvement of 4.5 points in 2020. Compared to the selected countries, Turkey is in the middle-upper ranks with this ratio. South Korea (99.69%) has the highest rate of internet access in households, followed by Singapore (98.43%) and Japan (95.74%). The countries with the lowest internet access in households are South Africa (63.3%), Mexico (52.86%), and India (23.80%) (See Figure 14).

Figure 14.

Internet access in households (%)



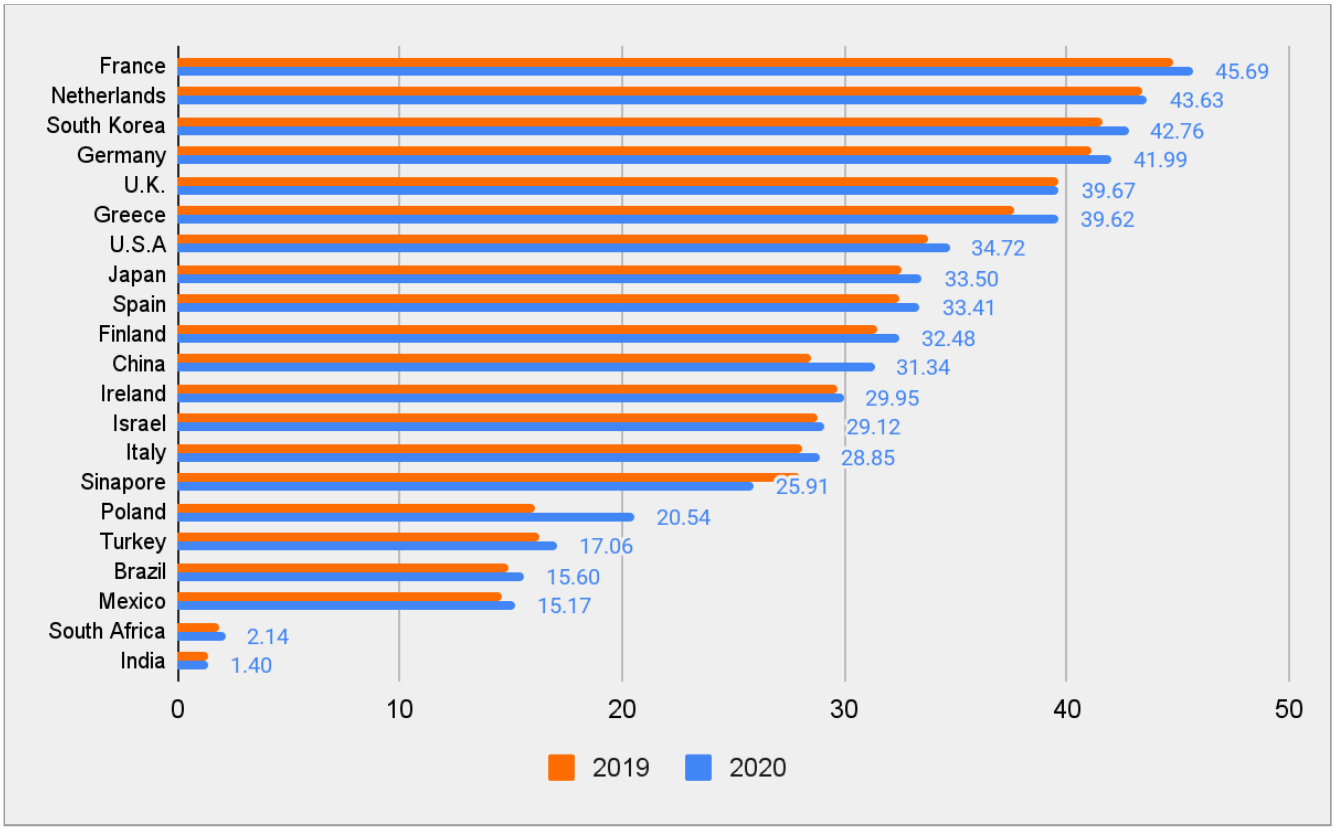
Source:

International Telecommunication Union (ITU), 2021

Another internet access indicator that needs to be examined is fixed broadband internet membership. Fixed broadband internet subscription includes total fixed (cable) broadband internet subscriptions (high-speed access subscriptions to the public internet — one TCP / IP connection - at stream rates of 256 kbps or greater). This includes cable modem, DSL, fiber to home/building and other fixed (cable) band subscriptions (TÜBİSAD, 2020). Fixed broadband internet subscription does not include subscriptions with data access via mobile cellular networks and wireless broadband technologies (TÜBİSAD, 2020). 17.06 out of every 100 people in Turkey have a fixed broadband internet membership (See Figure 15). It is observed that Turkey remains below average of selected countries. As a matter of fact, the fixed broadband internet membership rate of many countries is over 25%. France, the country with the highest rate, has 45.69% fixed broadband internet subscriptions, while the fixed broadband internet subscription rate in India is only 1.34%. Finally, it is seen that fixed broadband internet membership has increased in all countries in 2020 compared to 2019.

Figure 15.

Fixed broadband internet subscription (Per 100 people)



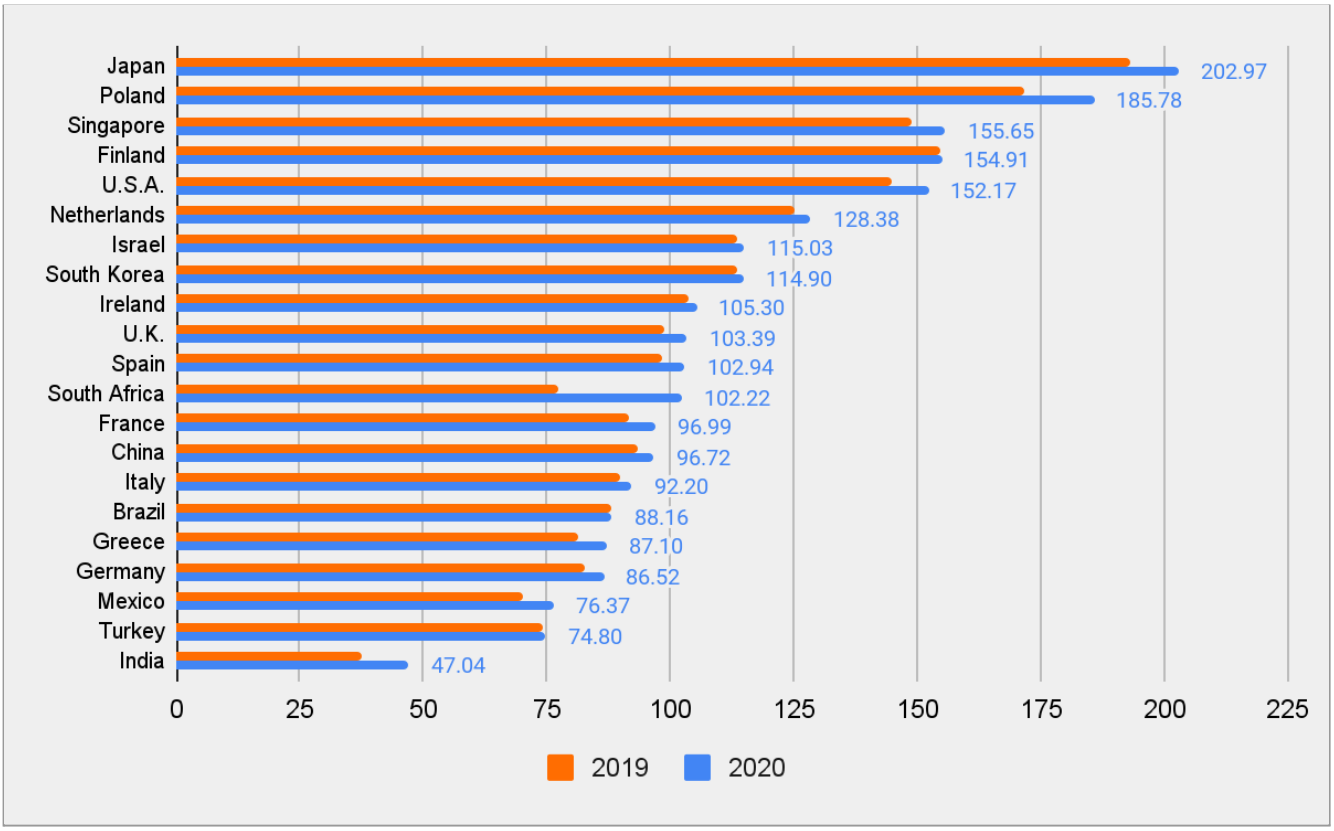
Source:

International Telecommunication Union (ITU), 2021

The last indicator regarding internet access, one of the indicators of the digital transformation index, is mobile broadband internet membership. This indicator expresses the sum of standard mobile broadband and real mobile broadband subscriptions allocated to the public internet (TÜBİSAD, 2020). In Turkey, 74.80 out of every 100 people have a mobile broadband internet subscription (See Figure 16). With this ratio, Turkey is the second from the last among the selected countries after India (47.04). Among the countries with the highest number of mobile broadband internet memberships, Japan has 202.97 mobile broadband subscriptions for every 100 people, while this number is 185.78 and 155.65 in Poland and Singapore, respectively. When 2019 and 2020 data are compared, it is observed that mobile broadband internet membership per 100 people has increased in all selected countries in 2020.

Figure 16.

Mobile broadband internet subscription (Per 100 people)



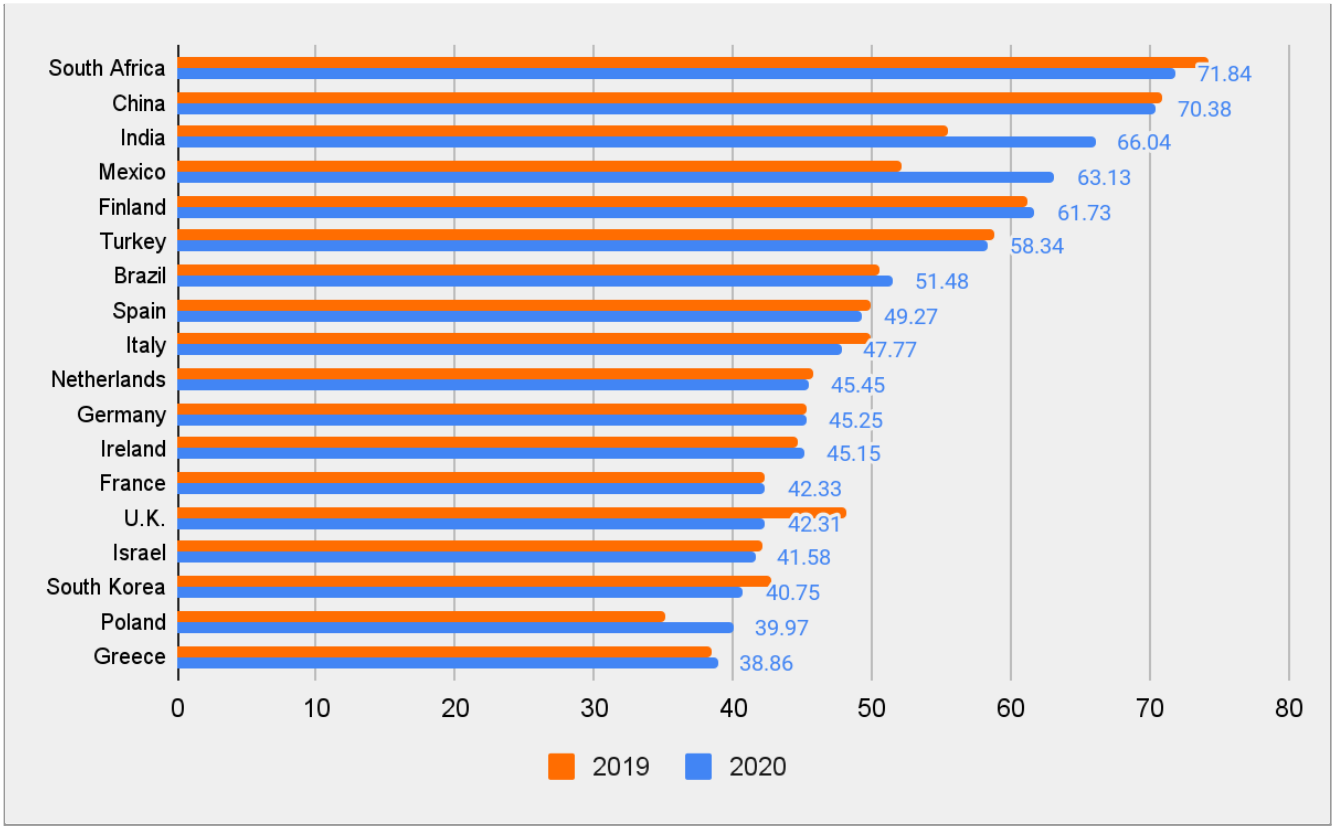
Source:

International Telecommunication Union (ITU), 2021

58.34% of total telecommunication services revenues in Turkey consist of revenues from mobile networks (See Figure 17). This rate decreased very little in 2020 compared to 2019. Among the selected countries, the highest ratio of revenues from mobile networks to total telecommunication services are South Africa (74.84%), China (70.38%), and India (66.04%). The countries with the lowest rates are South Korea (40.75%), Poland (39.97%) and Greece (38.86%). When 2019 and 2020 are compared, the highest increases in the ratio of revenues from mobile networks to revenues from total telecommunications services among selected countries were observed in India, Mexico and Poland, while the highest decrease was observed in England.

