ALPHA BANK

Information and Communication Technologies and Digital Transformation

SECTORS IN FOCUS

Alpha Bank Economic Research

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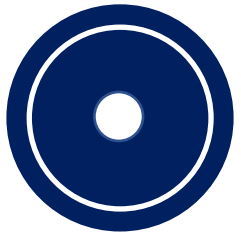
Executive summary

While digital transformation is a relatively new concept, it basically began several decades ago with the commercialization of the first personal computers. Today, we live in a time when digital transformation is widespread. New technologies such as AI, IoT, 5G broadband, robotics, cloud computing, etc. are paving the way for profound changes in businesses, in society and in the way they interact.

The Information and Communication Technologies (ICT) sector has produced many of the tools and services used to support and accelerate digital transformation. The ICT sector thus forms the basis for the development of the digital transformation, as it is an important driver of economic growth, the creation of economies of scale and the increase in productivity and efficiency. To reap the full benefits of digitalization, individuals, companies and the public sector, the main players in economic life, should adapt to the disruptive changes by expanding digital infrastructure, strengthening digital skills and intensifying R&D.

- **The ICT sector plays a crucial role as a carrier and transmitter of new** technologies and innovations. It includes subsectors of manufacturing, such as computers, communication equipment, and consumer electronics, and services, such as computer games, telecommunications, programming, and data processing.
- **In Greece, ICT services account for 3.2% of GDP and constitute the largest part** of the ICT sector in terms of basic structural figures, as they account for almost 98% of the total number of enterprises, turnover, production value, value added and employment. In contrast, ICT manufacturing in Greece, as in all other EU countries, is significantly underdeveloped compared to ICT services.
- **The Digital Economy and Society Index (DESI) measures the digital performance** in the EU-27 and is composed of four indicators, namely human capital, connectivity, integration of digital technology, and digital public services. Greece is a latecomer in the DESI index, ranking 25th among the EU-27 member states.
- **Regarding the different DESI dimensions, although Greece has improved its** scores over time, but it still has a long way to go to achieve digital transformation. The country ranks among the latter in advanced digital skills and fixed broadband coverage, while the Greek private and public sectors perform poorly in integrating digital technologies and providing digital public services.
- **In 2021, 21% of the Greek SMEs and 30% of the large enterprises received** orders through a website, a special application, marketplace, or EDI-type sales. The percentage of turnover from e-commerce sales is higher in SMEs (11%) compared to the large enterprises (8%).
- **ICT specialists, who work mainly in large enterprises rather than SMEs, account** for only 2.8% of total employment in Greece, whereas ¾ of them have tertiary education. Men ICT specialists largely outnumber women (75% vs 25%).
- **FinTech is a key concept for the digitalization process and structural changes** applied in financial services. Banks adopt various fintech features, such as mobile payments and internet banking. In Greece, 42% of individuals used the internet for internet banking in 2021.
- **Industry 4.0 and the Fourth Industrial Revolution represent the era of digitalization** which embodies the transformation of the organization and control of the industrial value chain through cyber-physical systems. Industry 4.0 is driven by high-impact digital technologies which include Big Data, robotics, simulation, system integration, AI, 3D printing, IoT, cloud computing and augmented reality.
- **The use of high-impact digital technologies is still limited in the EU-27 and rather** contained in Greece, being more prevalent in large enterprises than in SMEs. The use of these technologies can positively affect EU growth over the next decade, with “digital frontrunners” reaping the benefits of digitalization the most and “catching-up” countries having a positive, albeit lower, growth effect.
- **The Greek Bible of Digital Transformation incorporates the national strategy for** the digital transformation of the country and builds around seven targets, closely aligned with the key objectives of the EC’s 2030 Digital Compass.
- **Digital technologies can have a critical role in achieving climate neutrality**, enabling other industries to save up on global CO_2 emissions, placing the ICT sector at the heart of the EU policies that support climate change combat.
- **The acceleration of digitalization in the EU is supported by funding programs** such as the RRF, Horizon, and CEF Digital. Greece 2.0 reflects the targets and action plan of the Digital Transformation Greek Bible and focuses on productivity and innovation-driven economic growth.

Structural analysis of the ICT sector in Greece



The role of ICT and digitalization on economic dynamics

Technological development, as embraced today by information and communication digital technologies, is a key driver of economic growth.

Entering the digital transformation era

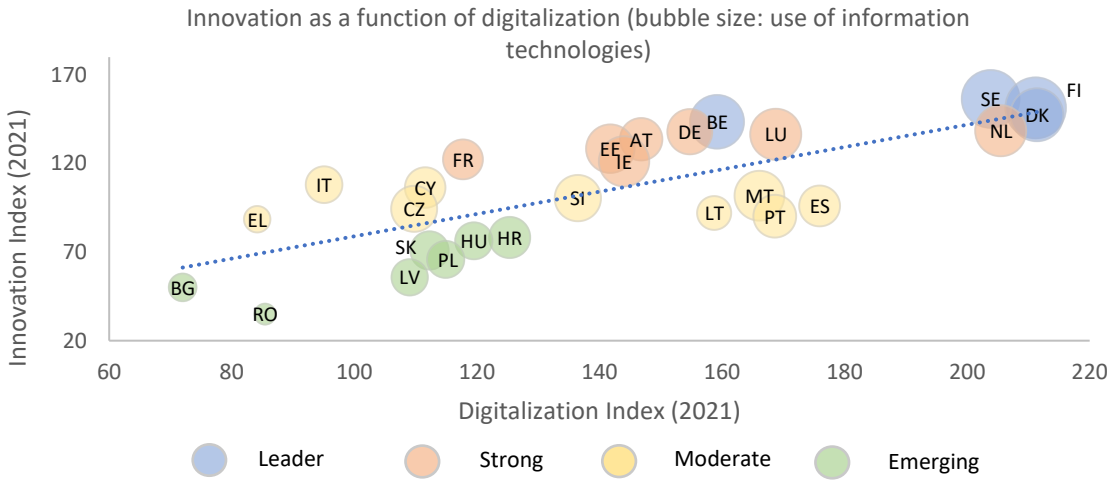
Digital transformation encompasses the various economic, social, environmental, and cultural aspects of the expanded use and incorporation of digital technologies. The COVID-19 crisis revealed the importance of digitalization and digital technologies as critical tools for the smooth continuation of many business processes.

There is a variety of definitions for digital transformation, often used interchangeably with digital transition, determining the processes and mechanisms of the digital age. Vial (2019) sees digital transformation "as a process where digital technologies create disruptions triggering strategic responses from organizations that seek to alter their value creation paths while managing the structural changes and organizational barriers that affect the positive and negative outcomes of this process."

ICT as a driver of productivity and economic growth

Information and communication technologies (ICT) provide most tools as products, services and processes needed for digital transformation. The positive relationship between the development of information and communication technologies and innovation, productivity and economic growth has been demonstrated in various studies. ICT investments contribute significantly to the growth of value added and are responsible for the observed productivity differences between countries and the reduction of social income inequality (OECD 2013, Cioaca et al 2019).

Studies have shown that EU industries, which were relatively more ICT-intensive before 1995, have outpaced others in terms of labor and total factor productivity growth after 1995 (Dahl et al 2010). The growth rate in the USA after 1995 is also due to the rapid growth in ICT production and use, which led to a fundamental revival in labor productivity and changes in business practices (Jorgenson et al 2008, Stiroh 2001). In countries such as Sweden, with one of the largest ICT investment and R&D shares of GDP, the growth of ICT and R&D capital is found to be positively and strongly correlated with the growth rates of value added in various industries, making it an important driver of economic growth (Edquist et al. 2017).



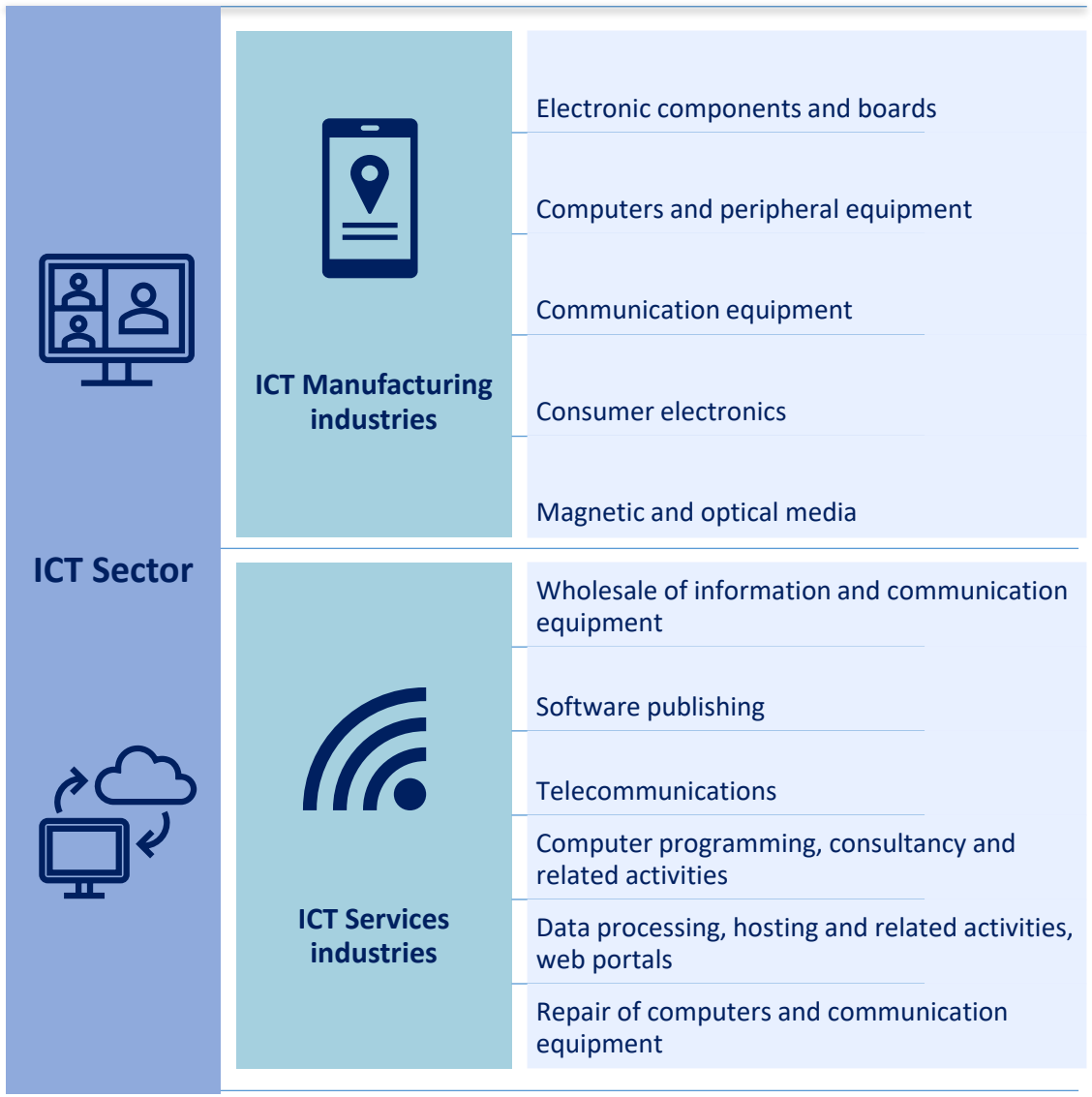
Note: EL stands for Greece.
Source: European Commission, European Innovation Scoreboard

Innovation and digitalization in the EU-27

The European Innovation Scoreboard (EIS) assesses the strengths and weaknesses of the national innovations systems and distinguishes countries to leaders, strong and moderate innovators, and emerging innovators, based on their innovation performance. The variables of the EIS include the index of digitalization with the sub-indices of broadband penetration and people with above-average basic digital skills, and the index of information technology use with the sub-indices of companies offering ICT training and employed ICT specialists.

There is a positive and high correlation between the innovation index and the digitalization index of the European countries as well as between innovation and the use of information technologies. The leaders, i.e., the frontrunner countries with the highest innovation indices, are Sweden, Finland, Denmark and Belgium, which also have the highest digitalization indices. Greece belongs to the group of moderate innovators, with a level of digitalization and use of information technologies that is among the lowest in the EU-27 countries.

Identifying the ICT sector



Source: Eurostat, NACE Rev. 2 classification

ICT is a composite sector with a considerable direct and indirect contribution to productivity, technological change and economic activity.

Information and Communication Technologies (ICT) combine sectors from manufacturing and services that are related to communications networks and technologies, aiming to *"fulfill* or enable the function of information processing and communication by electronic means, including transmission and display" (OECD 2011).

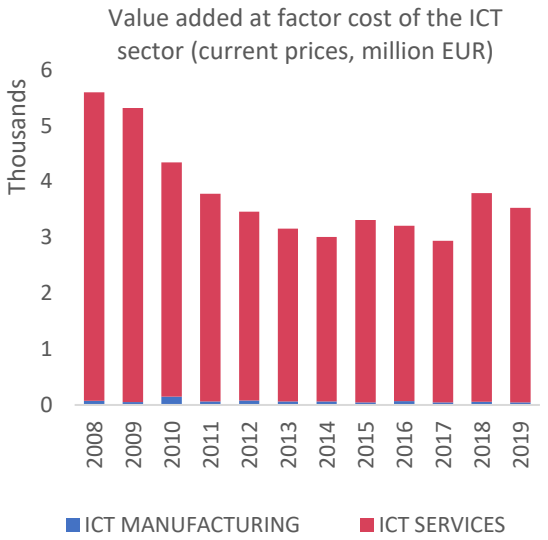
According to the Eurostat definition, on a NACE Rev. 2008 sectoral classification level, ICT includes a wide range of subsectors. In the manufacturing industry, the ICT spans various divisions, such as a) loaded electronic components and electronic boards (e.g., semi-conductors, printer cables, interface cards), b) computers and peripheral equipment (e.g., desktop computers, laptops, storage devices, printers, monitors, keyboards), c) communication equipment (e.g., cellular phones, modems, burglar and fire alarm systems), d) consumer electronics (e.g., televisions, audio recording, speaker systems, microphones, CD and DVD players), and e) magnetic and optical media.

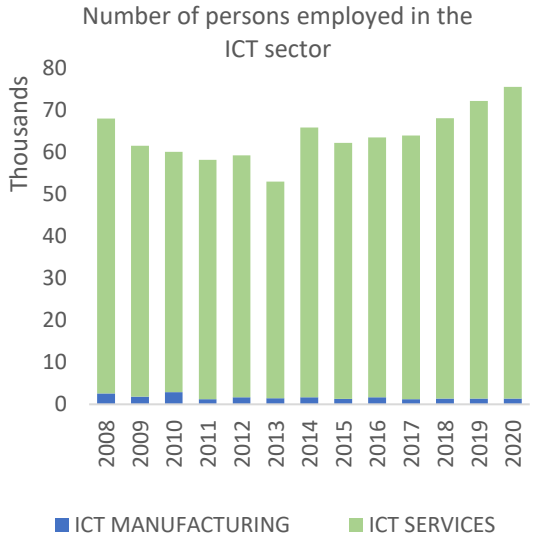
ICT services also range in various divisions, such as a) computer games and other software publishing, b) telecommunications, for transmitting voice, data, text, sound, and video, which include wired, wireless, satellite, and other telecommunications activities, c) computer programming, computer consultancy and related services, such as computer facilities management activities, and in general, activities that provide expertise in information technologies, d) data processing, hosting and related activities, web portals (e.g., web hosting, streaming services, generation of specialized reports from data supplied by clients), and e) repair of computers and peripheral equipment, and communications equipment.

