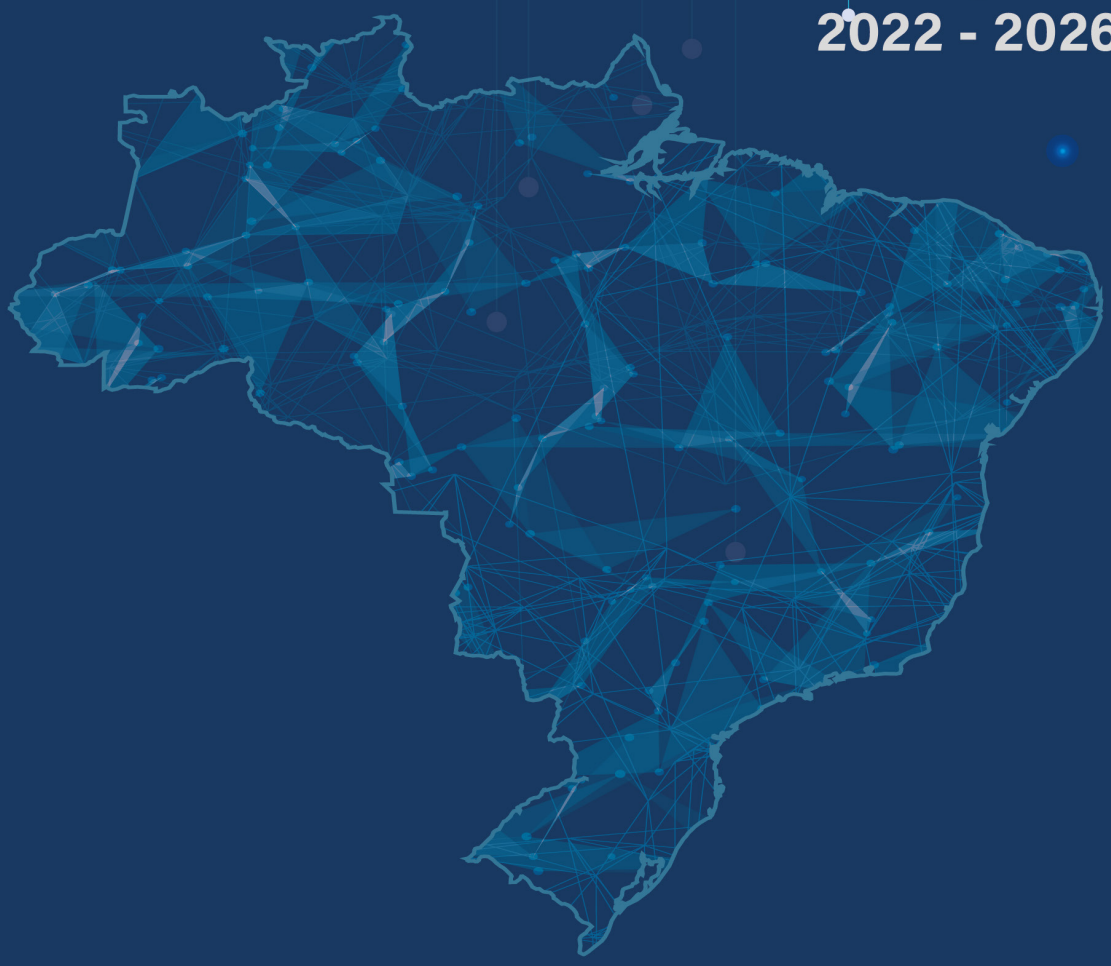
Brazilian Digital Transformation Strategy (E-digital)

2022 - 2026 Cycle



Brazilian Digital Transformation Strategy (E-Digital)

2022-2026 Cycle

Brasília – DF

2022

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Brazilian Digital Transformation Strategy (E-Digital)

2022-2026 Cycle

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2022-2026 Cycle

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Presentation

This document is a revision of the Brazilian Digital Transformation Strategy (E-Digital) for the period 2022-2026. The update, which takes place in four-year cycles, is provided for in Article 3 of Decree No. 9.319/2018 (BRASIL, 2018a), which establishes the National System for Digital Transformation (SinDigital), composed of E-Digital, its thematic axes, and its governance structure.

The review is critical as the world continues and will continue to be transformed by the Internet and related digital technologies such as the Internet of Things, Artificial Intelligence, Big Data analytics, cloud computing, mobile systems, social media and collaboration network, cyber-physical systems, deep learning, information security, cyber-security, high-performance computing, quantum computing, and most recently, the metaverse.

Data, information, and knowledge relate in an increasingly imperceptible way to daily activities, by means of handheld devices that are progressively more and more stably and quickly connected. This relationship provides for the creation of new forms of interaction between the physical and the virtual; the reorganization of life in the city and in the countryside; more efficient access to public and private services; and the emergence of new possibilities for remote or hybrid work.

In parallel to this scenario, the Covid-19 pandemic and geopolitical conflicts expose more clearly the enormous challenges that the country needs to face in order to move forward, such as: unequal access to the benefits of the digital economy; instabilities in the trade flows of essential digital products and inputs; and growing threats to privacy and cybersecurity.

In this context, E-Digital 2022-2026 presents a renewed diagnosis on the challenges to be faced for the digital transformation of the country. In addition, it brings new actions to be implemented in the next four years, with the objective of harmonizing the initiatives of the Federal Executive Branch related to the digital environment and to take advantage of the potential of digital technologies to promote sustainable and inclusive economic and social development, with innovation, increased competitiveness, productivity, and employment and income levels.

This revision of the strategy reinforces actions for digital inclusion, the deployment of digital infrastructures, professional training, information security, cyber security, and technological development.

E-Digital continues to be a collaborative, multi-institutional and multi-sectoral effort, aimed at Brazil's full insertion in the new world that is emerging. The biggest challenge now is to speed up digital transformation, without leaving anyone behind.

Introduction

Brazil has achieved advances on many fronts of digital transformation in recent years, such as the update of the Information and Communication Technology Law, or ICT Law; the launch of the Brazilian Artificial Intelligence Strategy; the implementation of the National Data Protection Authority; the launch of the Brazilian instant payment (Pix); the completion of the 5G auction notice; and the unification of government services on the gov.br platform.

Many of these outcomes, while originating from and dependent on specific institutional contexts, were driven by the legitimacy created by E-Digital. In fact, the logic of the E-Digital organization, standardized by Decree 9.319/2018 (BRASIL, 2018a), has contributed to give light to these and countless other initiatives that are essential for the digital transformation of the country.

It must be noted, however, that several challenges presented by E-Digital 2018-2022 still require more effective action by the Brazilian state. At the same time, the Covid-19 pandemic that broke out in the second half of the cycle accelerated changes in the digital sector, making the strategy update even more pressing.

This document, therefore, brings an update of the challenges and opportunities for digital transformation in Brazil, guided by the same axes and specific objectives of the strategy built in 2018, as stablished by the aforementioned decree.

Thus, E-Digital continues to be based on two major thematic axes: Enabling Axes and Digital Transformation Axes.

The Enabling Axes are understood as those that will form the foundations for the digital transformation to happen. They are:

A. ICT infrastructure and access;
B. Research, Development and Innovation;
C. Trust in the digital environment;
D. Education and professional training; and
E. International dimension.

For more information on the progress of the E-Digital 2018-2022 actions, access the page www.gov.br/mcti/pt-br/acompanhe- o-mcti/transformacaodigital/estrategia- digital-repositorio. (BRASIL, 2022e)

Each of the Enabling Axes has a general objective and specific objectives defined by the decree, as shown in Table 1:

Tabela 1 – General objective and specific objectives of the **Enabling Axes** of E-Digital

Enabling Axess	General objective (Decree No. 9.319/2018 and its amendments)	Specific objectives (Decree No. 9.319/2018 and its amendments) (BRAZIL, 2018a)
A. Infrastructure and access to Information and Communication Technologies	Expand the population's access to the Internet and digital technologies, with quality of service and cost-effectiveness.	• Bring high-capacity data transport networks to all Brazilian municipalities;
		• Expand the mobile and fixed broadband access networks, in urban and rural areas;
		• Disseminate digital inclusion initiatives
B. Research, Development and Innovation;	Stimulate the development of new technologies, with the expansion and seek solutions to challenges national.	• Integrate the enabling instruments for the promotion of RD&I, as well as the research infrastructures aimed at to the development of digital technologies
		• Improve the legal frameworks of Science, Technology and scientific and technological production, Innovation (ST&I);
		• Use public purchasing power to encourage the development of innovative solutions based on digital technologies.
C. Trust in the digital environment	Ensure that the digital environment is secure, reliable, and favorable to services and consumption, with respect for citizens' rights.	• Improve mechanisms to protect rights in the digital environment, including aspects related to privacy and personal data protection, and recognize the specificities of this environment;
		• Strengthen the country's cybersecurity, with the establishment of cooperation mechanisms among governmental entities, federal entities and the private sector, aiming at the adoption of best practices, incident response coordination and critical infrastructure protection; and
		• Strengthen international cooperation instruments between authorities and companies in different countries to ensure law enforcement in the digital environment.
D. Education and professional training	To train society for the digital world, with new knowledge and advanced technologies, and prepare it for the work of the future.	• Connect public, urban and rural schools, with broadband access, and provide equipment for access to digital technologies;
		• Incorporate digital technologies into school practices, with development of computational thinking among students' skills;
		• Reinforce the math, science, technology and engineering disciplines and the technical training tracks for acting in sectors of the digital economy, with a focus on entrepreneurship; and
		• Promote the improvement of teachers' initial and continuing education, regarding the use of technology in the classroom.
E. . International dimension	Strengthen Brazil's leadership in global forums on digital issues, stimulate the competitiveness and presence of Brazilian companies abroad, and promote regional integration in the digital economy.	• Promote the active participation of the country in coordination initiatives and regional integration in the digital economy, as well as in international instances that treat the subject as a priority;
		• Foster the competitiveness and the presence abroad of Brazilian companies operating in the digital segments;
		• Promote the expansion of exports through e-commerce and support the insertion of small and medium Brazilian companies in this segment.

Source: Decree No. 9.319 of March 21st, 2018 (BRASIL, 2018a)

The Digital Transformation Axes, on the other hand, involve strategies to digitally transform government and economic activities, based on the foundations developed in the previous axes. They comprise the Digital Transformation axes, as represented in Table 2:

A. Economy digital transformation; and
B. Government digital transformation and citizenship.

Tabela 2 – General objectives and specific objectives of **Digital Transformation Axes** of the E-Digital

Enabling Axes	General Objective (Decree nº 9319/2018)	Specific objectives (Decree No. 9319/2018) (BRASIL, 2018a)
F1. Digital transformation of the economy: data based economy	Foster the computerization, dynamism, productivity and competitiveness of the Brazilian economy, in order to keep up with the world economy.	• Promote the creation of a strong ecosystem for the development of the data economy, with incentives for the development of telecommunications infrastructure and to attract data centers to the country;
		• Enhance technical and human capabilities related to the use and handling of large volumes of data;
		• Promote a legal-regulatory environment that encourages investment and innovation, in order to provide security for the data processed and adequate protection for personal data;
F2. Digital transformation of the economy: a world of connected devices		• Support professional education and training in skills needed to develop and use new digital technologies related to connected devices;
		• Promote the development of technological solutions in the priority areas of health, agriculture, industry, and smart cities;
		• Foster the regulatory and business environment that promotes the attraction of new investments in connected devices to ensure trust and the preservation of users' rights.
F3. Digital transformation of the economy: new business models		• Strengthen the performance of Brazilian companies in the digital business environment;
		Encourage and support nascent technology-based companies;
		• Develop flexible regulatory environments for experimentation with innovative business models.
G. Citizenship and digital transformation of the government	Make the federal government provision of services to citizen, in line Digital.	• Offer simple and intuitive digital public services, consolidated on a single platform and with satisfaction ratings available;
		• Grant broad access to government information and open data, to enable the exercise of citizenship and innovation in digital technologies;
		• Promote the integration and interoperability of government databases;
		• Promote public policies based on data and evidence and more accessible to the population predictive and personalized services, using technologies and more efficient in emerging;
		• Implement the General Data Protection Law at the government level with the Government Strategy federal and ensure the security of digital government platforms;
		• Make digital identification available to the citizen;;
		• Adopt cloud government processes and services technology as part of the technological framework of federal public administration services and sectors;
		• Optimize the Information and Communication Technology infrastructures; and
		• Train government teams with digital competencies.

Source: Decree No. 9.319 of March 21st, 2018 (BRASIL, 2018a)

The axes are related in a matrix way, as shown in Figure 1:

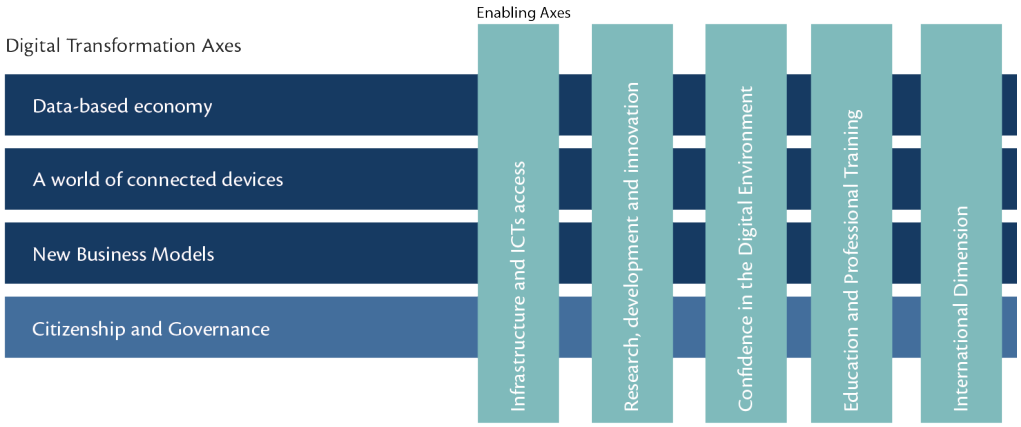


Figure 1 - Matrix of axis organization

Source: BRASIL, 2022e

Following the example of the previous edition (2018-2022), the new E-Digital aims to contribute to the achievement of the Sustainable Development Goals of the United Nations 2030 Agenda, in addition to preparing the country to advance in the main rankings of competitiveness, security, and digital economy.

In addition to this introduction, this document has a section that explains the methodology for updating E-Digital, and also sections that contextualize and establish the strategic actions for each of the Enabling Axes and Digital Transformation Axes.

This strategy contemplates, since its formulation, the coherence and synergy between different actors, aiming to take advantage of all the potential that digital technologies have to offer for the real growth of the country.

Strategy Update Methodology

The update of the Brazilian Digital Transformation Strategy 2022-2026 is the result of a structured process, which had as its starting point the first version of E-Digital.

The document seeks to coordinate the various government initiatives linked to the theme around a single vision, in order to support the digitalization of production processes and training for the digital environment. Thus, the document uses the same conceptual model established in E-Digital 2018-2022 (BRASIL, 2022e), demonstrated below:

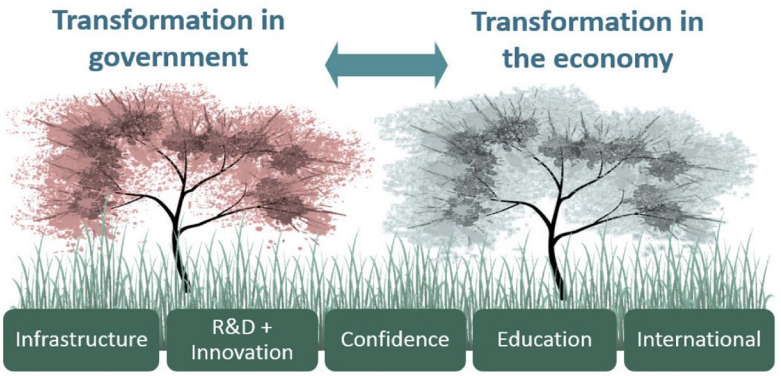


Figure 2 - E-Digital conceptual model

Source: BRASIL, 2022e

The document uses the same logic model developed for E-Digital 2018-2022 (BRASIL, 2022e):

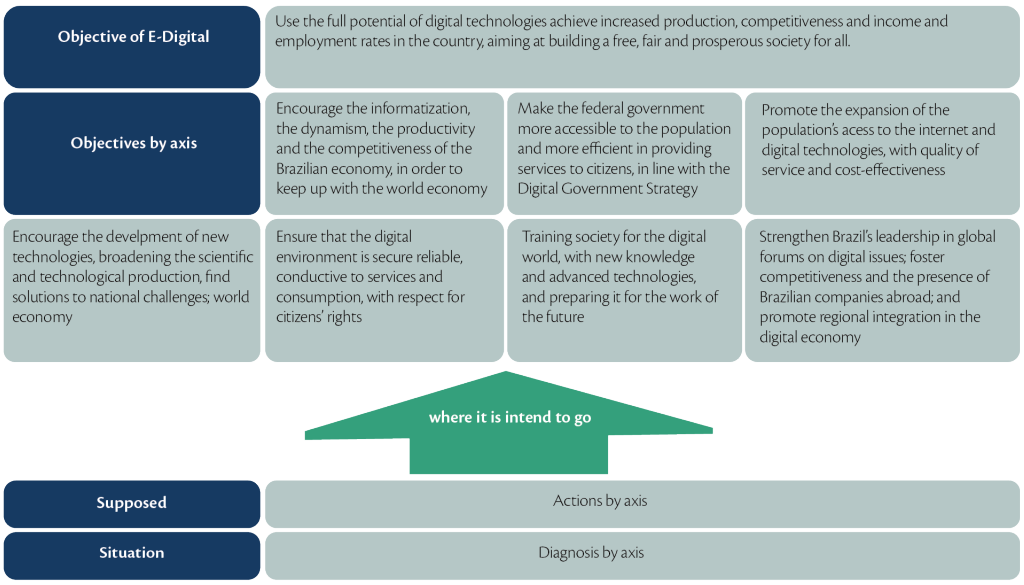


Figure 3 - E-Digital Logical Model

Source: Elaborated by the author

In other words, the main goal of the policy is to "harness the full potential of digital technologies to achieve increased productivity, competitiveness, and income and employment levels throughout the country, aiming to build a free, fair, and prosperous society for all". This means that the strategic vision for the digital transformation of the country proposed in 2018 is maintained and that the actions undertaken by the state aim to achieve this goal. Moreover, each of the axes is composed of its own general objectives - understood as part of the engineering that allows the macro objective to be achieved - as well as specific objectives, which are linked to the general objectives of each axis. This diagnosis was elaborated with the purpose of gathering data about the digital transformation situation in the country, in order to facilitate the understanding of which actions should be undertaken for the next four years.

The design of the logic model represented in Figure 3 allows the state to organize the process of monitoring the actions and to define the focus of monitoring and evaluation. In this sense, it was established that the monitoring and evaluation model (ME) should prioritize the monitoring of the E-Digital actions, in addition to its results and impacts consolidated by the axes to which they belong. The overall evaluation of E-Digital will be given by consolidating the results of the Enabling Axes and the Digital Transformation Axes, according to Figure 4:

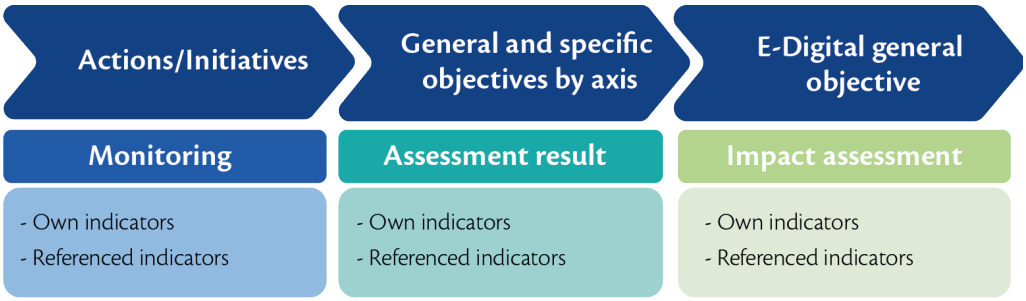


Figure 4 - Basic E-Digital monitoring and evaluation model

Source: Elaborated by the author

The indicators already regularly collected by the Ministry of Science, Technology and Innovations (MCTI) itself and E-Digital 2018-2022 were given preference in the monitoring and evaluation model. In addition to these, the core indicators will include those used by the Organization for Economic Cooperation and Development (OECD) and other international reference organizations. This E-Digital cycle establishes the monitoring and evaluation model, reviewing the indicators established in the previous cycle.

The work was led by MCTI, through the Executive Secretariat of the Inter-ministerial Committee for Digital Transformation (CITDigital), by request of the Committee's chair, occupied by the Civil House of the Presidency of the Republic, in order to meet the requirements of Decree No. 9.319/2018 (BRASIL, 2018a). With technical support from the Center for Strategic Studies and Management (CGEE)

and with the participation of all CITDigital members, the Brazilian Digital Transformation Strategy was updated in the order of the following steps (Figure 5):

Figure 5 - Elaboration stages of E-Digital

Source: Elaborated by the author

In the first stage of the E-Digital update, between the months of July and September 2021, there was the preparation of a diagnosis on the Brazilian digital transformation. Later, the follow-up report of the actions undertaken by E-Digital was updated and, likewise, the actions undertaken in the scope of other plans and other federal strategies with related themes were surveyed. The goal was to decide which actions should be removed from the previous document and which should be prioritized for the next quadrennium.

In September 2021, the virtual workshop cycle was held, divided into subgroups according to the axes of the strategy. The workshops had more than 100 participants from all over Brazil, from several public, private, and academic institutions. Themes and strategic actions were discussed, suggested both by forms previously answered by the participants and during the workshops.

From the consolidation of the diagnoses and the proposed actions, a base document was elaborated, which was submitted to public consultation between November 23rd, 2021, and February 14th, 2022. The public consultation was structured by axes that contained a diagnosis and a set of actions to be evaluated, and counted on more than 170 respondents, which generated more than a thousand comments and more than 10 thousand objective answers.

In parallel to this step, meetings were held with experts in digital transformation, to validate the results achieved and capture other considerations about the document. After these steps, the proposals for updating E-Digital were analyzed, consolidated, and submitted to a final evaluation by CITDigital members.

This final version was consolidated by CITDigital and, subsequently, disciplined from an act of the Minister of State of Science, Technology and Innovations, as defined by Decree No. 9.319/2018 (BRASIL, 2018a).

Thematic – Enabling Axes

A. Infrastructure and access to Information and Communication Technologies

Board 1 - General objective and specific objectives of Enabling Axis A

Enabling Axis	General objective	Specific objectives
A. Infrastructure and access to Information and Communication	Expand the population's access to Internet Technologies and digital technologies, with quality of service and affordable.	• Bring high-capacity data transport networks to all Brazilian municipalities; • Expand the mobile and fixed broadband access networks, in urban and rural areas; • Disseminate digital inclusion initiatives.

Source: Decree No. 9.319 of March 21st, 2018 (BRASIL, 2018a)

Before Brazil can achieve a fully digital society, the internet infrastructure must serve all citizens. The expansion of this infraestructure in remote areas and the lack of acess to technological devices by the population are the biggest challanges of this axis. In a complementary way, the limites quality and speed of broadband internet and mobile internet offered th the entire Brazil society are also obstacles. The actiond forwarded through this axis allow - many of them in a comprehensive way - to face the challenges mentioned, as long as this occurs through partnerships between the public and private sectors. Strengtheningg small ISPs will contribute to broadening the quality and supply of internet in remote areas. The challenge of acessibility for the vulnerable population can be mitigated by expanding the supply of internet in public spaces. the connection spped in Brazil can be improved with the expansion of the high-speed fiber network in the territory . Finally, contributing to the advance of connectivity in the country, we hope to advance in the improvement of regulatory frameworks and in the viability of financial instruments.