Figure 17.

Revenues from mobile networks (% Telecommunications services)



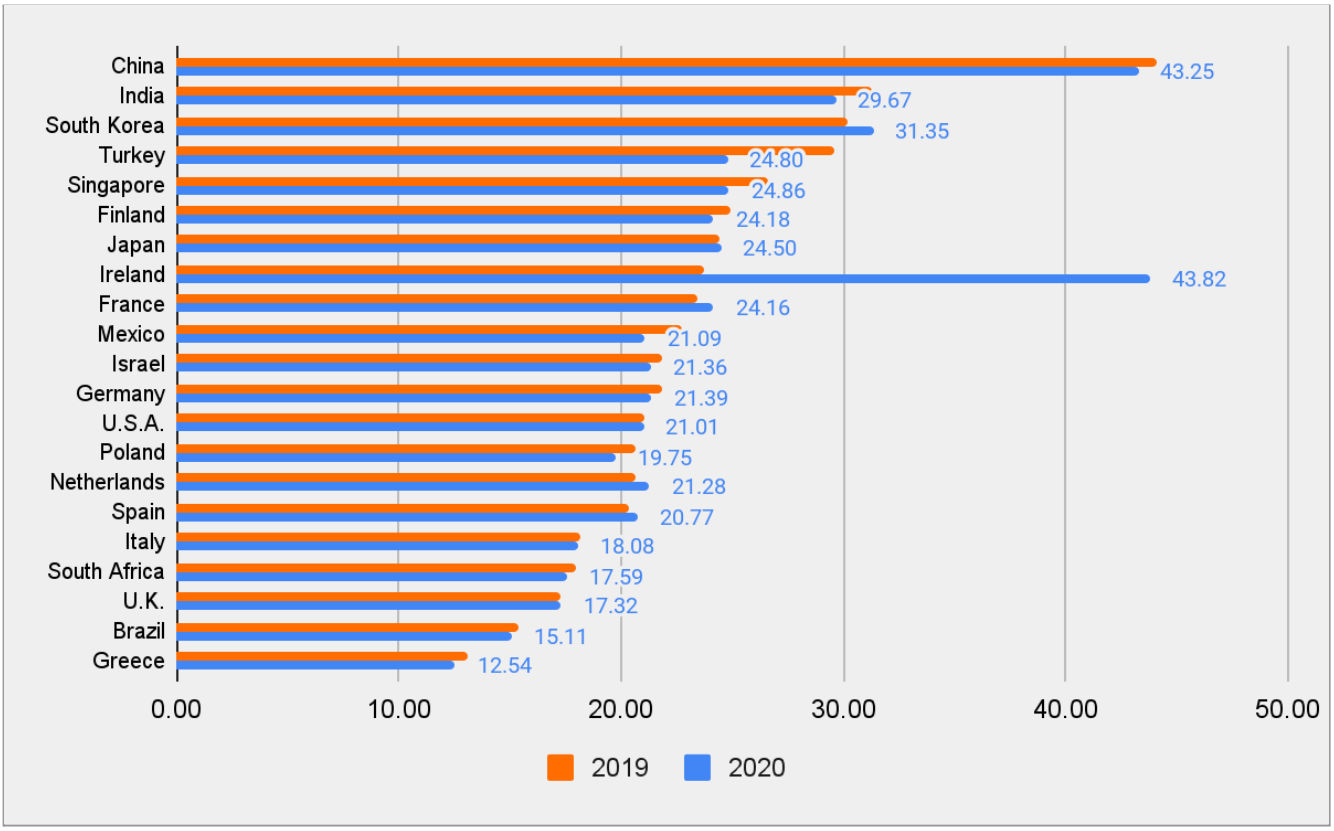
Source:

International Telecommunication Union (ITU), 2021

Another indicator we use in the calculation of the index is gross capital formation. Gross capital formation is defined as the net capital accumulated in an economy during one year and is usually given as a percentage of GDP. Turkey's 2020 gross capital formation rate is 24.80% (See Figure 18). We can say that this rate is above the average of the countries we examined. However, when 2019 and 2020 are compared, there has been a decrease of approximately 16% in Turkey's gross capital formation rate. This shrinkage is the highest among the selected countries. Ireland, on the other hand, almost doubled its capital formation from 2019 to 2020. This shows that the pandemic affects countries differently in terms of capital formation. Finally, while the country with the highest gross capital formation is China with 43.25%, this rate is 12.54% in Greece, which is the lowest country.

Figure 18.

Gross capital formation (% of GDP)



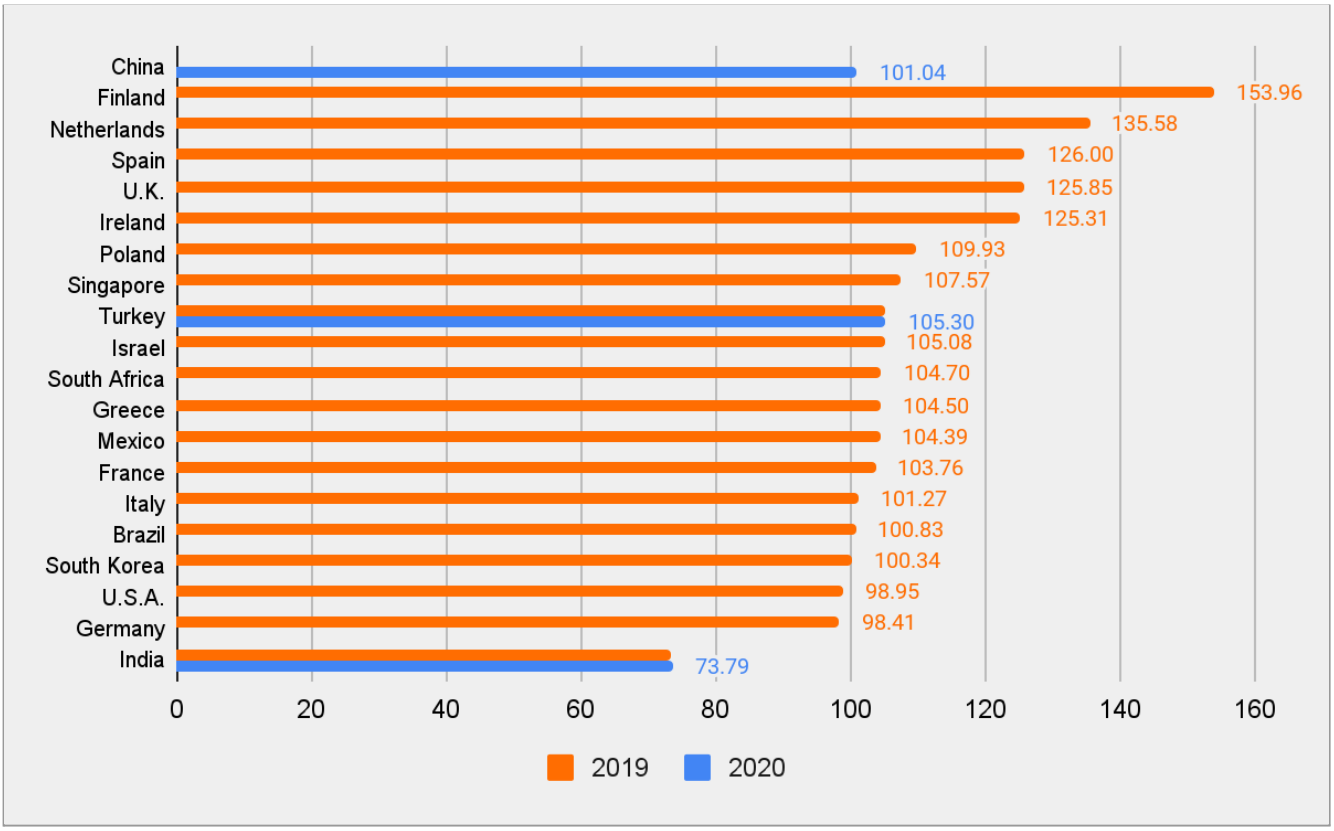
Source:

World Development Indicators, 2021

Among the education variables we use in calculating the index, the first variable we will examine is the schooling rate in secondary education (See Figure 19). The secondary school enrollment rate is the ratio of total secondary school enrollees (regardless of age) to the secondary school-age population. The schooling rate in secondary education in Turkey is 105.3% as of 2020 (See Figure 19). Turkey ranks in the middle among the selected countries with this ratio (See Figure 19). In Finland and India, the countries with the highest and lowest schooling rates in secondary education, these rates are 153.96% and 73.79%, respectively. Data allowing for comparison between 2019 and 2020 for enrollment rate in secondary education are only available for Turkey and India. While this rate remained stable for Turkey in 2020, it increased from 73.48% to 73.79% for India.

Figure 19.

Schooling rate in secondary education (%)



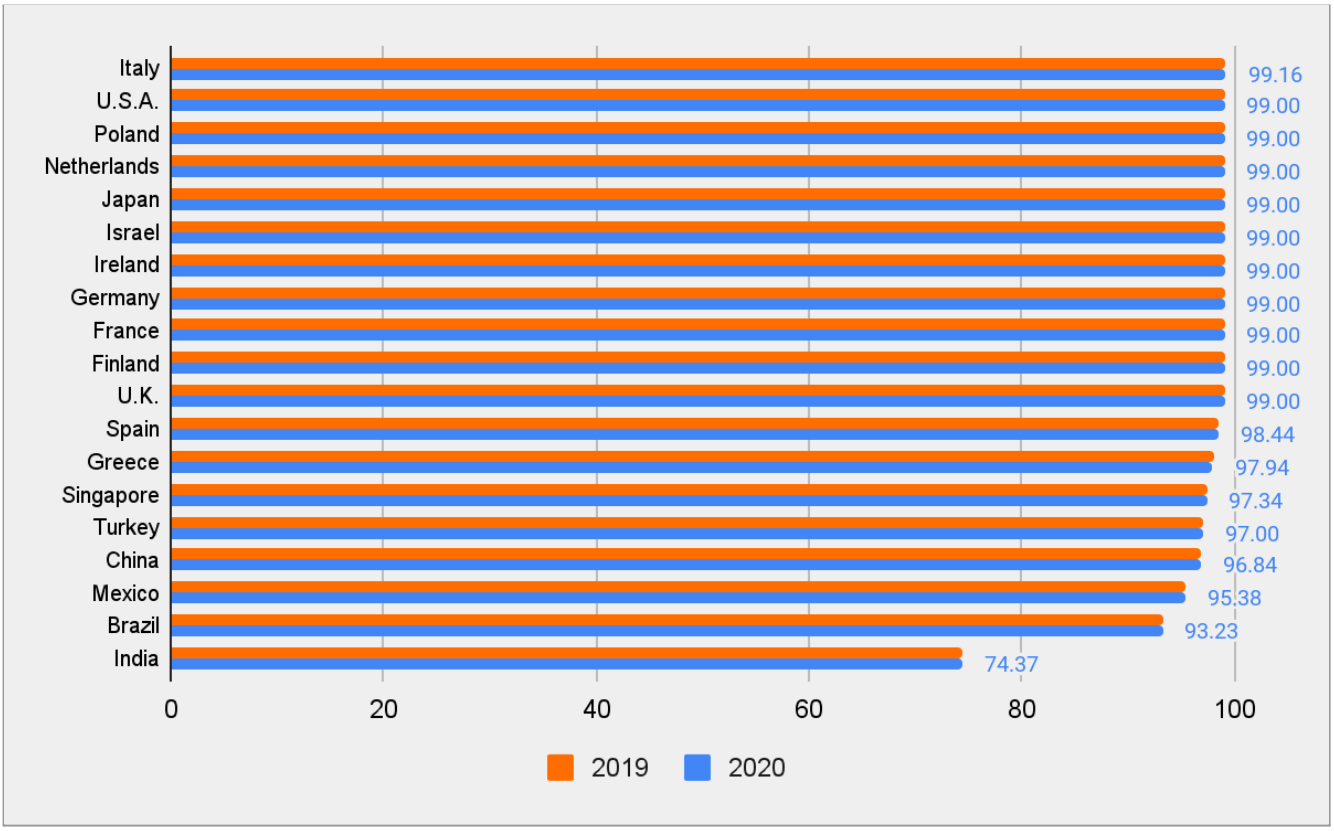
Source:

World Development Indicators (2021) ve TÜİK (2021)

Literacy rate is one of the education indicators that is no longer important today. This rate is close to 100% in developing and developed countries. Low literacy rates may be seen only in least developed countries. Literacy rate is defined as the percentage of the population aged 15 and over in a country who can both read and write by understanding a short, simple statement about their daily life (TÜBİSAD, 2020). The literacy rate in Turkey is 97% (See Figure 10). When we compare this rate with selected countries, it is seen that Turkey is behind the average of selected countries along with China (96.84%), Mexico (95.38%), Brazil (93.23%) and India (74.37). The country with the highest literacy rate is Italy with a rate of 99.16%. Since the literacy rate has changed as a result of long-term education policies, no country has observed a change in this rate between 2019 and 2020. Among the countries we examined, the country with the lowest literacy rate is India with 74%.

Figure 20.

Literacy rate (%)[1]



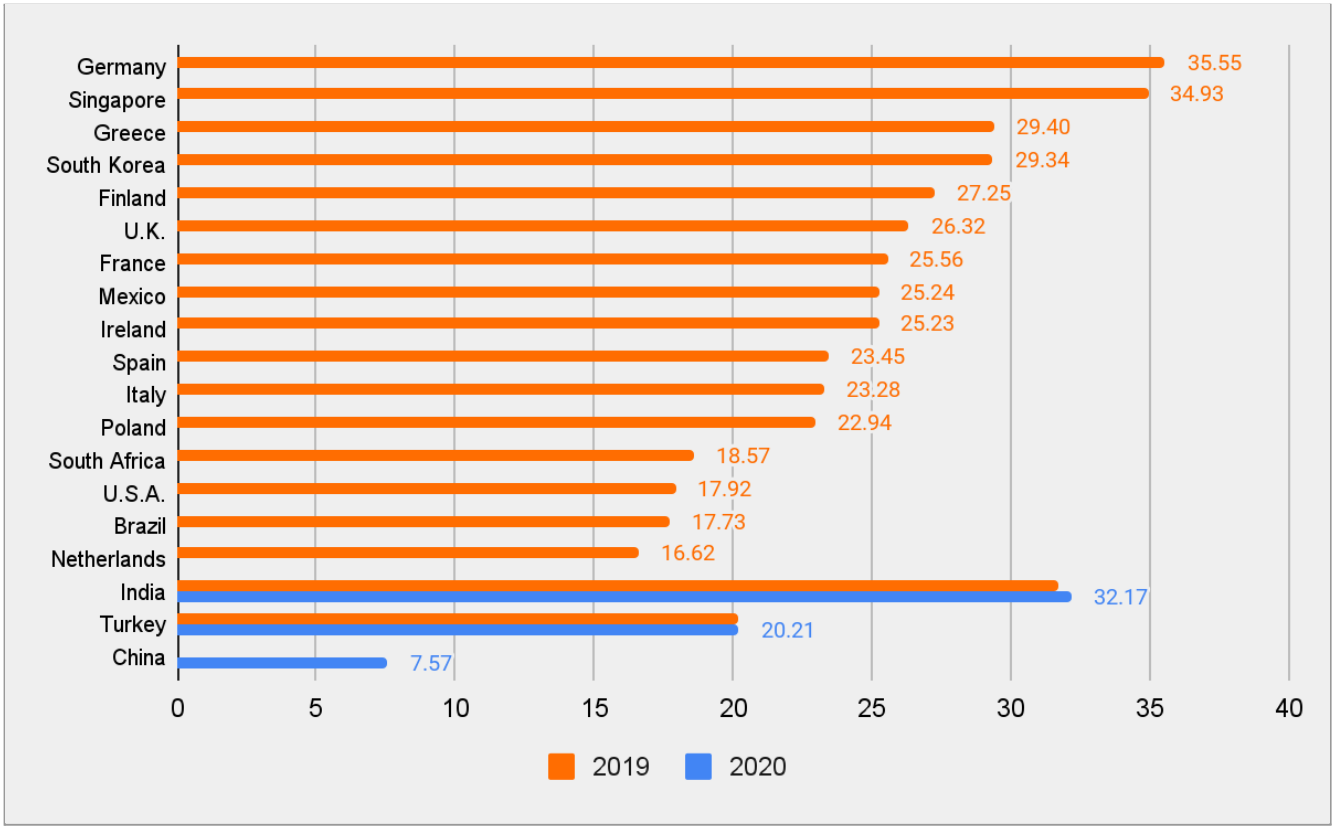
Source:

UNESCO, 2021

[1]For OECD member countries, the literacy rate was taken as 99 percent when data were missing. This approach has been chosen in line with the approach adopted by the United Nations Development Program (UNDP) in calculating the 2009 edition of the Human Development Index.

A much more important education indicator, especially for the information society and digital transformation, compared to literacy and schooling rates, is the statistics of graduates of tertiary education in the field of STEM (Science, Technology, Engineering and Mathematics). As it can be seen from Figure 21, the number of higher education graduates in the STEM field in the age range of 20-29 per 1000 people for Turkey in 2020 is 20.21. This ratio did not show any change compared to 2019. When compared to selected countries, this figure is below the average. While this figure is 7.57 for China which is at the bottom of the list, it is 35.55 for Germany which is at the top of the list.

Figure 21.
Graduates of tertiary education in the field of STEM
(20-29 years old, per 1000 people)

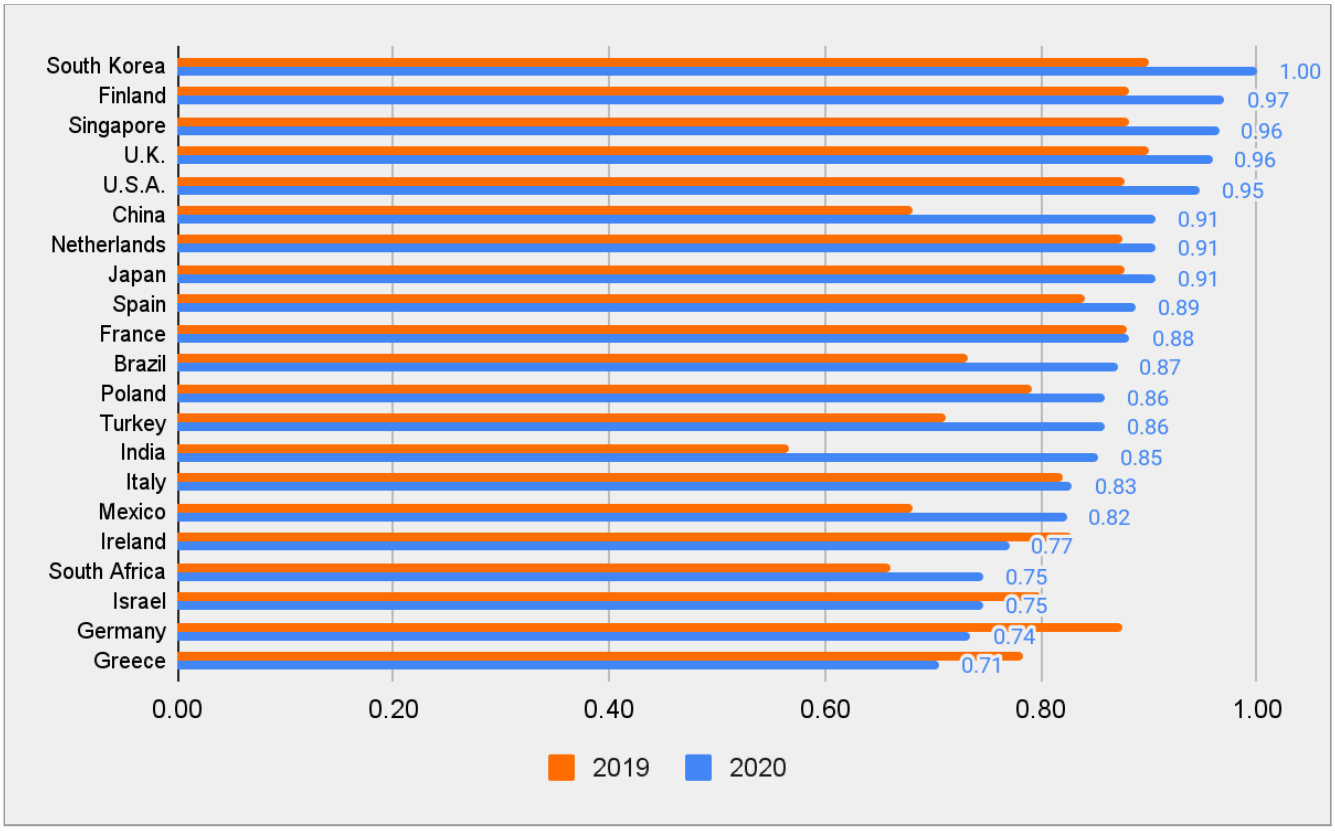


Source:
UNESCO, 2021

In the information society and digital transformation, perhaps more important than the private sector is the digitalization of the public sector which provides services to individuals from many fields. According to the United Nations Public Administration Network, the Government Online Service Index measures the performance of a government in providing online services to its citizens (TÜBİSAD, 2020). The Online Public Services Index is an index that is between 0 and 1. Turkey's Online Public Services Index value is 0.86 (See Figure 28). This rate was 0.71 in 2019. From this, we can say that the public sector has come a long way in digitalization in the year of the pandemic. Compared to the selected countries, Turkey ranks in the middle. The countries with the highest online public services index scores are South Korea (1.0), Finland (0.97) and Singapore (0.96). At the bottom of the list are Greece (0.71), Germany (0.74) and South Africa (0.75). When 2019 and 2020 are compared, it is observed that the online public services index has increased in most of the countries, while this rate has decreased in Ireland, Israel, Germany and Greece.

Figure 22.