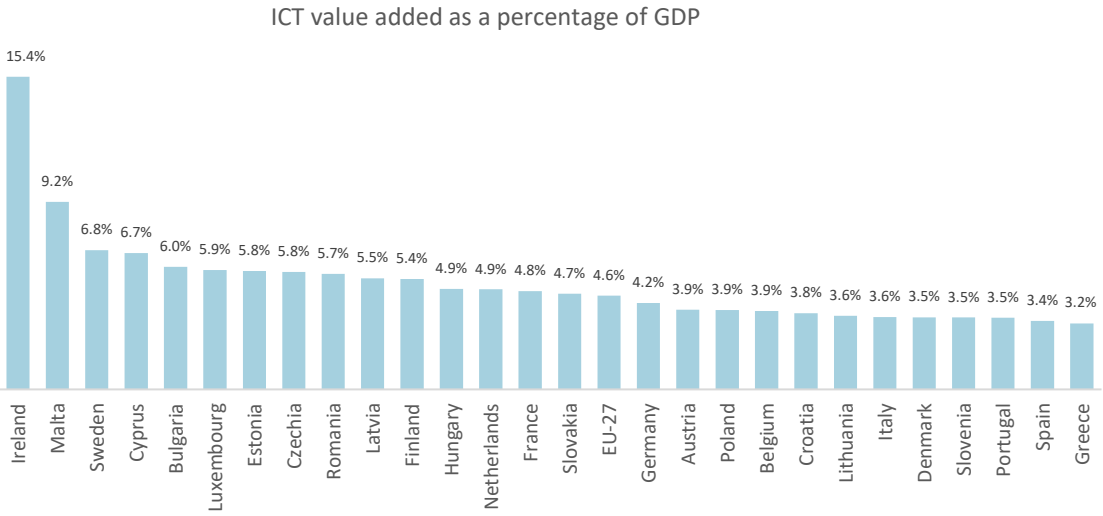
ICT services also include the wholesale of information and communications equipment, which is further divided into the wholesale of computers, computer peripheral equipment and software, and the wholesale of electronic and telecommunications equipment and parts.

In the era of digitalization, ICT manufacturing and services play a critical role as carriers and transmitters of new technologies and innovations. ICT R&D breakthroughs can affect all aspects of economic and social life, with the output of the sector being diffused over almost all economic activities, but also over society, skills and education.

Key figures of the Greek ICT market







Source: Eurostat, Structural Business Statistics, PREDICT database

Greece records the lowest share of ICT sector value added in GDP among the European countries.

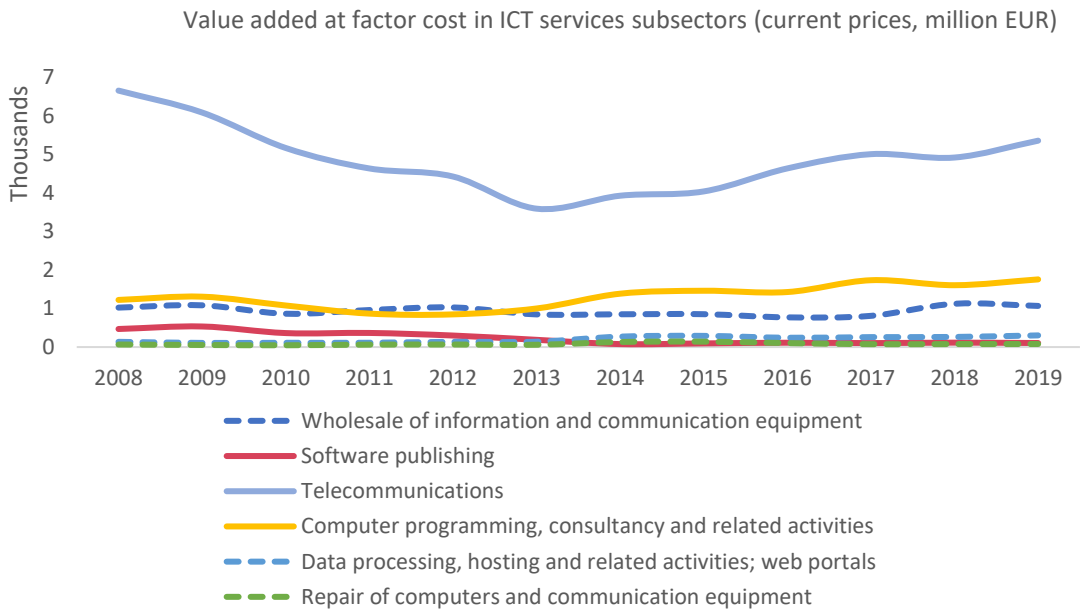
The value added (at factor cost) of the Greek ICT sector represents 6.9% of the value added of the total business economy (excluding sectors such as financial and insurance activities) (2019) and 3.2% of the country's GDP (2021) (current prices, SBS and PREDICT databases). Ireland has the highest ICT value added to GDP at 15.4%, followed by Malta (9.2%) and Sweden (6.8%). According to a survey conducted by Deloitte on behalf of SEPE (Association of IT and Communications Companies of Greece), ICT value added will increase by an average annual rate of change of 13.4% by 2024 and will have a significant positive impact on the Greek economy (Deloitte 2021, Stochasis 2022).

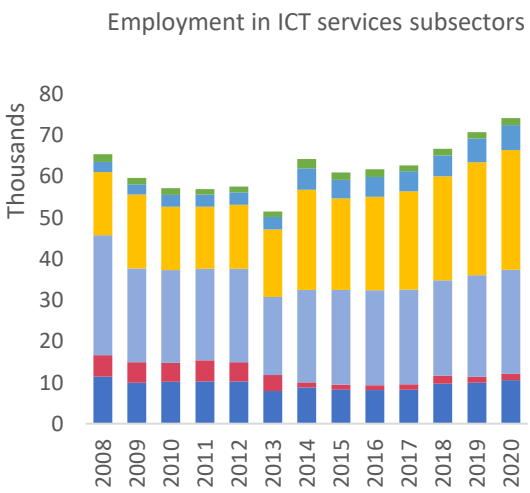
ICT services make up the largest part of the ICT sector in terms of basic structural figures, as they significantly outnumber ICT manufacturing, accounting for almost 98% of the total number of enterprises, turnover, production value, value added and employment (2019). In 2019, there were about 13,650 ICT companies, of which 300 belonged to manufacturing and the rest to services. In terms of size, 98% of ICT companies are small with up to 19 persons. The number of ICT firms jumped in 2014 and increased cumulatively by 41% in the decade 2009-2019.

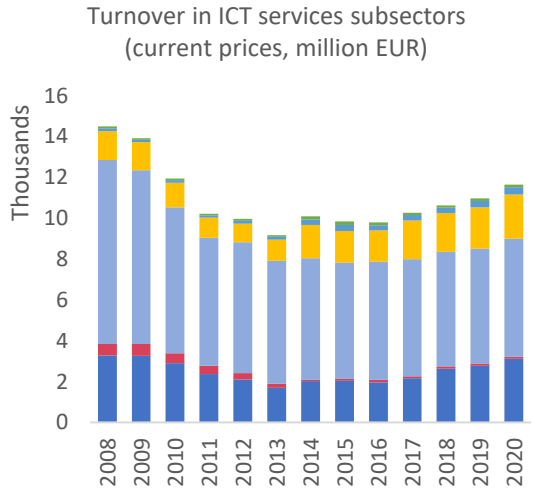
ICT employment recovered after 2014, although it was negatively impacted by the 2008 financial crisis, which led to a 22% decline in the 2008-2013 period. In 2020, the number of the persons employed exceeded 75 thousand. ICT manufacturing recorded a 54% decrease in employment in the decade 2010-2020. The effects of the crisis were also evident in the value added and turnover of the ICT sector, with losses of 44% and 37% (in current prices), respectively, in 2008-2013. In the following years, the sector regained momentum, but did not fully recover. Labor productivity of the ICT sector fell significantly during the crisis, from EUR 87,000 in 2009 to EUR 49,000 in 2019 (in current prices). This decline was due to the productivity loss in ICT services (-44%), since ICT manufacturing recorded an increase during the same period (7%).

In the 2019 Deloitte survey, the main problems faced by ICT companies were more related to taxation (60%), lack of staff (60%), lack of funding (53%), social security (28%), bureaucracy (18%) and the small size of the market (18%), and less related to legislation (9%), R&D development and the market, the general image of Greece and infrastructure (2-3%) (Deloitte 2019).

The domestic sector of ICT services







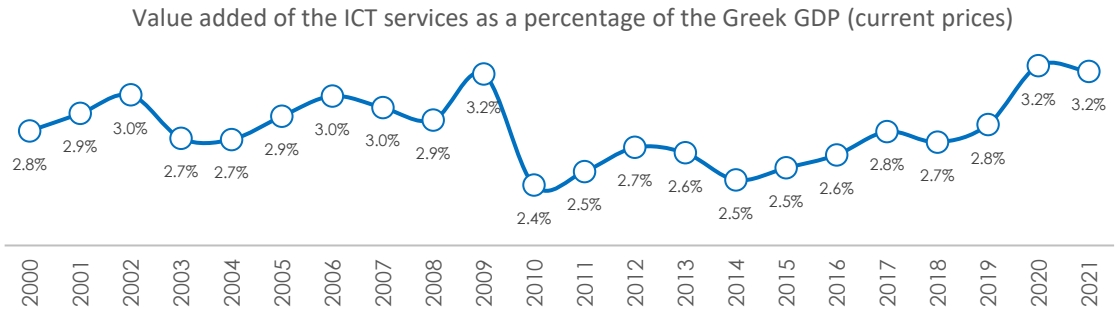
Source: Eurostat, Structural Business Statistics, National Accounts

The share of Greek ICT services value added in Greek GDP has returned to its pre-crisis level and stands at 3.2% in both 2020 and 2021.

Telecommunications and computer programming, consultancy and related activities are the two largest divisions of ICT services. Telecommunications account for ½ of the value of turnover and value added at factor cost of ICT services and 2/3 of their production value (all measured in current prices). Computer programming, consultancy and related activities account for 55% of the number of enterprises and almost 40% of employment in the sector (2019). Among the largest players in the Greek ICT services market are Unisystems, IBM Hellas, Space Hellas, Qualco, Processing Services, SAP, Microsoft Hellas, Kaizen, Performance Technologies, Betta, as well as OTE, Cosmote, Vodafone, Wind and Nova in the telecommunications sector (Stochasis 2022).

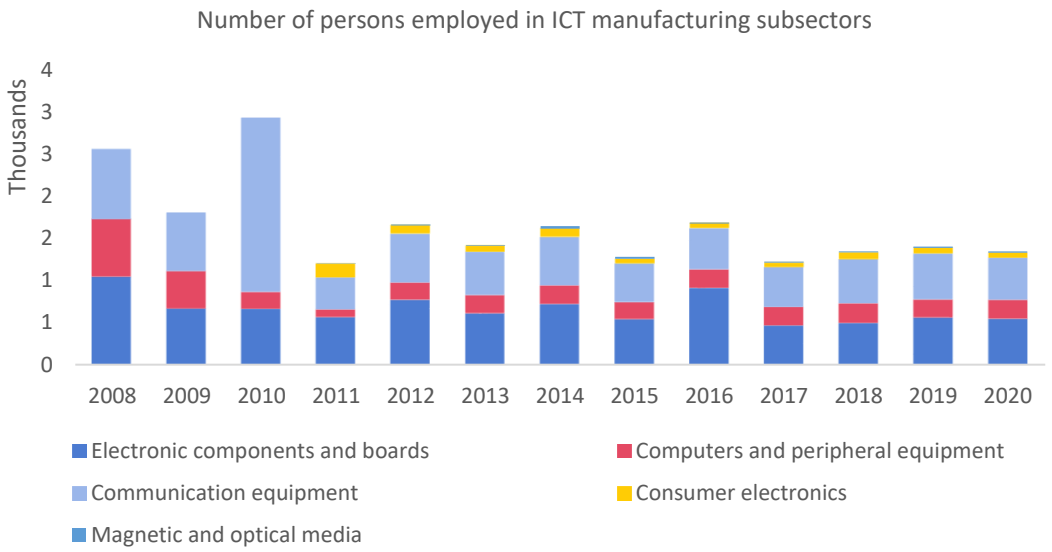
Although telecommunications is one of the largest subsectors of ICT services, it comprises only 11% of the number of companies (2019). Despite the small share in terms of enterprises, it is the subsector with the largest increase in the number of its companies in the decade 2009-2019, which grew rapidly after 2012 to reach an average of 1,582 in the period 2014-2019.

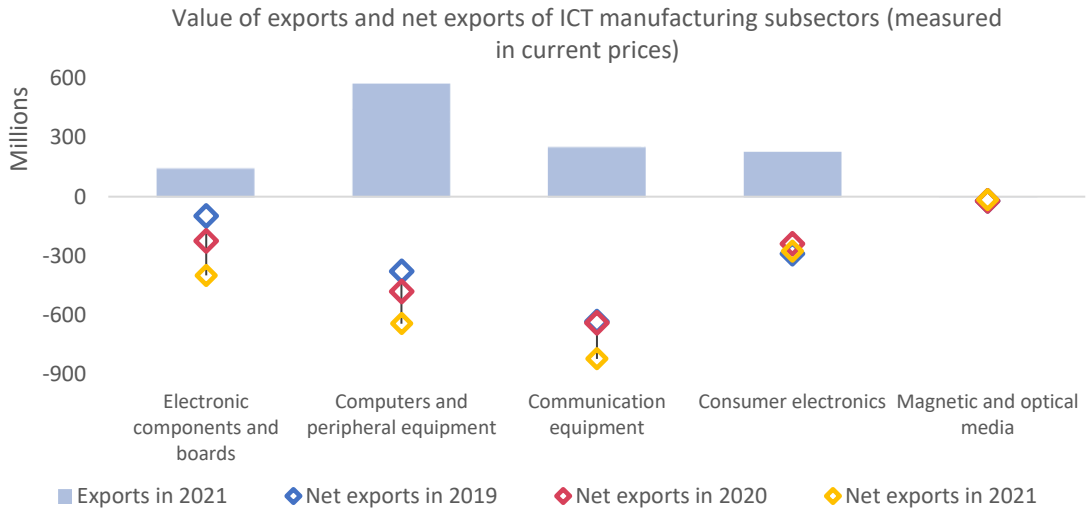
Wholesale of information and communication equipment is the third largest subsector of ICT services, accounting for ¼ of the sector's turnover, 13% of value added, and 14% of employment. Data processing, hosting, related activities, and web portals, although a small subsector, are among the fastest growing, having more than doubled their production value, turnover, and value added over the 2009-2019 period, and increased employment by 128%.



Source: European Commission, EU Science Hub, PREDICT database

The domestic sector of ICT manufacturing





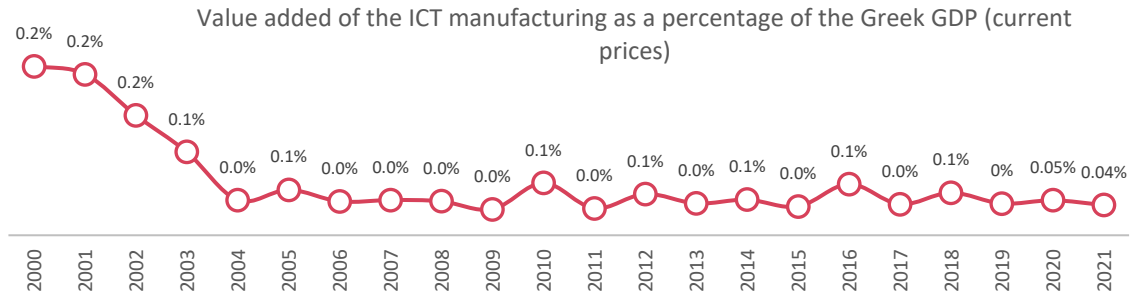
Source: Eurostat, Structural Business Statistics, International Trade

ICT manufacturing in Greece, like in the other EU countries, is underdeveloped compared to services, accounting for only 0.05% of GDP (2021).

The value added of the ICT manufacturing sector in the early 00s amounted to almost €341 million, equivalent to 0.2% of GDP (at current prices). By 2004, however, the sector had lost a large part of its production value and value added. This decline was due to the containment of communications equipment, which reduced its share of ICT manufacturing from nearly 70% in 2000 to 50% in 2004 (at current prices).