Diagnosis

Expanding the **internet service** offer in unserved areas, added to the improvement of **quality and speed** to the entire Brazilian society is one of the most important steps towards digital transformation in Brazil.

Achieving a good and extensive telecommunications infrastructure is fundamental for any nation that aspires to some position of leadership on the international stage. Therefore, by promoting a broad connectivity to society, prioritizing actions that aim at digital inclusion and national competitiveness, the effects and potentialities of this global and irreversible transformation process are also directed, mitigating its risks and stimulating its positive aspects. In this sense, the expansion of the internet service offer, together with the improvement of quality and speed throughout the territory, continues to be a key element for the Brazilian digital transformation. Brazil has several challenges for the extension of access to broadband networks, and the expansion of the infrastructure of fiber optic data transport networks for the flow of traffic to national backbones is fundamental.

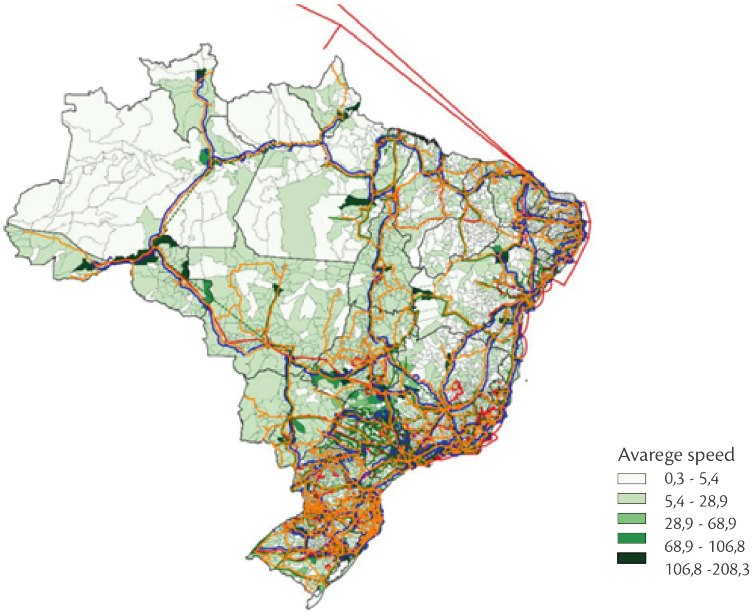


Figure 6 - Distribution of Multimedia Communication service (MCS) Speed bands in Brazil and back bone fiber route, in Megabytes per second (Mbps)

Source: ANATEL, 2021a, p.35.

Figure 6 shows the distribution ranges of backbone fiber in the country. Note that both urban and rural areas need increases in the reach and quality of mobile and fixed broadband access networks - especially in the North, Northeast and Center-West regions, where there are extensive territories that have not obtained guarantees of supply and meeting the demand for mobile telephony and fixed broadband. For remote areas, the most appropriate responses tend to be those that are based on local characteristics and specificities, so that a plurality of technological solutions is indispensable.

For example, satellite network expansion can be articulated to connect these hard-to-reach areas to national backbones . To meet the demand for telecommunications services throughout the Brazilian territory, providing high-speed Internet access, it is first necessary to increase the supply via the market, meeting a repressed demand. One line of action to enable the supply of services is to combine market action with complementary induction mechanisms, the so-called sustainability frontier (BRASIL, 2018b, p.14).

Taking the data from the ICT Households survey (CGI, 2021a) as a reference, with regard to the type of connection, fixed broadband is currently the most used and was present in 69% of households in 2020, compared to 40% in 2017. About the average speed of fixed broadband contracted and made available to service subscribers, a study by the National Telecommunications Agency (ANATEL, 2021a) points out that the average contracted speed of MCS was 76.6 Mbps in 2020[1]. Data from the Speedtest Global Index (SPEEDTEST, 2022) show that the speed received by users in May 2022 was 92.75 Mbps[2], placing Brazil in the 34th position worldwide. In comparative terms, Chile has an average speed of 206.97 Mbps and occupies the 2nd position in the ranking. The relationship between speed and the existence of transport infrastructure(backbone/backhaul) was analyzed and it was found that 36.5% of the municipalities have speeds below 5 Mbps and 63.5% above 5 Mbps.

When analyzing the correlation between average internet speed and transport infrastructure(backbone/backhaul), a high correlation was observed, i.e., municipalities that have high speed have robust internet infrastructure (ANATEL, 2021a, p.34). When fixed broadband access is analyzed, the density[3] of this service, which measures the penetration of fixed broadband calculated by dividing accesses by households, was 50.96% in 2020 and 58.66% in Brazil in 2021. (ANATEL, 2021c, p.8). The difference in density by Region is discrepant. The South Region reached the 65.82% mark in 2020, closely followed by the Southeast Region with 63.39%. On the other hand, the North and Northeast regions score 27.16% and 28.5%, respectively. The Midwest is in an intermediate position, with 50.17% (ANATEL, 2021b, p.20). Among the technologies that allow access via fixed broadband are:

- Optical fiber, responsible for 46.82% (17.04 million accesses) of the total in 2020;
- Connection via coaxial cable, with 26.38% (9.6 million accesses);
- Metal cables, with 19.45% (7.08 million);
- Radio, with 5.88% (2.14 million); and
- LTE + Satellite, with 1.45% (0.53 million) (ANATEL, 2021b, p.38).

1 Anatel points out that the data correspond to the number of active accesses in each speed package sold by the companies, and not to the actual traffic speed.
2 The analysis was performed with data from the largest MCS providers in the 5,562 municipalities in which they were present.
3 Access density refers to the total number of accesses divided by the total population, in PCS; and by the total number of households, in SFTS and MCS.

Anatel provides data on the number of accesses among the various services, in order to measure the use of Internet access services. The data provides information about Personal Communications Service (PCS), Switched Fixed Telephone Service (SFTS), Multimedia Communication Service (MCS), and Pay TV Services (CAS). In 2020, the number of fixed broadband accesses surpassed fixed telephone accesses, which shows the growth of this service. Access via mobile telephony peaked in 2014(ANATEL, 2021a), with a slight drop and consolidation in subsequent years, as shown in Chart 1.

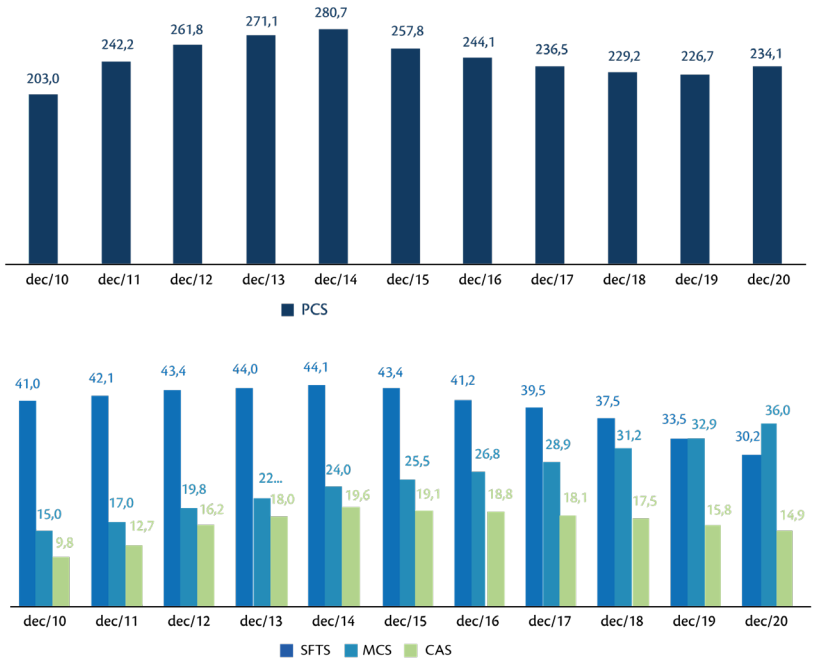


Chart 1 - Evolution of accesses in services (in millions of accesses)

Source: ANATEL, 2021a, p.35.

According to data from the ICT Households 2020 (CGI, 2021a), in that year, 99% of the user population aged 10 or more accessed the Internet via cell phones. Furthermore, for 58% of the Brazilian population, access was exclusively through the cell phone. Among cell phone internet users, 75% of them used the mobile network (3G and 4G), 90% used Wi-Fi, and 66% used both technologies (CGI, 2021a). In contrast, computers are restricted to 45% of the population. Class A has 100% of its households with computers, while in classes D and E this rate drops to 13%.

The information made available by Anatel in its Brazilian Infrastructure Data Panel (ANATEL, 2022a) shows that, in May 2022, 90.31% of Brazilians were covered by the mobile internet (PCS), considering the 2G, 3G and 4G technologies. In addition, there were no cities without coverage. The 4G covers 89.42% of households and 88.3% of Brazilians; and 3G, 90.58% of households and 89.52% of Brazilians.

Despite the wide coverage, it is the rural areas that remain on the margin of broad connectivity: only 34.24% of its inhabitants have 4G coverage and 37.07% have 3G coverage. In addition, regional differences in mobile coverage of rural areas are high. The Federal District has coverage of 89.48% of its residents, while in Roraima this percentage is only 2.67%. In order to serve remote regions with low coverage, investing in the implementation of a large-scale mobile network would be the best option, given the greater penetration of this service, not to mention the facilities of the wireless network and the offer of prepaid services.

Besides the rural areas, the Brazilian highways, which are fundamental for logistics and transportation of goods, lack greater mobile coverage by 3G and 4G. From the 125,956 km of Brazilian roads, 45.5% (57,315 thousand km) have mobile coverage, with the largest gap observed in the North Region, as shown in Figure 7.

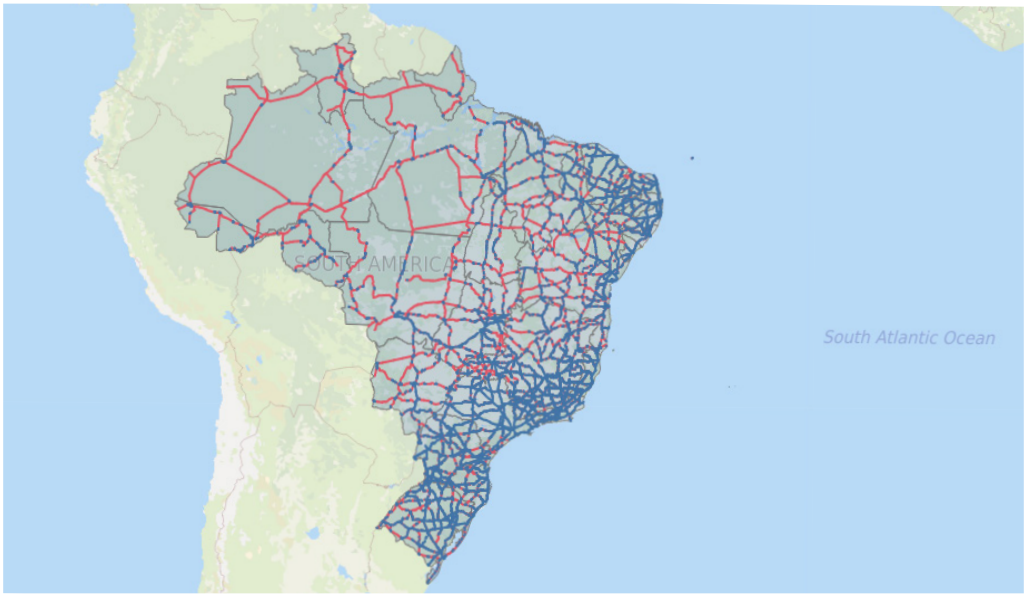


Figure 7 - 3G and 4G mobile coverage on Brazilian roads.

Source: Anatel's Infrastructure Data Panel - Mobile Coverage on the Highways. Accessed on: May 26th, 2022.

According to data from the Speedest Global Index (SPEEDTEST, 2022), in May 2022 the mobile internet download speed in Brazil was 22.72 Mbps and upload speed was 8.13 Mbps. These numbers place the country in 79th position in the world ranking and below the global average performance, which is 30.75 Mbps and 8.78 Mbps, respectively. One of the main obstacles that result in this low average mobile broadband speed is the great discrepancy in the distribution of antennas throughout the territories, creating a strong inequality of digital access by more remote populations. Information from Anatel's Data Panel corroborates this hypothesis and shows that only 10.85% of rural areas are covered by 3G and 4G, against 91.73% of urban areas.

Finally, it is worth mentioning that the arrival of telecommunications infrastructure in the municipalities requires an adequate and standardized legal apparatus that combines the initiatives of the different States. In the specific case of mobile networks, the legislation in force in the vast majority of municipalities, including capital cities, is not prepared to receive 5G antennas. According to a survey by

Conexis Brasil Digital (CONEXIS, 2021), only 7 from the 27 Brazilian capitals have a legal framework prepared for 5G implementation. In this sense, the harmonization of municipal legislation, reinforcing actions developed by Anatel, for the use and occupation of land has a fundamental importance to continue the expansion of new communication technologies and especially for the benefits to be implemented in a synergistic manner with existing authorizations and facilities.

Tabela 3 – Proposed Strategic Actions for the 2022-2026 quadrennium - Enabling Axis A

Strategic Action
Strengthen the provision of telecommunications services from small or regional ISP, as well as facilitate access to network infrastructures, especially to high traffic ones, promoting digital, economic and financial inclusion of less favored classes, small retailers and the population in remote regions and/or where large operators are absent, seeking to raise the quality of service.
Expand the number of points served by the Wi-Fi Brazil program.
Enable the application of resources from the Fund for the Universalization of Telecommunication Services (Fust) to expand broadband access and use, both in urban environments and in rural and remote areas.
Support initiatives for the development and deployment of advanced telecommunications network infrastructure, through public-private partnerships.
Expand the services to municipalities with low connectivity rates or low connection speeds by making high-speed networks or satellite services available.
Strengthen the use of the resources of the Conduct Adjustment Terms (CAAs) for the development of infrastructure for the digital transformation.
Monitor the implementation of 5G in Brazil, including the goals and counterparts established in the bid notice.
Encourage and enable the joint deployment of synergistic infrastructures, such as: (i) underground cabling of broadband networks jointly with power or public lighting networks; and (ii) road construction and paving (dig once policy), speeding up the approval of works by the right of way (right of way policy) by regulatory agencies, paying attention to environmental issues.
To promote the harmonization of the legislation of municipalities, in order to update the laws of land use and occupation and to speed up the processes of issuing permits for the installation of telematic network infrastructure (antennas).
Promote the deployment of secure networks (covering connectivity, processing, and storage resources) to integrate research, education, and health institutions into high-speed networks, stimulating scientific and technological exchange while benefiting populations located in remote regions.
Make long-term investments and coordination between initiatives of data communication infrastructure, computing (such as high performance computing - HPC) and data storage, in order to meet the needs of cyberinfrastructure services for large science and technology projects, in cooperation with companies in high demand of ICT, supporting RD&I projects in this sector.

Some results of the actions taken for Enabling Axis A in the 2018-2022 quadrennium

- Release of the 700 MHz radio frequency band in the municipalities that do not depend on this band in the transition to digital TV (BRASIL, 2020a).
- Reformulation of the Fund for Universalization of Telecommunications Services (Fust) to enable its application to expand broadband access and its use in urban environments and in rural and remote areas. Fust was revised and a new law was drafted. The text is pending analysis by the National Telecommunications Agency (Anatel) to regulate its operation (BRASIL, 2020a).
- Publication and realization of the 5G Auction in late 2021. The ordinance, released in January 2021 (BRASIL, 2021a), established the deadlines for 5G offering: until July 31st, 2022, in the Brazilian capitals, and until 2028, for the other locations[. The text defines a set of conditions, depending on the spectrum negotiated, for the auction winners, which meet several of the challenges raised in the Structural Plan of Telecommunications Networks (Pert) (ANATEL, 2021a). Among the conditions, the following stand out: the implementation of internet in public schools, the obligation to expand optical fiber cables to unserved municipalities - Integrated and Sustainable Amazon Project (Pais) - and the installation of two public networks (private of the federal government). Besides these, the ordinance also contains obligations related to the installation of 4G in all municipalities with more than 600 inhabitants, mandatory national roaming, and road coverage with high-speed internet (BRASIL, 2021a).
- Use of Conduct Adjustment Agreements (CAAs) in 2020 and 2021 to direct resources to structural projects aimed at expanding connectivity in municipalities not served by operators and reducing the rate of signal loss in some municipalities, as well as the construction of fiber optic backbone infrastructure for unserved municipalities (ANATEL, 2022b).
- The Bella project, which houses the EllaLink submarine cable and marks the development of cooperation between Brazil and Europe in research areas, with the aim of creating high connectivity between the European continent and Latin America. The network consists of a 6,000 km cable, connecting Lisbon to Fortaleza (BELLA, 2021; CONNECT, 2021), with an origin point in Madrid and destinations in Bogotá, Lima, and Santiago. The network will enable high-speed data transfer (100 gigabytes per second). In 2021, the operation of Bella-S (submarine cable between Portugal and Brazil) began and the equipment and routes for the completion of Bella-T (land route Brazil - Chile) were acquired (Figure 8). From the point of view of the Internet for large consumers, such as cloud computing providers, industrial plants, and research and development centers, actions are being taken to meet the high demand for high-capacity data transport networks, requiring the installation of high--connectivity cables directly via backbones. E-Digital 2018-2022 contains an action that seeks to promote the deployment of networks with a scientific purpose, benefiting populations located in remote regions and providing a scalable capacity over 25 years for education, research, and innovation without additional operational maintenance costs (Source: MCTI/RNP).
- The Norte Conectado (Connected North) Program (BRASIL, 2022c) advanced between 2018 and 2022. Its goal is to improve connectivity in the North Region by creating a subfluvial infovia using fiber optic cables throughout the Amazon region. The stretch between Macapá (AP) and Santarém (PA) already has the inputs for the network installation, having received 770 km of fiber until 2021. Construction has also begun on the metropolitan networks that will connect schools, higher and technical education institutions, research institutions, judicial points, and university hospitals in the cities along the route.
- The Nordeste Conectado (Northeast Connected) Program (BRASIL, 2022d) aims to expand and internalize high speed networks in the Northeast Region. By 2022, equipment for the lighting of the Fortaleza (CE) to Teresina (PI) routes and the installation of the Teresina (PI) - Sobradinho (BA) and Salvador (BA) routes were implemented, reaching approximately 4,000 km of new networks lit or under implementation. Furthermore, 19 metropolitan networks are being built or expanded, with the installation of 38 points of the Wi-Fi Brazil Program (BRASIL, 2022b).

Figure 8 - EllaLink Submarine Cable Map

Source: Bella-programme - Redclara (BELLA, 2021)

- The MCTI/Embrapii Networks for Innovation in Artificial Intelligence and Digital Transformation have also been operating in this area of knowledge sharing and infrastructure in their units, aimed at meeting corporate R&D demands with a focus on cybersecurity services.

- The Financier of Studies and Projects (Finep), with resources from the Fund for the Technological Development of Telecommunications (Funttel), structured lines of support to the expansion of connectivity and broadband via financing for equipment developed in Brazil, in programs such as the Innovative Acquisition and the Finep 5G (Source: Finep).

- Expansion of connectivity in schools, especially rural ones. Around 10 thousand schools have been attended by the Inovação Educação Conectada (Connected Education Innovation) Program (Piec)

B. Research, Development and Innovation

Board 2 - General objective and specific objectives of Enabling Axis B

Enabling Axis	General objective	Specific objectives
B. Research, Development and Innovation (RD&I) Solutions	Encourage the development of new technologies, with the expansion of scientific production and technology, and seek para for national challenges.	• Integrate the enabling instruments for the promotion of RD&I, as well as the research infrastructures aimed at the development of digital technologies; • Improve the legal frameworks of Science, Technology and Innovation (ST&I); • Use public purchasing power to encourage the development of innovative solutions based on digital technologies.

Source: Decree No. 9.319 of March 21st, 2018 (BRASIL, 2018a)

The growing digital transformation of Brazilian society is evident in many ways. However, in production processes, which are responsible for supplying goods and services to society, digital transformation is a determining factor. For these processes to be efficient and bring increasing returns, constant investments must be made, especially in research and development in Information and Communication Technologies (ICT). To be successful in this area, it is necessary to reverse the low public and private investment in R&D in the ICT sector, which compromises the productivity and competitiveness of the Brazilian economy in relation to world trade.

In this sense, the actions suggested in this axis seek to promote R&D in strategic themes for digital transformation, through public and private investments, according to sectorial demands. The promotion of ICT innovation ecosystems, with a careful look at the need to pulverize resources and research in different centers and technologies, will make it possible to develop R&D in a surgical and more efficient way. Finally, the integration of enabling instruments to promote R&D aimed at the development of digital technologies will strengthen investments in the sector.

Diagnosis

The digital transformation is present in all productive sectors, **highlighting the low public and private investments** in R&D in the ICT sector, which compromises the productivity and competitiveness of the Brazilian economy against the world trade

Information and Communication Technologies (ICT) are one of the main drivers of economic and social change in the 21st century. In fact, since the 1960s, different countries, mainly the United States of America, have spent large amounts of money on Research, Development and Innovation (RD&I) in this now consolidated sector (ØVERBY, H.; AUDESTAD, J.A., 2021). These efforts have become central to increased productivity and economic growth, as they have resulted in an extensive set of new products and services that have transformed industry and consumption habits, thus producing a relentless digital transformation process (FERNÁNDEZ-PORTILLO, et al, 2020; ECLAC, 2021).

Considering this situation of growing competitiveness and aiming at a more favorable insertion of Brazil in global value chains, it is essential that the country intensifies public and private investments in RD&I, especially in ICT. Thus, as a result of this effort, new jobs are expected to be created, income levels will increase, and the digital inclusion of citizens, that is, the promotion of access to the services and facilities that ICT can provide.

The E-Digital 2022-2026 aims, through the Research, Development and Innovation axis, at Brazilian prominence in the world scenario in digital technologies, with advances in positions related to scientific production, technological development and innovation, particularly in the information and communication technology sectors.

As for trade flows, according to data surveyed by Brasscom (2021), in 2020 ICT and Telecom Services exports reached about R$13 billion - a 30% increase over the previous year - and, for the first time, surpassed hardware exports, which totaled R$12.4 billion.

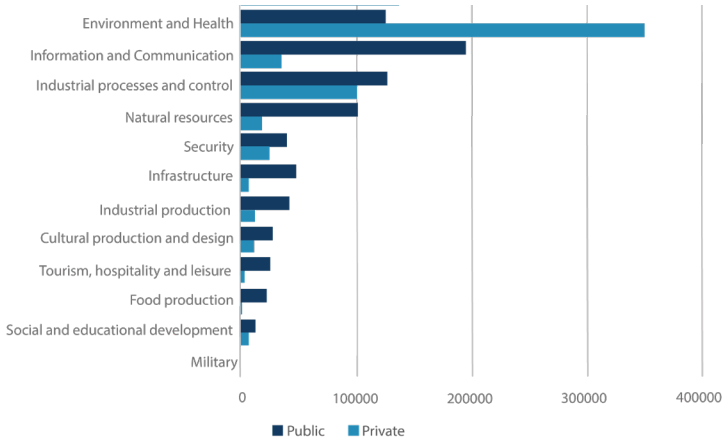


Chart 2 - ICT/Telecom services exports and hardware exports between 2013 and 2020, in billions of reais

Source: BRASSCOM (2021)

Thus, prior investments are essential to maintain and expand the capabilities of companies in the ICT macro-sector, something particularly important because of the growing competitiveness in the global digital economy, with the entry of new players that have invested substantially in RD&I.