Online Public Services Index (0-1)



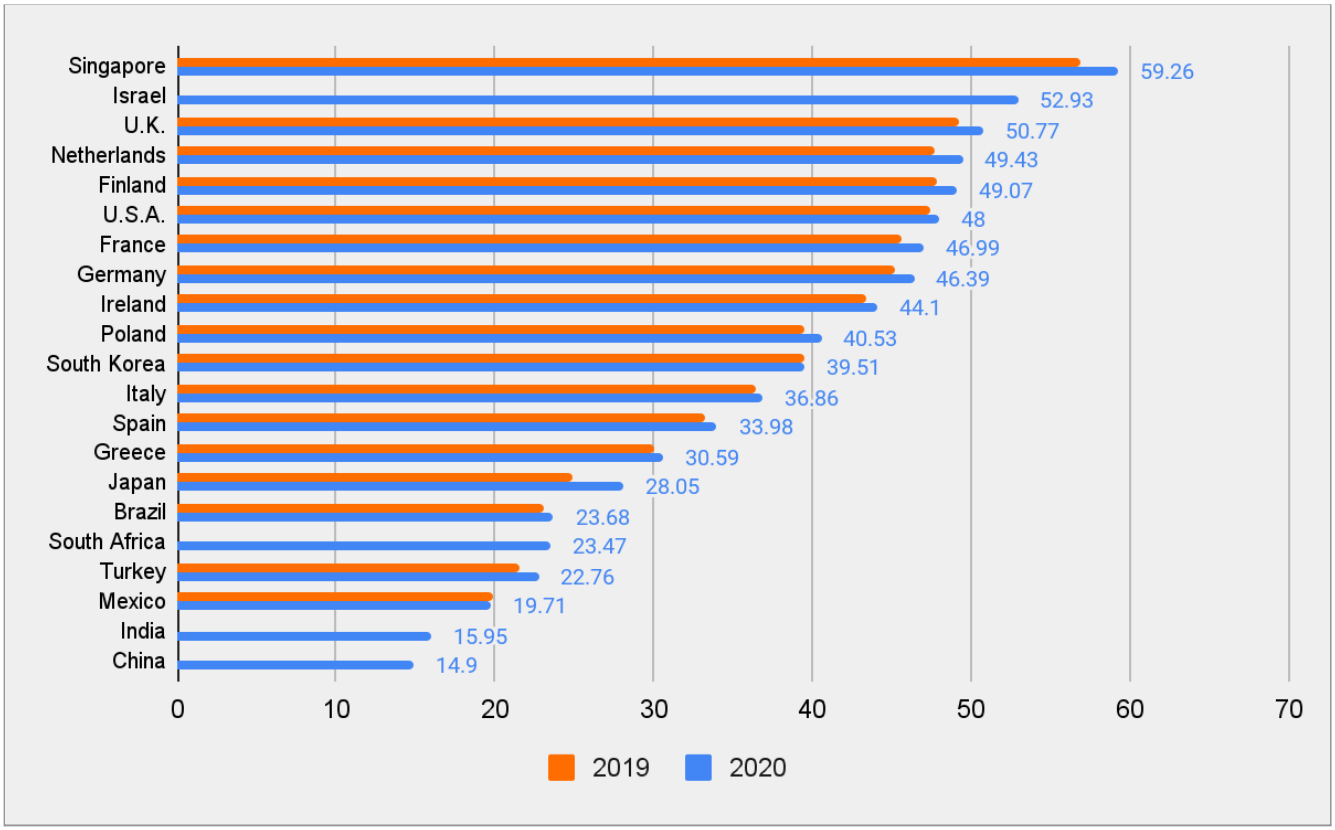
Source:

United Nations (UN), 2021

People employed in knowledge-intensive activities correspond roughly to “managers, professionals and technicians” of the occupational categories of the International Labor Organization (ILO) (TÜBİSAD, 2020). The size of employment in this occupational group is one of the important indicators that show the digital transformation potential of that economy. The rate of labor force employed in knowledge-intensive activities in Turkey is 22.76% (See Figure 23). This shows that Turkey is the fourth from the last among the 21 selected countries. The countries with the highest rate of workforce employed in knowledge-intensive activities are Singapore (59.26%), Israel (52.93%) and England (50.77%). When 2019 and 2020 are compared, it is seen that the ratio of the workforce employed in knowledge-intensive activities to the total workforce has increased in all selected countries. The largest increase in this area was in Japan and Singapore. There was a slight increase in Turkey as well.

Figure 23.

Proportion of labor force employed in knowledge-intensive activities (%)



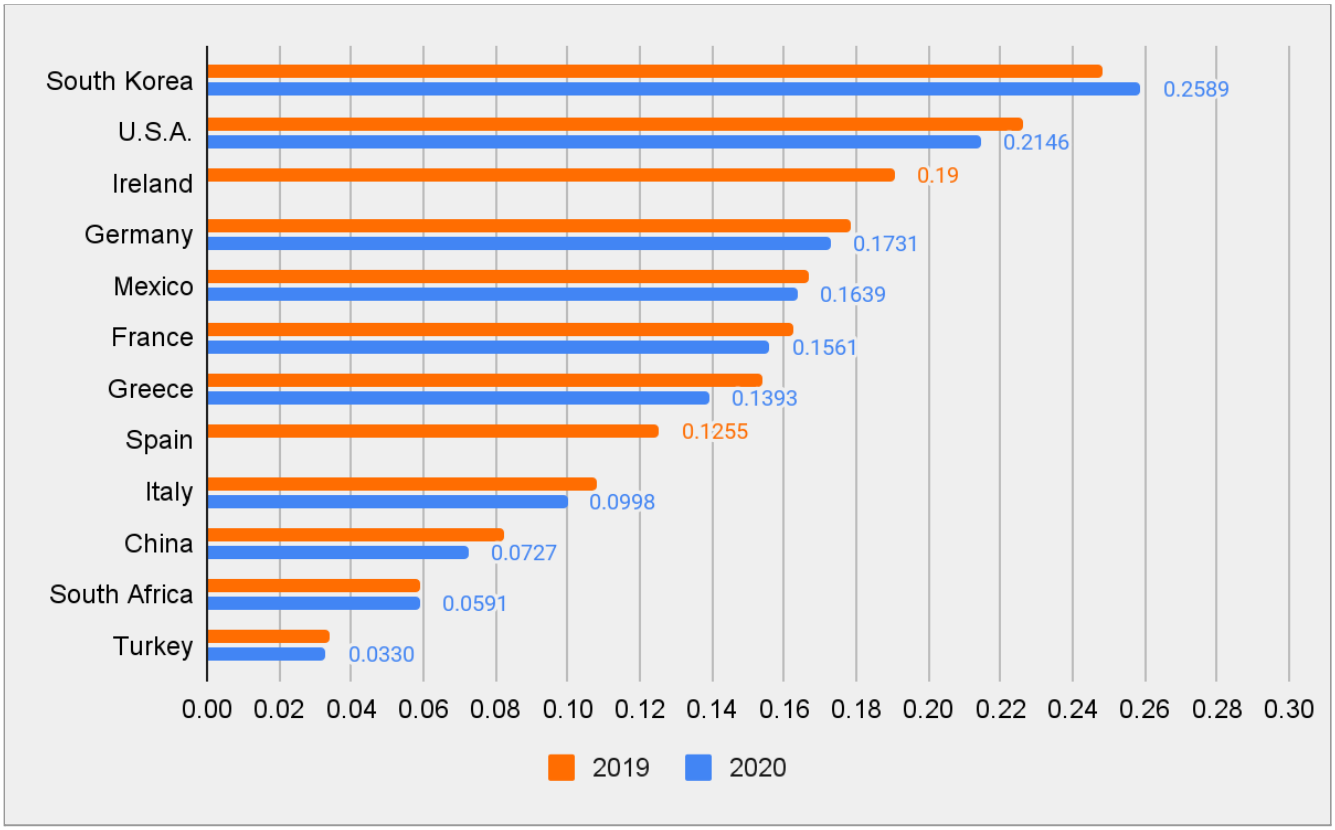
Source:

International Labor Organization (ILO), 2021

Another similar statistic is full-time telecommunications workers. In Turkey, 330 of every 1 million population serve as full-time telecommunication workers (See Figure 24). With this ratio, Turkey is in last place among the selected countries. The countries with the highest number of full-time telecommunication workers serving a population of 1 million are South Korea (2589), USA (2146) and Ireland (1906). This statistics shows that the Turkish telecommunications industry is underdeveloped and its service capacity is relatively limited.

Figure 24.

Full-time telecommunications workers (per million population)



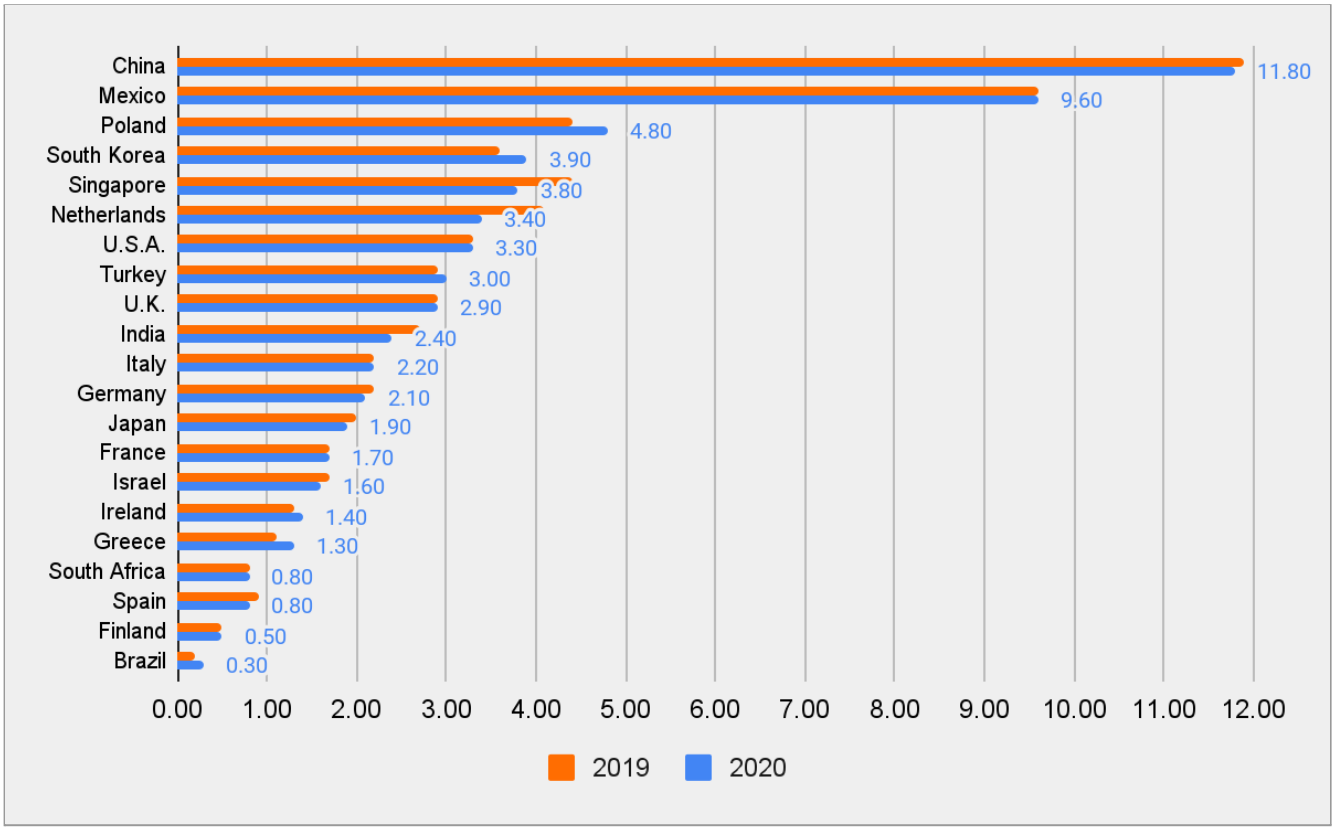
Source:

International Telecommunication Union (ITU), 2021

Export of creative industries such as advertising, architecture, arts and crafts, design, fashion, film, video, photography, music, performing arts, publishing, research and development, software, computer games, electronic publishing and TV/radio, are considered a part of creative goods exports (TÜBİSAD, 2020). When we look at the share of creative goods exports in total trade, we see that 3% of Turkey's total trade is realized as creative goods exports (See Figure 25). With this ratio, it is understood that Turkey is in the middle-upper ranks among the selected countries and therefore does not perform badly. China is the country with the highest ratio of creative goods exports to total trade with a value of 11.80%. While Brazil is the country where this ratio is the lowest with only 0.30% of total trade is in creative goods export. When 2019 and 2020 are compared, this ratio has grown in Poland, South Korea, Turkey, Ireland, Greece and Brazil, while it has remained stable or shrunk in other selected countries. The countries with the highest shrinkage were Singapore, the Netherlands and India.

Figure 25.