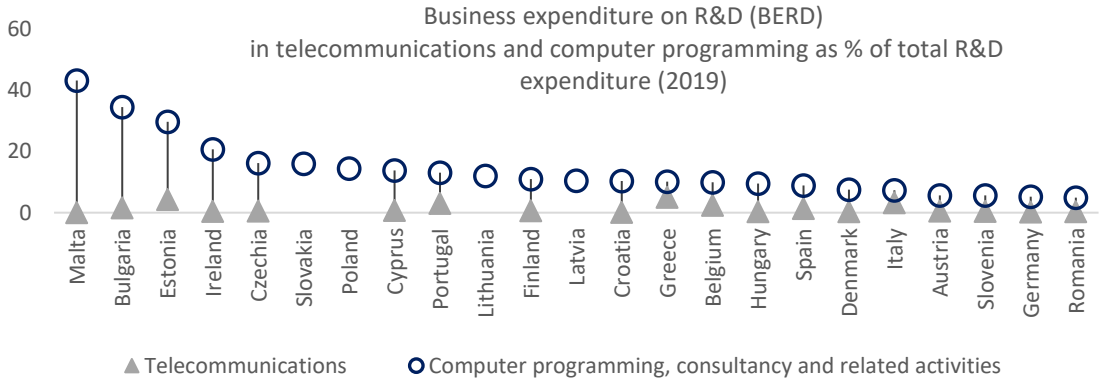
Electronic components and boards are currently one of the largest subsectors of ICT manufacturing in terms of number of enterprises, turnover, production value, value added and employment. The sector comprises 123 enterprises, accounting for 41% of total ICT manufacturing companies, and employs just over 500 people, the same number as communications equipment, which is currently the second largest subsector. Electronic components and boards and communication equipment account for over 90% of the turnover (58% and 33% respectively) and production value (62% and 29%, respectively) of ICT manufacturing. The two subsectors account for 86% of value added (2019).

ICT manufacturing had a trade deficit of €2.2 bn in 2021. Although the sector's exports rose by 12% to almost €1.2 bn in the same year, ICT manufacturing imports increased twice as much (25%), resulting in a 34% rise in the trade deficit. The sectors' exports account for 3% of total Greek exports, with 40% directed to Cyprus and Italy. Computers and peripheral equipment account for 48% of the ICT manufacturing exports, but also 36% of its imports. Communication equipment accounts for 21% of the ICT sector's exports, consumer electronics 19% and electronic components and boards 12%.



Source: European Commission, EU Science Hub, PREDICT database

Research, development, and ICT equipment investment



Source: Eurostat, Structural Business Statistics

Business expenditure on R&D (BERD) is the expenditure on research and experimental development "performed within the business enterprise sector on the national territory during a given period, regardless of the source of funds" (Eurostat Statistics definition).

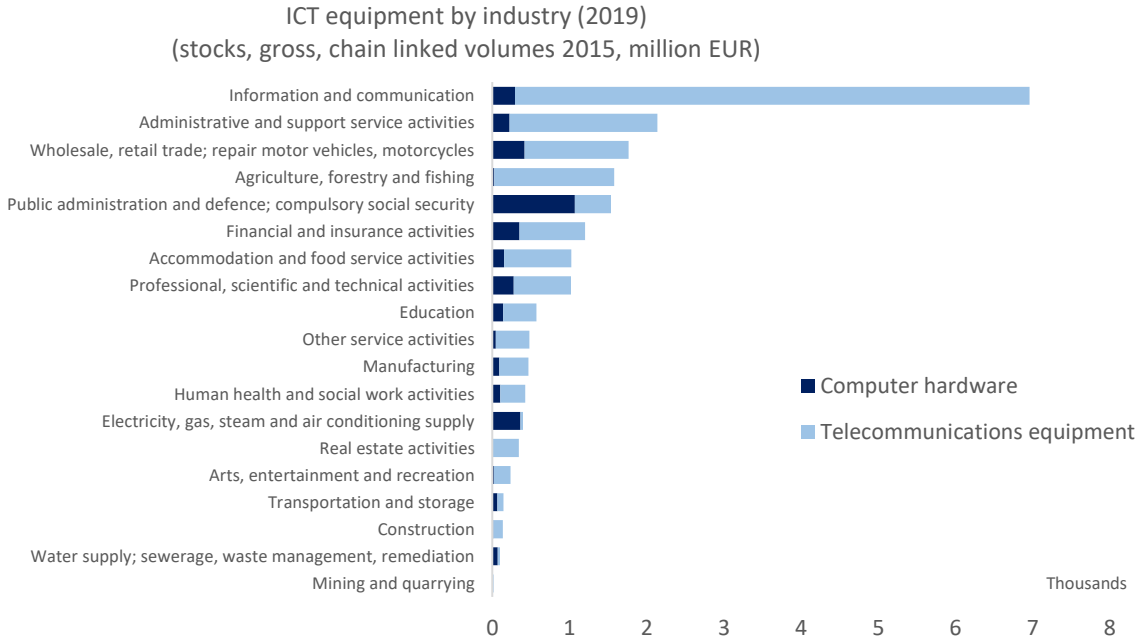
In Greece, the BERD of the ICT manufacturing sector in total R&D expenditure is quite low for all its subsectors: 0.45% for the manufacture of electronic components and boards, 0.44% for the manufacture of communication equipment, 0.1% for computers and peripheral equipment, and 0.05% for consumer electronics. Croatia is among the countries with the highest BERD percentages in the manufacture of communication equipment (almost 18% in 2019, with available data for only 23 countries).

As for ICT services subsectors, computer programming, consultancy and related activities have the highest BERD in all EU countries, with the largest value recorded in Malta (43.1%). In Greece, the corresponding percentage is 10.1%. The BERD of Greek telecommunications is among the highest compared to other EU countries (23 with available data), reaching almost 5% (2019). Wholesale of information and communication equipment accounts for 3.8% of total R&D expenditure and software publishing for 1.8%. Data processing, hosting and related activities and web portals have the lowest BERD among the Greek ICT services subsectors (0.4%), while repair of computers and communication equipment has a zero BERD.

Computer programming, consultancy, and related activities have the largest business expenditure on R&D in the ICT sectors in EU, including Greece.

ICT equipment as fixed assets is divided into two main categories: Computer hardware and telecommunications equipment. In most sectors of the economy, telecommunications equipment accounts for the largest share of ICT equipment investment. Specifically, 82% of fixed assets in ICT equipment are telecommunications equipment and 18% are computer hardware.

The ICT sector retains the largest share of telecommunications equipment (gross, €6.7 billion or 40% of the total in 2019), followed by the sector of administrative and support services (11%). Only in the sectors of water supply, sewerage, waste management and remediation, electricity, gas, steam and air conditioning supply, and public administration, defense and social security is the share of computer hardware in ICT fixed assets greater than that of telecommunications equipment.



Source: Eurostat, National Accounts

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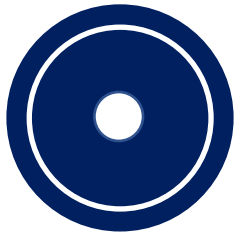
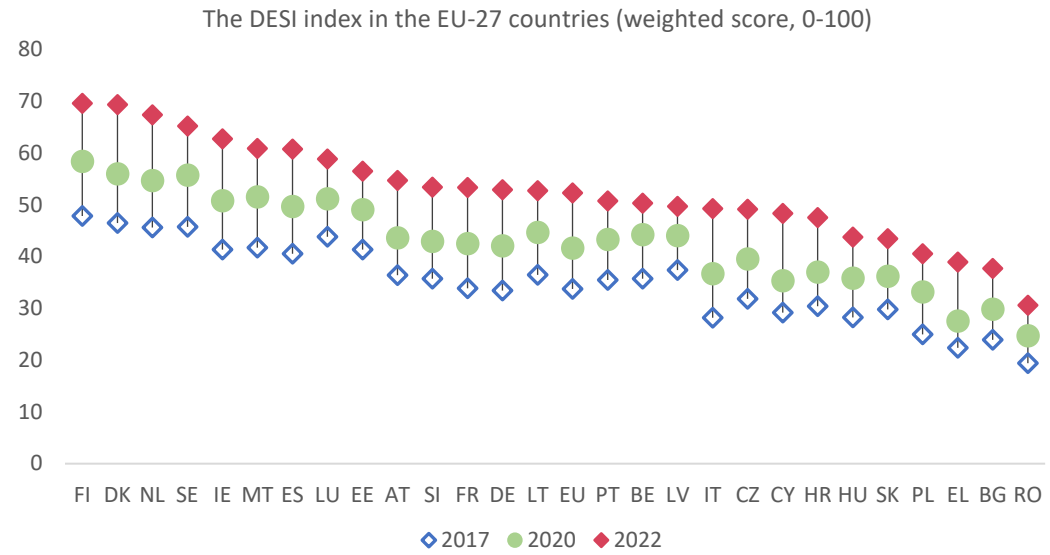
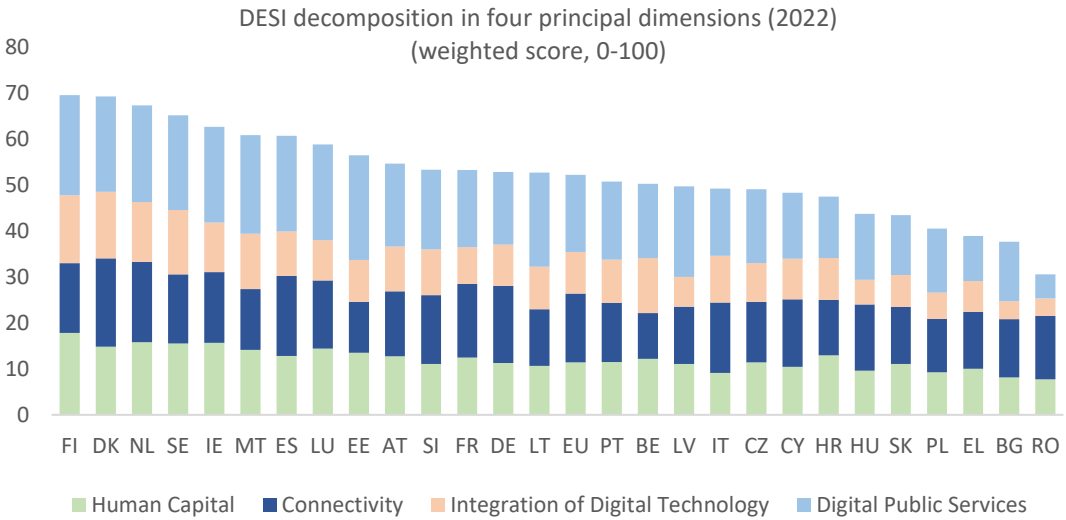
Digital performance in the Greek economy and society



Decomposing the DESI index in four principal policy areas





Source: European Commission, The Digital Economy and Society Index

The Digital Economy and Society Index (DESI), launched by the European Commission in 2014, measures the progress of EU countries in terms of their digital performance.

The DESI 2022 report is primarily based on 2021 data and captures the state of digitalization in EU countries following the COVID -19 pandemic. In recent years, the DESI index has been adjusted to "reflect the two major policy initiatives set to have an impact on the digital transformation in the EU in the coming years: the Recovery and Resilience Facility and the Digital Decade Compass" (EC DESI 2021).

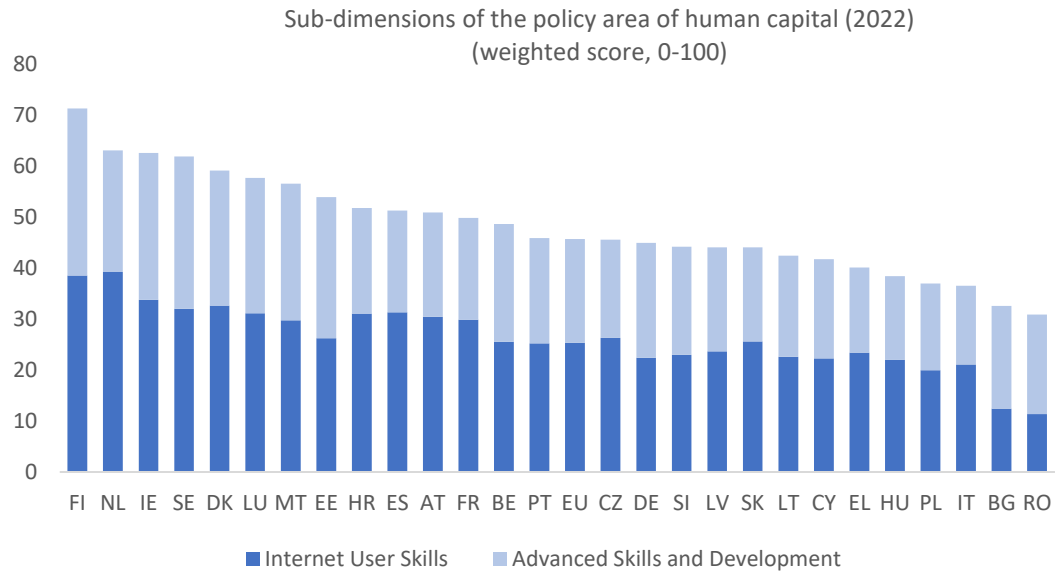
The DESI consists of indicators of four principal and interrelated policy dimensions aligned with the corresponding areas of the EC's 2030 Digital Compass: a) human capital, b) connectivity, c) digital technology integration, and d) digital public services. The DESI per country is the average of the scores in these four areas. In the DESI 2022 Index, Finland, Denmark, the Netherlands, and Sweden ranked first.

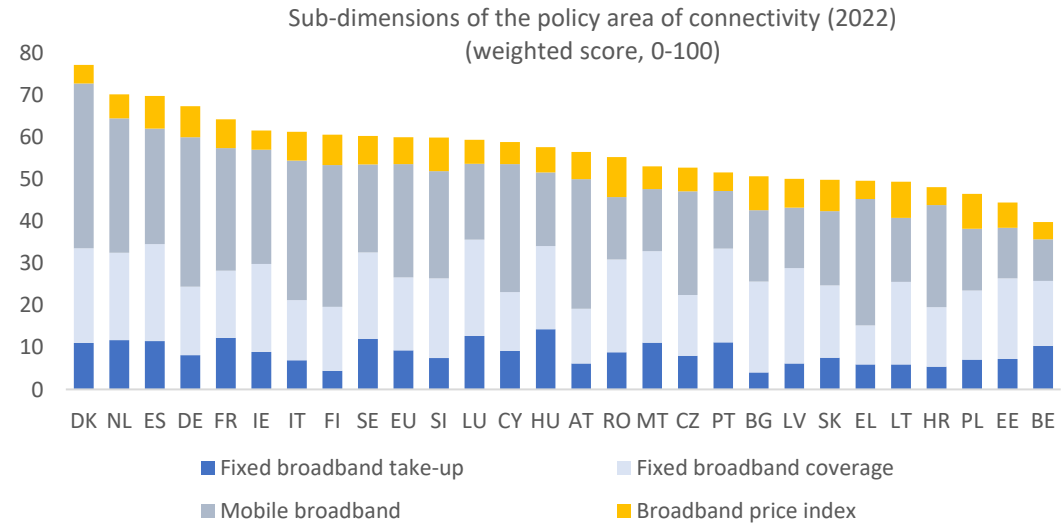
Greece has improved its performance compared to 2021, but remains a laggard, ranking 25th among the 27 member states with 38.9 out of 100 units in 2022, with the EU average at 52.3/100. Greece is almost 17 units higher in 2022 than in 2017, but this difference is smaller than the EU-27 average difference (19 units). Denmark and the Netherlands show the highest improvement in performance over these 5 years.

Although Greece's score in 2022 compared to 2017 is higher in all four dimensions of the DESI, especially in connectivity and digital public services, the country's overall ranking in 2022 remains among the lowest in the EU-27. Compared to 2017, Greece's relative position in 2022 has improved only in the dimensions of human capital and connectivity.

In terms of human capital, Greece ranks 22nd in 2022, one position higher than in 2017 but also one position lower than in 2021, with 10.0/100, which is below the EU average (11.4/100). Regarding its position in integration of digital technologies, Greece remains 22nd in 2022, as in 2017, but has worsened by one place compared to 2021. It scores 6.7 out of 100 (the EU-27 average at 9 units), an increase of 2.5 units compared to 2017. In terms of connectivity, Greece has significantly improved its position in 2022 and is now ranked 22nd among the 27 EU Member States, although it was a laggard in previous years (27th). In terms of digital public services, the country improved its score in 2022 compared with 2017, but not its position (26th).