Since the 1990s, Brazil has had apparatuses aimed at the industrial development of these companies, a factor that is reflected in the data on the financing of RD&I in the country. Among these instruments, the ICT Law (BRASIL, 1991a; BRASIL, 2001) and the Informatics Free Zone Law (BRASIL, 1991b) stand out specifically, adding respectively 6.9 billion and 308 million reais in tax waivers to companies in the sector that proved their RD&I activities in 2021 (MCTI - CT&I Indicators) (BRASIL, 2022f). In the bigger picture, the public sector (federal government and state governments) accounted for about 53.6% ($196.776 billion) of national RD&I spending in the decade from 2010 to 2019. In turn, business sector spending was approximately 46.4% of the total (US$ 170.111 billion).

However, in 2019, the trend reversed and in that year, the private sector's share of RD&I investments ($20.295 billion, or 51.73% of the total) was greater than that of the public sector ($18.937 billion, or 48.27% of the total), as shown in Chart 3. This has not happened since 2005, when public spending was US$ 9.772 billion (47.66%) and business spending was US$ 10.731 billion (52.34%) (MCTI - CT&I Indicators) (BRASIL, 2022f).

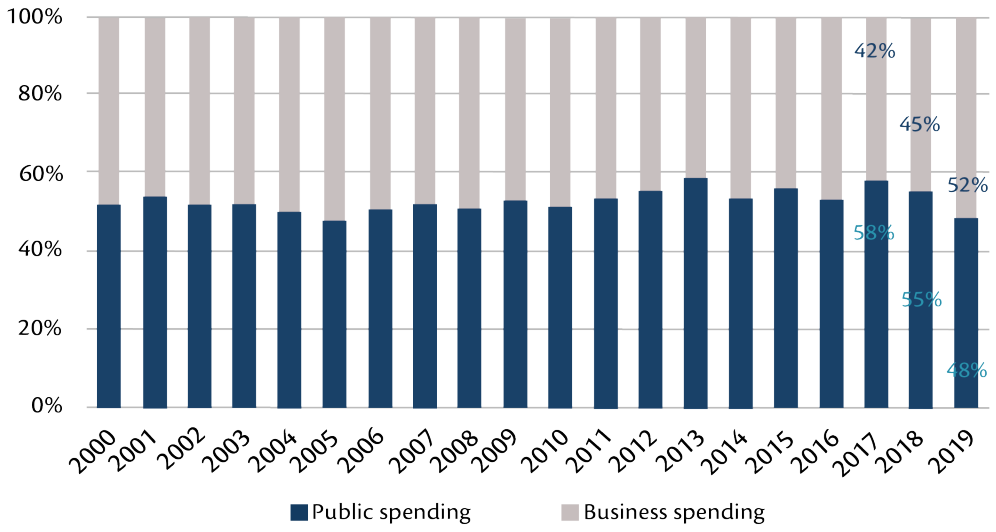


Chart 3 - Participation of companies and government in investments in RD&I in Brazil, from 2000 to 2019

Source: MCTI - CT&I Indicators (BRASIL, 2022f). Own authorship.

However, the proportion of corporate spending on RD&I in Brazil recorded in 2019 (51.73%) is lower than that observed in some of the countries that occupy the technological leadership, such as the United States of America (63.3%), Japan (78.9%), South Korea (76.9%) and Germany (64.5%) (MCTI - CT&I Indicators) (BRASIL, 2022f).

Besides financing, the Brazilian State needs to act on the other elements that make feasible and drive the actions of RD&I, striving both for excellence and democratization in the formation of human capital - in order to increase the number of trained engineers, scientists and technologists - and the creation of job market opportunities, in order to retain and attract talent to the National System of Science, Technology and Innovation (SNCTI). According to the UNESCO Science Report: The race against time for smarter development (2021), Brazil has about 888 researchers per million inhabitants, a number that is below the world average (1.368 professionals per million inhabitants) and very distant from the proportions observed in Germany (5,212), South Korea (7,980), USA (4,412) and Japan (5,331) (UNESCO, 2021, p.7). This distance shows, therefore, the need to quickly mitigate the problem of the low availability of professionals with a technological profile in Brazil, considering that this obstacle impacts the ICT macro-sector in particular.

Among the instruments currently made available by the government to support innovative activity are tax incentives, such as the ICT Law. According to the MCTI's IT Law Results Report - Base Year 2019(BRASIL, 2021b), the ICT Law benefited 479 companies in 2019 (BRASIL, 2021b), with a large concentration in the Southeast and South Regions. From these, 42% (202) were micro or small companies; 33% (159) were medium-sized; and about 25% (118) were medium-large and large companies. Together, these companies employed 9,379 professionals in RD&I in 2019, in a greater universe

of 171,140 employees, responsible for the execution of 1,320 own projects and the production of 217 patents and 319 publications, which moved R$ 570 million.

In addition to this effort, there are 885 other projects under contract. Among them, 44 generated patents and 256 publications, which moved R$ 748 million. Regarding the main activity areas of the projects of the benefited companies, 41.9% (358) were dedicated to the manufacture of machines and equipment; 21.7% (185), scientific research and development; 15.7% (134), information technology service activities; and 12.2% (104), telecommunications.

The concentration of companies benefited in a few states shows the magnitude of regional inequalities in terms of installed capacity for the generation of ST&I. Regional particularities, whether obstacles or advantages, need to be addressed so that the incentives aimed at deconcentrating the generation of knowledge, opportunities, and wealth, promoting inclusion, can be positioned appropriately, without harming consolidated players and networks that give good results.

The Legal Framework for Startups and Innovative Entrepreneurship, instituted in 2021, is also an important RD&I instrument for companies in the ICT sector, especially startups. This is because technology-based companies need to attract investments in the form of venture capital, due to the very uncertainties that surround the innovation process. The Legal Framework highlights the role of "angel investors" - which brings legal certainty and may stimulate more interactions of this type - as well as providing other instruments, including authorization for companies with investment obligations in RD&I to invest directly in startups, through Endowment Funds and Investment Funds. Another change that the Framework introduces is the recognition of the importance of experimental regulatory environments, or regulatory sandboxes , thus facilitating the process of creation and inter-institutional collaboration in innovative projects, providing legal security and foreseeing a more agile regulation of these relationships.

It is also established as a guideline the incentive to contract solutions from Brazilian startups via bids, a line of action that if well explored, can contribute to the generation of income and to the strengthening of these companies, in order to make them more competitive. The framework has regulations for this benefit, regulating the bidding process and the contracting of innovative solutions by the public administration, thus facilitating this type of acquisition by the government. With this instrument, it is possible to align the national startup sector with good international practices, a scenario that results in the modernization of the business environment, incentive to entrepreneurship, and generation of qualified jobs.

The Startup Framework, by bringing legal security, encourages the formation of synergistic relationships among the various players, thereby facilitating cooperation and support for innovative projects. An important step was taken towards greater coordination among researchers, companies, government agencies, institutes and universities. Thus, the actors in a position to innovate have the guarantees, something that tends to benefit the institutions recognized for their excellence, such as companies, research centers, institutes and universities.

Brazil needs, in short, both a present private initiative and a participative public power that follows the best international examples, doing justice to its potential and greatness.

Table 4 - Proposed strategic actions for the 2022-2026 quadrennium - Enabling Axis B

Strategic Action
Promote RD&I, including through government technology orders, in strategic themes for digital transformation, such as Internet of Things (IoT), Artificial Intelligence, robotics, automation, cloud computing, Blockchain, privacy, information security, cybersecurity, cryptography, data science, wearables, mesh networks and alternative and efficient connection technologies, as well as technologies that enable the circular economy of used electronic products and components.
Encouraging the technological development and of the production chain of software and electro-electronic, computer and mechanical components, considering the production cycle, operation and maintenance of robots, including through the creation of public-private cooperation platforms and the structuring of special or export processing zones.
Foster public and private investments in RD&I linked to the priority demands of Industry 4.0, Cities 4.0, Health 4.0, Agri 4.0, Tourism 4.0, and cybersecurity
Expand access of Small and Medium Enterprises (SMEs) and startups to innovation incentives in strategic themes for digital transformation.
Promote the specialization of research and graduate centers in priority technologies, making sufficient resources available, including from the ICT Law, in order to promote regional development and deconcentrate and optimize scientific production and innovation.
Integrate the enabling instruments for the promotion of RD&I, as well as the research infrastructures aimed at the development of digital technologies, along the lines of international technology hubs and the example of experimental environments(Testbeds) in innovative technologies, in order to ensure scale and strategic direction for the technologies to be developed.
Carry out scenario prospecting to define RD&I priorities that have positive impacts on the income level, employment generation, productivity and competitiveness, including foresighting and forecasting methodologies, consultation with experts (Delphi, panels, surveys), technological scenarios and roadmaps .
Promote permanent dialogues between representative entities from government, academia, and industry, in order to ensure that RD&I policies and initiatives associated with digital transformation are comprehensive, convergent, and coordinated.

Some results from the actions taken for Enabling Axis B in the 2018-2022 quadrennium

- Decree No. 9.854, of June 25th, 2019, and MCTI Ordinance No. 5.109, of August 16th, 2021, defined, among other topics, the environments and the lines of priority RD&I projects focused on digital transformation, in order to contribute to the leverage of sectors with greater potential for accelerating the economic and social development of the country. Agro, cities, industry, and healthcare environments, and technologies related to artificial intelligence, the internet of things, infrastructure, and communications have been established as priorities. Because of this, the MCTI and its linked entities have made adjustments to their promotion and action lines, highlighting the prioritized themes. Decree No. 9.854, of June 25th, 2019, also established the National Plan for the Internet of Things and set up the Chamber for Managing and Monitoring the Development of Machine-to-Machine Communication Systems and the Internet of Things - IoT Chamber.
- The MCTI National Platform for Research Infrastructure (PNIPE) was launched, with the objective of gathering information about the research infrastructure of the Scientific, Technological and Innovation Institutions (STIs) in the country, in order to promote shared access and use of this infrastructure by the scientific and business communities. The platform is available at https://pnipe. mctic.gov.br and already has, for example, information about the available infrastructure of the National Laboratory for Scientific Computing (LNCC), such as the Santos Dumont supercomputer. In October 2022, 317 institutions, 3,023 laboratories, and 15,989 pieces of equipment were registered in the platform.
- RNP has implemented, with the support of companies, the RNP's Testbeds Service, which offers, in an integrated way, to teachers, students, researchers and startups experimental environments (testbeds) to carry out experimentation, research, and validation of scientific hypotheses in network technologies and distributed computing. The Brazilian Agency for Industrial Development (ABDI) launched the Sandbox Guide for Smart Cities and has been implementing, jointly with partners, environments for experimentation, validation, and improvement of solutions in a real environment (sandbox) in Brazilian cities, such as Foz do Iguaçu in Paraná. Finep held a public call to support open laboratories and shared spaces, which aim to support the implementation or modernization of facilities in Institutes of Science and Technology (IST).
- The Center for Strategic Studies Management (CGEE) has contracted technical studies on the impacts of technological development on the labor market and companies, as well as on technological roadmaps and best practices in bringing together the productive sector and 4.0 technologies, entitled: (a) Technological development and labor market - Digitalization and man-machine relationship: Changes and trends in legislation at the global level; (b) Technological development and labor market - Subsidies for public policies; (c) Technological development and labor market - Study on labor relations in the financial sector; (d) Technological development and labor market - Employment and labor relations in the health economic-industrial complex; (e) Technological development and the labor market - Impacts of e-commerce expansion on employment levels, occupation structure and collective bargaining; (f) Industry 4.0 - Human resources and education for the 4.0 world; (g) Industry 4.0 - Regulatory framework for the implementation of Industry 4.0 in Brazil; (h) Industry 4.0 - Companies' perception about technical normalization for Industry 4.0 in Brazil; (i) Industry 4.0 - Segments or niches with higher percentage for the national technological development; and (j) Industry 4.0 - Mapping of the main approach methodologies between the productive sector and the 4.0 technologies.

- ABDI, in partnership with IPEA, has made Hubtec available, with the objective of helping managers and professionals involved with technology orders to overcome the challenges that arise during the planning and conception of a strategic public procurement project. ENAP, on the other hand, made available the course on technology orders developed by the TCU (Federal Court of Accounts) in partnership with the Inter-American Development Bank (IDB), aimed at training public servants on the characteristics of this mechanism for public procurement of innovation, as well as on the procedures for planning, management, and control of the instrument. ENAP has also made available the Challenges Platform that offers help to public managers to innovate together with society, taking advantage of collective intelligence to reduce the insecurities of the innovation process and increase the chances of success (https:// www.enap.gov.br/pt/servicos/plataforma-desafios).
- In 2022, a public notice was launched to support startups, with the amount of R$80 million in economic subsidies, for the development of solutions based on Artificial Intelligence aimed at overcoming technological challenges proposed by the Federal Government. The notice was elaborated in partnership between Finep, the MCTI and the ME/SGD, with technical support from the Ministry of Economy and ENAP, also aiming at the incorporation or adoption of these solutions by public entities, with the consequent improvement in the quality of federal public services. It is 80 million in economic subsidies. Other noteworthy notices include the 4.0 Technologies (R$228.8 million) and the Notice to support startups in AI for the Industry, Agribusiness, Health, Cities, and Tourism segments (R$80 million).
- Law No. 13.969, of December 26th, 2019, and Decree No. 10.356, of May 20th, 2020, improved the industrial policy for the ICT sector and the semiconductor sector. The new legislation has provided greater legal and tax security for the companies that benefit from the law, further clarifying the possibilities for using the tax waiver resources.
- Decree 4.382/2021 established new procedures for the approval of investment projects as priorities in the area of Intensive Economic Production in Research, Development and Innovation, for the purpose of issuing debentures with incentives, pursuant to the provisions of Law 12,431, of 06.24.2011, and for the purpose of investment in the national territory in new projects of economic production intensive in research, development and innovation by Investment Funds in Participation in Intensive Economic Production in Research, Development and Innovation (FIP-PD&I), pursuant to Paragraph 1-A of art. 1 of Law 11.478, of 05.29.2007.

- Establishment of the MCTI/EMBRAPII Network of Digital Technologies and Innovation, forming an integrated ecosystem of 25 EMBRAPII Units, aimed at leveraging the productive capacity and competitiveness of Brazilian companies by encouraging the use and development of frontier technologies in the industrial production process. The governance of the Network counts on: presidency, vice-presidency, and technical committees, whose representatives serve 12-month terms, which rotate among the units participating in the Network. The technical committees are composed of members appointed by the Network's Units and have the objective of discussing and proposing strategic guidelines to strengthen the Units' actions. By 2022 the MCTI/EMBRAPII Network has 77 accredited units.
- In 2021, the Basic Funding Alliance Program was launched, making available a new modality of EMBRAPII's funding that allocates non-reimbursable resources to co-finance research and development projects (R&D) whose scope is between technology readiness levels (TRLs) 2 and 4 and is developed by consortia involving at least two EMBRAPII Units, two companies and one startup.
- The Brazilian Artificial Intelligence Strategy (EBIA) was established by MCTI Ordinance No. 4.617, of April 6th, 2021, in order to guide the Brazilian State's actions aimed at promoting research, innovation and the development of solutions in Artificial Intelligence, as well as its conscious and ethical use for a better future. The EBIA is based on the five principles defined by the OECD and endorsed by Brazil for responsible management of AI systems, namely: (i) inclusive growth, sustainable development and well-being; (ii) human-centered values and equity; (iii) transparency and explainability; (iv) robustness, safety and security and; (v) responsibility or accountability."
- The creation of eight Applied Research Centers in Artificial Intelligence has been fostered by MCTI and FAPESP, in cooperation with CGI (the Brazilian Internet Steering Committee). The centers connect researchers and companies for the development of RD&I projects oriented to solving problems using artificial intelligence. Six centers act in environments prioritized by the ST&I policy (health, industry, cities, Agri). The other two centers will focus on AI Research applied to information security and cyber security, including investigation and design of algorithms, mechanisms and systems for cyber defense; and with a broad AI research agenda, encompassing, among others, topics such as machine learning, natural language processing, security and ethics, computer vision and image recognition, neural networks, autonomous systems, and robotics.
- The RHAE Program (Human Resources in Strategic Areas) seeks to insert masters and doctors in private companies, preferably micro, small, and medium-sized ones, aiming to train and qualify human resources to work in applied research or technological development projects, as well as to increase the interaction between academia and the business sector. The program, run by CNPq in partnership with MCTI, held a public call for support for R&D&I projects of innovative companies (line 1) and R&D&I projects of Startups (line 2). This Call for Applications provided resources worth R$ 104 million, in the form of SET, DTI, EV and ATP scholarships, and 473 proposals were approved. An agreement was also signed between Embrapii and the BNDES, allocating R$170 million to RD&I projects by national companies, R$50 million of which are earmarked for projects in the fields of Artificial Intelligence and Digital Transformation.
- The "MCTI Future: Future of Work, Work of the Future" Program was created by MCTI Ordinance No. 5.156, of August 30th, 2021, with the purpose of supporting actions that aim to expand the contingent of professionals to work in digital ecosystems, in digital transformation projects and research, development and innovation (RD&I), and that additionally, contribute to qualify or attract talent to undertake in the field of Information and Communication Technologies (ICTs). The ICT Residency and Digital Literacy project stands out in this context.

- The RNP Inter-ministerial Program has reviewed and updated the RNP System usage policy to include innovation systems and environments in 2018. The intention was to encourage the interaction between universities, research institutions (ICT), and companies in RD&I actions in digital technologies, both through the use of funding mechanisms and by strengthening business incubators, technology parks, and other innovative environments. RNP offers the NasNuvens (in the clouds) Platform, the first portal of 100% cloud solutions focused on the Research and Education segment (https:// www.nasnuvens.rnp.br/).
- MCTI Ordinance No. 5.720, of March 25th, 2022, and MCTI Ordinance No. 5.733, of March 29th, 2022, established, respectively, the ST&I International Cooperation Policy and the international cooperation priorities, within the scope of the Ministry of Science, Technology and Innovations. IT, automation and digital transformation is one of the areas prioritized by the policy. Regarding digital transformation, the following forums and countries have been defined as priorities: (i) ECLAC/ eLAC, (ii) G20, (iii) GPAI, (iv) OECD, (v) UNESCO, (vi) Germany, (vii) Australia, (viii) Canada, (ix) China, (x) Finland, (xi) Japan, (xii) United Kingdom, (xiii) Sweden, (xiv) European Union, (xv) United States, and (xvi) Slovenia.
- Partnerships have been signed with other countries, aiming to expand scientific and technological production through international cooperation in RD&I. In 2020, several seminars were held on the topic of Artificial Intelligence with Germany, Japan, and the United States, among others. Through RNP, calls were made with the European Union and the USA in research projects related to topics such as 5G, IoT, cloud computing, cybersecurity, etc.
- Signing of a Technical Cooperation Agreement (TCA) between CNPq, Ibict and RNP for the development of actions related to the construction of a national federation of research data repositories. And the National Consortium for Open Science (CoNCienciA) between CNPq, Ibict, Fiocruz, Embrapa and the Brazilian Center for Physics Research (CBPF), establishing bases for technical and operational cooperation to encourage the practice of open science. In this context, the LattesData Repository stands out as a place for researchers to deposit their datasets that were totally or partially funded by CNPq (https:// lattesdata.cnpq.br/deposito/).
- •The National Priority Programs and Projects of Interest (PPIs), namely: (a) National Microelectronics Program - PNM Design; (b) National Teaching and Research Network Program - RNP; (c) National Software for Export Program - SOFTEX; (d) Program for the Manufacture and Qualification of Electronic Products with Information and Communication Technology - HardwareBR; (e) IoT/Manufacturing 4.0; and (f) Digital Health.
- Public Call was launched for accreditation of Competence Centers by Embrapii, in partnership with the MCTI, under the HardwareBR Priority Program. The Competence Center is a new operational model of EMBRAPII that seeks to promote the emergence, strengthening and expansion of new knowledge in areas of technological frontier, connected with its demonstrable track record. Each Center must perform at least the following actions in the accredited thematic area: (a) expansion and strengthening of scientific and technological competence in RD&I; (b) training and qualification of HR for RD&I; (c) technological association; and (d) attraction and creation of startups.
- Launched in 2021 the MCTI Tower, a Science, Technology and Innovation Integration structure, created by MCTI Ordinance No. 5.134/2021 and available at: https://torre.mcti.gov.br/.

C. Confidence in the digital environment

Board 3 - General Objective and Specific Objectives of Enabling Axis C

Enabling Axis	General objective	Specific objectives
C. Trust in the digital environment.	Ensure that the digital environment is secure, reliable, and favorable to services and consumption, with respect for citizens' rights.	• Improve mechanisms to protect rights in the digital environment, including aspects related to privacy and personal data protection, and recognize the specificities of this environment; • Strengthen the country's cybersecurity, with the establishment of cooperation mechanisms between governmental entities, states and the private sector, with aiming at adopting best practices, incident response coordination, and protecting critical infrastructure; and • Strengthen international cooperation instruments between authorities and companies in different countries to ensure law enforcement in the digital environment.

Source: Decree No. 9.319 of March 21st, 2018 (BRASIL, 2018a

As noted in the previous axes, the digitalization of society is progressing increasingly, resulting in the availability of personal data of a large part of society in the digital environment. With the increased use of virtual media for transactions and other activities, network vulnerability has increased, with a higher risk of cyber incidents. Thus, ensuring the protection and autonomy of personal data without causing negative externalities to the economy, with the incorporation of new technologies and the creation of new business models, is fundamental to a secure digital society.

The actions suggested in this axis seek to support the confrontation of these issues. Strengthening and monitoring the Brazilian General Data Protection Law (LGPD) and regulating the use of data and algorithms by data processors is one way to preserve fundamental rights and ensure transparency in the digital environment. In addition, promoting cooperation between public and private institutions in cybersecurity can collaborate to raise the level of resilience in this topic in Brazil.

Diagnosis

The frequency of **cyber incidents** and the **vulnerability** of networks are still obstacles to the broad digitalization of society. Ensuring the **protection** and **autonomy** of personal data in the face of the incorporation of **new technologies** and **new business models** is fundamental for a secure digital society.