Export of creative goods (% Total trade)



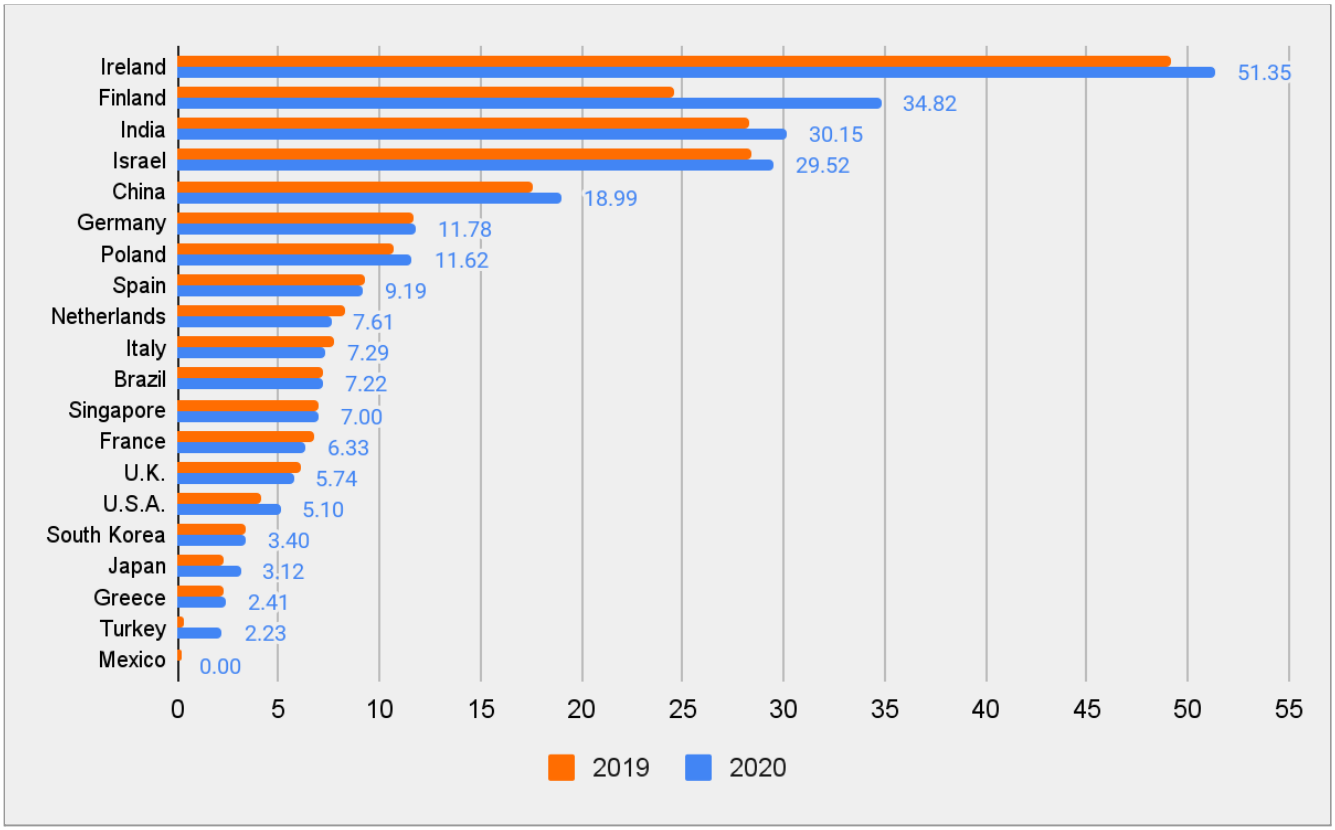
Source:

UNCTAD, 2021

As important as the production of ICT products is, the supply of ICT services is just as important. ICT service exports are extremely important, especially for developing countries such as Turkey. Therefore, ICT service export statistics are presented in Figure 26. Only 2.23% of total service trade in Turkey consists of ICT services exports (See Figure 26). This rate is quite low compared to selected countries. However, this rate, which was 0.34% in 2019, increased approximately 6 times and rose to 2.23%. This is extremely good progress. The share of ICT services exports in total services trade is the lowest in Mexico (0.00%). The countries with the highest share of ICT services exports in total service trade are Ireland (51.35%), Israel (29.52%) and India (30.15%). When 2019 and 2020 data are compared, it is observed that this rate decreased in Spain, Netherlands, Italy and England, while it remained stable or increased in other countries. The largest increase in this rate is in Finland, which rose from 25.62% to 34.82% (See Figure 26).

Figure 26.

ICT services exports (% Total service trade)



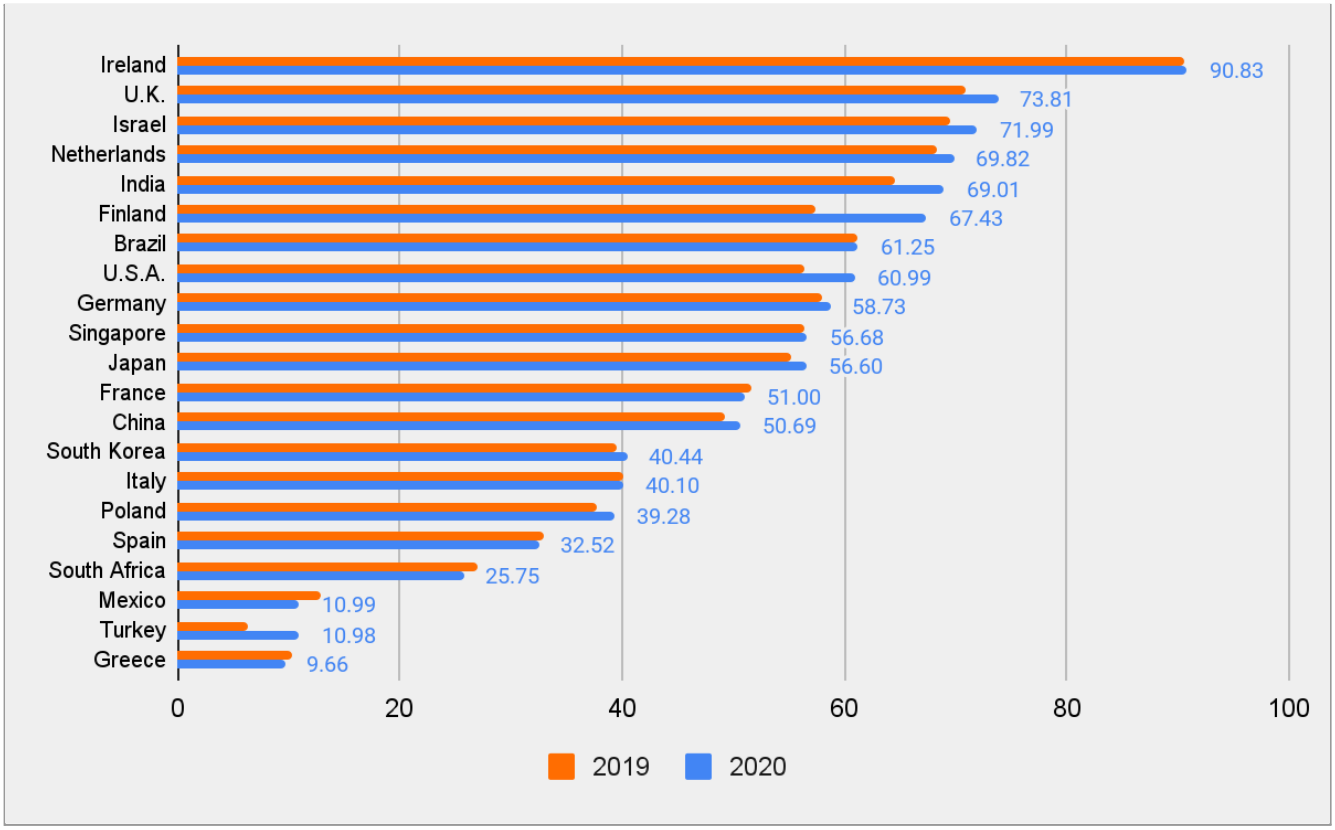
Source:

UNCTAD, 2021

Another important variable we use in calculating the digital transformation index is the export of digitally deliverable services. Turkey's exports of digitally deliverable services account for only 10.98% of total services trade (See Figure 27). With this ratio, Turkey ranks second from the last just before Greece (9.66%). The countries with the highest share of digital deliverable service exports in total service trade are Ireland (90.83%), England (73.81%) and Israel (71.99%). When the data for 2019 and 2020 are compared, it is seen that this rate increased in all countries except France, Spain, South Africa, Mexico and Greece, with the most significant increase in Finland.

Figure 27.

Export of digitally deliverable services (% Total service trade)



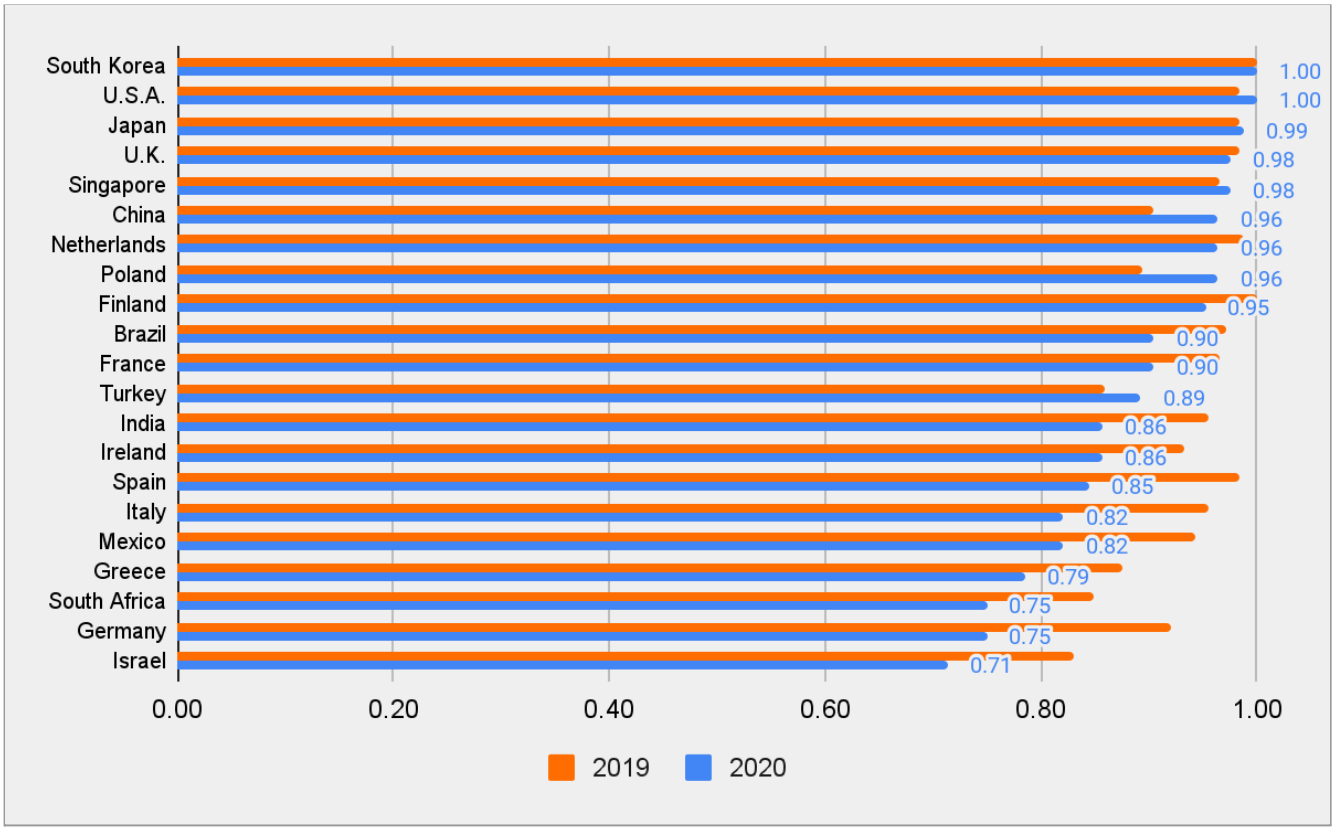
Source:

UNCTAD, 2021

The last sub-component of the digital transformation index that we will interpret in this section is the e-Participation index. According to the United Nations, the e-Participation Index evaluates the quality and usefulness of the information and services provided in order to involve its citizens in public policy making using e-Government programs provided by a country (TÜBİSAD, 2020). Looking at the e-Participation Index values between 0 and 1 in selected countries, it is seen that Turkey ranks in the middle with an index value of 0.89 in 2020 (See Figure 28). South Korea and the USA, which are among the countries with the highest e-Participation Index scores, have index scores of 1.00. When the data for 2019 and 2020 are compared, the dramatic decrease in this area was experienced in Germany, while the most significant increase was observed in Poland. It is a surprising finding that the e-Participation index has decreased in many countries in the transition from 2019 to 2020.