The dimensions of human capital and connectivity





Source: European Commission, The Digital Economy and Society Index

Although Greece has improved its scores over time in advanced digital skills and fixed broadband coverage, it ranks among the lowest in the corresponding EU-27 scale.

Human capital

The human capital dimension assesses both citizens' skills as internet users and the advanced skills of ICT specialists. The two subdimensions of human capital include (a) internet user skills, based on "the number and complexity of activities involving the use of digital devices and the Internet" (DESI 2021), and (b) advanced skills and development. Internet user competencies include "at least basic digital skills," "above basic digital skills," and "at least basic digital content creation" as indicators by which countries are assessed. Advanced skills and development include indicators for ICT specialists, female ICT specialists, companies providing ICT training, and ICT graduates.

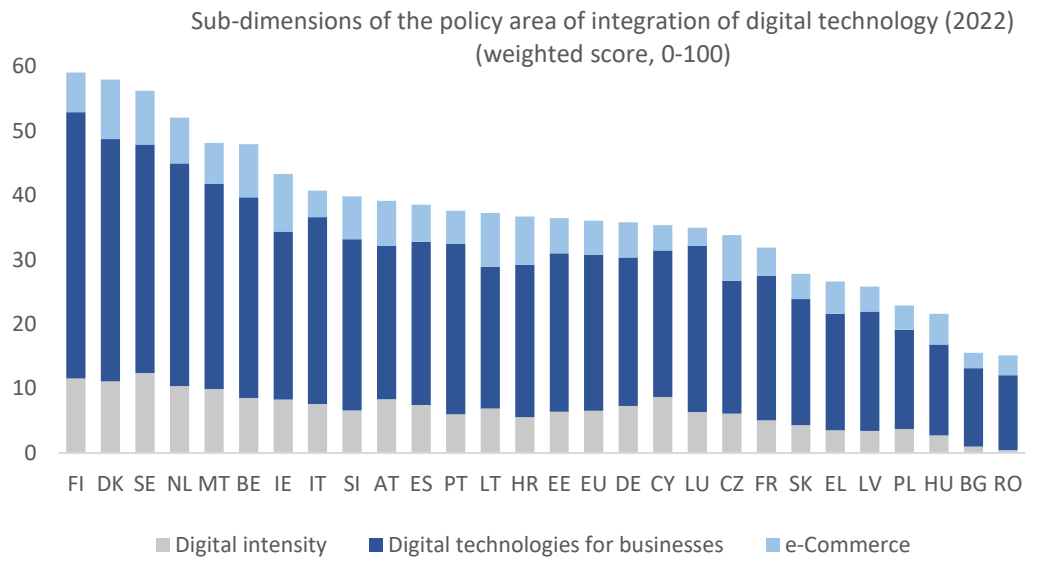
Greece's weighted score in 2022 is 23.4 and 16.7 out of 100 in internet user skills and advanced skills, respectively. Although the country has been improved in internet user skills, ranking 18th among EU-27 countries in 2022 (up from 20th in 2021), it is still among the bottom performers in advanced digital skills (25th).

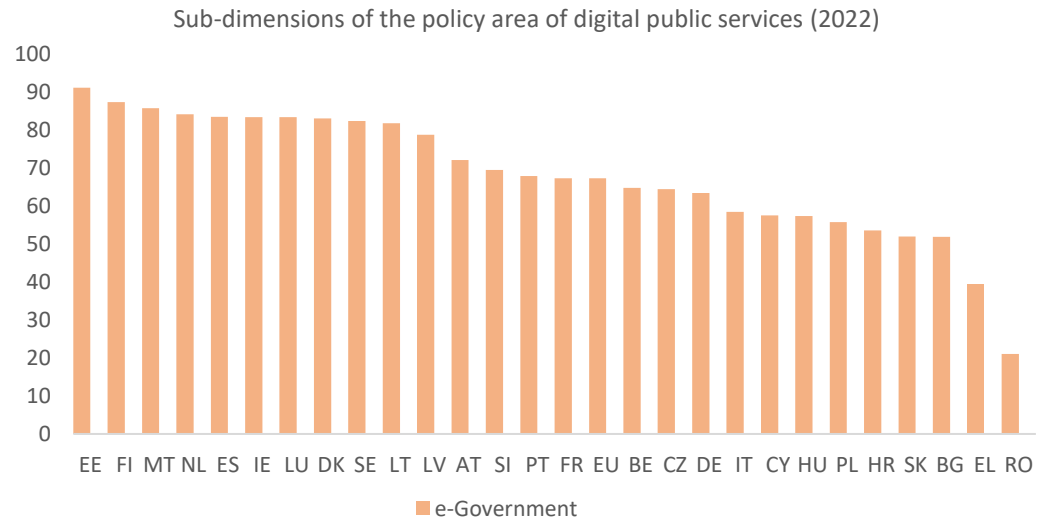
Connectivity

Connectivity includes indicators that measure both the supply and demand side of fixed and mobile broadband, as well as broadband retail prices. The four sub-dimensions of connectivity include a) fixed broadband take-up, which includes the indicators of overall fixed broadband take-up, fixed broadband of at least 100 Mbps, and fixed broadband of at least 1 Gbps, b) fixed broadband coverage, which includes the variables for coverage of fast broadband (NGA) and coverage of fixed Very High-Capacity Network (VHCN), c) coverage of mobile broadband, which includes 5G spectrum, 5G coverage, and mobile broadband take-up, and d) broadband prices.

In the sub-dimensions of fixed broadband take-up and broadband price index, Greece ranks 23rd and 25th respectively in 2022. Regarding the fixed broadband coverage of households, the country is making rapid progress, especially in NGA coverage, but its VHCN and FTTP coverage remains among the lowest. In mobile broadband, Greece exhibits the best performance of all its DESI indicators and ranks 8th in the EU-27.

The dimensions of digital technology integration and public services





Source: European Commission, The Digital Economy and Society Index

Despite the improvements, the private and public sectors in Greece perform relatively poorly in integrating digital technologies and public services.

Integration of digital technology

Integration of digital technology into business activities contains three sub-dimensions: a) digital intensity, b) digital technologies for businesses, and c) e-commerce. Digital technologies include seven indicators: electronic information sharing, social media, big data, cloud, AI, ICT for environmental sustainability, and e-invoices. E-commerce, the third sub-dimension, has three sub-indicators, namely SMEs selling online, e-commerce turnover, and selling online cross-border.

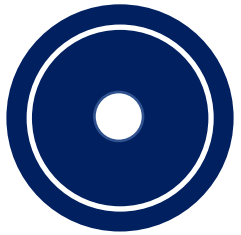
Greece ranked 23rd in digital intensity and digital technologies for business and 17th in e-commerce in 2022, with the country's position improving in e-commerce since 2017 but slightly deteriorating in digital technologies for business. The good news are that Greece will be among the few countries with investments by the world's cloud services leaders. There have already been significant investments from Microsoft, Amazon and Digital Realty, with Google currently investing in infrastructure and a peripheral hub for cloud services (Kathimerini).

Digital public services

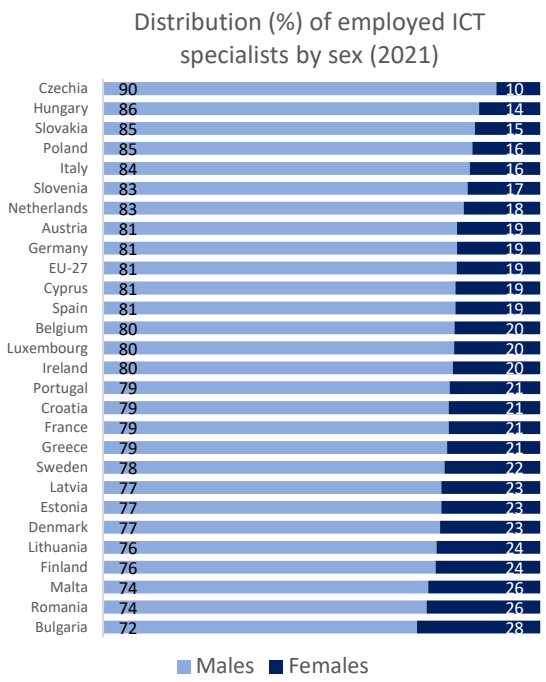
Digital public services have one sub-dimension, e-government, which includes five indicators: e-government users, pre-filled forms, digital public services for citizens, digital public services for businesses, and open data. Greece is a laggard in e-government services, as it ranks 26th in the EU in 2022, before Romania. Although it improved its score from 24/100 in 2017 to 39.4 in 2022, its relative position among the other countries has not changed. Estonia ranks 1st in e-government, scoring 91.2 out of 100 in 2022.

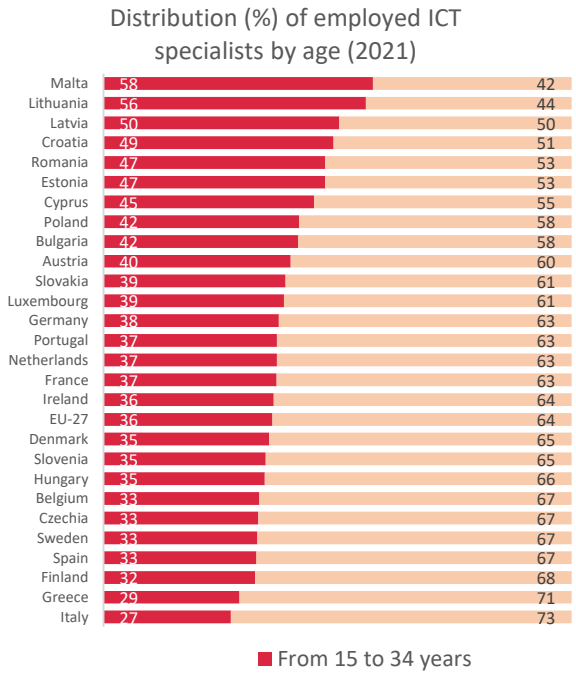
In terms of interaction with public authorities, Greece is slightly above the EU average on the open data maturity indicator, with 82%. Moreover, 69% of Greek Internet users were also users of e-government in the last 12 months (65% in the EU-27). In 2021, public digital platforms were significantly strengthened, with more than 566 million transactions taking place, six times more than in 2020 (DESI 2022). However, Greece is still far below the EU average (64 out of 100) in terms of pre-filled forms in all life events (45 out of 100) and availability of digital public services for citizens and businesses (52/100 and 48/100, respectively, compared to 75 and 82 in the EU).

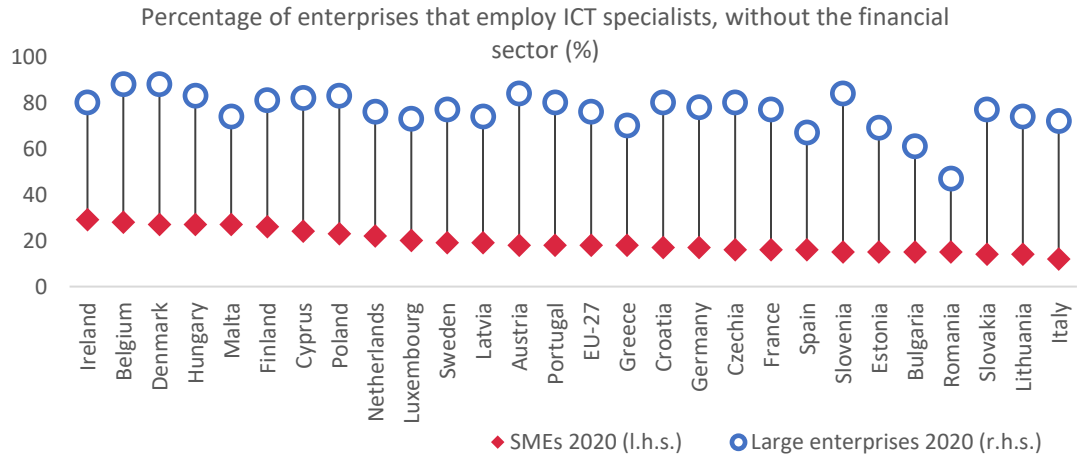
Digital skills and digitalized activities of businesses



Digital skills and ICT specialists in Greek enterprises







Source: Eurostat, Digital Economy and Society

The lack of advanced digital skills in the Greek workforce and of specialized ICT education and training programs is a major challenge for the Digital Decade.

Although Greece has launched several initiatives and has "placed the development of digital skills for all at the core of its new digital transformation strategy to facilitate the use of public services and ensure the reskilling and upskilling of the workforce" (DESI Greece 2021), the country still has one of the highest shares of unemployed persons with ICT education and training and one of the lowest shares of ICT specialists in the labor force.

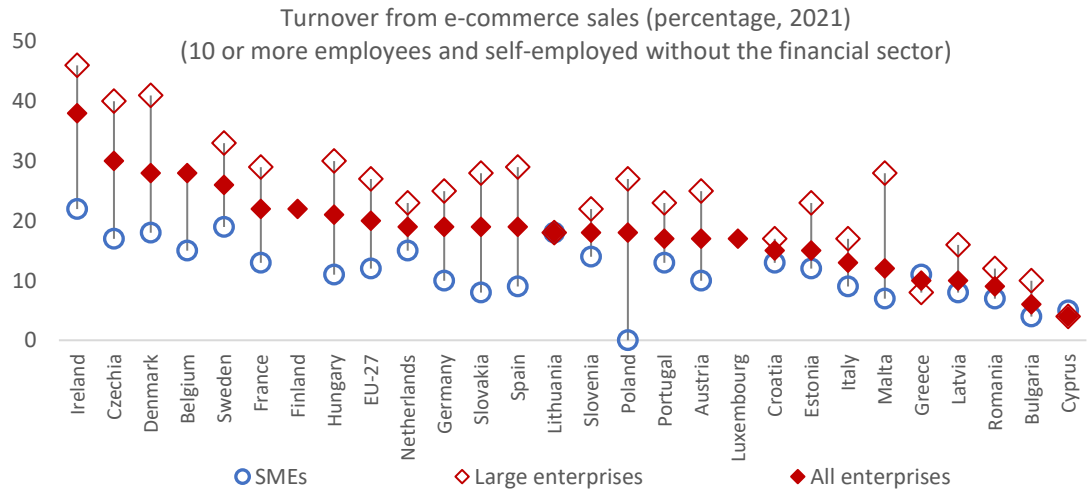
Despite the decline since 2011, Greece still has the highest unemployment rate of persons with ICT education and training, i.e., of persons with knowledge of computer use and/or database and network design and administration and/or software and applications development and analysis. This share was 19.5% in 2021 (26.2% in 2011), in contrast to the EU-27 average of 7.4%.

The number of Greek ICT specialists increased by 50% from 2011 to 2021 (EU-27: 58%), reaching 110.7 thousand. However, the share of ICT specialists in total employment is 2.8 % in 2021, putting Greece in second-to-last place after Romania. The corresponding EU-27 average was 4.5% of total employment, with Sweden leading the way (8%).

The percentage of the Greek SMEs that employ ICT specialists stands at 18% (2020), in line with the EU average, although the corresponding percentage for large companies excluding the financial sector is among the lowest (70% and 76% in the EU-27). Almost 75% of ICT specialists in 2021 were tertiary education graduates, above the EU average (64.5%). However, the country has the second lowest proportion of younger employed ICT specialists (15-34 years old) after Italy (29% vs. 36% in the EU-27), with the remainder (71%) over the age of 35. Among Greek ICT specialists, 79% are men and 21% are women. Although the percentage of women is low, it is the 10th highest in the EU-27 (19%).

Actions and initiatives such as the Greek National Coalition for Digital Skills and Jobs, the Digital Skills Academy, digital education plans and the Digital Access Program are in the right direction, but need to be complemented by further efforts to enhance advanced digital skills. Among the recent developments with positive spillover effects for the Greek labor force is that 138 international companies, including startups and big-techs, have established tech teams in Greece, employing 8,650 persons in tech positions (Endeavor).