Ensuring that people feel confident about developing their activities in the digital environment is a complex task, involving different dimensions of state action, which are grouped, in the design of this strategy, into two categories

1. Protection of rights and privacy; and
2. Defense and security in the digital environment.

1. Protection of rights and privacy

Promoting the integrity and transparency of data flows over the Internet is essential if cooperative relationships between actors are to flourish. In order to do so, it is necessary "[...] to determine more clearly how the protection of rights in the digital environment will take place" (BRASIL, 2018b, p.39). In other words, for the digital world to become more democratic, accountable and user-friendly, the public and private sectors need to include, in the design processes of ICT innovations, security, privacy, and ethical standards that guarantee human rights and the public interest. E-Digital (BRASIL, 2018b) points to this in its diagnosis, pondering that, despite the advances provided by the Brazilian Civil Rights Framework for the Internet (Brasil, 2014), which recognized the centrality of human rights, Brazil lacks a specific legal framework that:

1. "[defines] clearly the competencies of the public administration aimed at ensuring law enforcement...
2. [disciplines] the handling of personal data in a comprehensive manner, with rules applicable to public and private law entities, in the various sectors of the economy...
3. [allows] the rationalization of the use of information while protecting the citizen's fundamental rights." (BRASIL, 2014, p.38)
4. Clarifies the legal framework, resolving vagueness and simplifying processes; (BRASIL, 2014, p.39)
5. Promotes the "institutional innovation capacity of the state, which should seek to protect its citizens without inhibiting innovation and the beneficial use of new technologies" (BRASIL, 2014, p.39)

Indeed, E-Digital (BRASIL, 2018b) corroborates the recommendation of the UN-UNCTAD (2016, p.43), for the creation of an agency or body dedicated to this problem of international data traffic, by listing as a strategic action the creation of a "national authority with competencies regarding the protection of personal data and the international flow of data, capable of standardizing best practices and providing legal certainty." (BRASIL, 2018, p.40)

Thus, there has been significant progress. The creation of the Brazilian General Data Protection Law (LGPD) in 2018 and the institutionalization of the National Data Protection Authority (ANPD), responsible for its enforcement in 2020, point to a process of improvement in the public sector. In this short period of activity, the ANPD produced and made available guides aimed at standardizing practices and legal certainty, and launched communication channels for reporting non-compliance with the LGPD. Because it is a recent body, its results and impacts are still incipient, so their evaluation is something to be done.

The LGPD and the ANPD are important mechanisms to achieve minimum definitions of privacy and security protection in Brazil and, for this reason, they may act by encouraging public and private entities to proactively position themselves, anticipating such issues even in the design of ICT innovations, making their regulation more dynamic and effective, and favoring mutual learning. For this, the ANPD needs to be supported and strengthened, with a view to acquiring the competencies and capabilities that are necessary for such an coordination.

It is worth remembering that ICT innovations are often disruptive in nature, so that the challenges faced by their regulation are shrouded in super-specialized technical knowledge. This makes it important to have the support of qualified professionals to the ANPD, aiming at the construction of answers that will solve eventual impasses. This means, in other words, that the ANPD, being a regulator, can also act as a promoter of innovation, without compromising the protection of human rights.

In this way, new technologies that interface with the emergence of Big Data can be driven or framed in the public interest. The elaboration and wide dissemination of high-quality prospective studies, which can inform and articulate public and business decisions around agendas and consensus, are adequate methods to this end. Initiatives of this kind could mitigate uncertainties and risks by indicating safer routes or possibilities, which would be duly supported by the public authorities. In short, considering that important steps have been taken towards the consolidation of an institutional framework for data protection in Brazil, it is necessary to advance towards the construction and dissemination of best practices and projects aimed at using the exponential flow of data in socially constructive and beneficial directions.

The regulatory process is also a time for learning and collaboration among the actors. This benefits innovative companies, because the confidence and predictability generated promotes the attraction of investments, giving positive and directed signals to the markets, which gradually have a different perception of the technological and social risks involved. Therefore, it is important to support Brazilian comapanies in the acquisition of the necessary competencies, which necessarily includes

training of good professionals specialized in security and digital management, a very scarce labor force in Brazil,

2. Defense and security in the digital environment

The Regional Center for Studies on the Development of the Information Society (CETIC.br), in partnership with the Center for Information and Coordination of the Ponto BR (NIC.br) and the Brazilian Internet Steering Committee (CGI.br), produced the web research on the use of the Internet in Brazil during the pandemic of the new coronavirus. The data shows that by 2020, 54% of Internet users believed there were more risks than benefits in making their data available to governments and companies. The tendency to fear among individuals from classes A and B or older is relatively higher, exceeding the national average (Graph 4). In fact, Brazilian citizens' sense of trust in ICT is fragile, indicating a perception that their rights on the Internet may be somehow violated, especially by attempts at fraud, identity theft, invasion of privacy, and selling data to third parties (CGI, 2021c, p.75).

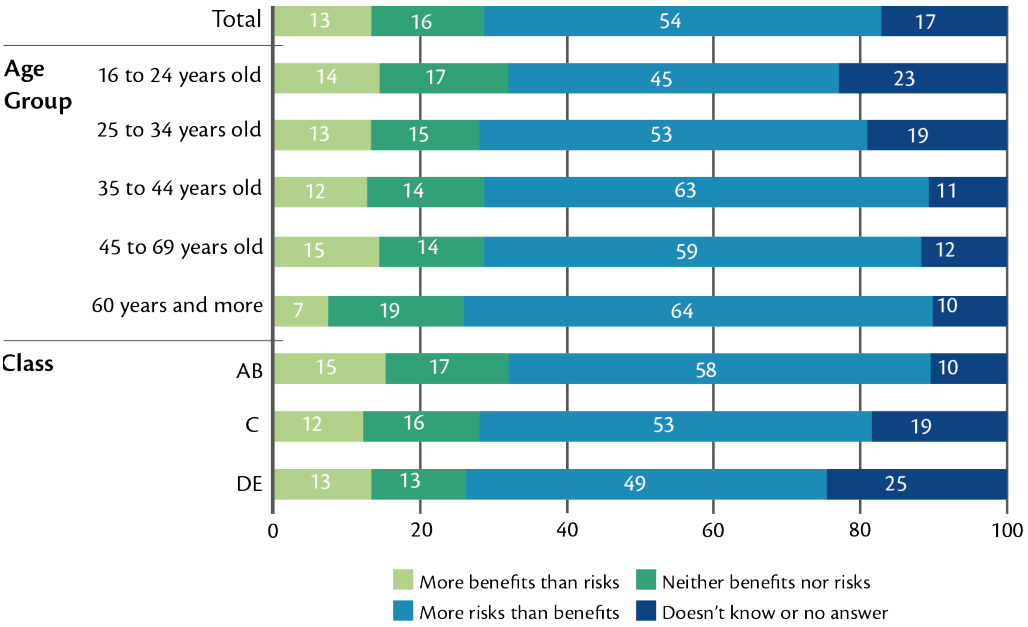


Chart 4 - Perception of the risks and benefits of making personal data available to governments and companies, by age group and class. Note: Internet users aged 16 and over (%).

Source: CETIC, NIC, CGI (CGI, 2021c, p.78).

Cyber attacks are a constant risk for government institutions that maintain the sensitive data of the population, as well as for society in general. According to the Global Cybersecurity Index (GCI) report (UIT, 2020), produced by the United Nations International Telecommunication Union (ITU), Brazil ranked 18th in the Global Cybersecurity Index 2020, closely followed by Belgium, Italy, Oman and Finland. In that year's ranking , there was a significant improvement, considering that in 2019 the country occupied the 70th position. However, despite Brazil is in a good position, it is also one of the most digitally attacked countries in the world. According to Sonicwall's report for the first half of

2021, Brazil was the fifth largest target of ransomware attacks in the world, with 9.1 million records, behind only the US (227 million), the UK (14.6 million), Germany (11 million), and South Africa (10.5 million) (SONI- CWALL, 2021, p.9). This implies that efforts directed at promoting defense and digital security need to be continuous, so that they are aware of new and possible threats.

In this regard, the National Cyber Security Strategy (E-Ciber) (BRASIL, 2020b) and the National Information Security Policy (PNSI) (BRASIL, 2018f) were important institutional advances made after E-Digital (BRASIL, 2018b).

Table 5 - Proposed Strategic Actions for the 2022-2026 quadrennium - Enabling Axis C

Strategic Action
Promote the strengthening of the culture of personal data protection, through strategic actions aimed at the prevention and detection of violations of the LGPD, as well as actions directed at the training and orientation of processing agents and of society regarding the rules for personal data protection.
Monitor all present and future changes, developments and/or implementations, as well as their effects, concerning the privacy and data protection regulatory framework, in particular Law No. 13.709, of August 14th, 2018, the LGPD (BRASIL, 2018c).
Propose best practices, codes of conduct, monitoring and appropriate regulation for the use of data and algorithms by data processors, and develop procedures with ethical guidelines, paying attention to fundamental rights and transparency, including in algorithmic decision-making and the use of data by digital technologies.
Promote guidance and awareness on the application of the LGPD in the private and public sectors and for citizens, including for micro and small businesses, startups, and individuals who handle personal data.
Promote appropriate and proportionate regulation of the information security, cybersecurity and privacy risks inherent in the processing of personal data that disruptive digital technologies (Artificial Intelligence, Big Data, data lake , Internet of Things, quantum computing, augmented reality and virtual reality, etc.) may pose to data subjects.
Establish effective mechanisms for monitoring and detecting LGPD violations.
Provide the National Data Protection Authority with adequate means to exercise its powers as defined by the LGPD, in order to ensure stability and legal security to the regulatory and supervisory environment related to data protection.
Supporting the implementation of personal data protection legislation by enforcing specific regulations.
Promote, through the Federal Network for Cyber Incident Management (Regic), mechanisms for cooperation and sharing of information between public and private institutions for the prevention for the prevention, management and response to cyber incidents, in order to raise the level of resilience in cybersecurity of their information assets.
Issue a national cyber security policy, including the definition of a national body responsible for the articulation of a national cyber security system, involving the public and private sectors.
Strengthen the country's cybersecurity ecosystem, through the creation of a national council in the scope of a national cybersecurity policy, with the participation of public authorities and representatives from society involved in cyber security in order to increase the cyber security resilience of society and the economy as a whole.
Issue national and subnational plans for preventing, handling, and responding to cyber incidents, including in critical infrastructure.
Encourage broad educational campaigns to expand public awareness on the subject of information security.
Consolidate the legal framework on cybercrime, harmonizing the criminal law and procedural provisions already existing in Brazilian legislation and advancing the forecast of new investigation instruments for the digital world.

Some results from the actions taken for Enabling Axis C in the 2018-2022 quadrennium

- Approval of the Brazilian General Data Protection Law (LGPD), which provides for the processing of personal data, including in digital media, by natural persons or public or private legal entities, in order to protect the fundamental rights of freedom and privacy and the free development of the personality of natural persons
- It is worth mentioning initiatives led by the Internet Steering Committee (CGI) (focused on security and the protection of human rights on the internet, especially the rights of children and adolescents) and the launching of publications by the ANPD.
- Aiming to advance international cooperation on the topic of security, in 2019, Brazil was invited to join the Budapest Convention for cooperation in the investigation of cybercrime.
- Creation of the National Data Protection Authority (ANPD) in 2019 (BRASIL, 2019).
- In order to disseminate the adoption of digital technology in the validation of electronic transactions and documents produced in the digital environment, the Mercosur Agreement on Mutual Recognition of Digital Signature Certificates (2019/2020) was signed.
- Approval of the National Cybersecurity Strategy (E-Ciber), the federal government›s manifest guidance to Brazilian society on the main actions intended, nationally and internationally, in the area of cyber security. E-Ciber will be valid for the 2020-2023 quadrennium. E-Digital 2018-2022 provided for a national cybersecurity policy, with the definition of a national body. In 2018, the National Information Security Policy (PNSI) (BRASIL, 2018f) was instituted within the federal public administration, with the purpose of ensuring the availability, integrity, confidentiality, and authenticity of information at the national level.
- In order to establish cooperation mechanisms between different entities with a view to adopting best practices and sharing information, among others, the Federal Network for Cyber Incident Management (Regic) was established in 2021 (BRASIL, 2021d). RNP has developed a model to qualify professionals and actively act (Security Operation Centers) in data security.
- Hacker do Bem (Hacker for the Good) Program, a project designed by Senai-SP and Softex, with the aim of training young people in information security and privacy.
- Creation of the Cybersecurity Group of Latin American Research and Education Networks in 2021, with the aim of exchanging information and solutions in the face of new risks.
- Aiming to train public agents in security and cyber risk mitigation, there are some activities, such as the training held by RNP with information technology managers in security for the RNP System and the availability of courses by the National School of Public Administration (Enap).
- Aiming to make the population aware of the information security theme, it is important to mention MCTI/RNP›s work of holding events. Furthermore, the Institutional Security Office of the Presidency of the Republic (GSI/PR) publishes monthly newsletters on information security and cybersecurity, and the National Laboratory for Scientific Computing (LNCC) runs regular campaigns with employees.
- Aiming to form specialized human resources and invest in research and development in the area of defense and cybersecurity, RNP, Embrapii and LNCC have been developing activities in the theme.

D. Education and professional training

Board 4- General objective and specific objectives of Enabling Axis D

Enabling Axis	Genera	Specific objectives
D. Education and professional training	To train society for the digital world, with new knowledge and advanced technologies, and prepare it for the work of the future	• Connect public, urban and rural schools, with broadband access, and provide equipment for access to digital technologies;
		• Incorporate digital technologies into school practices, with development of computational thinking among students' skills
		• Reinforce the math, science, technology and engineering disciplines and the technical training tracks for acting in sectors of the digital economy, with a focus on entrepreneurship; and
		• Promote the improvement of teachers' initial and continuing education, regarding the use of technology in the classroom

Source: Decree No. 9.319 of March 21st, 2018 (BRASIL, 2018a)

Brazil is on its way to becoming an increasingly digital society. However, in order to be successful in this process, some challenges need to be overcome, starting with the dissemination of digital skills throughout society. The lack of internet in schools, especially in remote areas, added to the lack of equipment and technological resources for Brazilian students, is a hindrance to proper learning. Also in the school environment, it is urgent to adapt the pedagogical content to the teaching of new technologies. Among professionals, capacity building and knowledge recycling needs to be oriented towards new digital technologies, enhancing the skills and competencies of Brazilian workers towards digital transformation.

Thus, the actions addressed in this axis aim to introduce the new themes and technologies in the pedagogical content of all levels of education. This requires that students have access to the internet and technological devices. Broad access can be made possible through actions that promote programs focused on the universalization of high-speed Internet access and on the pedagogical use of digital technologies in basic education. Finally, it is necessary to stimulate the offer of courses and training for professionals, through partnerships between academia, the private sector, and the public sector, in order to prepare Brazilian workers for the digital transformation of the productive sector.

Diagnosis

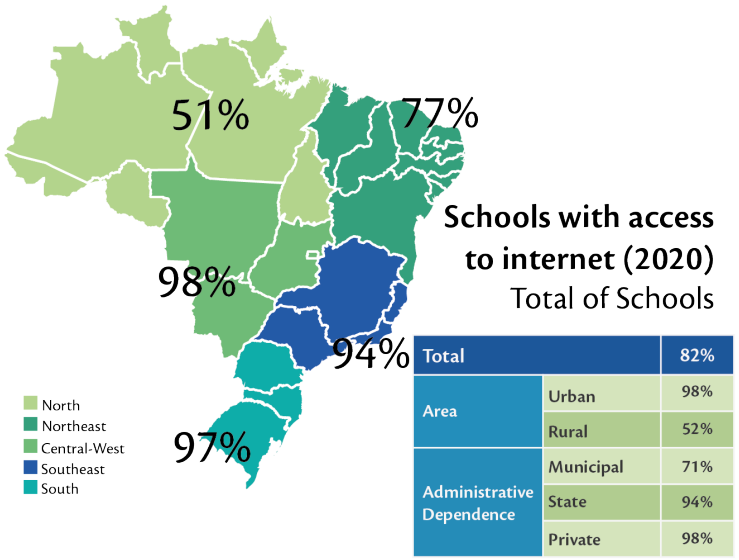
In order for Brazil to have a **digital society**, the introduction of digital content in all levels of education and the wide availability of Internet and technological resources in schools are fundamentally important. Added to this, the continued training and updating of Brazilian professionals in new digital technologies will allow them to meet the new demands of **digital transformation.**

Between the years 2000 and 2010, Brazilian education showed progress in the universalization of basic education (TREVISOL; MAZZIONI, 2018), with a significant reduction in illiteracy rates (IPEA, 2010) and an increase in people with a higher education degree (BORTOLANZA, 2017) and with master's and doctoral degrees (BRASIL, 2020e). Even with the progress achieved, the theme still presents challenges, such as the need to align:

- Teaching methods to the digital format, demanding equipment, connectivity, and teacher training;
- Supply and demand for professionals in the area of information and communication technology (ICT), in order to meet the labor market.

In this way, basic education must be capable of training children and teenagers with outstanding skills in new technologies; and professional education must offer short cycle courses with specific knowledge, in order to supply the current and emerging demands of the labor market.

For the educational challenge, making broad internet access available in schools is the initial step in promoting digital education. Although the ICT Education 2020 Survey (CGI, 2021b) indicates that 82% of Brazilian elementary schools have Internet access, there are regional disparities: while 98% of schools in the Midwest have accessibility, in schools in the North this percentage is only 51%. Rural schools are also at a disadvantage: only 42% of these teaching units have Internet access (Figure 9).



Total		82%
Area	Urban	98%
	Rural	52%
Administrative Dependence	Municipal	71%
	State	94%
	Private	98%

Figure 9 - Elementary schools with internet access - 2020 - (%)

Source: ICT Education 2020 Survey (CGI, 2021b)

In terms of administrative dependence, the municipal school systems - which have the largest number of students enrolled - are the most deficient. About 70% of the municipal schools have internet access, however, internet is available for students in only 27.8% of these units. The federal and private networks are the best equipped, according to the study, despite the small number of federal establishments.

The lack of internet in part of the schools, especially one that guarantees access to students, is still a challenge. Thus, it is extremely necessary to connect public schools, both urban and rural, with broadband access and make available equipment for access to digital technologies, which are still limited in many schools.

The quality of access is just as important as the access, i.e., to carry out pedagogical activities requires quality internet with adequate speed. However, 44% of Brazilian municipal schools have a connection of up to 10 Mbps.

These challenges put educational policies for digital transformation on alert, pointing to the need for basic infrastructure in schools, such as quality internet access, availability of equipment in good working condition for students, classrooms with robotics resources, etc., so that content suitable for the digital environment can be implemented.

Added to the challenges presented, it is important to mention the impact of the Covid-19 pandemic between 2020 and 2022, which touched on inequalities in Brazilian education (UNESCO, 2019). Virtualization in education has revealed social inequalities that have affected teaching and learning,

mainly in the lower classes: while the vast majority of students* from classes D and E use cell phones to follow the classes, in classes A and B this number drops to 28%. In the same sense, for classes A and B, 39% of the students use notebooks to attend classes and remote activities, while in classes D and E this number drops to only 5% (Chart 5).

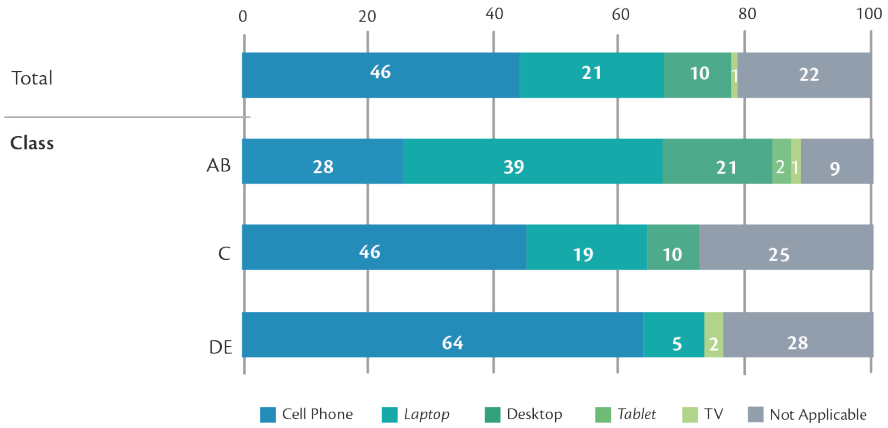


Chart 5 - Most frequently used devices for attending remote classes or activities, by class - 2022

* **Total** Internet users aged 16 and over attending school or university (%).

Source: ICT Covid-19 (CGI, 2021c)

Still, coordinated solutions between governments and public and private institutions are powerful in making an online educational system work. In Brazil, states and municipalities have given different answers to the educational crisis related to the pandemic. The learning space is not restricted to the school or the physical space, but virtual infrastructures such as teaching and training platforms must also be considered

Investment in teaching and training platforms is also important because of the possibility of digital inclusion for students with disabilities (BRASIL, 2018b). The wide adoption of remote learning during the years 2020 and 2021 revealed the urgency to serve this public in the virtual environment with adapted devices, since the person with disabilities can acquire more independence through digital activities (PARADIGMA INSTITUTE, 2022).

The strategic planning of the policies that guide the digitalization of education must consider the availability of assistive technology resources (screen readers, avatars, and Libras interpreter windows, among others). These technologies are essential to meet the specific needs of the students who are part of the Special Education audience. However, it is noticeable that it is not enough just to make this technology available to schools and students. It is necessary that, in parallel, teachers be offered continuous training for the proper use of assistive technology, in order to meet the pedagogical needs of their students in the digital world. In this way, the digitalization of education is a permanent and broad contingency, since it inhabits a society in full digitalization.

The digitalization of education is also relevant for the training and qualification of a country's labor force, strengthening society's abilities and capabilities in the face of new technologies. A study by the

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), the Serviço Nacional de Aprendizagem Industrial - SENAI (National Service of Industrial Training), and the Federal University of Rio Grande do Sul (UFRGS) (GIZ; SENAI; UFRS, 2021) analyzed the needs and opportunities for professional training. The manufacturing and services sector and the software and IT sector have the largest gaps in professionals in nominal terms, causing difficulty for other sectors to advance. This is because the area of software and IT is cross-cutting and serves as the foundation for digital transformation.

It is important to emphasize here the role of the federal network in professional training. Despite the lower proportion in the total, this network presents the majority of its enrollments in this type of education: in 2021, there were 332,727 enrollments. Besides this, the federal network is the biggest provider of professional education in rural areas, with 45 thousand enrolled students (41 thousand in the state networks, 7 thousand in the municipal, and 9 thousand in private schools). It is also important to emphasize the role of the federal educational institutes in this process of professional technical training, especially for digital trans-formation in agriculture.

Another relevant piece of information is the preponderance of young people under the age of 20 enrolled in professional education: this age group corresponds to more than 50% of the total enrollment. The Information and Communication technological axis is responsible for 12% of the total number of students enrolled in professional education, with prominence in the public network, whose enrollments represent 86% of the total in this axis (Chart 6).