Figure 28.

e-Participation Index (between 0-1)



Source:

UNCTAD, 2021

TURKEY'S DIGITAL TRANSFORMATION INDEX

TURKEY'S DIGITAL TRANSFORMATION INDEX

Table 1.Turkey's Digital Transformation Index

	2019	2020	2021
TURKEY'S DIGITAL TRANSFORMATION INDEX	2.94	3.06	3.24
ENVIRONMENT SUB-INDEX	**2.87**	**2.95**	**3.09**
1st pillar: Political and Regulatory Environment	2.76	2.82	3.01
1.01 Effectiveness of law-making bodies	2.24	2.36	2.49
1.02 Laws relating to ICTs	2.58	2.72	3.15
1.03 Efficiency of legal system in settling disputes	1.87	1.96	2.33
1.04 Efficiency of legal system in challenging regulations	2.06	2.15	2.47
1.05 Intellectual property protection	2.41	2.42	2.71
1.06 Software piracy rate (% software installed)	2.75	2.78	2.78
1.07 Cost for enforcing contract (% of claim)	4.33	4.33	4.33
1.08 Number of days to enforce a contract	3.85	3.81	3.81
2nd pillar: Business and Innovation Environment	**2.98**	**3.09**	**3.17**
2.01 Availability of latest technologies	3.07	3.89	4.00
2.02 Venture capital availability	2.48	2.38	2.67
2.03 Total tax rate (% profits)	3.73	3.66	3.66
2.04 Number of days to start a business	4.89	4.89	4.89
2.05 Number of procedures to start a business	3.74	3.74	3.74
2.06 Intensity of local competition	2.79	2.66	2.72
2.07 Quality of management schools	2.16	2.46	2.38
2.08 Government procurement of advanced technology products	2.11	2.29	2.65
2.09 Research and development expenditure (% of GDP)	1.85	1.83	1.82
READINESS SUB-INDEX	**3.19**	**3.21**	**3.37**
3rd pillar: Infrastructure	2.34	2.27	2.32
3.01 Electricity production (kWh/capita)	1.23	1.23	1.23
3.02 Mobile network coverage (% population)	4.99	4.97	4.97
3.03 International Internet bandwidth (kb/s per user)	1.04	1.03	1.03
3.04 Secure Internet servers (per million population)	1.09	1.07	1.10
3.05 Annual investment in telecommunication services / Revenue from all telecommunication services	1.23	1.65	2.28
3.06 Gross capital formation (% of GDP)	3.53	2.68	2.13
3.07 Firm-level investment on ICT	2.49	2.64	2.75
3.08 Quality of ICT infrastructure	3.11	2.91	3.09

4th pillar: Affordability	**4.54**	**4.54**	**4.63**
4.01 Prepaid mobile cellular tariffs (PPP $/min)	4.75	5.00	5.00
4.02 Fixed broadband Internet tariffs (PPP $/month)	4.88	4.55	4.77
4.03 Internet and telephony sectors competition index	3.98	4.06	4.11
5th pillar: Skills	**2.69**	**2.82**	**3.17**
5.01 Quality of education system	2.19	2.23	2.53
5.02 Quality of math and science education	1.69	1.78	2.20
5.03 Secondary education gross enrollment rate (%)	3.40	3.94	3.81
5.04 Adult literacy rate (%)	4.72	4.81	4.82
5.05 Graduates in tertiary education in STEM (by sex per 1000 of population aged 20-29)	2.20	2.16	2.37
5.06 Staff availability	1.95	2.45	3.31
USAGE SUB-INDEX	**2.88**	**3.16**	**3.36**
6th pillar: Individual Usage	3.20	3.22	3.31
6.01 Mobile phone subscriptions (per 100 population)	2.14	2.01	1.82
6.02 Individuals using the Internet (%)	3.55	3.66	3.91
6.03 Households with computer (%)	3.34	3.33	3.20
6.04 Households with Internet access (%)	4.24	4.30	4.51
6.05 Fixed broadband Internet subscriptions (per 100 population)	2.27	2.40	2.45
6.06 Mobile broadband Internet subscriptions (per 100 population)	2.12	2.14	2.21
6.07 Use of social networks (Facebook, Twitter, LinkedIn, etc.)	4.63	4.45	4.64
6.08 Use of ICT by households	3.33	3.49	3.76
7th pillar: Business Usage	2.77	3.32	3.41
7.01 Firm-level technology absorption	3.05	3.78	3.97
7.02 Capacity for innovation	2.62	3.82	3.86
7.03 PCT patent applications (per million population)	1.07	1.12	1.18
7.04 ICT use for business-to-business transactions	3.58	3.86	3.82
7.05 Business-to-consumer internet use	3.78	3.87	3.80
7.06 Extent of staff training	2.54	3.50	3.82
8th pillar: Government Usage	2.66	2.92	3.37
8.01 Importance of ICTs to government vision	2.34	2.48	2.98
8.02 Government Online Service Index (0–1)	3.35	3.97	4.42
8.03 Government success in ICT promotion	2.3	2.31	2.70
IMPACT SUBINDEX	**2.81**	**2.81**	**3.14**
9th pillar: Economic Impacts	2.36	2.18	2.25
9.01 Impact of ICTs on business models	3.87	3.77	3.91
9.02 ICT PCT patent applications (per million population)	1.03	1.04	1.05

9.03 Impact of ICTs on organizational models	3.68	3.71	4.02
9.04 Knowledge intensive jobs (% of the workforce)	2.39	2.24	2.34
9.05 Full-time equivalent telecommunication employees	1.10	1.09	1.10
9.06 Creative goods exports (% of total trade)	3.10	3.12	2.02
9.07 International trade in ICT services (% of total trade in services)	1.02	1.02	1.11
9.08 International trade in digitally-deliverable service (% of total trade in services)	1.20	1.16	1.34
9.09 Revenue from mobile networks (% of all telecommunication services)	3.88	2.47	3.33
10th pillar: Social Impacts	3.26	3.58	4.03
10.01 Impact of ICTs on access to basic services	3.47	3.56	4.05
10.02 Internet access in schools	2.78	2.81	3.58
10.03 ICT use and government efficiency	3.38	3.55	3.92
10.04 E-Participation Index (0–1)	3.43	4.39	4.56

Turkey's adaptation to digital transformation has been determined with a score of 5. While preparing the index, in addition to the indicators examined in detail in the section entitled "Where Turkey Stands in Digital Transformation?", the results of a survey conducted in the business world were also used. The details of the method are explained in the Calculation of the Digital Transformation Index section (in the original Turkish report).

In Table 1, Turkey's Digitization Index and the numerical values of the pillars that make up this index are given for the years 2019, 2020 and 2021. While Turkey's digitalization index was calculated as 3.03 out of five for 2020, it was calculated as 3.24 for 2021. It can be said that there is a 7% improvement in the index value from 2020 to 2021. If it is remembered that the rate of change in the index value between 2019-2020 is calculated as 4%, it can be said that the rate of change in digital transformation for 2021 has accelerated even more. While the most important component that lowers Turkey's digitalization rating is the "Environment" sub-index (2.95 in 2020 and 3.09 in 2021), the factor that raises this rating is the "Readiness" sub-index. In 2021, the index value of the "Readiness" sub-index is 3.37. While the "Impact" sub-index that brought down the digital transformation index value in 2020 (the index value of this component was 2.81 for 2020, it was calculated as 3.14 in 2021), the index component that created this effect for 2021 is the "Environment" sub-index. The second component that has the most positive impact on the 2021 index value is the "Usage" sub-index, which is actually a clear indication that the effects of the coronavirus pandemic are reflected in the digital transformation index. It is useful to examine each sub-indexes that make up the digitalization index and each pillar that composes these sub-indexes separately.

Table 2. Turkey's Digital Transformation Index

	2019	2020	2021
TURKEY'S DIGITAL TRANSFORMATION INDEX	2.94	3.06	3.24
ENVIRONMENT SUB-INDEX	2.87	2.95	3.09
1st pillar: Political and regulatory environment	2.76	2.82	3.01
2nd pillar: Business and innovation environment	2.98	3.09	3.17
READINESS SUB-INDEX	3.19	3.24	3.37
3rd pillar: Infrastructure	2.34	2.27	2.32
4th pillar: Affordability	4.54	4.54	4.63
5th pillar: Skills	2.69	2.89	3.17
USAGE SUB-INDEX	2.88	3.16	3.36
6th pillar: Individual usage	3.20	3.22	3.31
7th pillar: Business usage	2.77	3.32	3.41
8th pillar: Government usage	2.66	2.92	3.37
IMPACT SUB-INDEX	2.81	2.88	3.14
9th pillar: Economic impacts	2.36	2.18	2.25
10th pillar: Social impacts	3.26	3.58	4.03

1. Environment Sub-Index

Turkey's "Environment" sub-index value was calculated as 2.95 for 2020 and 3.09 for 2021 (See Table 3). It can be said that there is a relative improvement from 2020 to 2021. It's observed that two pillars ("Political and Regulatory Environment" and "Business and Innovation Environment") contribute similarly to the "Environment" sub-index as their index values are very close to each other. However, the contribution of the "Political and Regulatory Environment" pillar to digital transformation is increasing at a higher rate. As it can be seen in Table 3 and Table 4, the sub-components of these two pillars exhibit a rather heterogeneous structure.

Table 3. Political and regulatory environment

	2019	2020	2021
ENVIRONMENT SUB-INDEX	**2.87**	**2.95**	**3.09**
1st pillar: Political and Regulatory Environment	2.76	2.82	3.01
1.01 Effectiveness of law-making bodies	2.24	2.36	2.49
1.02 Laws relating to ICTs	2.58	2.72	3.15
1.03 Efficiency of legal system in settling disputes	1.87	1.96	2.33
1.04 Efficiency of legal system in challenging regulations	2.06	2.15	2.47
1.05 Intellectual property protection	2.41	2.42	2.71
1.06 Software piracy rate (% software installed)	2.75	2.78	2.78
1.07 Cost for enforcing contract (% of claim)	4.33	4.33	4.33
1.08 Number of days to enforce a contract	3.85	3.81	3.81

The worst performing sub-component of the "Political and Regulatory Environment" pillar, which constitutes the "Environment" sub-index, is again the "Efficiency of legal system in settling disputes" indicator as in the previous index (See Table 3). The index value of this sub-component was calculated as 1.96 in 2020 and 2.33 in 2021. It can be said that this situation is a very serious obstacle in Turkey's digitalization. Another important indicator that negatively affects Turkey's "Political and Regulatory Environment" pillar is "Efficiency of legal system in challenging regulations". The value of this sub-component is calculated as 2.47 for 2021.

In the digital transformation index calculated for 2020 in Turkey, two sub-components that positively affected the "Political and Regulatory Environment'' pillar were "Cost for enforcing contracts" and "Number of days to enforce a contract". These two indicators are calculated from the data in the Doing Business report published by the World Bank, and since this report was not prepared for 2021, the data from the previous year were used as a component in the index. Therefore, the sub-component with the best performance in this pillar other than these three indicators, including the "Software piracy rate" component, is the "Laws relating to ICTs" sub-component. The value of this indicator is calculated as 3.15 for 2021.

Considering that the worst and the best performing sub-components of the "Political and Regulatory Environment" pillar of the "Environment" sub-index were were derived from the Executive Opinion Survey of TÜBİSAD; it can be said that the insight of the executives, is that these are among most important constraints in front of Turkey's transition to a digital economy is the legal framework and bureaucracy related to the business environment.