E-commerce activities of Greek enterprises



Source: Eurostat, Digital Economy and Society

E-commerce transactions by internet users

During Q1 2021, 6 out of 10 people aged 16-74 purchased or ordered goods and services for personal use over the Internet, according to the Survey of ICT use by households and individuals (ELSTAT 2021). The majority (91.5%) of consumers who shopped online in 2021 chose domestic businesses for their purchases. Per region, the share of internet users who shopped online was highest in Attica (65.5% in Q1 2021) and lowest in Northern Greece (49.7% in Q1 2021).

For digital products, 19.5% of users purchased movies/series, either as streaming services or as digital downloads, 9.8% purchased music, 6% purchased electronic books, online newspapers and magazines, and 6% purchased games for cell phones, PC or game consoles. For physical products, 76% of users purchased clothing, shoes, and accessories online, and for services, 18% purchased internet subscriptions or mobile connections and 16% subscriptions for electricity, water, or natural gas.

Greek accommodation and travel agencies are among the sectors with the largest share of companies that generate at least 1% of their revenue from e-commerce.

E-commerce activities of Greek enterprises

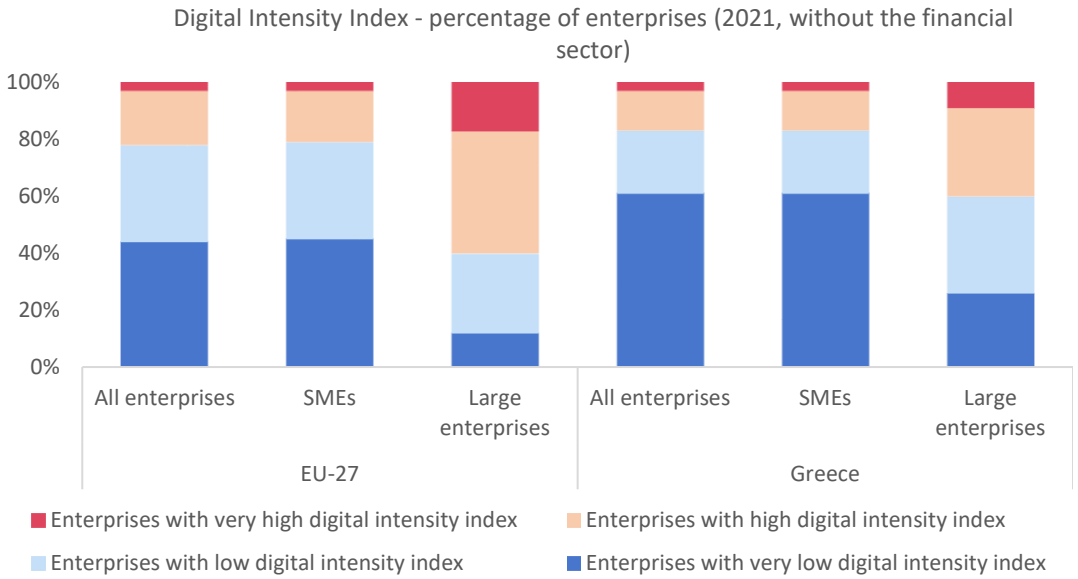
Electronic commerce or e-commerce is the sale or purchase of goods and services conducted over computer networks by methods designed solely for sending or receiving orders (ELSTAT). Payment and delivery of goods or services are not necessarily made electronically. Orders received by telephone, fax, or typed electronic messages (e-mail) are not considered electronic commerce.

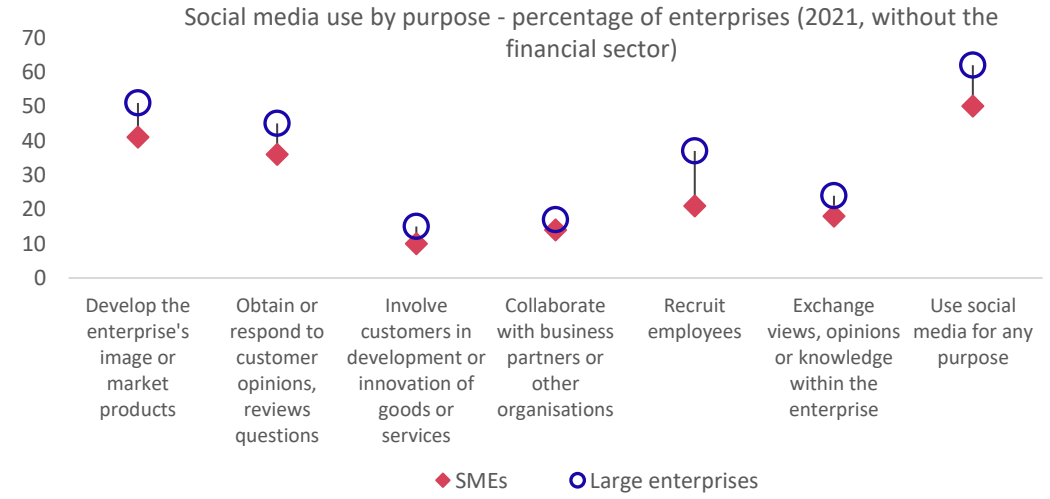
Among firms with more than 10 persons employed outside the financial sector, almost all (98.9%) had access to the internet for business purposes, while 62% of them had a website (ELSTAT 2021). Moreover, 21% of Greek SMEs, close to the EU average (22%), and 30% of large companies (44% in the EU) received orders through a website, special application, marketplace or EDI-like sales. However, only 7% of Greek companies made e-commerce sales to other EU countries and 6% to the rest of the world.

Sales from these orders amounted to €26 billion in 2021, or 9.8% of total company sales. The corresponding amount in 2020 was €10.5 billion for almost 37.5 thousand enterprises, or 4.3% of their total turnover. It is worth noting that Greece is the only European country where the share of turnover from e-commerce sales is higher among SMEs (11% in 2021) than among large companies (8%). Ireland has the largest share of e-commerce sales in the total sales of its enterprises (38%), significantly higher than the EU average (20%).

Only 19% of Greek SMEs with web sales declare that they have no difficulties, compared to 29% of large companies (2021). Of those facing obstacles to web sales, 12% attribute them to high costs of delivery or return of products, 6% to the system VAT and 3% to restrictions by business partners. Large Greek companies rank last on the European list when it comes to sending electronic invoices suitable for automated processing to customers and suppliers (19% vs. 53% for the EU-27 average). In addition, 40% of Greek large enterprises and 20% of SMEs use software solutions such as customer relationship management (CRM), while the corresponding EU averages are 65% and 34%, respectively.

Digital intensity of enterprises and use of social media





Source: Eurostat, Digital Economy and Society

Greek companies lag in competitively using advanced digital technologies and integrating their enabling functions to strengthen their digital profiles.

Digital Intensity Index

The Digital Intensity Index (DII v3 2021) measures the use of various digital technologies by companies. It is derived from the inclusion of various digital characteristics and includes the following conditions that determine companies' scores: 1) more than 50% of the employed persons use computers with internet access for business purposes, 2) ERP (Enterprise Resource Planning) software package for sharing information between different functional areas, 3) maximum contracted download speed of the fastest fixed-line Internet connection of at least 30 Mb/s, 4) web sales of more than 1% of total revenue and B2C (business-to-consumer) web sales of more than 10% of web sales, 5) use of IoT, 6) use of social media, 7) CRM (customer relationship management), 8) purchase of sophisticated or intermediate CC (cloud computing) services, 9) use of AI technology, 10) purchase of CC services used over the Internet, 11) e-commerce sales of at least 1% revenue, and 12) use of two or more social media.

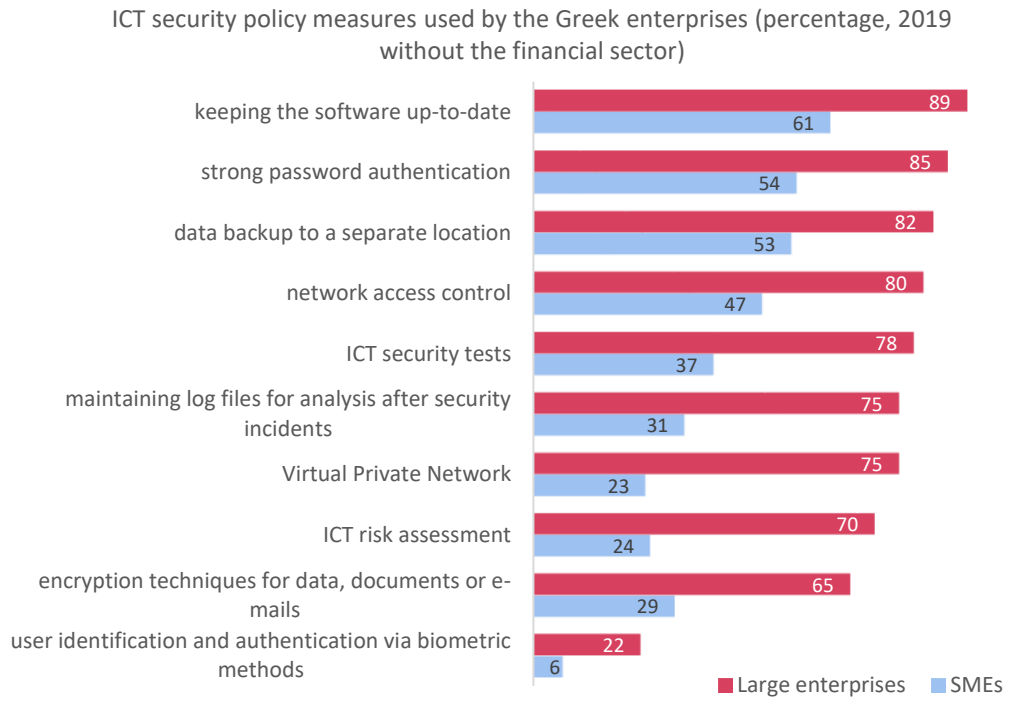
In 2021, 61% of Greek SMEs had very low digital intensity, indicating their limited investment in digital technologies, in contrast to the lower EU average (45%). Among large companies, 26% have a very low intensity (12% the EU average), while 40% have a high or very high digital intensity, in contrast to a higher EU average (60%).

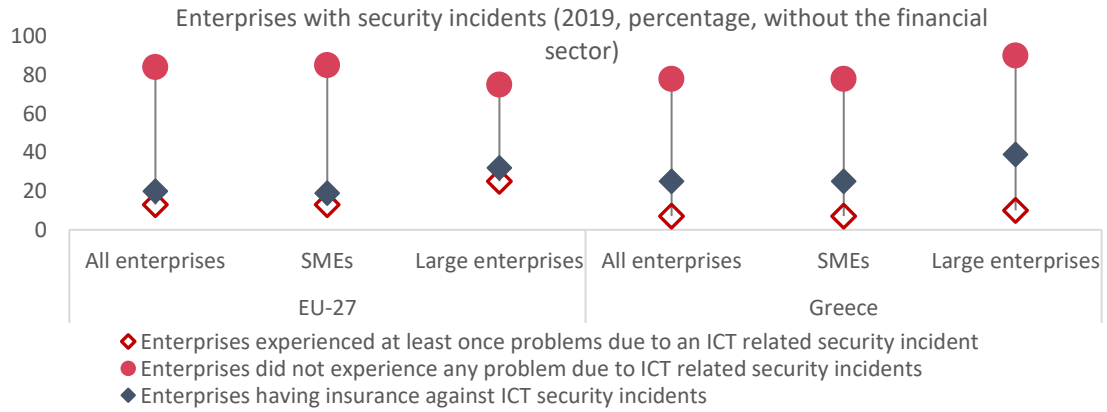
Social media use by enterprises

Regarding the use of social media and Internet advertising, 15% of Greek SMEs and 28% of large companies use the company blog or microblogs (e.g., Twitter, Present.ly, etc.), while 26% and 47%, respectively, use multimedia content sharing websites (e.g., YouTube, Flickr, Picasa, SlideShare, etc.). More than half of SMEs and large enterprises (56% and 67%, respectively) use some type of social media for advertising purposes.

41% of SMEs and 51% of large enterprises use social media to improve the company's image or market products, while 36% and 45% of SMEs and large enterprises, respectively, use social media to obtain or respond to customer opinions and questions reviews. In addition, 37% of large companies resort to social media to recruit employees and 15% to involve customers in the development and innovation of goods and services.

Cybersecurity policies of enterprises





Source: Eurostat, Digital Economy and Society

"ICT security means measures, controls and procedures applied on ICT systems in order to ensure integrity, authenticity, availability and confidentiality of data and systems." (Eurostat)

Most Greek companies use ICT security measures to reduce cyberattacks or other digital risks and raise awareness of their staff: 73% of SMEs (EU-27: 92%) and 96% of large enterprises (EU-27: 99%) use some ICT measure to prevent a security incident. The most commonly used security measure is to keep the software updated (including operating systems). Strong password authentication (e.g., a minimum length of 8 mixed characters, changed regularly) is the second most common security measure, used by 54% of SMEs and 85% of large enterprises, followed by data backup in a separate location (including backup in the cloud) and network access control (managing access of devices and users to the enterprise's network).

Other security policy measures used much more frequently by large companies than by SMEs include the following: ICT security testing (78% of large enterprises), keeping log files for analysis after security incidents (75% of large enterprises), VPN, i.e., a virtual private network that extends a private network over a public network to enable secure data exchange over a public network (75% of large enterprises), ICT risk assessment, i.e., periodical assessment of the probability and consequences of ICT security incidents (70% of large enterprises), encryption techniques for data, documents or e-mails (65% of large enterprises), and user identification and authentication via biometric methods implemented by the enterprise (22% of large enterprises).

Regarding security incidents, 78% of Greek SMEs (85% in the EU) and 9 out of 10 of large enterprises (75% is the EU-27 average) report that they have not experienced any problems due to ICT-related security incidents (2019). On the contrary, 7% of SMEs and 10% of large enterprises experienced problems due to an ICT-related security incident at least once. Of these companies, 4% reported that the incident resulted in the unavailability of ICT services due to external attacks, such as denial- of-service attacks, 5% reported that the incident resulted in the destruction or corruption of data due to infections or malicious software or unauthorized access, hardware or software failures, while only 1% reported that the incident resulted in the disclosure of confidential data due to intrusion, pharming or phishing attacks.

FinTech as a key driver of digitalization

The FinTech Innovation Hub initiative launched by the Bank of Greece has a dual objective: to support the development and diffusion of financial technologies, but also to raise awareness of the potential risks and challenges of FinTech (BoG, FinTech Innovation Hub).

FinTech Segments

- Financing (crowdfunding, credit and factoring)
- Asset management (social trading, robo-advice, personal financial management, investment and banking)
- Payments (alternative payment methods, blockchain and cryptocurrencies, other)
- Other FinTechs (insurance, search engines and comparison sites, technology, IT and infrastructure, other)

Source: Dornfleitner et al. 2017. Definition of FinTech and description of the FinTech industry

Opportunities and risks of FinTech

FinTech is considered a "disruptive" and "revolutionary" process that creates new opportunities and challenges for consumers and the financial market. FinTech operators can benefit from cost advantages in information transmission, economies of scale in big data collection, RegTech (regulation technology) and improved compliance processes, greater capital efficiency, and lower transaction costs (European Economy, 2017, BCBS, 2017). In addition, FinTech enables consumers to enjoy greater financial inclusion, more targeted, tailored, and faster banking services, as well as flexible pricing (Hill 2018, Al Ajlouni et al 2017).

While it can support growth and improve financial development, efficiency, and inclusion of financial services, FinTech could also pose risks to consumers and investors, associated with the financial stability and integrity of new business models, processes, and products (World Bank Fintech). Strategic and operational risks, volatility of bank funding sources, cybersecurity risks, and compliance risks related to meet data privacy and data protection regulation, anti-money laundering, and other obligations, as well as the risk of discontinuity in banking services, are among the key challenges facing the FinTech sector (Al Ajlouni et al 2017, BCBS 2017).

FinTech definition and categories

FinTech is an abbreviation for Financial Technology, a key concept for the digitalization process and structural changes in the financial services industry. FinTech is based on digital infrastructures and applications that enable the creation and establishment of new agreements and procedures in the traditional banking and financial services landscape related to lending, payments, digital money, crowdfunding, exchanges, and investment strategies (Hill 2018).