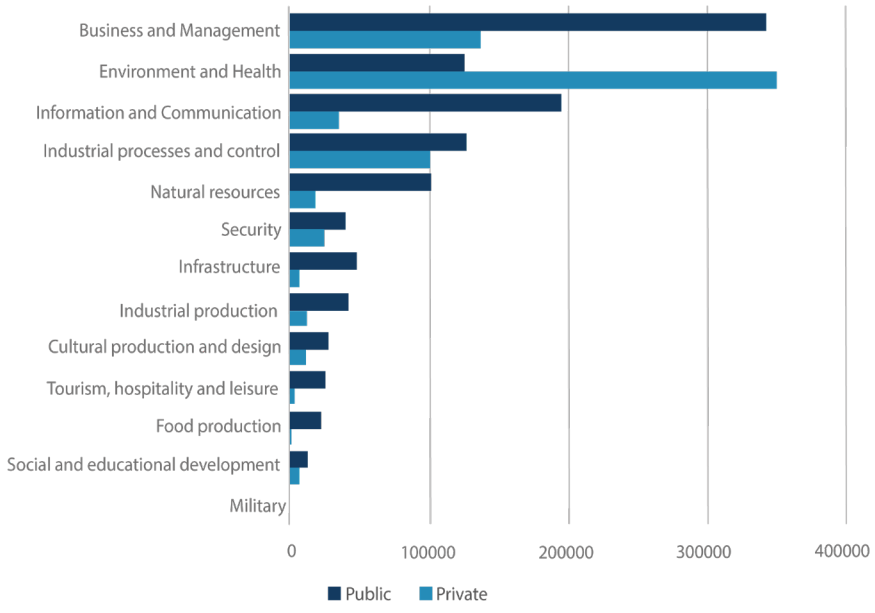


Chart 6 - Enrollment in high school technical professional education by technological axis, according to education network - Brazil 2021

Source: School Census 2021 (INEP, 2022)

The State provides quality training through universities, federal institutes, technical schools and the S System, which annually place thousands of new professionals in the market, besides playing an important role in offering continuing education and updating to this public. However, the state alone is not able to meet the significant and growing demand in the ICT sector. The demand for professionals in the area of technology and IT promises to be increasingly intense. The ICT macro-sector, which encompasses the activities of Information and Communication Technologies (ICT), in House IT and Telecommunications, currently employs 1.62 million people in Brazil. ICT alone employs 897 thousand, in House IT 413 thousand, and Telecom 310 thousand (BRASSCOM, 2020).

The scenario for the coming years will be one of intense demand, with the market needing 70,000 new professionals a year. Also, according to the Brasscom study (2020), between 2019 and 2024, 420,000 professionals will be in demand, 25.5% for IoT, 10.8% in the security area, 9.7% in Big Data, 5.9% in cloud, and 1.8% in Artificial Intelligence (AI). However, Brazil graduates 46 thousand professionals per year with a technological profile, with a relative geographical mismatch between supply and demand of labor (Figure 10).

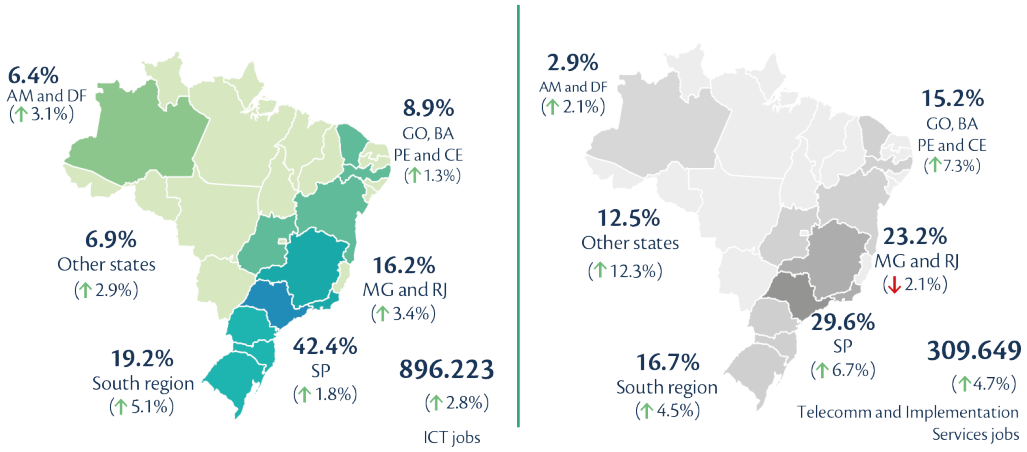


Figure 10 - Distribution of ICT and TELECOM jobs in Brazil - 2020

Source: Brasscom, IBGE, RAIS, CAGED and Novo Caged

Note: Deployment services refers to the provision of outside plant, fiber optic and coaxial cable installation services; and Telecom refers to companies providing telecommunications services and telecommunications infrastructure (wire, microwave, and satellite).

The participation of the private sector will be indispensable to supply the demand of the sector, especially in the offer of short courses. The training involves two fronts:

- Upskilling, a process of updating professionals to digital demands brownfield, that is, those that are already active in the market and have experience in the sector; and

- Skilling, a comprehensive training process for digital demands, aimed at greenfield professionals, that is, the new professionals in the market, with greater digital engagement, but without experience in the area (GIZ, Senai, and UFRGS).

The shortage of professionals in the ICT sector begins with the choice of undergraduate course. Less than 20% of students are interested in fields related to science, technology, engineering, and mathematics (STEM).

Fostering student interest in STEM content and training is important in the medium and long term, considering the growing demand in the industry. Thus, the importance of synergy between society, companies, universities, and public institutions in all its spheres is reiterated, to solve the gap of professionals in the sector. It is also important to reformulate courses, at all levels of education, so that citizens have contact with new content from their initial training. Moreover, there is a need for public and private investment in teaching and research grants, to train increasingly skilled professionals.

Tabela 4 – Proposed Strategic Actions for the 2022-2026 quadrennium - Enabling Axis D

Strategic Action
Review the pedagogical projects of science, technology , engineering and mathematics (STEM) courses, according to the new National Curriculum Guidelines (DCN), incorporating learning by competencies (digital, intuitive and socio-emotional, in addition to technical and cognitive); project-based learning (PjBL); problem-based learning (PBL) and challenge-based learning (CBL); and the CDIO model (conceive, design, implement, and operate).
Promote technical courses and professional master's and doctorate programs aligned with the demands of the productive sectors, involving, during the training process, regular internships in the productive sectors, in the cooperative model, theoretical and practical training, with themes from Industry 4.0, information security, and cyber security.
Encourage technological initiation and training in robotics, ICT, information security, and cyber security in basic education (elementary school I and II).
To monitor and improve the Inovação Educação Conectada (Connected Education Innovation) Program (Piec), of the Ministry of Education.
Promote the offer of technical courses and professional qualification courses in digital technologies, information security, cyber security, data protection and privacy, and insert basic notions in the curricular base of the Brazilian educational system.
Promote actions to foster training and qualification in companies focused on the application of technologies, to meet the production and distribution chains of industries, commerce, and services.
Develop and implement a technical level training program (technical courses and technical professional qualification courses) for retraining and professional relocation, in partnership with the productive sector, to meet the demands of the Digital Transformation (development of soft and hard skills).
Promote private investment in professional training to meet the new business models.
Expand programs to make low-cost computers available to students, through public and private resources.
Encourage and support open educational and remote learning labs and platforms around STEM and ICT, with computing devices available to students or groups of students, as well as cloud computing services for data hosting and machine virtualization.
Granting research, development, innovation, exchange, and technological extension fellowships at the technical, undergraduate, and post-graduate levels in digital transformation topics, meeting the demands of the productive sector.
Improve the initial and continuing education of basic education teachers, considering the technological transformations, information security, and cyber security, guiding in an eminently practical way the use of technology in the classroom.
Review traditional policies, such as the National Textbook Plan (PNLD) and the Ministry of Education's Technology Guide, for a planned transition from analog to digital educational resources.

Promote the acquisition of assistive technology, aimed at serving the special education public, as well as promote the continued training of school inclusion professionals on the use of these tools, in order to ensure the participation of these students in the context of digital education.
Evaluate and develop strategies for expanding the data science core curriculum in the higher education system.

Some results from the actions taken for Enabling Axis D in the 2018-2022 quadrennium

- Inclusion of Computational Thinking among the general competencies of basic education in the Brazilian National Common Curricular Base (BNCC).
- Regarding connectivity in schools, a new model for funding internet connection was developed and the expansion of school connectivity was implemented. The connection speed of schools served has also increased.
- The Inovação Educação Conectada (Connected Education Innovation) Program (Piec) was established in 2017. Through this, several outcomes were delivered, such as the deployment of internal Wi-Fi network infrastructure in 473 schools by RNP. In partnership with the Norte Conectado (Connected Northeast) Project, RNP has launched a subfluvial cable, which is also serving schools, HEIs, research institutions, hospitals, etc.
- Implementation of advanced network infrastructure for universities and research centers by RNP, throughout the national territory, relying on partnerships with other public bodies and companies to connect schools in urban areas at high speed
- Focused on improving the training of basic education teachers, activities such as sharing content in the Tempo de Aprender (Time for Learning) Program have been carried out. The Capacitação 4.0 (Capacity Building 4.0) Program, from Embrapii, the Ministry of Education (MEC), and the Serviço Nacional de Aprendizagem Industrial – SENAI (National Service of Industrial Learning), also works on training and developing soft skills in students. As part of the program, lectures were held to train teachers.
- In order to adapt educational resources to the digital environment, the National Fund for Education Development (FNDE), the Basic Education Secretariat of the MEC (SEB/MEC), and RNP have developed the National Digital Textbook Program (PNLD), which has made it possible to validate 100% works by digital means.
- Embrapii's Capacitação 4.0 (Capacity Building 4.0) Program enables lifelong learning, offering opportunities for young people to carry out projects in the technology area.
- Embrapii/MCTI, in partnership with companies, offers virtual and free training and improvement courses focused on digital technologies and guided by practical market demands.
- In 2020, in the emergency context of the pandemic, some actions that RNP supported are highlighted, such as the Alunos Conectados (Connected Students) Project, which distributed more than 158 thousand chips to 100 higher education institutions, in order to provide free mobile Internet so that students in socio-economic vulnerability could study remotely.

E. International dimension

Board 5 - General objective and specific objectives of Enabling Axis E

Eixo Habilitador	General objective	Specific objectives
E. International dimension	Strengthen Brazil's leadership in global forums on digital issues, stimulate the competitiveness and presence of Brazilian companies abroad, and promote regional integration in the digital economy	• Promote the active participation of the country in coordination initiatives and regional integration in the digital economy, as well as in international instances that treat the subject as a priority; • Foster the competitiveness and the presence abroad of Brazilian companies operating in the digital segments; • Promote the expansion of exports through e-commerce and support the insertion of small and medium Brazilian companies in this segment.

Source: Decree No. 9.319 of March 21st, 2018 (BRASIL, 2018a)

The digital transformation of society depends to a large extent on agreements and treaties that are established globally, since the topic encompasses many cross-border aspects, such as the flow of data of individuals and companies. Brazil's active participation in multilateral forums and meetings is fundamental to align themes such as information security, cybersecurity, technological norms and standards, taxation, and intellectual property, among others. Apart from that, improving regulatory frameworks and promoting the participation of Brazilian companies in international e-commerce is important for the growth of Brazilian e-commerce .

The actions established in this axis seek to meet these challenges, with the promotion of Brazilian participation in forums and international organizations on issues of digital transformation, such as information security and protection of personal data, cyber security and cross-border e-commerce. The actions also seek to leverage Brazil's participation in international digital commerce, discussing solutions to expand exports of Brazilian companies via e-commerce and promoting national companies in global markets.

Diagnosis

The **digital transformation** of society is first and foremost global, and depends on **Brazil's active participation in decision-making processes on global issues**, such as regulatory frameworks, international data flow, taxation, technological norms and standards, information security, privacy and cybersecurity, among other challenges.

1. Internet Governance

The Brazilian advances in the issue of Internet governance have become an international reference already consolidated a few years ago. However, the country's diagnosis on these aspects has shown little change in the last four years.

Among the advances, the Brazilian Civil Framework of the Internet stands out, which establishes rights and obligations in the use of the network and defines principles such as neutrality, privacy protection, and freedom of expression and content, as well as mechanisms that promote greater legal certainty in these matters. For governance itself, the multistakeholder model of the Brazilian Internet Steering Committee (CGI.br) has been presented internationally as a positive example since its foundation, in 1995, as one of the first bodies responsible for network governance in the world.

The international debate on Internet governance is spread across several forums, both in the political arena, the United Nations and its specialized agencies, and in forums more related to the economic area. In view of this absence of a multilateral forum with a clearly defined mandate to conduct the issue in a deliberative manner, Brazil has positioned itself in international forums on the subject of internet governance, emphasizing certain themes and visions:

- Complexity of the network ecosystem, with various actors assuming different roles;
- Multisectoriality and the definition of distinct and complementary roles and responsibilities for each represented sector;
- Digital gap persistence;
- Structural problems that contribute to the digital gap, such as difficulty in accessing technology;
- Asymmetry of representation among countries in international forums, given the restrictions of human and financial resources to engage on all negotiation fronts.

The governance system currently in place faces many challenges. The topics of cybersecurity, critical resource management, data governance, jurisdiction, and taxation are examples of critical points for global network governance.

2. Coordination and Integration Processes in the Digital Economy

Brazil has actively participated in agreements and international debate forums for the strengthening of the digital economy and the development of electronic commerce.

In 2020, Brazil participated in the G20 digital economy ministers meeting (OECD, 2020). The resulting declaration highlighted five points for countries to follow as key elements to drive inclusive, resilient and sustainable policies in the digital economy, considering the economic and health crises resulting from the Covid-19 pandemic: i) development of full access to connection, coupled with constant training and improvement of the skills needed to increase productivity in the economy; ii) enhancement of the use of Artificial Intelligence for economic and social development; iii) maximum utilization of the data flow, with security and reliability guarantee; iv) policies aimed at smart mobility; and v) production of knowledge about the digital economy, creation of indicators and continuous promotion of statistics that support the market.

Likewise, the final declaration of the sixth edition of the 2019 Brics Competition Conference highlighted the need for large-scale digital inclusion. The report on the meeting, generated by the Administrative Council for Economic Defense (CADE, 2019), also highlighted the problem of data concentration in certain regions and by the private sector, considering the fairness of competition in the global digital market. In 2021, ministers from the five BRICS countries signed a declaration of cooperation towards digital inclusion, with particular emphasis on expanding connectivity in remote rural areas (BRAZIL, 2021e).

With respect to electronic commerce, Brazil has sought to insert itself in different negotiating fronts, in which regulatory disciplines are established on the subject: Mercosur's extra-regional free trade agreements, with specific chapters on the subject (such as the agreement concluded with the European Union); the electronic commerce chapter in a bilateral protocol to the Economic Complementation Agreement with Chile; Mercosur's e-commerce agreement; and negotiations under the World Trade Organization (WTO) Joint Initiative on Electronic Commerce.

Finally, it is worth mentioning that Brazil has positioned itself within the United Nations in order to advance the discussions in favor of an open, secure, stable, accessible and peaceful cyberspace, with the enforcement of international law, including international humanitarian law and international human rights law.

3. Internationalization of Brazilian companies in the digital economy

According to the World Bank (2021), in 2020, the Brazilian service sector exported $28.4 billion, following a worldwide downward trend from the previous year. The result observed that year places Brazil as the 32nd nation in terms of service exports, as can be seen in Figure 11.

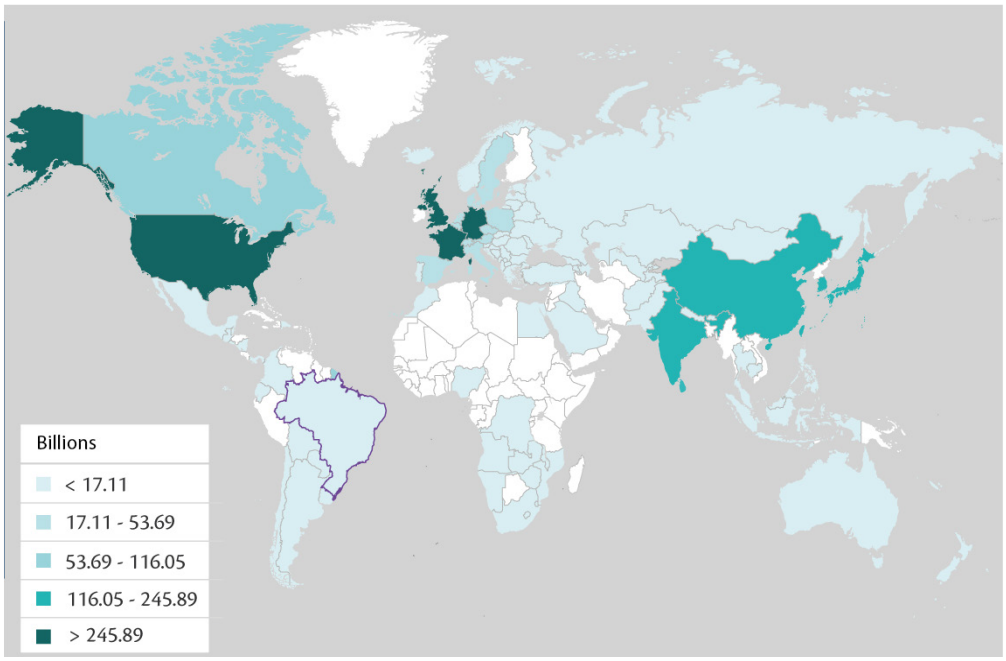


Figure 11 - Map of services exports (in US$ billion)

Source: World Bank (2021c)

According to statistics from the United Nations Conference on Trade and Development 2021 (UNCTADStat, 2021), in 2020 ICT services accounted for 8.6%, of total Brazilian exports, compared to 7.2% in the previous year, as shown in Chart 7. By comparison, in Argentina and Uruguay, Brazil's neighboring countries, this proportion reached about 20% of total exported services. This difference points out that there is room for growth, as long as it occurs by fostering competitiveness of Brazilian companies, especially those in the digital and small and medium segments.

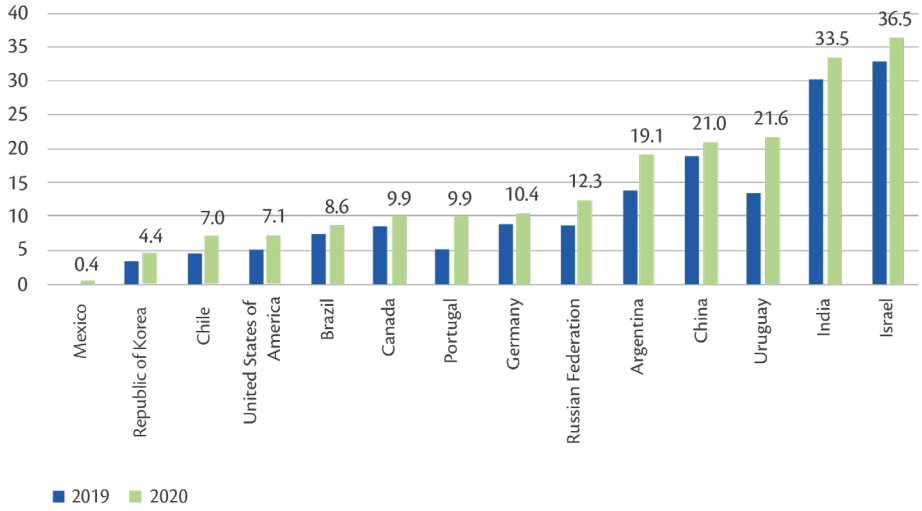


Chart 7 - Brazilian exports of ICT services (in % of total services exports)

Source: UNCTADstat (2021)

The governance of data and internet infrastructure, as well as regulation over critical technologies (in particular Artificial Intelligence), make up the biggest challenges facing countries in the international dimension, but these are not the only issues that relate to the outside world for digital transformation.

Equally important are initiatives that seek to insert Brazil in the international arena as a relevant player in the sector, such as the Diplomacia da Inovação (Innovation Diplomacy) Program (PDI), of the Ministry of Foreign Affairs (MFA). It is also fundamental to support innovative technology-based companies in their internationalization process, especially in terms of strategic advising on technological trends and routes and promoting connections with the world's most promising innovation ecosystems and environments. In this last aspect, the performance of the Science, Technology and Innovation sectors of the Brazilian embassies and consulates abroad should be highlighted.

Table 7 - Proposed Strategic Actions for the 2022-2026 quadrennium - Enabling Axis E

Strategic Actions
Take action in forums and promote negotiations to leverage the participation of Brazil in international digital commerce, including in the scope of the World Trade Organization (WTO)
Promote the issues of information society and Internet governance in forums, negotiations, mechanisms and coordination that deal with this agenda, guided by the goals of protecting human rights and promoting an open, secure and interoperable Internet.
Work for the implementation of the recommendations issued by the Open-Ended Working Group (OEWG) and the Governmental Expert Group (GGE), dedicated to promoting responsible behavior by states in cyberspace in the context of international security, and participate in the evolution of these recommendations in the OEWG 2021-2025 and other relevant forums.
Work with the various sectors of the economy and their supply chains to set goals and engage with global commitments, particularly with regard to the link between 2030 Agenda, the Sustainable Development Goals (SDGs), and the challenges of connectivity and digital transformation.
Promote the coordination of the Brazilian policy with the countless digital literacy development plans existing around the world, with emphasis on the actions of the United Nations (UN) and private organizations such as OpenExO.
Enter into international agreements that increase the security of cross-border e-commerce and minimize risks to society.
Expand and strengthen the country's participation in international organizations and forums on issues of digital transformation, including those that promote the ethical use of priority technologies.
Promote effective cooperation with international data protection authorities and the insertion of Brazil as a reference country in the personal data protection scenario.
Support the expansion of exports through electronic commerce of goods and services, including the creation of sector and regional portals and the promotion of training of Brazilian companies for exports, with support from national and international consultants specialized in e-commerce, Apex, the Brazilian Service of Support to Micro and Small Enterprises (Sebrae) and class associations.

Some results from the actions taken for Enabling Axis E in the 2018-2022 quadrennium

- The Ministry of Foreign Affairs is active in international forums on internet governance, such as the World Summit on the Information Society (WSIS), Internet & Jurisdiction (I&J), the Internet Governance Forum (IGF) and, within the United Nations, the UN Secretary General's Roadmap for Digital Cooperation. This includes, among its recommendations, the evolution of the current IGF into an IGF+, through the establishment of a multistakeholder high-level body (MHLB) (source: MRE).

- Under the coordination of the Ministry of Foreign Affairs (MFA), the GSI/PR has been regularly participating in various international forums. Among them are the UN (GGE, Ad hoc group, OEWG and IEG), the Organization of American States, Brics, and the India-Brazil-South Africa Dialogue Forum (Ibas) (source: GSI/PR).

- On the subject of internet governance and digital transformation, Brazil has been participating in bilateral dialogues with the European Union, Germany, the UK, the US, China, and Argentina, in which topics such as digital infrastructure, 5G, IoT, data privacy, etc. are discussed. Within Mercosur, pressing issues of internet governance and the development of a digital Mercosur are discussed.

- In the BRICS framework, the Ministry of Foreign Affairs has been acting in the Working Group on Cooperation in Information and Communication Technologies regarding the digital economy theme.

- Within the G20, the Ministry of Foreign Affairs is active in the Digital Economy Task Force, which as of 2021, has been elevated to the category of Working Group in the G20 structure, in the areas of expansion of connectivity infrastructure, SMEs digitalization, production digitalization, IoT, trust in the digital environment, indicators and measurement of cross-border data flows, etc.

- The MFA is active in the Internet & Jurisdiction Policy Network, a multistakeholder organization focused on policies and solutions to address legal challenges intersecting the digital economy, human rights, and security.

- The GSI has been participating in groups for the implementation of new mechanisms for the peaceful resolution of conflicts in the cyber environment, such as the UN's OEWG.

- Brazil has joined the Convention on Cybercrime (Budapest Convention), which serves as a guideline for the development of comprehensive national legislation against illicit acts on the Internet.

- The MFA is active in various mechanisms and bilateral and multilateral forums that permeate the issue of cybersecurity, such as transnational cybercrime and illicit activities (including terrorism), the use of ICTs in the context of international peace and security, emerging technologies, digital transformation, data protection and international human rights protection in cyberspace, etc.