Another pillar that constitutes the "Environment" sub-index is the "Business and Innovation Environment" pillar. Its worst sub-component is "Research and development expenditure (% of GDP)", which is around 1.82 (See Table 4). This is a phenomenon that we come across in every analysis about Turkey. Other factors that disrupt the business and innovation environment in Turkey are the inadequacy of "Government procurement of advanced technology products" and "Quality of management schools" and difficulties in "Venture capital availability". Excepting the three indicators “Number of days to start a business”, “Number of procedures to start a business” and “Total tax rate” using the previous values as the Doing Business report of the World Bank is not published in 2021, the sub-component that Turkey is good at is “Availability of latest technologies”. The value of this indicator was calculated as 4.00 for 2021. In other words, when compared to the previous index year, it can be said that the access of companies to the latest technologies has changed positively in line with the predictions of the managers in Turkey.

Table 4. Business and Innovation Environment

	2019	2020	2021
ENVIRONMENT SUB-INDEX	**2.87**	**2.95**	**3.09**
2nd pillar: Business and Innovation Environment	**2.98**	**3.09**	**3.17**
2.01 Availability of latest technologies	3.07	3.89	4.00
2.02 Venture capital availability	2.48	2.38	2.67
2.03 Total tax rate (% profits)	3.73	3.66	3.66
2.04 Number of days to start a business	4.89	4.89	4.89
2.05 Number of procedures to start a business	3.74	3.74	3.74
2.06 Intensity of local competition	2.79	2.66	2.72
2.07 Quality of management schools	2.16	2.46	2.38
2.08 Government procurement of advanced technology products	2.11	2.29	2.65
2.09 Research and development expenditure (% of GDP)	1.85	1.83	1.82

2. Readiness Sub-Index

The second sub-index constituting the digitalization index is the "Readiness" sub-index. This sub-index shows how ready and sufficient the economy is for digitalization. We see that this sub-index is the one Turkey performs the best in the digital transformation index for both 2020 and 2021. The values of the “Readiness” sub-index were calculated as 3.21 and 3.37 for the years 2020 and 2021, respectively (See Table 5). The “Readiness” sub-index has three pillars: “Infrastructure”, “Affordability” and “Skills”. The worst of the three pillars that constitute the "Readiness" sub-index is "Infrastructure". As in the previous index period, the three most important factors that make the infrastructure inadequate in digital transformation are “Electricity production”, “International Internet bandwidth” and “Secure Internet servers”. In terms of infrastructure, it is seen that the area where Turkey is the best in 2020 and 2021 is the "Mobile network coverage" sub-component. For the 2021 index, a remarkable deterioration is observed in the "Gross capital formation" sub-component. In terms of infrastructure, the indicator that Turkey performed slightly more positively than the previous index is the "Secure Internet servers" indicator. Among the indicators that showed an increase in performance compared to 2020 within the “Infrastructure” pillar, the "Annual investment in telecommunication services / Revenue from all telecommunication services" sub-component is remarkable. From 2020 to 2021, there is a 35% improvement in the value of this indicator. In addition, there has been a visible improvement in the sub-components "Firm-level investment on ICT" and "Quality of ICT infrastructure".

Table 5. Infrastructure

	2019	2020	2021
READINESS SUB-INDEX	**3.19**	**3.21**	**3.37**
3rd pillar: Infrastructure	2.34	2.27	2.32
3.01 Electricity production (kWh/capita)	1.23	1.23	1.23
3.02 Mobile network coverage (% population)	4.99	4.97	4.97
3.03 International Internet bandwidth (kb/s per user)	1.04	1.03	1.03
3.04 Secure Internet servers (per million population)	1.09	1.07	1.10
3.05 Annual investment in telecommunication services / Revenue from all telecommunication services	1.23	1.65	2.28
3.06 Gross capital formation (% of GDP)	3.53	2.68	2.13
3.07 Firm-level investment on ICT	2.49	2.64	2.75
3.08 Quality of ICT infrastructure	3.11	2.91	3.09

In 2021, Turkey performs the best in “Affordability”, which is one of the three pillars in the “Readiness” sub-index, just like the index of 2020. This can be explained because prepaid ‘mobile cellular tariffs’ are relatively cheap in Turkey. However, there has been a 5% improvement in the affordability of “Fixed broadband Internet tariffs" from 2020 to 2021. In line with the executives predictions for 2021, it can be said that the cost of ICT infrastructures in Turkey has increased relatively.

Table 6. Affordability

	2019	2020	2021
READINESS SUB-INDEX	**3.19**	**3.21**	**3.37**
4th pillar: Affordability	**4.54**	**4.54**	**4.63**
4.01 Prepaid mobile cellular tariffs (PPP $/min)	4.75	5.00	5.00
4.02 Fixed broadband Internet tariffs (PPP $/month)	4.88	4.55	4.77
4.03 Internet and telephony sectors competition index	3.98	4.06	4.11

Another "Readiness" sub-index pillar that Turkey is not very good at is "Skills". In terms of skills, like in 2020, Turkey's worst sub-component is "Quality of math and science education". It is also confirmed by the PISA test results that Turkey is not good in this regard. According to the PISA 2018 mathematics results, 15-year-old students in Turkey get an average of 454 points in mathematics, while in OECD countries they get an average of 489 points. Similarly, the average science performance of 15-year-old students in Turkey is only 468 points, compared to the average 489 points in OECD countries.

Table 7. Skills

	2019	2020	2021
READINESS SUB-INDEX	**3.19**	**3.21**	**3.37**
5th pillar: Skills	**2.69**	**2.82**	**3.17**
5.01 Quality of education system	2.19	2.23	2.53
5.02 Quality of math and science education	1.69	1.78	2.20
5.03 Secondary education gross enrollment rate (%)	3.40	3.94	3.81
5.04 Adult literacy rate (%)	4.72	4.81	4.82
5.05 Graduates in tertiary education in STEM (by sex per 1000 of population aged 20-29)	2.20	2.16	2.37
5.06 Staff availability	1.95	2.45	3.31

Two other important skills that negatively affect Turkey's readiness in digitalization are the insufficient "Quality of education system" and the low number of "Graduates in tertiary education in STEM". Even though there is a relative improvement in both skill indicators compared to 2020, it can be stated that there are still deficiencies in the qualified human resource in the field of ICT when both the variables used to measure the pillars and the executives' predictions are taken into account.

The two sub-components that Turkey is good at in terms of the skills needed for digital transformation are the improvement in the indicators of "Adult literacy rate" and "Secondary education gross enrollment rate". Another indicator parallel to these improvements is the sub-component "Staff availability". According to the answers of the Executive Opinion Survey, the prediction that it is easier to find employees with suitable skills in the field of Information and Communication Technologies in both large-scale companies and SMEs points to the positive performance in the digital transformation index for 2021 compared to 2020.

3. Usage Sub-Index

We can say that the second area where Turkey performs well in digitalization is "Usage". The “Usage” sub-index calculated as 3.36 for 2021, is the sub-index with the second highest value (See Table 8). The “Usage" sub-index is examined in three pillars as “Individual Usage”, “Business Usage” and “Government Usage”. While the index values of “Business Usage” (3.32) and “Individual Usage” (3.22) were close to each other for 2020, the pillar with the lowest performance for the same year was the “Government Usage” (2.92). In 2021, while the “Business Usage” (3.41) was the highest pillar, the “Individual Usage” pillar was the lowest (3.31). Compared to 2020, the 15% improvement in the pillar “Government Usage” (3.37) is striking. The two worst sub-components for “Individual usage” are “Mobile phone subscriptions” and “Mobile broadband Internet subscription”. The area where we are the best in “Individual Usage” is “Use of social networks (Facebook, Twitter, LinkedIn, etc.)”. The second best sub-component is “Households with Internet access”. Although the “Individual Usage” pillar within the "Usage" component of the digital transformation index did not show a big change between the years 2020 and 2021, the positive development in the indicators of "Individuals using the Internet" and "Households with Internet access" is remarkable. In addition to this, in the predictions of the Executive Opinion Survey, the dominating opinion is that individuals have adopted and started to use the latest technologies and that there has been an increasing acceleration in the prevalence of areas such as education, health and financial services, because of the coronavirus pandemic.

Table 8. Individual Usage

	2019	2020	2021
USAGE SUB-INDEX	2.88	3.16	3.36
6th pillar: Individual Usage	3.20	3.22	3.31
6.01 Mobile phone subscriptions (per 100 population)	2.14	2.01	1.82
6.02 Individuals using the Internet (%)	3.55	3.66	3.91
6.03 Households with computer (%)	3.34	3.33	3.20
6.04 Households with Internet access (%)	4.24	4.30	4.51
6.05 Fixed broadband Internet subscriptions (per 100 population)	2.27	2.40	2.45
6.06 Mobile broadband Internet subscriptions (per 100 population)	2.12	2.14	2.21
6.07 Use of social networks (Facebook, Twitter, LinkedIn, etc.)	4.63	4.45	4.64
6.08 Use of ICT by households	3.33	3.49	3.76

Our findings show that the use of ICT by the business world is relatively good (See Table 9). It can be said that the business world performed relatively better in 2021 compared to 2020, especially in the sub-components of "Firm-level technology absorption" and "Capacity for innovation". As in 2020, the worst area in the “Business Usage” pillar in 2021 is the “PCT patent applications”. However, there is a slight (5%) increase in patent applications (per million people) compared to the value of 2020. Unlike 2020, it can be said that the business world has regressed slightly in terms of "Business-to-consumer internet use" and "ICT use for business-to-business transactions". The area where our businesses perform the best is related to “Extent of staff training”. Considering that this indicator was derived from the Executive Opinion Survey, it is a sign that the business world prioritizes training investments in order to provide their employees with professional skills and to increase their ICT competencies.

Table 9. Business Usage

	2019	2020	2021
USAGE SUB-INDEX	2.88	3.16	3.36
7th pillar: Business Usage	2.77	3.32	3.41
7.01 Firm-level technology absorption	3.05	3.78	3.97
7.02 Capacity for innovation	2.62	3.82	3.86
7.03 PCT patent applications (per million population)	1.07	1.12	1.18
7.04 ICT use for business-to-business transactions	3.58	3.86	3.82
7.05 Business-to-consumer internet use	3.78	3.87	3.80
7.06 Extent of staff training	2.54	3.50	3.82

Table 10. Government Usage

	2019	2020	2021
USAGE SUB-INDEX	2.88	3.16	3.36
8th pillar: Government Usage	2.66	2.92	3.37
8.01 Importance of ICTs to government vision	2.34	2.48	2.98
8.02 Government Online Service Index (0–1)	3.35	3.97	4.42
8.03 Government success in ICT promotion	2.3	2.31	2.70

Finally, when we look at the “Government Usage”, the first finding that we encounter is that the government is quite good at providing online public service (See Table 10), as seen with the value of the sub-component “Government Online Service Index” for 2021 being 4.42. The Online Public Service Index performance calculated by the United Nations has shown a relatively high change for Turkey in 2021. According to the index we calculated, we can easily say that the factor that most negatively affects “Government Usage” is the low level of “Government success in ICT promotion”. However, unlike other pillars, it is seen that there is a significant increase in all sub-components of "Government Usage".

4. Impact Sub-Index

While Turkey's worst performing sub-index was the "Impact" in 2020 , we see that the performance of this sub-index has increased slightly in2021. The “Impact” sub-index was calculated as 2.81 for 2020, but the same sub-index was calculated as 3.14 with an increase of 11% in 2021. The "Impact" sub-index has two pillars: "Economic Impacts" and "Social Impacts". When we examine the pillars of this sub-index, we can say that the “Social Impacts” are far ahead than “Economic Impacts”, as in the previous index. In other words, the positive trends observed in indicators such as the “Impact of ICTs on access to basic services" and the “Internet access in schools” indicate that the impact of digitalization on society is faster and more pronounced than its impact on economic indicators.