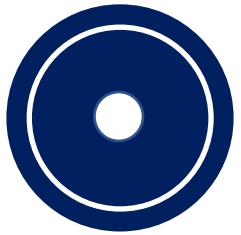
Dorfleitner et al. (2017) define FinTech as "companies or representatives of companies that combine financial services with modern, innovative technologies," while the Bank of Greece describes it as the "technologically enabled financial innovations that could result in new business models, applications, processes, or products with an associated material effect on financial markets and institutions and the provision of financial services." (BoG, FinTech Innovation Hub).

FinTech comes in many types and forms and includes software, mobile applications, and any other technology, such as blockchain and distributed ledger technologies, cloud computing, Big Data, artificial intelligence, and machine learning that automate various aspects of financial transactions for businesses and consumers. These technologies have reshaped the way of transferring, storing and protecting digital money and transactions and as such they have revolutionized financial services, which have entered a new, digitalized era.

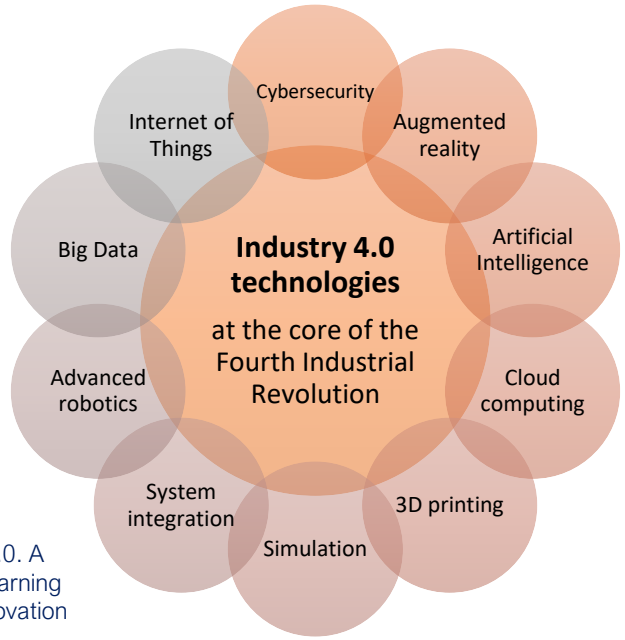
Banks are adopting various fintech features, such as mobile payments and internet banking, as well as loan application and disbursement, to meet customers' needs. Although it has increased over the years, Greece still exhibits a low share of e-banking transactions. In 2021, 42% (37% in 2020 and 9% in 2011) of individuals used the internet for internet banking (EU-27 average: 58%). However, financing of fintech startups has increased sharply. It accounts for more than 55% of the total capital invested in Greek startups in 2021 and is mainly focused on the payments, banking and insurance sectors (Endeavor). In 2022, the total value of transactions in Greek digital payments is projected at €6,931 million (Statista).

ALPHA BANK

Digital technologies as enablers of Industry 4.0



The Fourth Industrial Revolution and the rapid change of technology



Source: EU. 2019. Industry 4.0. A policy brief from the Policy Learning Platform on research and innovation

Technologies that drive Industry 4.0

The three technological pillars on which 4IR is based are a) IoT, i.e., the interaction of objects with each other and with their neighboring smart components, b) Cyber-Physical Systems (CPS), which integrate computation and digital processes with computers and networks that monitor and control physical processes, and c) context-aware smart factories, which are based on the computerization and automation of industrial plants and support the execution of the various tasks of the workforce and machines (EIT Digital 2021, UNIDO 2019).

The key components driving Industry 4.0 form a complex system of advanced digital technologies and include Big Data and analytics, autonomous robots and advanced robotics, simulation, horizontal and vertical system integration, artificial intelligence, 3D printing or additive manufacturing, Internet of Things (IoT), cloud computing, augmented reality, and cybersecurity (EU 2019, in which nanotechnology and synthetic biology are also included).

Industry 4.0 and the Fourth Industrial Revolution reflect the age of digitalization and embody the organizational transformation of the industrial value chain through cyber-physical systems.

What is the Fourth Industrial Revolution or Industry 4.0

The Fourth Industrial Revolution (4IR) is the latest wave of technological breakthroughs based on the digitalization and information sharing of industrial processes and the advancement and generalization of the Internet. The Fourth Industrial Revolution conceptualizes the use and integration of digital technologies across all industrial sectors, as well as the integration and interconnection of production systems and processes based on automation, machine learning, and real-time data (EU 2019, EIT Digital 2021).

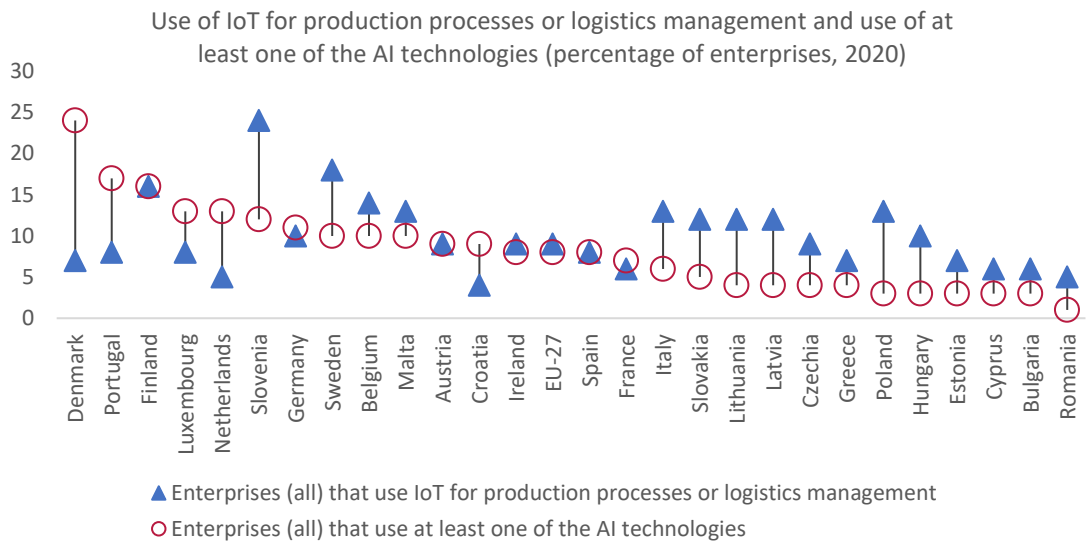
4IR is often used interchangeably with the term Industry 4.0, which was invented in Germany in 2011 (Industrie 4.0) to express the vision of computerizing German manufacturing and increasing its competitiveness (Hermann et al 2015). Some studies distinguish between 4ID and Industry 4.0, the latter being considered a narrower term that mainly stands for smart factories and the application of advanced digital production (ADP) technologies in manufacturing (UNIDO, 2019). Industry 4.0 was later popularized before being adopted globally as a term envisioning the new era of digitalization of all industrial processes.

Advantages and challenges of Industry 4.0

The Fourth Industrial Revolution has several positive impacts on the economy, associated with increased resources and business revenues, product innovation, product customization, time and operational efficiencies, productivity gains, market growth, and increased competitiveness, as well as lower costs and inclusive, sustainable production processes in the longer term (EU 2019 and EIT Digital 2021, UNIDO 2019).

However, large R&D investments associated with high costs are needed to participate in the creation and use of ADP technologies, as their diffusion, adjustment and exploitation is still limited, especially in European SMEs. Industry 4.0 impacts business models and organizational behavior, but also the employment landscape, raising challenges regarding the requirement of new, digital skills, and competencies of the labor force that could often lead to the creation of new jobs, but also to the substitution of human labor and the replacement of low-skilled labor tasks by robotic automation (EU 2019, EIT Digital 2021).

Internet of Things, Artificial Intelligence and System Integration



Source: Eurostat, Digital Economy and Society

Horizontal and vertical System Integration (SI)

Information system integration is the aggregation of different component systems or subsystems that work together as one large system so that they facilitate synergies between technologies for the collection, communication, and use of data (Horizon 2022). SI is divided into two main methods, horizontal SI and vertical SI.

Horizontal system integration involves connected networks that link enterprise and cyber-physical systems through the use of automation in the production process. In horizontal SI, there is constant communication between all systems, processes and connected machines, which enables the creation of smart factories.

Vertical integration SI links all organizational processes, from production to R&D, quality control, IT, sales, marketing, accounting and HR. It includes methods such as matching raw material purchasing with market demand or product customization.

Greece has the 4th lowest share in the use of IoT and the 3rd lowest in the use of at least one AI technology among the EU-27 member states.

Internet of Things (IoT)

The Internet of Things (IoT) is an ecosystem of interconnected computers, mechanical and digital machines, and objects that provide unique, recognizable data that are collected, processed, and transported via smart networks and cloud computing without the need for human intervention (EC 2020, EIB 2021). The IoT is deployed across a wide range of industries and aims to drive more efficient processes, decision-making, and optimization of business value, as well as a better understanding of consumer needs (Stochasis 2022).

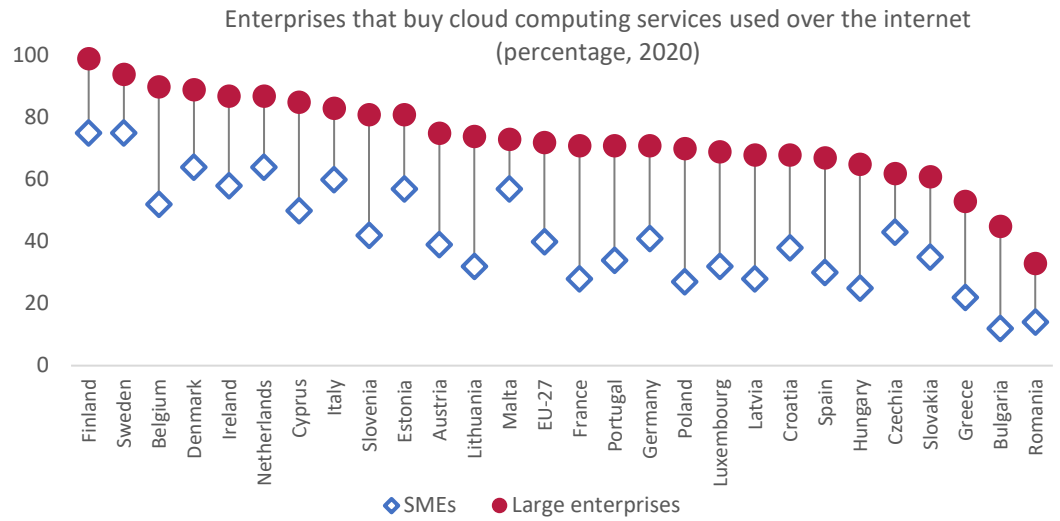
Per industry, IoT is mainly used in manufacturing, construction, infrastructure, and services (EIB 2021). In 2021, Greek companies using IoT for production processes or logistics management accounted for 7% of all companies (SMEs and large enterprises excluding the financial sector), a relatively low share among EU-27 countries (9%). Slovenia had the highest share (24%) and Croatia the lowest (4%). Depending on company size, 15% of Greek large enterprises (EU-27: 25%) and 7% of SMEs (EU-27: 9%) used IoT for production processes or logistics management.

Artificial Intelligence (AI)

Artificial intelligence, or AI, is defined as information technology systems that operate on large data sets and can perform complex functions and tasks that require intelligence and human capabilities, such as asking questions, testing hypotheses, and producing advanced analytics to make automated decisions (Basel Committee on Banking Supervision 2018). Subcategories of AI include robotics, problem-solving machine learning, natural language processing, computer vision, and virtual assistants (EC 2020).

The use of AI technology in Greece is very limited, with only 4% of Greek companies using at least one AI technology in 2021 (EU-27: 8%), while 94% did not use any AI technology (EU-27: 87%). In the EU-27, Denmark had the highest proportion of companies using at least one AI technology (24%), while Romania had the lowest (1%). Depending on size, 10% of Greek large enterprises (EU-27: 28%) and 4% of SMEs (EU-27: 7%) used at least one AI technology. Depending on the sector, the use of AI technologies is highest in ICT (63%) and lowest in waste management (21%) (EC 2022).

Cloud computing, big data and simulation technologies



Source: Eurostat, Digital Economy and Society

Simulation technology

Simulation technology is the process of imitation/reproduction of real-world system operations or processes through the use of a system model called a reality or virtual model. Its use has evolved from a technology used by mathematicians and computer experts to a standard tool for engineers (EC 2020). In industry, simulation technology refers to the modeling and virtualization of product design and production processes.

Simulation technologies can be extended to all phases of a product's life cycle through the use of the "Digital Twin" which is the development and testing of the product in a virtual environment where each phase of the product life cycle uses the information generated and collected in the previous phases.

Simulation has also proven effective for understanding the dynamics of business systems. It enables testing and optimization of products, production processes and planning models that improve decision-making, while helping to reduce costs, shorten product development phases and improve product quality.

Greece has the 3rd lowest share in the EU-27 in the purchase of cloud computing services used over the Internet and is close to the European average in the use of big data analytics.

Cloud computing

Cloud computing is an online network known as the "cloud", used by many hosting processors, enabling "convenient on-demand network access to a shared pool of configurable computing resources, e.g., networks, servers, storage facilities, applications and services that can be rapidly released with minimal management effort or service provider interaction" (Basel Committee on Banking Supervision 2018). Its widespread use following the sharp increase in network density and speed reinforces computing capacity over resources and creates economies of scale (EC 2020).

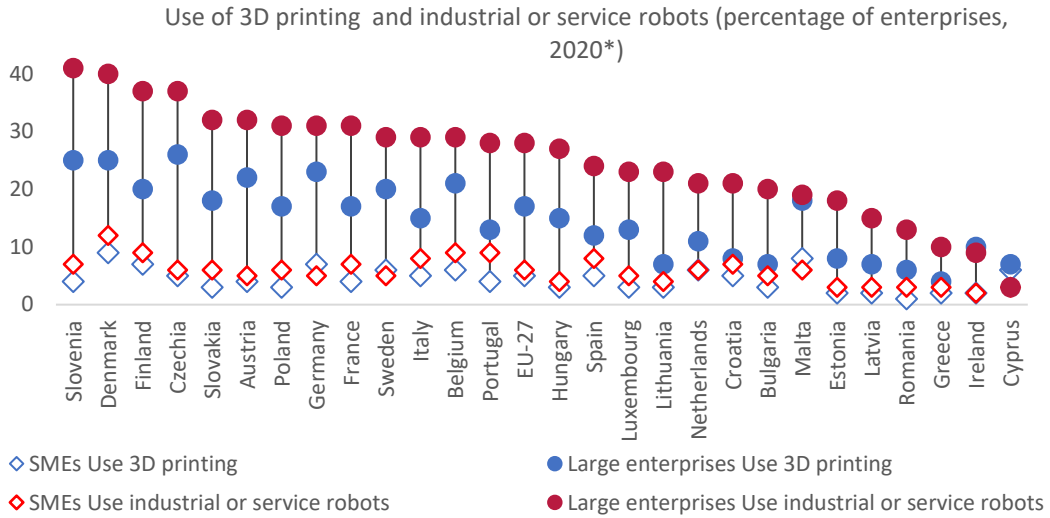
Greek companies that purchased "cloud computing services used over the Internet" accounted for 22% of all companies in 2021 (EU-27: 41%), with the largest share in Sweden and Finland (75%) and the smallest in Bulgaria (13%). In terms of company size, Greek large companies retain a much higher share (53%, EU-27: 72%) compared to SMEs (22%, EU-27: 40%) (2021). Per sector, the highest share of cloud computing services usage (65%) was recorded in computer programming and consultancy (2020).

Big data

Big data is a term that expresses the generation, processing, and high-speed analysis of massive amounts of data by information systems (Basel Committee on Banking Supervision 2018). The combination of big data with advanced analytics techniques (big data analytics) is often used to leverage information from very large and diverse data sets by uncovering correlations, trends, and hidden patterns using fast and cost-effective techniques (EC 2019).

In 2020, big data analytics was performed by 13% of Greek companies, which is close to the EU-27 average (14%). Malta had the highest percentage among the EU-27 countries (33%) and Romania the lowest (5%). In terms of company size, large companies using big data analytics in the EU-27 had a larger share (34%) than SMEs (14%) in 2020. By industry, the largest share was recorded in travel agencies, publishing (28% in 2020), and computer programming (27%) (EC 2020, 2022).