- In the digital economy theme, the GSI has been acting in forums such as the OECD, G20, WTO, ECLAC, and Mercosur; and participates in the OECD's evaluation of digital economy policies, as well as in negotiations of trade agreements, subscriptions, and commitments signed. In its 2019 Brics presidency, Brazil presented a concept note for e-commerce cooperation, with proposed actions regarding regulatory frameworks, case studies in the areas of e-commerce, etc

- With regard to international e-commerce, the Brazilian Trade and Investment Promotion Agency (Apex-Brasil) leads the E-Xport Program, which has been working for companies to expand their business, using the best possibilities offered by e-commerce.

- In order to promote the expansion of exports via e-commerce from Brazil, the MFA has been working with Apex-Brasil in the mapping of opportunities and barriers, with partnerships for the elaboration of tools to encourage exports

- Aiming to support small and medium-sized enterprises (SMEs) to operate in international e-commerce, the Ministry of Economy (ME), in partnership with the UK, has been acting through the Prosperity Fund's Brazil Trade Facilitation Program, which seeks to increase the competitiveness of companies.

- The MFA has been working to promote the interaction between companies and entities interested in the expansion of exports with events and business rounds.

Digital Transformation Axes

F. Digital Transformation of the Economy

Board 6. General objective and specific objectives of the Digital Transformation Axis F (F1, F2 and F3)

Thematic axes	General objective	Specific objectives
F1. Digital transformation of the economy: data based economy	Promote the computerization, the dynamism, the productivity and competitiveness of the Brazilian economy, in order to keep up with the world economy.	• Promote the creation of a strong ecosystem for the development of the data economy, with incentives to develop telecommunications infrastructure and attract data centers to the country;
		• Enhance technical and human capabilities related to the use and handling of large volumes of data;
		• Promote a legal-regulatory environment that encourages investment and innovation, in order to provide security for the data processed and adequate protection for personal data;
F2. Digital transformation of the economy: a world of connected devices		• Support professional education and training in skills needed to develop and use new digital technologies related to connected devices;
		• Promote the development of technological solutions in the priority areas of health, agriculture, industry, and smart cities;
		• Foster the regulatory and business environment that promotes the attraction of new investments in • connected devices, in order to ensure trust and the preservation of users' rights.
F3. Digital transformation of the economy: new business models		• Strengthen the performance of Brazilian companies in the digital business environment;
		• Encourage and support nascent technology-based companies;
		• Develop flexible regulatory environments for experimentation with innovative business models.

Source: Decree No. 9.319 of March 21st, 2018 (BRASIL, 2018a)

Axes A to E of this strategy are crucial for the digital transformation to permeate all sectors of the economy and promote the expected effects on society, as well as for the consolidation of this process. Still, a set of measures must be taken in other spheres, such as investment in data infrastructure, allowing the storage and sharing of the growing volume of information produced. A technology responsible for generating a growing volume of data is related to connected devices (Internet of Things), which will allow greater competitiveness and added value to the Brazilian economy.

For this reason, this axis is subdivided into three, so that each of the themes can be discussed from its own perspective. Thus, F1 is dedicated to discussions of the data-driven economy; F2 is dedicated to the topic of connected devices; and F3, to new business models.

Diagnosis

The **infrastructure for storing and sharing** the growing volume of data created at all times and in all spheres of society is critical. Among those responsible for the growing generation of data are connected devices **(Internet of Things)**, which demand targeted investments for the development of technologies in the area. Furthermore, through IoT and other technologies, it will be possible to **implement new business models** , provided that regulatory frameworks are instituted, investments are made, and ICT innovation ecosystems are fostered, with the participation of various sectors of society.

F1. Data-based Economy

The reuse and repurposing of data promotes the recurrent increase of its value and makes it a new factor of production, just like material goods and human capital. At the same time, data also drives changes in sociability, so that its mobilization becomes increasingly habitual and indispensable. In this way, the production of data has direct consequences for the creation of new opportunities. However, this process involves risks, so formulating a strategy for its governance is essential.

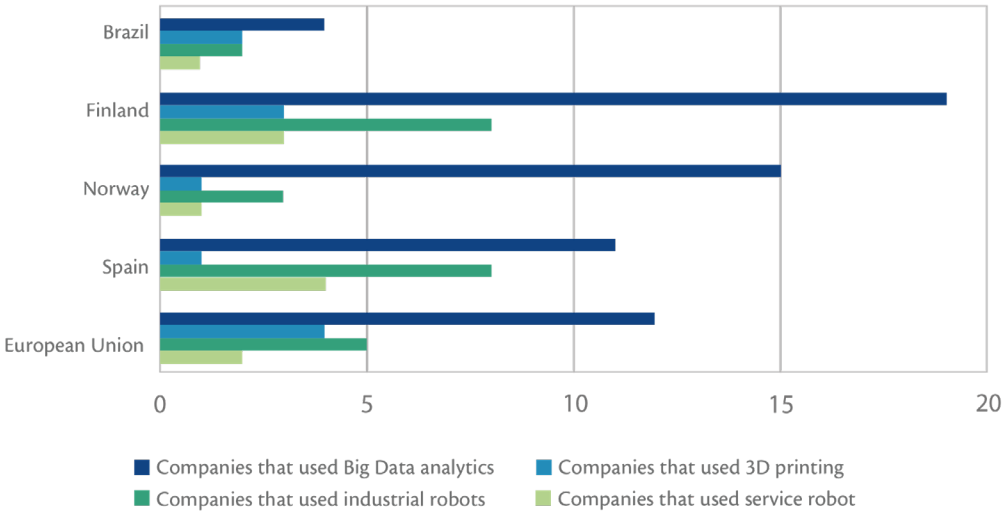
The large production of data has become essential for economic activity, so that it is not possible to conceive the improvement of business models and technological innovation - such as in artificial intelligence, machine learning , augmented reality, Big Data, cloud computing , biomedical technologies, among other relevant fields for socioeconomic development - without taking it into account. However, the increasing volume of data gives no guarantee that its effects will be beneficial. This growth requires an action plan that qualifies it, aiming at the data circulation and its reciprocal fertilization towards more complex services and products, in a consistent development movement capable of increasing the Brazilian income in the medium and long terms. Building converged solutions, such as an integrated national data system, requires that the design consider the security, privacy, integrity, and ethicality issues that their use may entail. In this way, issues are anticipated and guarantees are obtained that the aggregate result of these solutions will be the concomitant promotion of economic opportunities and social equity (WORLD BANK, 2021a, p.20).

Several countries already have the data economy as a pillar of their digital strategies, such as Denmark and the UK. The latter, for example, seeks, through its strategy, to leverage the use of Big Data, in order to increase the competitiveness and productivity of its economy. The reasons for this focus lie

in the importance and market value of the companies that produce, collect, and share data in the global economy.

In some respects, Big Data analysis has become a core activity in the contemporary economy, as it allows for a thorough observation of the user audience. Thus, approaches to potential consumers become more individualized and effective, although often invasive of users' rights, privacy, and security.

Still, the low use of Big Data by companies is a global phenomenon, observed also in countries with a high degree of economic and technological development. As an example, less than 20% of companies in Finland did Big Data analytics in 2018, while the average for the European Union was 12%. In Brazil, the proportion is considerably lower, with only 4% of the companies performing this type of activity (Graph 8). This scenario makes explicit a highly competitive dynamic, in which developing countries, such as Brazil, are at a disadvantage (CGI, 2020, p.106).



Graph 8 - Percentage of companies making use of new technologies in Brazil (2019) and European countries (2018)

Source: CGI, 2020, p.107.

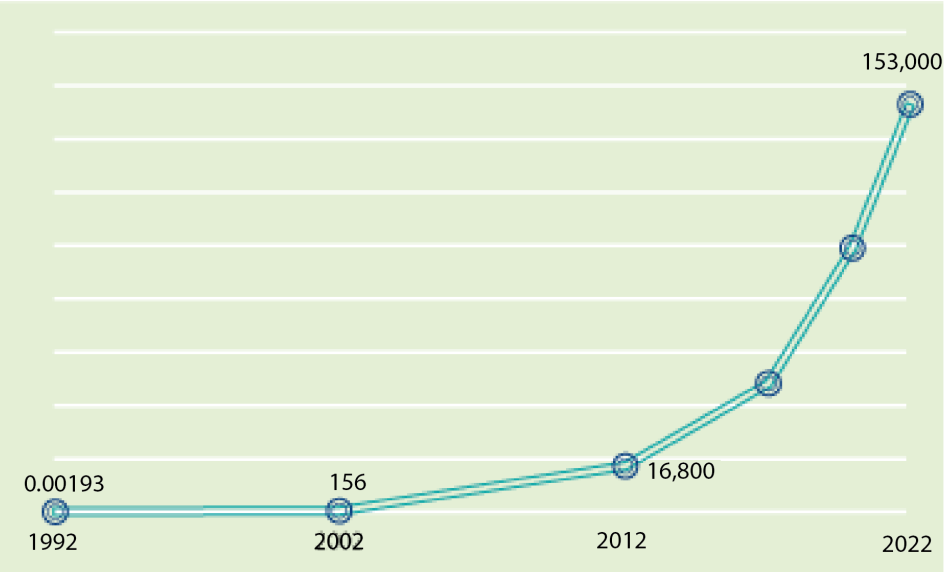
In this sense, the Brazilian Internet Steering Committee (CGI, 2020) recommends: the implementation of "collaborative public policies", such as the creation of "testbeds" or "structures for demonstration and prototyping of digital technologies" (CGI, 2020, p.116); the prioritization of initiatives aimed at solving social problems through more flexible instruments, such as technology orders; and the training of a qualified technical and managerial staff (CGI, 2020, p.117). Such indications corroborate the World Bank's argument about building convergent solutions and are, therefore, complementary. Furthermore, it is worth mentioning the importance of promoting institutions recognized for their excellence in data analysis and processing, bringing them closer to companies through flexible arrangements in order to optimize the bureaucratic framework, making it simpler and more agile. One example among these institutions is the National Laboratory for Scientific Computing (LNCC/MCTI), the main Brazilian research center in this field. Such a proposal was pointed out as the main

goal of E-Digital (BRASIL, 2018b, p.95-96) and highlighted by the CGI report (2020, p.37) as a persistent problem, to which is added as a recommendation the realization of more cohesive investments (reducing fragmentation) in larger projects (aiming at social outcome).

However, it is important to keep in mind that even countries that have developed regulatory frameworks lack institutions with administrative capacity, decision-making autonomy, and financial resources, resulting in obstacles to the implementation and enforcement of effective measures. Indeed, governance of the risks associated with data sharing is generally premature around the world, but especially in low-income countries. In these places, the gaps in key safeguards (such as cybersecurity, data protection, and cross-border data flows protection) and the dearth of mechanisms that promote collaboration (such as open licensing and interoperability) are often more severe. It is also worth noting that no low-income or lower-middle-income country has a data governance entity. Moreover, among upper-middle-income countries, Brazil is one of the few that has such an entity: the Central Committee for Data Governance (CCGD) (WORLD BANK, 2021a). The CCGD is a differential and needs to be strengthened, so that it can promote cohesion and speed in the process of formulating and implementing state actions in this area.

International Data Transfer

Cross-border data flows are an increasingly essential element of international trade as they intensify the production and distribution of goods, services, and products. Especially with the beginning of the 2000s, the trade of digital services and the commercial Internet has undergone a strong global expansion, bringing with it a huge increase in circulating data. The World Bank (2021c) estimated in 2020 global internet traffic at more than 3 zettabytes, equivalent to 100,000 GB per second (GB/s) per day, or 32 GB for every person on the planet per month. The projection for 2022 is a 50% increase in traffic, reaching 4.8 zettabytes, or 150,000 GB/s (Chart 9). Such exponential growth in data circulation has been greatly enhanced by the digital inclusion, even if partial, in middle-income countries like Brazil, which has benefited more people with Internet connections. In this regard, the Ericsson Mobility Report (2021, p.6) highlights the correlation between the increase in global traffic and the popularization of 4G in India and China in mid-2017 and 2018, thereby highlighting the importance of emerging country markets. As an example, in Latin America alone, 5G is projected to generate about $28.4 billion annually (ERICSSON, 2021, p.13).



Graph 9 - Global Internet traffic growth, 1992 to 2022, in zettabytes

Source: World Bank (2021c)

More recently, after the advent of the Covid-19 pandemic, with the need for remote working, a global increase in data traffic has been identified. In Brazil alone, internet consumption has doubled from 3 hours and 41 minutes to 6 hours and 44 minutes per day (ABRANET, 2021). Until the early 2020s, video calling was a little-used service. In the 12 months prior to the Covid-19 pandemic, only 35% of adults used the video calling service on a weekly basis. By May 2021, the number had jumped to 71%. Among these users, 38% used the service on a daily basis. Also, with regard to the study's data, among the countries that make up Latin America, Brazil has 20% inter-regional capacity and 79% of its population is a broadband user.

Developed countries have a more intense flow of data than developing nations. One of the reasons for this is the size of the population with Internet access. In the former group, about 90% of individuals in 2021 had this benefit, while in developing countries, the penetration rate was 57% (ITU, 2022). Moreover, developed countries tend to be leaders in the creation and diffusion of digital services and products in global trade, which results in a greater number of accesses to their platforms and websites (WORLD BANK, 2021b, p.99).

The World Bank (2021b) presents a diverse set of recommendations, emphasizing three pillars: values, trust, and equity. Among them can be highlighted:

1. Forge a new social contract for data, in order to increase its use and reuse, aiming at generating value and income;

2. Promote equitable access to the benefits derived from the digital economy;

3. Promote trust through safeguards that protect citizens and institutions against potential harm caused by the misuse of personal or sensitive data; and

4. Formulate and implement a national integrated data system.

The **open transfer** model is characterized by the absence of any restrictions on cross-border transfers of personal data. About 40 countries have adopted this model, and in these places it is the private companies that carry out their self-regulation, with voluntary adherence to eventual principles. In turn, the data model based on **conditional transfers** seeks to strike a balance between the imperatives of personal data protection and the need for openness of data transfers. Adopted by 66 countries, including Brazil, this model makes countries require a series of regulatory safeguards, and therefore mandatory for their trading partners, to allow the free flow of personal data between countries and companies(WORLD BANK, 2021b, p.239).

Therefore, it is important for Brazil to maintain and expand its open data policy, as a way to boost new businesses and solutions for society, but at the same time ensure that the state controls and reduces the risks associated with the misuse of data, such as political surveillance, monopolistic and anti-competitive practices, espionage, and leakage of personal or sensitive data.

It is also worth mentioning that the process of opening government data has been an important mechanism to promote a transparent environment for the state to act. Since the institution of the Open Data Policy of the Federal Executive Branch in 2016, Brazil has acted to consolidate the culture of open data and foster the theme and its importance. This effort aims to raise awareness among government agencies and society about the potential of data made available in an open format and the relevance of the subsequent sharing of analyses, applications, and other results obtained.

Promoting the participation and awareness of all actors in the open data ecosystem is also crucial for the Open Data Policy to generate concrete benefits for society. This is, therefore, a constant concern for Brazil. As a result, the country seeks to increase the dissemination of data of public interest, as well as improve the quality of the data made available, in order to strengthen the culture of open data; contribute to decision-making by public managers; and encourage social control and the development of new businesses.

Decree No. 9.903/2019, which amended Decree No. 8.777/2016, gave the Office of the Comptroller General (CGU) responsibility for managing the Open Data Policy of the Federal Executive Branch. This attribution is in addition to the previous one, to follow up and monitor, in a systematic way, the compliance with the Open Data Plans (PDA) by the agencies and entities of the Federal Executive Branch.

Since then, the Federal Executive Branch, through the CGU, has sought to act in line with internationally established guidelines and recommendations. Thus, initiatives are continuously undertaken to promote and engage the actors that make up the open data ecosystem; to encourage partnerships between the public and private sectors in order to create additional value for society; to

increase transparency and encourage the adoption of responsible data governance practices; to train social groups and organizations; and to prioritize access to data taking into consideration applicable laws and regulations.

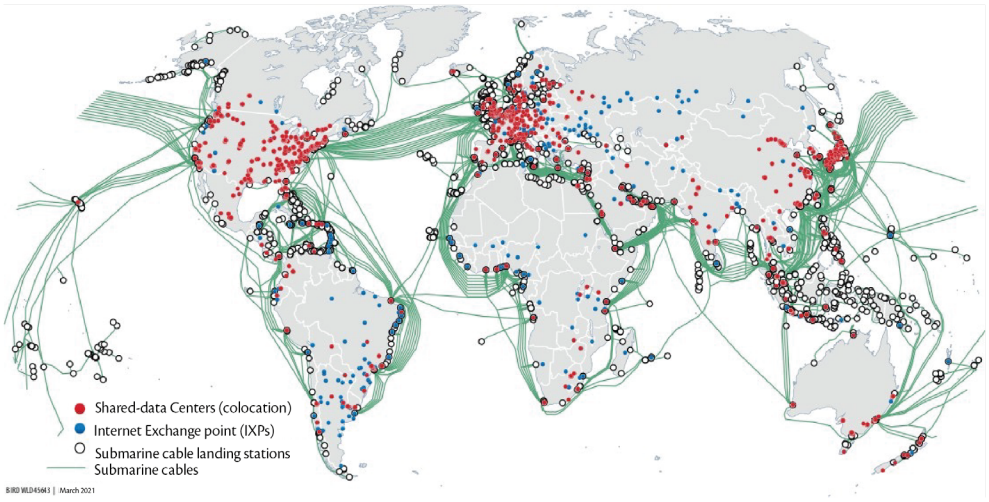
Data centers

Data centers are centralized repositories of data and information, integrated into a telecommunications network. The implementation of this physical infrastructure is a necessary element for storing, managing, and disseminating data and information. E-Digital (BRASIL, 2018b, p.64) highlighted the importance of the existence of data centers in national territory and their positive impacts on the economy by promoting the attraction and creation of innovative companies. The success of these companies depends on the availability of skills, infrastructure, funding, and regulation that aims at RD&I and boosts the production of software, digital content, and cloud computing, among other new technologies.

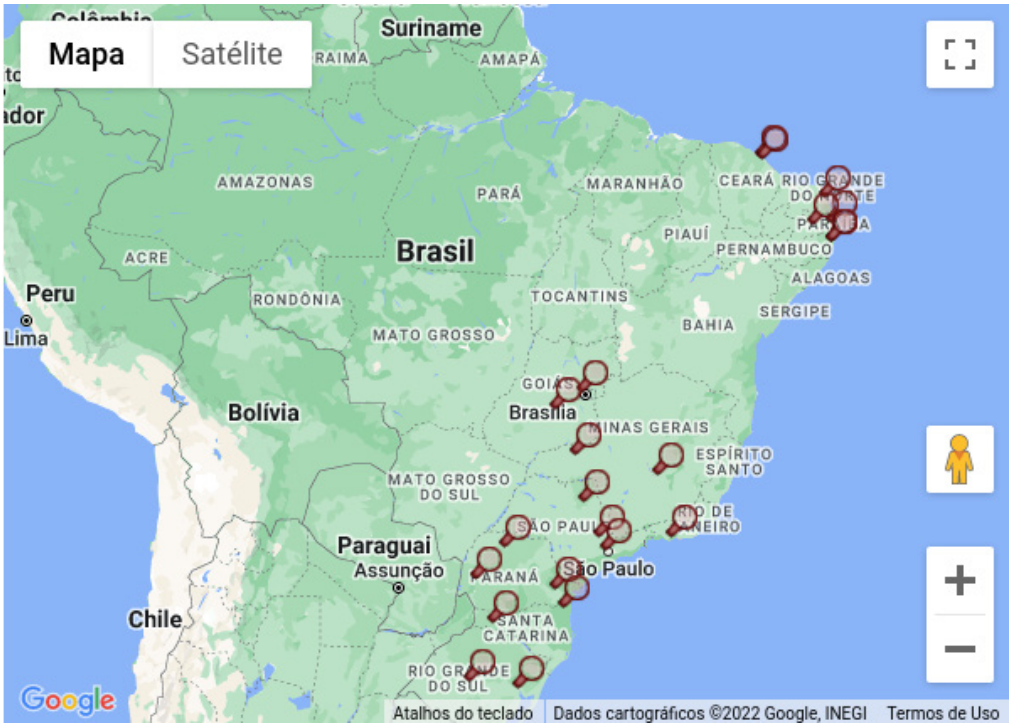
The Covid-19 pandemic has decisively impacted the demand for interconnection in data centers in Latin America. Similarly, the demand for public cloud use and hosting for 2025 is projected to grow by 50% (ABDI, 2022, p.3-4, 11). However, this market expansion has not been well used, because there are factors that restrict the expansion of data center implementation in Brazil. Among these factors, the Brazilian Agency for Industrial Development (ABDI, 2022, p.14) highlights three:

1. High costs for building and operating data centers related to the high tax burden and the high cost of energy and equipment imports;
2. Legal and regulatory uncertainty, derived from an instability in the rules and legal frameworks; and
3. Lack of qualified labor in the different expertise needed in the IT sector.

Considering Brazil's continental dimensions, its extensive land borders with other Latin American countries, and its large domestic market, the lack of data centers, even between capital cities, is a clear disadvantage, compared to the wide dissemination of these centers in the United States and Europe. Map 1 represents the availability of submarine cables, data centers, and Internet exchange points. In Latin America, the largest concentration of submarine cables is in Brazil, as well as the largest number of data centers. Currently, according to the Data Center Map (2022), there are 74 data centers in Brazil, distributed in 20 cities. As can be seen on Map 2, the Southeast and South regions stand out, with emphasis on São Paulo (28), Rio de Janeiro (9), Campinas (7), and Porto Alegre (4). In Latin America, Brazil is the country with the most data centers, followed by Argentina and Chile, both with 15. Also, according to the Data Center Map (2022), in the global scenario, the USA has the largest conglomerate of data centers (1,834), followed by the UK (264), Germany (227), and Canada (179), with Brazil in 12th place ahead of Spain (69) and Turkey (66). The average number of centers for the set of countries is approximately 38 and the median is 7, numbers that show a low dissemination and a high concentration of this type of infrastructure



Map 1 - Data Infrastructure Worldwide.
Source: World Bank (2021a, p.11)



Map 2 - Dissemination of data centers in the Brazilian territory.

Source: Data Center Map, 2022

ABDI's study (2022, p.31) points out that investments in data center units are expected between 2022 and 2024. It is noteworthy that public policies and incentives can promote new investments in the provision of services, including suburban regions and thus promoting the adoption of edge computing and 5G, which will be in increasing demand after 2023.

Table 8 - Proposed Strategic Actions for the 2022-2026 quadrennium - Digital Transformation Axis F1

Strategic Action
Enhance the open data policy of the Federal Executive Branch, involving all federal entities and civil society; encouraging and funding interoperability and processes based on data and the co-creation of tools, systems and platforms; and promoting the standardization of forms of access and supply of public data.
Create a National Interoperability Policy (syntactic and semantic at various levels, from architecture, system and device communication, terminology, and security).
Promote cooperation between competent authorities, seeking the harmonization of regulatory frameworks related to data (based on the processes and good practices of standardization in the national scenario) and contributions to international normative processes (ISO, IEC, ITU, WHO, etc.) in order to facilitate the insertion of Brazilian companies, including small and medium-sized ones, in global markets.
Use public sector procurement mechanism to support Data Center Policy implementation , in order to attract data centers and the development of the Brazilian data market.
Encourage open innovation, data portability and open data as tools for access to technologies, aiming at increasing the competitiveness of companies.