Table 11. Economic Impacts

	2019	2020	2021
IMPACT SUB-INDEX	2.81	2.88	3.14
9th pillar: Economic Impacts	2.36	2.18	2.25
9.01 Impact of ICTs on business models	3.87	3.77	3.91
9.02 ICT PCT patent applications (per million population)	1.03	1.04	1.05
9.03 Impact of ICTs on organizational models	3.68	3.71	4.02
9.04 Knowledge intensive jobs (% of the workforce)	2.39	2.24	2.34
9.05 Full-time equivalent telecommunication employees	1.10	1.09	1.10
9.06 Creative goods exports (% of total trade)	3.10	3.12	2.02
9.07 International trade in ICT services (% of total trade in services)	1.02	1.02	1.11
9.08 International trade in digitally-deliverable service (% of total trade in services)	1.20	1.16	1.34
9.09 Revenue from mobile networks (% of all telecommunication services)	3.88	2.47	3.33

Table 12. Social Impacts

	2019	2020	2021
IMPACT SUB-INDEX	2.81	2.88	3.14
10th pillar: Social Impacts	3.26	3.58	4.03
10.01 Impact of ICTs on access to basic services	3.47	3.56	4.05
10.02 Internet access in schools	2.78	2.81	3.58
10.03 ICT use and government efficiency	3.38	3.55	3.92
10.04 E-Participation Index (0–1)	3.43	4.39	4.56

Two areas where Turkey is good in the pillar of "Economic Impacts" are "Impact of ICTs on business models" and "Impact of ICTs on organizational models" (See Table 11). The worst sub-components are “ICT PCT patent applications”, “Full-time equivalent telecommunication employees” and “International trade in ICT services”. Among these three indicators, the only sub-component that saw a slight acceleration in performance from 2020 to 2021 is “International trade in ICT services”. While there is a 9% improvement in the “International trade in ICT services” indicator, it is not possible to say the same for the other two indicators. Finally, we can say that the sub-component “Revenue from mobile networks” used in calculating the index in this pillar showed a significant increase in performance in 2021.

While the digitalization of the economy is problematic, it can be said that the digitalization of society is better (See Table 12) as the index value of the "Social Impacts" pillar was calculated as 4.03 for 2021. As for the "Affordability" pillar in the "Readiness" component, where Turkey performs the best in 2021, the "Social Impact" pillar in the "Impact" sub-index also has a high value when compared to other pillars.

Considering the contribution of the digitalization of society to the “Impact” sub-index, it can be said that a very good performance has been observed in terms of "Impact of ICTs on access to basic services", " ICT use and government efficiency" and "E-Participation Index". It is observed that the indicator of "Internet access in schools", which has the worst value in 2020 compared to other sub-components of the “Social Impacts”, increased in 2021 accordingly because of the coronavirus pandemic. "E-Participation Index" which is used in order to evaluate the quality and usefulness of the information and services provided in order to involve its citizens in public policy making by using the e-Government programs provided by a country, and was published by the United Nations, contributes 4% more to the digital transformation index compared to 2020. The fact that this indicator is the most effective component in the "Social Impact" pillar points to the important role of the government in the digital transformation of society.

CONCLUSION

Conclusion

The global coronavirus outbreak, which started in 2020, has tremendously accelerated the digitalization trends all over the world. Digital technologies have suddenly become the most important factor in the continuation of economic and social life with the least damage. From education to shopping, from maintaining economic activities in many sectors, to daily life practices, and even in many areas that were not thought of before, such as socialization, cultural activities and health examinations, everything has been possible thanks to online technologies. With the spread of vaccination extreme applications such as quarantines, lockdowns and restrictions are being left behind, and the activities such as education that were carried out completely online during the peak of the pandemic, return to be made on a face-to-face basis. However it is also revealed that the post-pandemic normalization will not be a return to the pre-pandemic times. It is seen that everyone will continue to benefit from the opportunities provided by digital technologies in a number of fields from education to working life. The fact that digital technologies have become widely used in many areas has made the speed and scope of the digital transformation process of countries even more important.

In this context, Turkey's Digitization Index Report, the first of which was published in 2020, has become a very important reference point for closely monitoring and accelerating the digitalization performance of the Turkish economy and society.

Turkey's digitalization index has been on an upward trend since 2019, when it was first calculated. It is calculated as 2.94, 3.03 and 3.24 out of five for the years 2019, 2020 and 2021, respectively. There was a 4% improvement in the index value between 2019-2020 and 5% between 2020-2021. These results can be interpreted as a further acceleration of digital transformation in 2021. It is pleasing that Turkey's rate of transformation has increased at a time when digital transformation is accelerating all over the world with the coronavirus pandemic.

All four sub-indexes of Turkey's digitalization rating improved positively in 2021. Among these four sub-indexes, the "Environment" sub-index lowers the digitalization value the most, while the dominant factor that raises this value is the "Usage" sub-index.

The two pillars of Turkey's "Environment" sub-index, "Political and Regulatory Environment" and "Business and Innovation Environment", define the ‘environment’ that is important for the development of ICT. There is an improvement in both pillars compared to the previous year. Between these two pillars, it is the “Political and Regulatory Environment” that brings the performance down. The fact that the “Environment” is the most serious obstacle in Turkey's digitalization points to the importance of this area, which will have a positive impact on the entire economy.

Although there is an improvement in the 2021 performance of the sub-components in the pillar of "Political and Regulatory Environment", this is not enough. It is noteworthy that the scores of the indicators "Efficiency of legal system in settling disputes" and "Efficiency of legal system in challenging regulations" remained below 2.5. The fact that Turkey's score in the sub-component of "Laws relating to ICTs" in this pillar is 3.15 makes us

think that the main problem is not specific to the sector. Progress in the “Political and Regulatory Environment” will accelerate digitalization and will be important for the development of other sectors.

In the digital transformation index calculated for 2020 in Turkey, two sub-components that positively affected the “Political and Regulatory Environment” pillar were “Cost for enforcing contract” and “Number of days to enforce a contract”. These two sub-components are calculated from the data in the Doing Business report published by the World Bank, and since this report was not prepared for 2021, the data from the previous year were used in the index. Therefore, the indicator that performed the best, excluding the first two sub-components and “Software piracy rate” was the “Laws relating to ICTs'' indicator.

Another pillar that constitutes the "Environment" sub-index is the "Business and Innovation Environment" pillar. In this pillar, Turkey's worst sub-component index value is "Research and development expenditure (% of GDP)", which is around 1.82. In addition, the value of this sub-component has been decreasing for 3 years. The fact that the share of R&D expenditures in GDP in countries such as Israel and South Korea has increased to almost 5%, indicates an important step in increasing the pace of digitalization in Turkey. Other factors that disrupt the "Business and Innovation Environment" in Turkey are the inadequacy of "Government procurement of advanced technology products" and "Quality of management schools" and difficulties in "Venture capital availability".

The "Readiness" sub-index that makes up the digitalization index shows how ready and sufficient the economy is for digitalization. The development rate of the “Readiness” sub-index is lower than the other sub-indexes. The “Readiness” sub-index has three pillars: “Infrastructure”, “Affordability” and “Skills”. Among these pillars, the "Infrastructure" pillar is the one with the lowest performance, along with the "Economic Impacts" pillar. As in the previous index period, the values calculated for "Electricity production", "International Internet bandwidth" and "Secure Internet servers", which are the three most important factors that make the infrastructure insufficient in digital transformation, are below 2. Troubles in the economy also negatively affected the “Gross capital formation” sub-component. In order for Turkey to accelerate its digitalization, it needs to improve its infrastructure and to transfer more resources to this field.

Turkey’s best score in 2021 in the "Readiness" sub-index, is the pillar "Affordability”, just like in the index of 2020. The value, which was 4.54 in 2020, improved further to 4.63 in 2021. The fact that ‘prepaid mobile cellular tariffs’, ‘fixed broadband Internet tariffs’ and the ‘cost of ICT infrastructures’ are cheap in Turkey compared to other countries provides an important opportunity for digitalization.

Another "Readiness" pillar that Turkey is not very good at is "Skills''. Considering that digitalization can only be achieved with skills suitable for this field, Turkey will need to improve the "Quality of math and science education", "Quality of education system", and increase the number of "Graduates in tertiary education in STEM". Even if an improvement is observed in these indicators compared to 2020, values not exceeding 2.5 reveal that the issue of qualified human resources is a serious problem in terms of digitalization.

The two sub-components that Turkey performs well in terms of the skills needed for digital transformation can be seen in the improvements in the indicators of "Adult literacy rate" and "Secondary education gross

enrollment rate". Another indicator parallel to these improvements is the sub-component "Staff availability". According to the answers of the Executive Opinion Survey, the prediction that it is easier to find employees with suitable skills in the field of Information and Communication Technologies in both large-scale companies and SMEs points to the positive performance in the digital transformation index for 2021 compared to 2020.

The area where Turkey excels in digitalization is "Usage". The three pillars of the “Usage” sub-index, "Individual Usage", "Business Usage" and "Public Usage", are all above 3 for 2021. Among these three pillars, the highest index value belongs to “Business Usage”.

The two worst sub-components for “Individual Usage” are “Mobile phone subscription” and “Mobile broadband Internet subscription”. The area where Turkey performs the best in “individual Usage” is “Use of social networks (Facebook, Twitter, LinkedIn, etc.)”. In Turkey, where individuals are prone to adopt and use the latest technologies, the prevalence of use in the fields such as education, health and financial services has increased with the coronavirus pandemic. This situation is expected to have a positive impact on the index values in the coming years.

While the performance of the business world in the sub-components of "Extent of staff training", "Firm-level technology absorption" and "Capacity for innovation" improved even more in 2021 compared to 2020, there was a regression observed in the "ICT use in business-to-consumer transactions" and "Business-to-consumer internet use". However, the value of each of these indicators is close to 4. The sub-component that pulls down the ”Business Usage” pillar the most is the “PCT patent application” indicator, which has a value of little over 1.

When we look at the government’s use of ICT, it is striking that there is a rapid improvement in all sub-components in 2021. It is seen that the government is quite good in providing ‘online government services’ with a value of 4.4. According to the index we calculated, the factor that affects government use most negatively is the low level of "Government success in ICT promotion".

While Turkey's worst area for digitalization in 2020 was the "Impact" sub-index, the performance of this sub-index has increased for 2021. The "Impact" sub-index has two pillars: "Economic Impact" and "Social Impact". Both pillars have improved compared to last year. Between these pillars, the “Social Impact” is quite strong with a value of 4, while the “Economic Impact” is far from meeting the expectations with a value of 2.25. The coronavirus pandemic has shown how important the digitalization of society and economy is in terms of avoiding interruptions and disruptions in economic and social life.

While the indicator "Internet access in schools" had the lowest value in the “Social Impact” in 2020, a rapid improvement was observed in this sub-component in 2021, but it still doesn’t seem possible to be satisfied with this value of 3.5. The improvement in the "Economic Impact" does not seem satisfactory considering that the pandemic conditions have accelerated online activities. Additionally the values of "ICT PCT patent applications", "full-time equivalent telecommunication employees", "International trade in digitally-deliverable service" and "International trade in ICT services" indicators under this heading are around 1, indicating the problems of digital transformation in the economy. The fact that ICT has an impact of around 4 on “Business and organizational models” reveals the desire for change in the business world. Despite the desire for digital

transformation, the fact that domestic technologies are not yet at the desired level of development points to the difficulties that the transformation process may involve.

When the sub-components used in the calculation of the Digital Transformation Index are examined, “Mobile network coverage” (99.7% of population), “International Internet bandwidth” (121 kb/s), “Households with Internet access” (88%), “Revenue from mobile networks” (58% of telecommunications service revenues), and “Gross capital formation” (25% of GDP) indicators that Turkey performs well or above the average stand out. On the other hand, indicators that performs relatively poor compared to other countries are “Research and development expenditure” (1% of GDP), “Mobile broadband Internet subscriptions” (75 people per 100), “Full-time equivalent telecommunication employees” (330 people per million population) , “International trade in ICT services” (2.2% of total services trade) and “International trade in digitally-deliverable service” (11% of total services trade).

As a result, index figures show that Turkey is open and willing to digital transformation, but lacks the necessary infrastructure and skills for it. Under these constraints, the digital transformation of the economy remains insufficient. In the face of the constraints faced by the development of the ICT sector with local dynamics, the increasing use of digital technologies makes import-based solutions inevitable.

www.tubisad.org.tr