3D printing, advanced robotics and Augmented Reality



Source: Eurostat, Digital Economy and Society
*Greek enterprises: 2018, except for large enterprises in robotics (2020)

Augmented Reality (AR)

AR is defined as the technology that blends the real physical world with digital visual or auditory elements and other sensory stimuli. In this sense, AR is an interactive experience which adds to the real world, displaying images of the real environment "augmented" by computer-generated sounds, text, and effects, through the use of wearable devices such as smart eyewear. AR bears little resemblance to Virtual Reality (VR), as the latter creates a simulated cyber-environment that generally does not include elements of the real world in which the user is immersed.

AR can be used in a variety of fields, including manufacturing, construction, tourism, education and training, healthcare, advertising, e-commerce, cultural heritage, and entertainment. In manufacturing, AR can improve decision-making and workflow by providing real-time information and supporting the training of workers to use large machines and specialized devices through holographic imagery. In construction, AR can optimize space views and provide designers and engineers with greater precision (EC 2020).

Greece brings up the rear in the use of 3D printing and ranks second lowest among the EU-27 countries in the use of industrial or service robots.

3D printing

3D printing or additive manufacturing (AM) is characterized as "the revolution of turning data into things" and refers to the computer-controlled process of creating three-dimensional solid objects through the use of a digital file and the layer-upon-layer precise addition of various materials such as plastics, powders, resins, metal, carbon fiber, paper and others (EC 2017, 2020).

Only 2% of Greek companies use 3D printing (2018 the latest available data, EU-27: 5% for 2020), a share that is among the lowest in the EU-27, along with those of Estonia, Latvia, Romania and Ireland. Denmark has the highest share of AM use (9%). In terms of company size, only 4% of Greek large companies use 3D printing (EU-27: 17% in 2020). Manufacturing, and in particular aerospace, automotive and medical manufacturing, are the sectors where 3D printing is most widely used in the EU, followed by construction and infrastructure (EIB 2021 and EC 2017).

Advanced robotics

Robots are used to perform repetitive and simple human tasks. However, in the last decade, robotics technology has advanced significantly, from the development of autonomous robots that can perform more complex tasks to collaborative robots (cobots) that work alongside humans to perform repetitive tasks. Robotics has also recently introduced robo-advisors, which are applications that use machine learning and digital interfaces to provide various financial services (e.g., automated financial recommendations, contract brokering, portfolio management) (Basel Committee on Banking Supervision 2018).

Robots can be used in various sectors of the economy, such as manufacturing, agriculture, energy, transport, logistics, and healthcare (EIB, 2021). In Greece, the use of industrial or service robots is limited, with only 3% of companies (2018, the latest available data) using robotics (EU-27: 7% for 2020). The highest share among EU-27 companies was in Denmark (13%), and the lowest in Ireland (2%). Among large Greek companies, 10% used industrial or service robots in 2020 (EU-27: 28%), compared with 40% in Slovenia and Denmark.

Distinguishing between enabling and applied digital technologies

High-impact digital technologies are expected to cumulatively contribute by €2.2 trillion to the European GDP by 2030, equal to an increase of 14.1% compared to 2017.

The European Commission distinguishes between advanced, high-impact digital technologies and categorizes them into two broad groups: a) enabling technologies and infrastructure and b) applied digital technologies, each of which plays a different role in the development of the digitalization process (EC 2020).

Enabling digital infrastructure technologies

Digital infrastructure refers to the foundation for digital economic activities and technological applications. Enabling technologies and digital infrastructures support many other applications and are the "underlying technology groups and structures of models that enable transformative digital applications" (EC 2020).

Enabling technologies and infrastructures include general-purpose technologies such as AI, big data analytics, and high-performance computers by providing the infrastructures, such as platforms and cloud computing, upon which the development of various other digital applications is built.

For example, broadband connectivity, i.e., the high-speed and high-bandwidth communication and transmission infrastructure for data, voice, and video, connected to gigabit networks and 5G coverage, is numbered among the key digital infrastructure technologies by the EC. It is considered a key technology for the digital transition that enables improved mobile broadband and extensive machine-type communications (Bieser et al 2020). Quantum and high-performance computing of vast and composite analytical tasks at very high speeds, is also listed among key digital infrastructures.

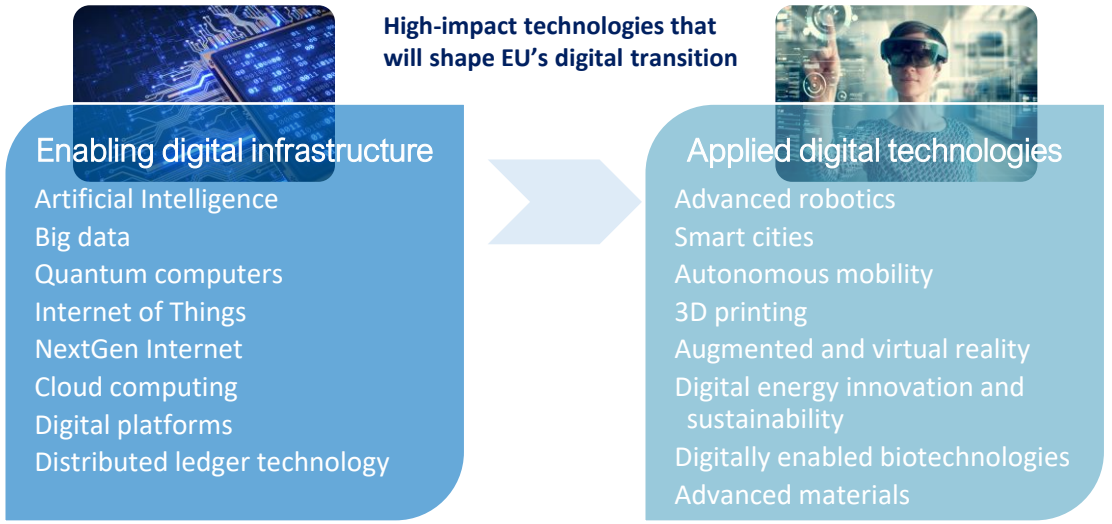
High-impact applied digital technologies

High-impact applied technologies are "applications of technologies that could have a transformative impact on a specific sector, area or function" (EC 2020). These digitalized applications take on characteristics that can have a considerable impact on the economy, society, business models, and value chains, and unleash significant sustainable growth potential. Examples include autonomous robotics, 3D printing, VR and AR, smart cities, digital energy innovation and sustainability, digitally enabled biotechnologies, advanced materials, and autonomous mobility.

Estimation of the economic and social disruptions of digital technologies

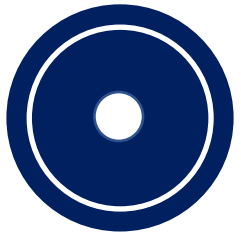
According to a study of macroeconomic simulations performed by McKinsey, high-impact digital technologies, both enabling and applied, can contribute an average of 1.1% of additional growth in the EU annually over the next decade, or a cumulative €2.2 trillion (EC 2020), due to their positive impact on productivity and economic activity and their spillover effects. The "digital frontrunners," i.e., the more digitally advanced EU member states, will benefit the most from digitalization (through an annual growth contribution of 1.4%), while the "catching-up countries," i.e., the less digitally advanced countries, will also have a positive, albeit smaller, growth effect (0.4% annually) (EC 2020).

On the other hand, disruptive digital technologies are expected to have some adverse displacement effects on the European labor market, especially in the early stages of their implementation, as according to the same study almost ¼ of the European jobs will face the risk of becoming automated.



Source: European Commission. 2020. Shaping the digital transformation in Europe.

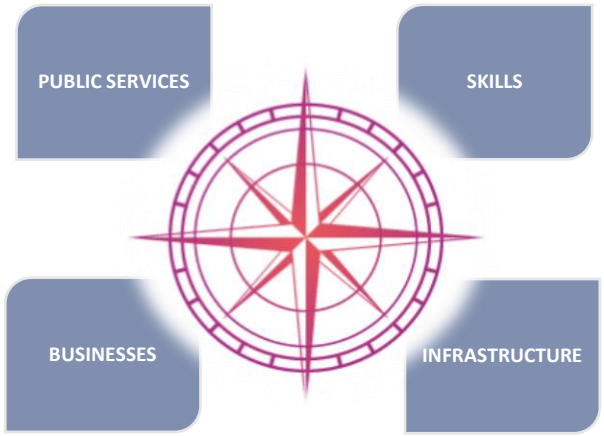
Policies and strategies towards the digital decade



The path to EU's Digital Decade and the 2030 Digital Compass

The digital transformation of European countries is about pursuing digital policies that enable citizens and businesses to enter the ecosystem of the digital decade in a sustainable and human-centered manner.

2030 Digital Compass of the European Commission



Source: EC, 2030 Digital Compass

The EU is entering the digital decade with specific objectives, targets and roadmaps to support its digital transformation. The Path to the Digital Decade is the program that sets these goals and ensures that the EU achieves them by 2030. Monitoring progress on these targets is based on the evaluation of DESI indicators per country.

To accomplish the targets, the EC has proposed the 2030 Digital Compass, a roadmap to prepare the EU member states for the digital decade so as to elaborate on their digital targets. The roadmap evolves around four cardinal points: digital skills, digital transformation of businesses, secure and sustainable digital infrastructure, and the digitalization of public services.

In this context, the EC intends to launch multi-country, large-scale projects to facilitate investments combining RRF and national and private sector funding in areas such as data infrastructure, 5G communication, blockchain and others.

Digital skills

To foster the development of digital skills and increase the number of digital experts and professionals, the Compass has two main targets. The first is for 80% of adults to have "at least basic digital skills" by 2030. Proper education and digital training will also help achieve the second target, which is 20 million employed ICT specialists in the EU, such as ICT service managers, professionals, technicians, installers and servicers. The goal is also to achieve greater convergence rates between male and female ICT specialists.

Secure and sustainable digital infrastructure

The second point of the Digital Compass revolves around sustainable digital infrastructures in the areas of connectivity, microelectronics and big data processing. In terms of connectivity, the EC aims at a Gigabit network coverage for all EU households and 5G coverage for all populated areas. Other targets include significantly increasing the production of microprocessors and cutting-edge sustainable semiconductors in the EU, establishing 10,000 climate neutral edge nodes, i.e., cluster computing with end-user portals, and creating the first European quantum computer by 2025.

Digital transformation of businesses

The target of more digitalized European businesses by 2030 pertains to strengthening the ability of businesses to rapidly adopt advanced digital technologies. McKinsey, in a study for the EC (2020), identified five key ecosystems, namely manufacturing, healthcare, construction, agriculture and mobility, where there is great potential for the adoption of digital technologies and products. To this end, the Compass sets targets such as 75% of EU companies using cloud computing, artificial intelligence and big data, and 9 out of 10 SMEs to reach at least the basic level of digital intensity.

Digitalization of the public services

Public services and "Government as a Platform," which improves transactions between European citizens and businesses with the State, are also at the heart of digital transformation. The online provision of a digital ID, key public services for citizens and businesses, and access to digital health records for all are the main targets of this area.

The 2020-2025 Digital Transformation Strategy of Greece

The Greek Bible of Digital Transformation contains the country's national digital transformation strategy and builds on seven goals that are closely aligned with the main objectives of Europe's digital future, but also tailored to Greece's specific digital needs.

Targets of the Digital Transformation Strategy

An important dimension of the new digital strategy is the transformation of the state apparatus to strengthen the supply of user-friendly digital services oriented to the needs of citizens and businesses. The citizen-user is at the core of the redesign and implementation of new digital services. The targets included in the Greek Digital Transformation Bible are the following:

1. *Safe, fast and reliable internet access for all:* Indicatively, this target includes interventions such as the upgrade of network infrastructures for 5G connectivity, the management and security of information systems improvement, and the redesign of digital services and websites.
2. *A digital State that better serves people's needs:* Centralized digital solutions, new digital services for citizens, the single National Portal of Digital public services, and the Authentication Centre with a single sign-on point to all digital services, are all included in the actions directed to this target.
3. *Developing digital skills of all:* this objective aims at integrating innovative technologies and providing digital skills courses at all levels of education, developing the Digital Academy for Citizens, training programs for all and a single digital skills certification system.
4. *Facilitating the digital transformation of the Greek businesses and SMEs:* Interventions under this objective include training the workforce to improve digital skills, creating a centralized system for digital invoices, and supporting e-commerce solutions.
5. *Supporting and strengthening digital innovation:* A suitable environment for the development and efficient operation of ICT startups and the development and synchronization of digital innovation hubs for innovation ecosystems are among the actions related to digital innovation.
6. *Exploiting the data value of the public sector:* The target is to create a unified model for data governance, standards and procedures for the open data of public institutions, and to implement technologies to limit tax evasion and monitor public procurement, income collection, etc.
7. *Integration of digital technologies in all economic sectors:* The aim is to support the transition of existing systems to new infrastructures (telemedicine, distance learning, teleconferencing, sensors network for environmental data collection).

Digital transformation projects in the public sector

The Digital Transformation Bible identifies a multitude of targeted projects, classified into short and medium-term, affecting all policy sectors, thereby contributing to cost savings and the modernization of public sector operations. Of the 455 projects in the strategy, 145 have already started being implemented and are in progress. The projects provide easy access to all intervention measures based on the needs of each sector and are divided into three main categories:

I. *Horizontal interventions*, which include "accelerators", such as open data, open science, privacy and data protection, interoperability, enhancing accessibility, and other horizontal projects.

II. *Strategic Axes of Intervention*, which are divided into digital infrastructure (connectivity, cybersecurity, public infrastructure), skills, businesses, digital State, and digital innovation (e.g., AI, High-Performance Computing Systems).

III. *Public policy sectors*, e.g., Environment & Energy, Transport & Infrastructure, Education, Health, Culture, Justice, Agriculture & Food, Public Administration.

Among others, progress is more evident in actions such as Gov.gr, the national portal for digital services, operational since March 2020, which has so far digitalized 1,406 public services, or the Digital Academy for Citizens, which offers 315 courses on 34 different topics related to digitalization. During COVID -19, several other measures such as prescriptions by SMS or email, the National Patient Registry for COVID-19 patients, telemedicine, and EODY mobile medical units contributed to the containment of the pandemic by accelerating the digitalization of public services (Deloitte-SEV 2020).

The twin transition of digital and climate actions

Digital technologies can have a critical role in achieving climate neutrality, enabling other industries to save up on global CO_2 emissions, placing the ICT sector at the heart of the European policies that can support the combat against climate change.

European policies and initiatives for digitalization and environmental sustainability

Advanced digital technologies can have a significant contribution to the greening of businesses, the tackling of energy efficiency problems, the reduction of the overall anthropogenic impact on the environment, and the achievement of the European Green Deal climate neutrality target by 2050.

However, it was not until recently that the EC adopted measures to incorporate environmentally targeted actions into its digitalization strategies, recognizing that green and digital transition are twin challenges and are equally important to the success of related policies. For this reason, the Strategy for Shaping Europe's Digital Future (2020) focuses on making digital transformation work for people and businesses, but also on putting technology at the service of environmental sustainability and action against climate change. In this context, Europe's digital transformation is seen as an important tool for the "successful transition to a climate-neutral, circular and resilient economy" (EC 2021).

Still, in the EU's 2030 Digital Decade targets for 2030, although it is stated that "digital devices should support sustainability and the green transition, and people need to know about the environmental impact and energy consumption of their devices", there are no measurable targets which focus on the role of digital transition in the green transition (DIGITALEUROPE 2022). However, various initiatives that have been pursued, indicate the urgency to provide solutions that will combine the two actions of digitalization and environmental sustainability.