F2. A world of connected devices

E-Digital (BRASIL, 2018b) has already pointed to the emergence and multiplication of connected devices, which very soon will be everywhere and with the most diverse functions. In the update of this document, it is possible to state that these devices are incorporated into the routine of many Brazilians. Several houses already have televisions, air-conditioners, and lamps connected to the Internet, among other equipment. In industry, Internet of Things (IoT) applications are promising, given the increased productivity and competitiveness that can result from them, as a vector of advanced manufacturing or Industry 4.0 (Figure 12) (CGEE, 2022, p.24, 40).

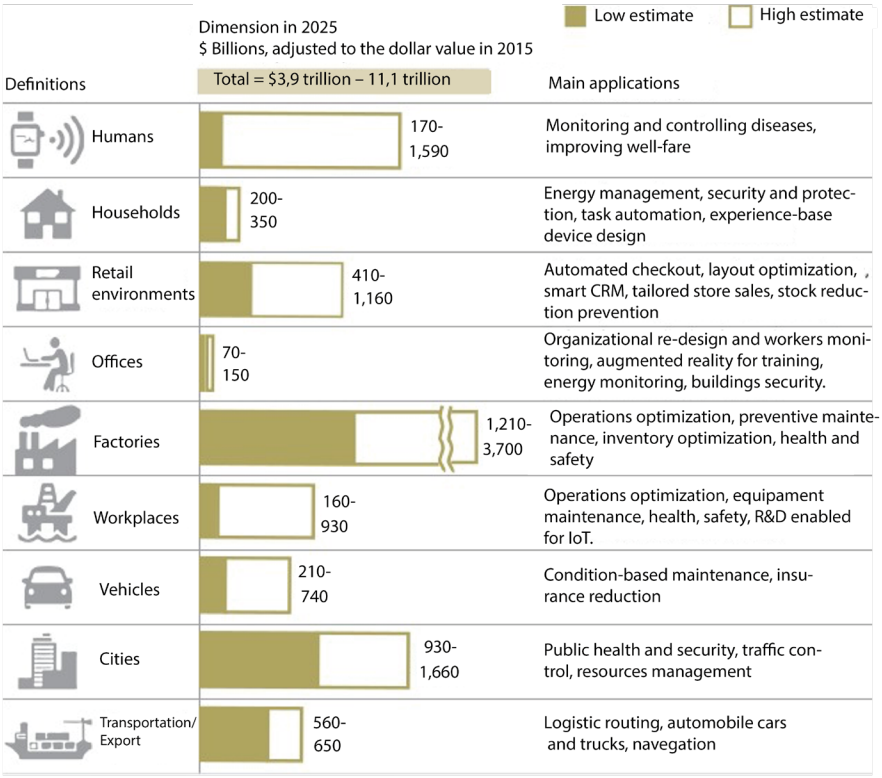


Figure 12 - Potential economic impact of the Internet of Things worldwide in 2025.

Source: CGEE, 2022, p.24.

There are many spaces that already have devices connected to the Internet, making people's lives easier. One example is the sensors connected to public transportation, which ensure greater assertiveness of bus and subway schedules (Figure 13).

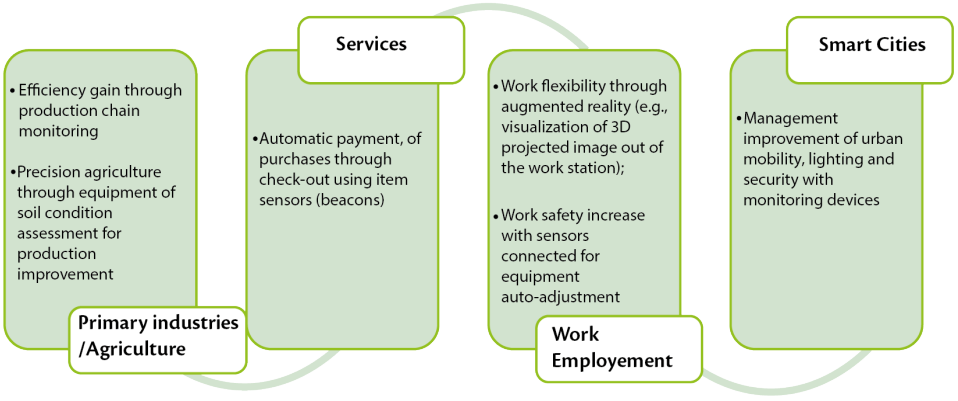


Figure 13 - Possible Uses of Internet of Things (IoT)

Source: Elaborated by the author

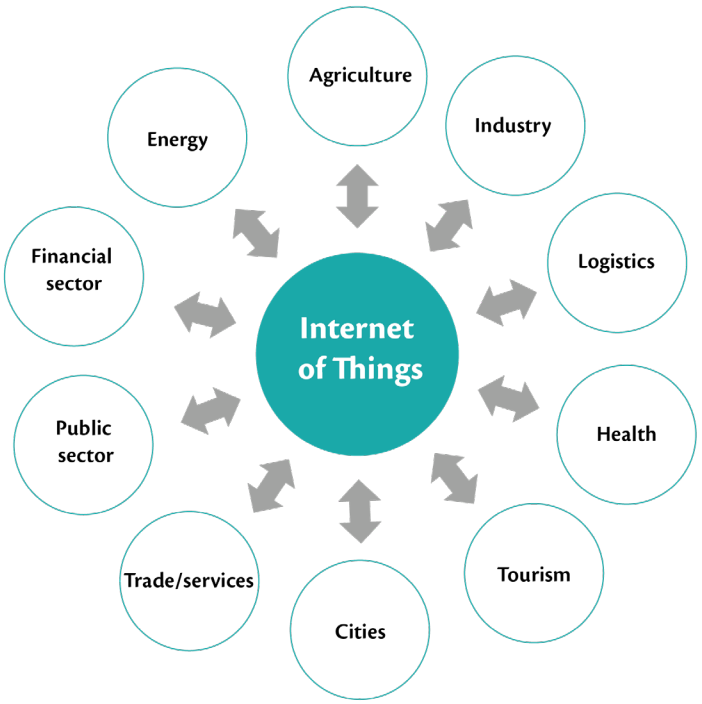


Figure 14 - Dimensions of the Internet of Things (IoT)

Source: Own elaboration from E-Digital (BRASIL, 2018b)

In fact, the growing connectivity and the emergence of new technologies based on the Internet of Things (IoT) will produce relevant transformations in the world of work, affecting the most diverse productive sectors and social dimensions (Figure 14). This will require new skills, expertise, and understanding about the potential and limitations of IoT (CGEE, 2022, p.45-51). These technologies are increasingly integrated, sometimes replacing and sometimes complementing professionals in tasks that are performed better and faster by employing innovations such as Artificial Intelligence, Big Data, 3D printing, cloud computing, and advanced robotics. The potential benefits of these innovations for rapidly adopting economies (frontrunners) seem to be significantly higher than those perceived in follower (e.g., Brazil) and laggard countries. Thus, the dissemination of such technologies is marked by a pattern of inequality that tends to widen the gap between developed, developing, and poor countries (CGEE, 2022, p.47).

Data from Cisco's report (2020, p.1) corroborates the diagnosis about the ubiquity of connected devices, the so-called ubiquitous computing. It is predicted that 66% of the global population will be connected by 2023, rising from 3.9 billion users in 2018 to 5.3 billion in 2023. Furthermore, the number of connected devices is also expected to increase, possibly reaching 29.3 billion by 2023, up from 18.4 billion in 2018. Machine-to-machine (M2M) connections are projected to account for half

of all connections: about 14.7 billion. From these, 2.1 billion are attributed to Latin America (CISCO, 2020, p.3), a region in which the average number of devicese and connections per capita projected for 2023 is 3.1, down from 2.2 in 2018. However, this is below the global average (Idem, p.7. Table 9).

Table 9 - Average devices and connections per capita

Region	2018	2023	Growth (%)
Middle East and Africa	1.1	1.5	0.4
Latin America	2.2	3.1	0.9
Asia-Pacific	2.1	3.1	1
Eastern and Central Europe	2.5	4	1.5
Western Europe	5.6	9.4	3.8
North America	8.2	13.4	5.2
Global	2.4	3.6	1.2

Source: CISCO, 2020, p.7.

According to the National Plan for the Internet of Things (BRASIL, 2019), the number of people connected to the Internet in the country grows year by year. A study by the National Bank for Economic and Social Development (BNDES) with emphasis on the industry sector and cities points out that the impact of the Internet of Things in Brazil is expressive. It is expected that by 2023, 199.8 million people will be connected to the Internet. Regarding the number of connected devices, the trend is for a 48% increase over 2018, totaling 755 million new devices. This growth will promote an impact on the Brazilian economy of $132 billion by 2025.

Some countries, such as India and the United Kingdom, in tune with the impacts of IoT, include in their digital strategies actions in favor of this technology or related ones, in order to boost productivity and gain competitiveness in international trade. Estimates by Unido (2019) point out that Brazil has been losing its capacity to add value to industrial production compared to other developing economies, while China's share has risen over the period 1990 to 2019. In the industrial competitiveness ranking among emerging countries, Brazil moved from 33rd to 35th place between 2010 and 2019. China moved from 8th to 3rd place.

Continuing to guarantee investment in technologies that promote greater productivity and competitiveness for the various sectors of the economy, especially considering the advance that 5G will bring, is the main initiative that Brazil must follow in this and the coming years. As mentioned in the E-Digital 2018-2022 (BRASIL, 2022e), it is important to highlight the relevance of the involvement of government sectors, companies, and academia (research) in initiatives aimed at the adoption and development of the Internet of Things (IoT) and new digital technologies, such as standardization of digital applications, digital security, modernization of the legal framework, training and professional qualification, and improvement of the business environment and infrastructure.

National Plan for the Internet of Things

In 2019, the National Plan for the Internet of Things was established (BRASIL, 2019), which was listed in E-Digital 2018-2022 (BRASIL, 2022e) as a strategic action to be implemented. The Plan aims to adopt and develop the Internet of Things in the country, based on free competition and free flow of data, from guidelines focused on information security and personal data protection.

The goals of the National Plan for the Internet of Things are:

1. Improve people's quality of life and promote efficiency gains in services by implementing IoT solutions;
2. Promote professional training related to IoT application development and job creation in the digital economy;
3. Increase the productivity and foster the competitiveness of Brazilian IoT developers by promoting an innovation ecosystem in this sector;
4. Seek partnerships with the public and private sectors for IoT implementation; and
5. To increase the country's integration in the international arena, through participation in standardization forums, international cooperation in research, development and innovation, and internationalization of IoT solutions developed in the country.

It was determined that certain environments would be prioritized for IoT solution applications, based on supply, demand, and local development capacity criteria. Among the environments, at least healthcare, urban, industrial and rural environments would be included.

Among the topics established to integrate the plan, with the goal of identifying solutions to enable the Internet of Things in Brazil, were: Science, Technology and Innovation (ST&I); international insertion; education and professional training; connectivity and interoperability infrastructure; regulation, security and privacy; and economic viability. Finally, the Chamber for Managing and Monitoring the Development of Machine-to-Machine Communication Systems and the Internet of Things (IoT Chamber) was created.

The National Internet of Things Plan addresses 43% of the SDG targets, such as target 2.4 (by 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase production), target 3.4 (by 2030, reduce premature deaths from non-communicable diseases by one-third via prevention and treatment), and target 7.3 (by 2030, double the global rate of improvement in energy efficiency).

The IoT Plan focuses on four main objects for innovation anchored on the Internet of Things: cities, health, agribusiness, and industry. In the cities, the proposal aims to: i) reduce travel times, considering the different vehicle modalities, and increase interest in public transportation; ii) increase surveillance and monitoring capacity aiming at public safety; and iii) reduce energy waste by creating a public lighting network with smart IoT-based solutions.

For healthcare, the IoT Plan's main objectives are to: i) improve the cost and effectiveness of treatments; ii) promote decentralized diagnosis; and iii) monitor the use of resources and supplies nationally, in order to improve management efficiency.

For the rural sector, the IoT Plan's main objectives are: i) to improve weather and soil monitoring to increase productivity; ii) to emphasize machinery performance management and; iii) to improve sanitation safety with increased animal health monitoring.

It is important to mention that Embrapii supported 591 RD&I projects in digital transformation (including projects focused on connected devices, systems integration, IoT, automation and robotics, among others), with 424 partner companies. More than R$789.7 million was mobilized and a total of 364 projects were concluded, resulting in 305 intellectual property applications.

To ensure that the Internet of Things is used and disseminated in society efficiently and promoting socioeconomic development, it is of utmost importance to pay attention to some bottlenecks in this theme. One example is the need to train professionals with the necessary skills to develop and use new digital technologies related to connected devices, a topic related to axis D of this strategy. Another challenge related to the Internet of Things refers to the need to ensure trust and the preservation of users› rights, an issue addressed in Axis C, about the use of new disruptive technologies and their ethical use.

Impacts on the primary sector: advanced manufacturing

The new industrial models, arising from advanced manufacturing and the Fourth Industrial Revolution, encompass extensive systems of advanced technologies, such as Artificial Intelligence, robotics, the Internet of Things, and cloud computing. According to the Industry Portal, from the S System, the use of these technologies has been changing on a large scale in automation and data exchange, as well as in production steps and business models, through the use of machines and computers.

Among the impacts of this type of industrial production, the gains in productivity stand out, with an average increase of 22% in the productive capacity of micro, small, and medium-sized companies in the segments of food and beverages, metalworking, etc. However, the challenges for companies to adopt the new technologies are diverse and include: investments in equipment that incorporate the new technologies; adaptation of processes and of the forms of relationship between companies along the production chain; creation of new specialties and development of competencies, etc. Few companies are prepared to face these changes, but thousands more will have to adopt and disseminate new technologies gradually, according to their trajectories, capabilities, and strategies. Thus, it is necessary to create incentive policies for companies to adapt to new techniques and new manufacturing structures.

The National Plan for the Internet of Things, considering the challenges explained, emphasized the creation of sectorial chambers, among which stands out the Industry 4.0 Chamber. Formalized in

2019, this chamber seeks to promote dialogue between the public sector, representatives of the industrial sectors, and academia in order to formulate and implement public and private initiatives aimed at the adoption of new technologies by Brazilian industry. Among the challenges of this chamber are:

1. Increase the competitiveness and productivity of Brazilian companies, by means of Industry 4.0;

2. Improve Brazil's insertion in global value chains;

3. Introduce the use of Industry 4.0 technologies in small and medium-sized enterprises; ensure instruments for technology-based companies and startups; and

4. Identify and develop solutions for Industry 4.0, among others.

Impacts on the primary sector: agriculture and livestock

According to the study by the United States Department of Agriculture (USDA) (2020), since the early 2000s, Brazil has led, among 187 countries, in the world agricultural production of soybeans, corn, beef, chicken meat, sugar, coffee, and orange juice.

Agriculture and livestock accounted for 27.4% of Brazil's GDP in 2021 (CEPEA/USP, 2022) and this participation is growing year by year. In 2017, the sector contributed 22% of Brazil's GDP. The expressive numbers are the result of growing productivity (between 2000 and 2021, the productivity of agriculture and livestock will grow an average of 3.18% per year).

The impact on GDP and the increasing productivity gains are due to the robust supply of agricultural credit, the provision of technical assistance, and investments in research, development, and innovation, favoring the adoption of new technologies by rural producers since the 1960s. At the same time, food and energy consumption is gradually increasing due to the growing world population and rising incomes in populous countries such as China.

Meeting demand and maintaining global leadership will only be possible with a broad digital transformation of agriculture and cattle-raising, including all strata of farmers. Among the prominent innovations in the field are mapping and remote sensing technologies, such as digitalization of machines and supplies, dissemination of Internet of Things devices and sensors, embedded software ,and Information and Communication Technologies (ICT).

However, it is important to highlight that a greater adoption of ICT in agriculture and cattle raising is strongly dependent on the availability of personnel trained to deal with these technologies in the field. According to the 2017 Agricultural Census (IBGE, 2017a), in that year, there were 15.1 million people employed in agricultural establishments. The projection is that in 2023 the sector will demand a total of 18.3 million jobs, and in 2031 the total demand will reach 18.8 million. It is also worth noting the more than 60% increase in demand for professionals in the fields of digital agriculture, digital

agribusiness, and digital agricultural engineering. In parallel, the demand for connectivity is essential for the use of applications, since it enables information dissemination, training, and integration to markets and databases in real time.

The supply and adoption of digital transformation in the field will depend on the public and private sectors, which have already been taking important actions in this direction. Embrapa's Strategic Plan for the 2014-2034 cycle is focused on the "insertion of agricultural assets in the digital market", enhancing its databases and ways of making available the company's technological assets, including recent internal developments. The company also develops projects in the robotics and Internet of Things segments, notably with applications in precision agriculture, from the digitalization of sensors, machines, and implements.

The National Plan for the Internet of Things includes the agriculture and livestock sector, with emphasis on the **Tropical Farm 4.0** initiative, which aims to increase the productivity and quality of Brazilian rural production with the use of data that helps to accurately monitor biological assets.

Furthermore, digital entrepreneurship stands out in the sector, through agritechs (agribusiness startups). There are 1,574 agritechs in Brazil, with most of them developing digital or related businesses. To leverage startups, some nascent business acceleration programs have been structured, within the scope of the federal government, such as Startup Brazil (MCTI) and InovAtiva Brazil (Ministry of the Economy).

Impacts on the Tertiary Sector: Digitization in the Service Sector

The services sector represented 72.8% of the value added to the Brazilian GDP in 2021. The sector is composed of various activities, such as transportation, logistics, postal services, information and communication, among others. Specifically, the transportation and ICT sectors were the activities with the most intense growth in the year 2021.

As pointed out in E-Digital 2018-2022 (BRASIL, 2022e), the connection between devices and other digital technologies will impact the service sector, with increasing productivity gains in activities such as health, logistics, infrastructure, and finance. One piece of evidence for the expected positive impact on the sector is in the fact that most innovative technology-based companies operate in the service sector.

According to McKinsey Global Institute (2021), the implementation of the Internet of Things in smart cities can improve the quality of life in several ways, such as: reducing water consumption by up to 20% and the problems with non-recyclable waste by between 10% and 20%; reducing commuting time by public transport by between 15% and 20%; causing a drop between 30% and 40% of the urban violence problems; and decrease by 20% to 30% the responses to emergency calls.

In healthcare, the uses of the Internet of Things can also be diverse, as in reducing queues in hospital care and in reducing operation costs, among others. The National Plan for the Internet of Things has as a proposal the **Hospital 4.0** project, which aims to use IoT for disease monitoring, making hospitals

of the Unified Health System (SUS) and primary care units more efficient. IoT use in healthcare has the potential to reduce 8% to 15% of health problems.

Among the measures already implemented with the objective of boosting this sector is the initiative of the MCTI/Embrapii Network for Innovation in Digital Transformation. The action supported 120 projects focused on IoT applied to the health area, mobilizing more than R$1.82 billion. In the area of intelligent cities, there are 20 projects so far, totaling more than R$1.37 billion.

As you can see, the Internet of Things has a multitude of existing and potential uses in the areas mentioned above and in many other sectors of the economy. Thus, it is necessary to be aware (foresight) of new uses and to foster innovation ecosystems. Special mention is made here of attractive environments for IoT investments, with investments in sandboxes, collaborative environments, and other related technologies that can boost the use and development of the Internet of Things.

Table 10 - Proposed Strategic Actions for the 2022-2026 quadrennium - Digital Transformation Axis F2

Strategic Actions
Foster the development and deployment of environments/platforms for validation and evaluation of Internet of Things (IoT) solutions, especially for the five priority verticals: Health 4.0, Agri 4.0, Industry 4.0, Cities 4.0, and Tourism 4.0.
Promote and foster scalability and replicability of national IoT open platforms, hardware, application in Research, Development and Innovation (RD&I) and entrepreneurship in the sectors prioritized in the IoT plan
Encourage innovative formats for digital and robotics product and service offerings, such as open IoT platforms and Robot as a Service (RaaS).
Updating the Legal Framework for Science, Technology and Innovation and having mechanisms for its disclosure, application and monitoring, with the objective of increasing the interaction between public research centers and companies and the coordination between national research infrastructures and promotion lines aimed at development of connected devices, aiming to promote scale gains and greater coordination in this type of investment in the country.
Stimulate the deployment of private 5G networks in various verticals of the economy.

F3. New Business Models

Digital platforms are services that enable interactions between two or more distinct and interdependent sets of users (businesses or individuals) who interact via the internet (OECD, 2019). In general, they integrate the various services available on the Internet, such as e-commerce, social media, search engines, applications, payment systems, and collaborative economy, among others (CADE, 2021).

This type of market has the potential to reach a global value of $30.4 billion by 2030. The growth projection is a result of the organizations' investments in the digital market, based on the opportunities seen in the last decade, and especially during the Covid-19 pandemic. Furthermore, companies in the industry are developing advanced technologies such as machine learning, Artificial Intelligence, and data analysis (BLOOMBERG, 2022).

According to the European Union (EU, 2016) report used in E-Digital 2018-2022 (BRAZIL, 2018b), to classify digital platforms, there are five types of business models:

1. **Online marketplaces** – where transactions are brokered between buyers and sellers of goods and services

2. **Mobile ecosystems and application distribution platforms** – through software, applications, and digital content are offered, either free or paid. They are also known as app stores

3. **Internet search services** – where users search for information on the Internet. The monetization of these spaces occurs through ads on the search pages.

4. **Social media and content platforms** – which the exchange of information, connections, conducting business, communication, and expression of ideas take place. Monetization also occurs through search engine advertising and user data aggregation[4];

5. **Online advertising platforms** – where the sale and purchase of web page advertising space take place.

Online marketplaces offer individuals and small and medium-sized enterprises opportunities for work and income. However, they need improvements, since regulatory and competitive challenges are still present, mainly due to the transnational nature of these companies (BRASIL, 2018b). E-Digital addresses these challenges.

When it comes to mobile ecosystems and application distribution platforms, Brazil is one of the countries where people stay connected the longest on their smartphones. Data from the State of App Marketing in Brazil report (APPANNIE, 2021) point out that in 2021, Brazilians spent an average of five and a half hours a day connected to a smartphone, an average increase of 30% over the time spent in 2019. The app market in Brazil will grow 20% between 2019 and 2021, reaching 230 billion app downloads in 2021, with spending of $170 billion (APPANNIE, 2021).

This market has great potential, considering the increasing use of smartphones for new functions and services offered on such platforms. One should also consider the scenario presented by the diffusion of the Internet of Things[5] and the potential to connect a considerable number of objects to the web.

In mature economies, such as the United States, app downloads stabilized during the pandemic. In Latin America, especially in Brazil and Mexico, the growth was very intense. Among the types of apps with the most expansion among Brazilians are finance (60% growth), business (55%), and education (45%) (DATA.AI, 2021). Brazil is the fourth largest download market in the world and a big market for

4 Regarding the use of personal and non-personal data aggregates, it is necessary to observe the ethical and legal issues of using this information. For further discussion,see the Enabling Axis Trust in the digital environment.

5 See thematic axis A World of Connected Devices.

local app developers, as 12% of the most installed apps in 2021 were produced domestically. China is the main developer market for apps consumed in Brazil (21% of the total) (APPANNIE, 2021).