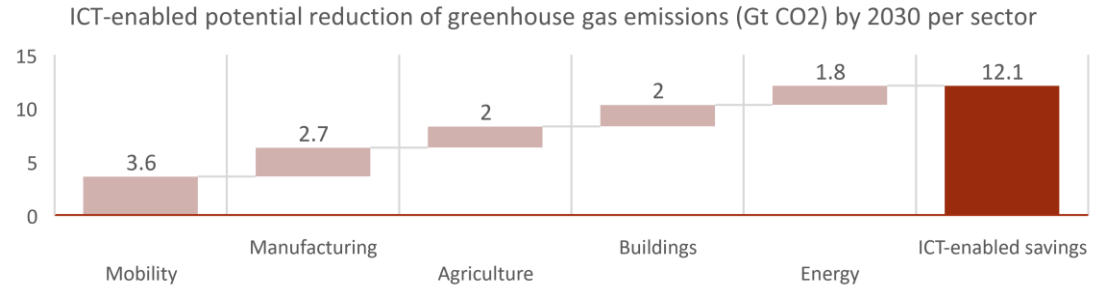
The European Green Digital Coalition (EGDC), launched in 2021 as a cluster of European ICT companies to support the Green and Digital Transformation of the EU, is an initiative to provide green digital solutions to "maximize the sustainability benefits of digitalization". The participating companies are committed to take action, such as investing in solutions with sizeable energy and material efficiency that will have a net positive impact in various sectors or developing tools to measure the net impact of green digital technologies on the environment.

ICT-enabled solutions for reducing emissions footprint

The use of digital technologies can maximize the impact of climate change and renewable energy transition policies and contribute to environmental protection and resource efficiency. Smart sensors and satellites can monitor various activities and strengthen climate awareness. Machine learning, AI, and drones can be used as early warning systems and support smart climate adaptation measures and crisis management (EC 2021, DIGITALEUROPE 2022).

Studies have shown that ICT-enabled solutions across the economy can help reduce global GHG emissions by 12 Gt CO_2 by 2030, with the greatest impact coming from smart manufacturing, agriculture, buildings, energy technology, and mobility (Accenture 2015). 5G is expected to contain CO_2 emissions by 85% compared to 2G-4G networks (Bieser et al 2020). Advanced technologies can also have a positive impact on reducing the consumption of scarce resources, for example in agriculture or water use, where crop yields can be increased by 900 kg per hectare and over 300 trillion liters of water can be saved (Accenture 2015).

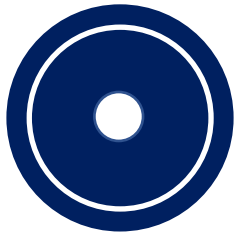
Nearly ½ of the ICT sector emissions are related to end-use devices. Reducing its own emissions is equally important for the ICT sector, as rapid growth, particularly in the production of digital devices, can increase CO_2 emissions (Accenture 2015). Electronic waste generated as a byproduct of digital technologies also needs to be contained through circular processes such as reuse and recycling.



Source: Accenture. 2015. ICT Solutions for 21st Century Challenges.

ALPHA BANK

Financial support of the digital transition



EU funding programs for a digital Europe

The acceleration of digitalization in Europe is supported and driven by EU funding programs that focus on economic recovery, infrastructure, and R&D.

Recovery and Resilience Facility (RRF)

The digital transition is a key pillar of the EU's Recovery and Resilience Facility (RRF), which aims to make a major contribution to the targets of the Digital Decade. The Plan calls for at least 20% of the funds to be allocated to measures that contribute to the digital transition of the EU-27 member states.

To date, the amount of RRF to support digitalization is €127 billion, or 26% of the total allocation of the 25 national RRPs approved by the European Council. Most of the funding (37%) is allocated to the digitalization of public services and government processes. The contribution of EU member states to the digital objectives of their RRPs varies from 20% in countries such as Romania and Sweden to 53% in Austria and Germany (DESI Report 2022).

Connecting Europe Facility Digital (CEF Digital)

CEF Digital is an infrastructure investment program with an estimated budget of €2.1 billion for 2021-2027, representing 6% of the total CEF funds. It is designed to support investments in digital connectivity infrastructures and transport, as well as in the digitalization of energy networks, with actions such as the deployment of very high capacity networks (VHCN) and backbone networks, including submarine cables and cross-border projects in transport and energy (EP 2022, EC 2021).

Horizon Research and Innovation Program

Horizon Europe is an R&I framework program that aims to the “creation and better diffusion of excellent knowledge and technologies”. In Horizon 2014-2020, €15.2 billion was allocated to 4,221 projects in ICT-related areas. In the new 2021-2027 program, more than 16% of its €95.5 billion budget is dedicated to the digital and industrial technologies cluster of Pillar II, for "climate-neutral, circular, digitized, resource-efficient and resilient industrial production" (Horizon 2021-2027).

At the heart of the program lie the twin green and digital transitions and the development of key enabling technologies, with funded actions for clean and climate-neutral digital systems, infrastructure development (networks, data centers), sustainable-by-design advanced materials, and breakthrough technologies.

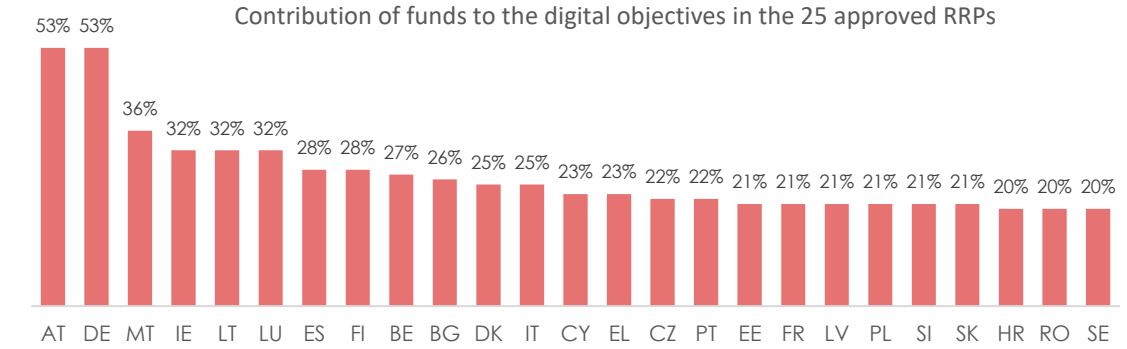
Digital Europe Programme (DIGITAL)

DIGITAL is a new EU funding program aimed at supporting the green and digital transition in Europe. The program's budget is €7.6 billion and is intended to complement funding from other programs such as Horizon Europe, CEF Digital and the RRF (EC 2021).

DIGITAL funds will be allocated to five strategic areas, including supercomputing (29% of funds), AI (28%), cybersecurity (21%), broad use of digital technologies in business and society in key capacity areas (15%), and advanced digital skills (8%). The program aims, among other things, to increase the use of high-performance computing in areas such as health, environment, and security and of AI in business and public administration, as well as to develop and implement advanced digital skills programs and internships (EC 2021).

Technical Support Instrument (TSI) 2021-2027

TSI 2021-2027 is part of the 2021-2027 Multiannual Financial Framework (i.e., the current long-term EU budget) and the RRF, which is EC 's instrument for providing technical assistance and expertise for reforms. The €864 million budget will provide technical support for the design and implementation of reforms that facilitate digital transformation in areas such as green and digital policy, e-government, digital economy, infrastructure, skills, and e-health (EC 2021, 2022).



Source: European Commission, DESI 2022 Report

Digital transformation in the Greek NRRP

Greece 2.0, the Greek Recovery and Resilience Facility, reflects the goals and action plan of the "Digital Bible," but also focuses on and facilitates digital transformation, productivity, and innovation-driven economic growth.

Greece 2.0, the Greek National Recovery and Resilience Plan (NRRP) of €31.1 billion budget in grants (€18.4 billion) and loans (€12.7 billion), has allocated 23.3% for the country's digital transition. It also reflects the targets of the Greek Digital Transformation Bible 2020-2025 and encompasses reforms and investments that aim to improve the country's DESI scores.

The digital pillar's funding is closely related to the components of connectivity and digitalization of public administration and businesses. In addition, the pillar of employment, skills, and social inclusion of the Greek NRRP is also indirectly connected to digital transformation since it includes components that aim to foster the workforce's digital skills. Greece also participates in various digital multi-country projects in the adopted RRPs, such as those for 5G corridors, Euro quantum communication infrastructures, Euro high-performance computing, connected public administration, submarine cables, and security operation centers (DESI 2022).

Connectivity in the digital transformation pillar

Connectivity pertains to investments and reforms that correspond to €522 million in grants, which constitute 24% of the digital transformation pillar grants. The key objectives of connectivity are to facilitate the installation of fiber optic infrastructures, to develop 5G networks that cover major Greek highways, to apply fast broadband connections and 5G technologies for the development of innovative remote services, and to utilize space technologies and applications (Greece 2.0, 2021).

In particular, small satellite development accounts for 36% of connectivity funding, 5G corridors for highways 29%, submarine fiber cables 20%, and fiber optic infrastructure in buildings 16%. Putting forward these investments and reforms, the country also aspires to be aligned with the target of the twin transition by enabling decarbonization and environmental footprint reduction via digital solutions.

Modernization of the public sector in the digital transformation pillar

The modernization of the public sector is associated with investments and reforms corresponding to €1,281 million in grants. These actions represent 59% of the Digital Transformation grants and are aimed at introducing new technologies to improve the efficiency and effectiveness of public services. Investments to digitalize public sector archives account for 43% of these funds.

Investments include interoperability and web services development, the Next Generation interoperability center, eRegistries, the e-MHTE tourism registry, the improvement of public sector business continuity, a new public procurement system, upgrade of cloud computing infrastructure and services of the National Infrastructures for Research and Technology, the creation of customer relationship management (CRM) for the general government, the further modernization of the one-stop shops of the public administration, the digital transformation of the Greek National Tourism Organization, and the development of smart cities.

Digitalization of businesses in the digital transformation pillar

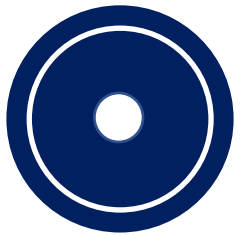
Actions under this component aim to improve the performance of businesses in integrating digital technologies, expand the adoption of digital technologies, and ensure greater transparency in interactions between businesses and government agencies (Greece 2.0 2021). €375 mn in grants or 17% of the total grants under the digital pillar, have been earmarked for the digitalization of businesses.

The digitalization of enterprises also includes investments and reforms related to SMEs. In particular, investments for the digital transformation of SMEs account for 79% of the funds of this component. Other actions include reforms to create a digital business ecosystem and the introduction of tax incentives to facilitate the digital transformation of SMEs.

Education, training, and skills in the pillar of employment, skills and social inclusion

The need to invest in training programs to develop digital skills and improve the country's workforce is also addressed in Greece 2.0, as nearly half of the associated pillar's grants are directed toward improving the human capital criteria of the DESI index. Investments in digital education and skills account for 45% and 16%, respectively, of the €2,311 million in grants under this component.

Policy recommendations and SWOT analysis



Policy recommendations for the future of digital transformation

Although certain steps have been taken by Greece to reap the full benefits of digitalization, progress is still needed in several areas.

Support the twin challenges of green and digital transition

Digital transformation and green transition are the twin objectives of the coming decade for all European countries. Greece recognizes the importance for a sustainable growth path and has set ambitious targets, prioritizing the inclusion of policies that endorse the development of both green and digital transition.

Although the current state of play of the geopolitical developments affects the energy and decarbonization objectives and can potentially risk the deployment of the green transition, the enabling role of digitalization in this effort should not be side-lined, but instead reinforced. New technologies can help cut down polluting emissions and support greening efforts across different economic sectors. The limited use of IoT by Greek businesses and especially SMEs should be amplified, so as to reap the benefits of devices' synchronization in optimizing energy flows, especially in energy-intensive sectors, contributing to the containment of harmful emissions.

Broadband deployment and investments must be continued and accelerated. Greece, although a laggard in terms of connectivity, improved its score in the 2022 DESI index. Accelerating the use of fast broadband connections, 5G, and fiber network technologies is critical for the twin transition (DIGITALEUROPE 2022).

Empower digital skills and human capital

A larger portion of the Greek population needs to acquire basic digital skills. Developing advanced digital skills should also be a priority in the context of the EU Digital Decade. The focus should be on cultivating digital skills in primary and secondary education, promoting collaborations between universities and companies, and increasing the number of ICT specialists, especially women.

In addition, companies should be motivated to implement lifelong learning, retraining and upskilling programs, as improving digital skills is a prerequisite for adapting digital solutions in business and industry. A focus on green digital skills is also needed, as green and sustainable digital solutions can only be applied by well-trained workers who have the knowledge to develop them (DESI Greece 2021, DIGITALEUROPE 2022, Albani, M. et al 2019).

Strengthen research and innovation

Although R&I in digital technologies is supported by programs such as Horizon Europe, it can also be strengthened through the provision of ICT advisory services and, as in the case of Ireland, through the development of government-funded R&I centers that increase collaboration between academia and industry and seek to commercialize research (Deloitte-SEV 2020). Even though 20-25% of patents on EU ICT are already related to green technologies, climate-driven ICT and digital innovations need to be intensified to achieve the goal of climate neutrality in 2050 (DIGITALEUROPE 2019, 2022).

Facilitate the digitalization of SMEs

Digitalization of SMEs usually involves high implementation costs. Facilitating their access to appropriate external financing instruments can reduce these costs. In addition, the use of tools developed by chambers of commerce or associations that assess SMEs' digital maturity can demonstrate the benefits of digitalization and accelerate their digitalization. Support for SMEs' digital transformation can also be provided by ICT companies and innovation hubs that offer digital products, services and solutions. Regional authorities can support SMEs' digital transformation by creating collaborative integrated innovation ecosystems with providers, users and technological research centers (EC 2019).

Continue to foster public sector digitalization

During the height of the pandemic crisis and lockdowns, the Greek authorities adopted various digital measures that served as the first digital transformation initiatives of the public sector to efficiently address the crisis.

Although the Digital Transformation Bible is a promising tool in the hands of the Greek State to further advance the digitalization of public services, the effective and timely implementation of the digital objectives along with other initiatives must also be pursued. These supplementary actions include among others the establishment of a national open data strategy and the prioritization of key public ICT projects in analytics, blockchain, and cybersecurity (Deloitte-SEV 2020).

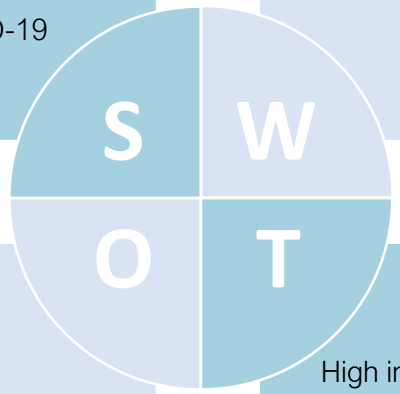
SWOT analysis

STRENGTHS

Rising number of ICT companies and employees
The production value of the ICT sector has recovered significantly
There is a stable and growing digital market
Well-developed infrastructure for 5G readiness
Expansion of e-commerce
Increasing online purchases
Widespread use of ICT security measures
Strong initiatives to digitize the public sector during the crisis COVID-19
Well-established national strategy for digital transformation
High percentage of ICT specialists with tertiary education

WEAKNESSES

Limited adoption of advanced digital technologies by enterprises
Low fixed broadband take-up and VHCN coverage
Lack of advanced digital skills
Low proportion of ICT specialists in the labor force
Poor performance in integrating digital technologies
Limited use of digital technologies in SMEs
Laggards in e-government despite improvements in recent years
Low use of online transactions within the public sector
Limited e-banking transactions, despite the increase
Greece is a moderate digital innovator



OPPORTUNITIES

Extensive use of digital technologies after the COVID-19 crisis
E-governance to enable transactions between the public and the State
Use of digital technologies for green transformation
Digitalization as a driver of efficiency, productivity, revenue and innovation
Collaboration of the ICT industry with academia
Funding digital transformation through various EU programs, especially the RRF
Targeted funding for SME digitization in the Greek NRRP
Greece will be among the few countries with investments in cloud service infrastructure from the largest cloud service companies

THREATS

High inflation rates that could affect the prices of ICT services and products
Economic uncertainties due to ongoing geopolitical tensions
Adverse impact of new technologies on low-skilled workforce and employment
Still high Greek unemployment rate of persons with ICT education
Organizational and technical complexity of the digitization process
High cost of investment in digital infrastructure technologies
Digital divide in the population
Low cybersecurity readiness

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