Considering that Brazil is a large market in this segment and has potential for expansion, it is necessary to strengthen the performance of Brazilian companies in offering new products and services. There is a wide range of possibilities for innovation and possibilities for the development of small and medium-sized enterprises in the industry. One point to be carefully observed is the concentration of application platforms, which must be monitored due to possible risks of economic power concentration.

The fundamental role of a search engine is to make it easier for users to find certain information, products, or services in the face of the plethora of pages on the Web, which registers 4.26 billion indexed pages by 2022 (WORLDWIDEWEBSIZE.COM, 2022). Since the fundamental source of funds for these services is concentrated in the ads on the search pages, the advertising revenue in this area is proportional to the size of these platforms.

The search service in Brazil is widely spread among the population. In 2021, 93% of Brazilians have done some kind of online search (HEDGEHOG, 2021). Among searcher users, 88% used a single service, which concentrates about 90% of searches worldwide (STATCOUNTER, 2022; STATISTA., 2022); Among people who performed some type of search, 82% searched for content and information, and 70% searched for products for consumption purposes

The consumers behavior in the online search process points out that Internet research is a decisive element in the purchase journey of Brazilian consumers. Even when buying in physical stores, 19% of consumers researched the product of interest on search engines prior to making the purchase, while 12% of them searched directly on marketplaces (HEDGEHOG, 2021).

Social media and content platforms are services that enable online connection, sharing, business, comunnication , and expression. An important point is that, although platforms generally offer free content to users, the advertisements on them, in assition to the monetization of personal data aggregates, constitute their source of revenue (BRASIL, 2018b). iN 2021, social media advertising revenue in the United States increased 136% over 2017 (STATIST, 2021).

E-commerce platforms

E-commerce is one of the key activities of the digital economy. In this modality, the entire process that involves the transactions is digital, from the offer of the product or service to the finalization of the purchase, with payment. This segment of the digital economy has great investment and profitability potential for small and medium-sized enterprises.

The turnover of e-commerce platforms in Brazil has grown considerably and jumped from R$16.88 billion in 2010 to R$81.29 billion in 2019 (CGI, 2020a), pointing to a migration trend from physical purchases to the digital environment. Brazilian e-commerce represented 17.9% of retail sales in 2021,

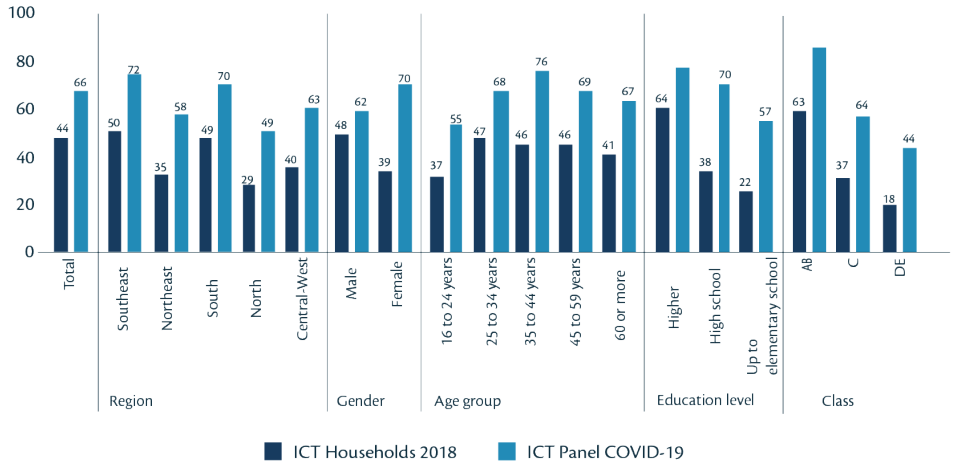
up from 4.7% in 2018 (MCC-ENET, 2022). With an average growth in revenues of around 20% a year, despite the economic crises, the sector remains strong and presents innovations and opportunities (CGI, 2020a).

Among the existing means for e-commerce are store websites , social networks, and instant messengers. Purchases made via instant messaging have increased from 26% of total transactions in 2018 to 46% in 2019. On store websites , transactions went from 60% to 67%, and on social networks, the variation was from 17% to 28% (CGI, 2021c). It is worth noting that the online sales market is driven not only by companies, but also by individuals offering products through different platforms.

Micro, small, and medium-sized companies have been growing in participation in Brazilian e-commerce . The share of small and medium-sized enterprises, of the total e-commerce companies, has gone from 8% in 2010 to 29% in 2019. Moreover, the share of micro and small enterprises in sales promises to reach more than a third of e-commerce by 2023 (CGI, 2020a).

The growth of micro and small businesses in online commerce matches to a large extent the parallel growth of marketplaces, which host stores of micro and small entrepreneurs on their platforms. Despite the many advantages, such as wide access to consumers, advertising and marketing, entrepreneurs face a high cost for using marketplaces (CGI, 2020a).

Online consumption has also grown at tremendous rates in recent years. Between 2010 and 2019, there was a 500% advance in the number of orders placed through e-commerce (CGI, 2020a). The increase in this type of consumption has occurred in all Brazilian regions, age groups, and social classes. In 2020, women surpassed men in the volume of online purchases: 70% of Brazilian women bought online, compared to 62% of Brazilians. A change in the consumption pattern can be observed in a short period of time, since in 2018 only 39% of women shopped online , while 48% of men did so (CGI, 2021a). Despite being well below the average of classes A and B - of which 83% of the members bought online in 2020 - there was a significant increase in online consumption among social classes D and E: from 18% in 2018 to 44% in 2020 (Chart 10).



Graph 10 - Purchasing products or services over the internet

Source: Covid-19 ICT Panel

***Inter**net users aged 16 and older (%)

In relation to the population's consumption expectations, in comparison to other countries, Brazil shows signs of maturity in online purchases. About 50% of the population consumes in digital and physical environments, and only 3% make their purchases exclusively in online stores. On the other hand, 10% of Brazilians choose only physical stores for purchases, a factor that indicates the resistance of a part of the population to online shopping. In other countries, the average population consuming exclusively online is 13% (UNCTAD, 2020).

To make consumers feel more comfortable in e-commerce, it is important to encourage new buying habits. In this regard, it is essential to ensure that transactions are secure and that consumers' rights are enforced, without causing unjustified harm to merchants and businesses. Even with the many advances made by e-commerce, the industry still needs adjustments to provide greater opportunities for companies to expand their business, create jobs, and consequently increase tax revenues. Furthermore, the sector has some obstacles in logistics and in tax, regulatory, and legal aspects (CGI, 2020a).

The Brazilian e-commerce still suffers from the lack of specific regulation of points specific to its dynamics. Among those generating the most impacts are consumer law, taxation, payments, and fraud (CGI, 2020a). The tax issue related to e-commerce received improvement in the rules for collecting the Tax on the Circulation of Goods and Services (ICMS) in omnichannel operations[6]. Moreover, the use of digital payment methods has become popular among the Brazilian population, through the Brazilian Instant Payment (Pix), launched in 2020. Pix has facilitated and enabled new people to enter digital entrepreneurship.

Brazilian e-commerce platforms continue to focus on the domestic market, as they did in 2018, due to the great potential for domestic consumption in the country. Few Brazilian companies are internationalizing or expanding their business to other countries, markets, and currencies, despite the fact that the Brazilian market has for some time coexisted with international players that can generate billion-dollar revenues (CGI, 2020a).

Creative economy platforms

With the intensification of digital transformation in the economy, almost all sectors have been incorporated in this digitalization process. The cultural sector is one of the most impacted, with entire segments practically adapted to the new business models.

The disruptive impacts of streaming platforms - data distribution whose information is reproduced as it is accessed, dispensing with the need for storage - are observed mainly in audiovisual consumption

6 Omnichannel is a retail trend that is based on the convergence of all channels used by a company. It is about the possibility of making the consumer not see the difference between the online and offline world. Omnichannel integrates physical stores, virtual stores, and buyers (SEBRAE).

environments, in which an effort to adapt to new technologies is perceived in an attempt to maintain economic viability.

Music

The E-Digital 2018-2022 (BRASIL, 2018b) pointed out the importance of digital transformation in the cultural market, especially music and audiovisual, encompassing all stages of the production chain: production, distribution, and consumption. The digital music market is widespread in Brazil, with 34% of people listening to music online daily or almost daily; 17% at least once a week; and 3% at least once a month (CGI, 2021a).

The streaming service accounted for 62.3% of the total global revenues of the (recorded) music industry in 2020, accounting for the strengthening of this market, which had been in decline since the early 2000s. Between 2019 and 2020, this global market showed a 20% increase in revenue. The number of subscribers to music streaming services worldwide has reached 443 million users, a growth of over 1,000% compared to 2017(IFPI, 2021).

As far as the Brazilian market is concerned, there was 28.3% growth in streaming subscriptions between 2019 and 2020. About 35% of Brazilians with a smartphone subscribed to some kind of music streaming service in 2021, compared to 32% in 2020. Among 16- to 29-year-olds, 47% have such a subscription. From people over 50, subscribers are 29%. It is worth noting that the country's market is still highly concentrated, with only three companies holding 77% of the paid digital music market (MOBILE TIME, 2021)

The E-Digital 2018-2022 (BRASIL, 2018b) presented the proposal for the regulation of some aspects concerning the applicable legislation for platform uses. The Normative Instruction No. 2 of 2016 from the Ministry of Culture established for collective management associations of copyright and related rights, complementary procedures to the qualification of the Internet collection activity.

However, it is important to note the transnational nature of music streaming services, which imposes the discussion of the issue on an international level. In 2016, Brazil presented, along with other Latin American countries, a document for discussion at the World Intellectual Property Organization (WIPO) that seeks to discuss these and other aspects related to the use of musical works in the digital environment.

Audiovisual

According to the National Film Agency (Ancine), the audiovisual sector's participation in the Brazilian economy was R$26.7 billion in 2018, representing 0.39% of GDP. Pay TV was largely responsible for the growth of the audiovisual sector until 2014 (BRASIL, 2018b). Between 2015 and 2018, growth was observed in the Video on Demand (VoD) segment, while the broadcast and pay TV segments

showed successive declines. In 2018, streaming already accounted for 20.9% of the value added by the audiovisual sector in the Brazilian economy, while in 2012 it represented 4.1% (ANCINE, 2019).

According to the Administrative Council for the Defense of Competition (CADE) (CADE, 2021), the VoD segment can be defined as the loose supply of audiovisual content, organized in a non-linear way and in catalogs, for on-demand access by the consumer. This activity is part of the life of a significant portion of the population: in 2021, 45% of Brazilians watched video on demand (VoD) (CGI, 2021a).

The audiovisual market is one of the most regulated in the world, encompassing several stages of the chain: content, financing, promotion, and exhibition. The E-Digital 2018-2022 (BRASIL, 2018b) identified that existing legislation for audiovisual activity did not apply to streaming platforms . This allowed the Ministry of Communications, through Administrative Rule 1.277/2020, to create a working group to conduct studies and prepare a proposal to update the legal framework regarding Conditional Access Services (WG-CAS)[7], in order to include streaming services.

The challenge for 2022 is to remain attentive to this issue and ensure a balanced competitive and regulatory environment that strengthens the sector's growth and guarantees quality of service for the consumer.

Digital Games

In 2021, the consumption of digital games in Brazil grew 46% compared to 2020, which resulted in a new rise in the sector's revenues that year: US$ 2.3 billion. The growth was 81% compared to 2016, which justifies the country's 12th position in the world scenario (GAME BRASIL, 2020).

According to the Games Sector Study (CODEMGE, 2020), there were 375 digital game companies in Brazil in 2018, 276 of which were formalized and 99 working in informality. The II Census of the Brazilian Digital Games Industry (IBJD) (BRASIL, 2018d) points out that developer companies are new: more than half had up to five years of operation in 2018. However, the percentage of non-formalized companies with operating time between two and five years is higher than the percentage of formalized companies in the same range. Among the reasons most cited by non-formalized companies for staying in informality are those related to costs and bureaucracy. Another challenge pointed out refers to financing. In 2018, about 30% of developers used their own or family capital to invest in the company and about 65% reported that they did not use any public funding sources.

Thus, even in the face of expressive numbers, the sector needs more incentives and investment for national developers. The Brazilian digital games industry is still at an early stage of development and

7 Conditional Access Service (CAS) is a telecommunications service for the transmission of audiovisual content in the form of packages and programming channels in several modalities, by any electronic means, technology or communication protocol. CAS is conditioned to some form of paid subscription or contracting, and includes mainly pay-TV, cable TV, DTV, and similar services.

needs to consolidate itself, with expansion of the sector and greater professionalization of businesses and entrepreneurs.

Digital Entrepreneurship

Technology-based companies have been leading the growth of the world economies. Between 2019 and 2020, new company projects in all sectors showed a 33% drop. Meanwhile, new company-specific projects in the IT sector have shown growth of 22%, according to the United Nations (UN) Investment Report (UNCTAD, 2021).

In 2010, the ten most valuable companies in Latin America were from the petrochemical, mining, and financial sectors. By 2021, three of the ten most valuable companies in Latin America will be digital-based, two from retail and one from the financial market. In the United States, the importance of technology-based companies is even more prominent, with the six most valuable companies in the country belonging to the IT sector. The sixth largest company produces automobiles, but is heavily IT-based (STARTUP GENOME, 2021).

Technology-based companies have several mechanisms to establish themselves in the market. Many prominent companies in the digital environment have migrated from traditional sectors, taking their activities into the digital environment, as has been happening with several companies in the retail sector. The pandemic has maximized this process, with many businesses migrating from the physical to the virtual environment, which demands a multitude of services from the Information and Communication Technology chain.

In this context, another strong and consolidated trend in digital entrepreneurship are startups. In Brazil, there are more than 14,000 startups (ABSTARTUPS, 2021). The state of São Paulo leads the ranking, with 4,642 startups, followed by Minas Gerais, with 1,427, and Rio Grande do Sul, with 1,116. Only three states in the South and Southeast concentrate about 50% of the Brazilian startups , which shows the strong regional concentration of this business model. Fostering initiatives in other regions would contribute both to leverage nascent businesses and to spread the distribution of startups throughout Brazil.

Regarding the market of operation, 11.5% of the existing startups in Brazil operate in the education sector; 9.4%, in the health and welfare area; and 8.5%, in the financial sector (ABSTARTUPS, 2021). In market value and ability to attract investments, the largest are in marketplaces and fintechs, capturing the largest share (35%) of private investments in startups in Brazil in 2021 (FINTECHS BRASIL, 2021). A market that is expected to grow in the coming years is the govtechs[8], which represented 1.8% of all Brazilian startups in 2021, with growth potential due to the increased digitalization of public services (KPMG, 2021). However, the challenges are still many, since the rules for contracting services by the public administration are stricter, such as the requirement to demonstrate experience and

8 Govtechs are companies dedicated to improving public services and processes, seeking to increase the efficiency of public management. They are active in several areas of public interest, such as smart cities, solutions for the environment, permits and bids, and data-driven monitoring.

prove financial sustainability. The Legal Framework for Startups, established in 2021, facilitates the contracting of startups by the public administration and, in this sense, measures for the evolution of laws are important.

The need for more resources for startups is not limited to the govtech sector. About 65% of Brazilian startups have never received investments. Among those that received, 41.4% got capital from angel investors; 22%, from seeds; 20%, from acceleration programs; 6.6%, from venture capital; etc. (ABSTARTUPS, 2021)

The insertion of startups in ecosystems is fundamental to create a cooperative environment between the companies themselves and other players in the system, which involves the public and private sectors and academia. About 30% of Brazilian startups have already connected with innovation hubs ; 21.6%, with corporations; and 17.6%, with academia (ABSTARTUPS, 2021). The incentives to mutual work enables the joint construction of projects to compete for funding public notices and other forms of investment. After the insertion of startups in ecosystems, it is necessary to ensure the sustainability of these communities, through the promotion of innovation culture, training and retention of professionals, support structure and infrastructure, a favorable regulatory environment, ensuring access to fair financing, and access to markets. Another challenge for this sector is the search for greater diversity

Table 11 - Proposed Strategic Actions for the 2022-2026 quadrennium - Enabling Axis F3

Strategic Action
Improve the competitive conditions between online platforms and intermediaries offering innovative services to end consumers by identifying mechanisms to mitigate network and lock-in effects arising from the scale of digital platforms.
To train public managers to encourage digital transformation in the productive sector, considering innovation in products, services, and business models, and prioritizing initiatives of a more technological nature and greater disruption of current models.
Promote and foster the mass adoption of ICT solutions for Small and Medium-sized Enterprises (SME).
Create and foster platforms for the development of new business models in sustainable markets, enabling greater value generation, increased scale, and competitiveness.
Support the implementation of mechanisms that increase security in online shopping.
Promote the integration of the collection processes and accessory operations, concomitantly with the export expedition procedures via electronic commerce, in an automated online and offline manner, including both the logistics and tax processes.
Encourage the adoption of alternative resolution mechanisms and friendly solution of conflicts in electronic commerce.
Create mechanisms to encourage access to computers, cell phones, devices , tablets, software, and cloud storage services for Individual Microentrepreneurs (MEI), strengthening the adoption of digital business models.
Strengthen the development of business models in the software and creative products and services market, such as audiovisual, music, and games.
Use mechanisms of absorption, in the public sector, of Information and Communication Technologies (ICT) developed by startups and companies.
Enable and expand access, by small and medium investors, to venture capital mechanisms for investing in startups.

Improve the legal frameworks regarding the use of human capital for entrepreneurial companies, including simplifying and facilitating the recruitment procedures for foreign professionals.
Reformulate legal and tax mechanisms for the reduction of investment risks and capital costs, facilitating more complex forms of capital composition capable of expanding the mechanisms available for investments in startups.
Strengthen initiatives aimed at cutting red tape to increase competitiveness, such as the modernization of corporate forms, the simplification of obtaining licenses, and the structuring of a favorable regulatory environment that does not make innovative business models unfeasible.
Enhance and coordinate government initiatives that support startups, including acceleration, fundraising, mentoring, and connection with investors, universities, and companies already consolidated in the market.
Develop flexible regulatory sandboxes for testing innovative business models.
Encourage and foster open innovation environments, aiming to promote the strengthening of innovative entrepreneurship and Brazilian startups , through the development of cooperative projects with the business sector, aiming to expand market access and success of startups, creating an internationally competitive environment to attract venture capital.
Develop a program to strengthen female entrepreneurship in areas related to Science, Technology and Innovation.

Some results from the actions taken for the Digital Transformation Axis F in the 2018-2022 quadrennium

- The institution of the Legal Framework for Startups, in 2021 (BRASIL, 2021f), is configured as one of the successful results achieved through the actions proposed in E-Digital 2018-2022. The law aims at modernizing the Brazilian business environment and encouraging innovative entrepreneurship as a means of promoting the productivity and competitiveness of the Brazilian economy and of generating qualified jobs. The text establishes new arrangements for resources input, the creation of an experimental regulatory environment (regulatory sandbox), and facilities for hiring startups to support the public administration;

- Programs to leverage the acceleration of technology-based startups, encourage the creation of innovative enterprises, and disseminate the entrepreneurial culture. Among these are the Startup Brazil Program, Centelha Program, Finep Startup , Finep Inovacred, Tecnova, Edital Tecnologia 4.0, Edital Startups IA, and the IA2 Program. Embrapii also has projects to foster startups, with hundreds of companies benefited by the program;

- The Ministry of Science, Technology and Innovation (MCTI) and the National Research Network (RNP) have projects with academia for the creation of startups, through the development of entrepreneurship within universities, with the counterpart of startups becoming suppliers in the products supply for the RNP system itself.

- Institution of the National Plan for the Internet of Things, through Decree No. 9.854, of June 25th, 2019, with the purpose of implementing and developing the Internet of Things in the country, based on free competition and free flow of data, observing information security and personal data protection guidelines.

G. Digital Transformation: citizenship and government

Board 7 - General Objective and Specific Objectives of the Digital Transformation Axis G

Enabling Axis	General objective	Specific objectives
G. Citizenship and digital transformation of the government	Make the federal government more accessible to the population and more efficient in providing services to citizens, in line with the Digital Government Strategy	• Offer simple and intuitive digital public services, consolidated on a single platform and with satisfaction ratings available. • Grant broad access to government information and open data, to enable the exercise of citizenship and innovation in digital technologies; • Promote the integration and interoperability of government databases; • Promote public policies based on data and evidence and predictive and personalized services, using emerging technologies; • Implement the General Data Protection Law within the federal government and ensure the security of digital government platforms; • Make digital identification available to the citizen; • Adopt cloud government processes and services technology as part of the technological framework of federal public administration services and sectors; • Optimize the Information and Communication Technology infrastructures; and • Train government teams with digital competencies.

Source: Decree No. 9.319 of March 21st, 2018 (BRASIL, 2018a)

The digital inclusion of society depends on the broad supply and use of digital public services. The Digital Government Strategy (EGD) has promoted advances in the digitalization of the federal public administration. However, many states and municipalities still need to expand the supply of digital public services. In addition, interoperability and open data policy must be improved.

The EGD has solved most of the challenges related to digital government, however, it is important that the strategy is constantly monitored to meet new demands and incorporate new technologies, and also encourage agencies and entities of the federal public administration, as well as state and municipal agencies, to adopt programs to implement and monitor digital government policies.

Diagnosis

The **broad supply of digital public services** depends on the implementation of digital government policies in states and municipalities. The constant improvement of the Digital **Government Strategy (EGD)**, considering the digital inclusion of the whole society, is the biggest challenge of this axis.

In 2020, the digital transformation plans resulting from the Digital Government Strategy (EGD) were put into execution (BRASIL, 2020b), by Decree No. 10.332, of April 28th, 2020, which establishes the guidelines, principles and focuses of action to move forward with the full digitalization of the State and its services. The EGD (2020-2022) is organized into 6 principles, 18 goals, and 59 initiatives, which drive the government's digital transformation through the use of digital technologies. The principles of the EGD are: citizen-oriented, integrated, intelligent, reliable, transparent and open, and efficient government.

In a continuous improvement movement, the Special Secretariat for State Modernization (SEME/SG-PR) and the Digital Government Secretariat of the Ministry of Economy (SGD/ME) promoted updating and adjustments to the EGD. Decree No. 10.996 (BRASIL, 2022g), published on March 14th, 2022, included security and privacy actions, focusing on critical government systems. Besides the concern with security and privacy aspects, initiatives have been incorporated that bring the government closer to the of govtechs environment, i.e., companies whose purpose is to generate innovation for public management and help save public resources, using technological solutions. There are still few companies in the sector, which needs more incentives and investment[9].

According to Digital Government data (BRASIL, 2020c), 89% of the actions planned in the Digital Transformation Plans have been delivered, considering the duration of the plan from 2020 to 2022. Among the 59 EGD initiatives, 37.3% are completed and 62.7% are in execution. The proposal is to offer, by the end of 2022, 100% of the Federal's services online. Data from April 2022 count 3,684 fully digital services offered to the population.

The main goal is to simplify bureaucratic processes of access to information and citizenship, and at the same time, to optimize investments, reallocating employees to areas that require strategic actions. The remarkable transversality of actions between institutions of different types shows that a digital government needs to have the power of macro-structural coordination, as well as to integrate data and services. In this sense, an initiative was established in the EGD that indicates the action to interoperate the federal government systems, so that at least 600 public services will have automatic information filling by 2022. By December 2021, there were 398 digital public services already integrated.

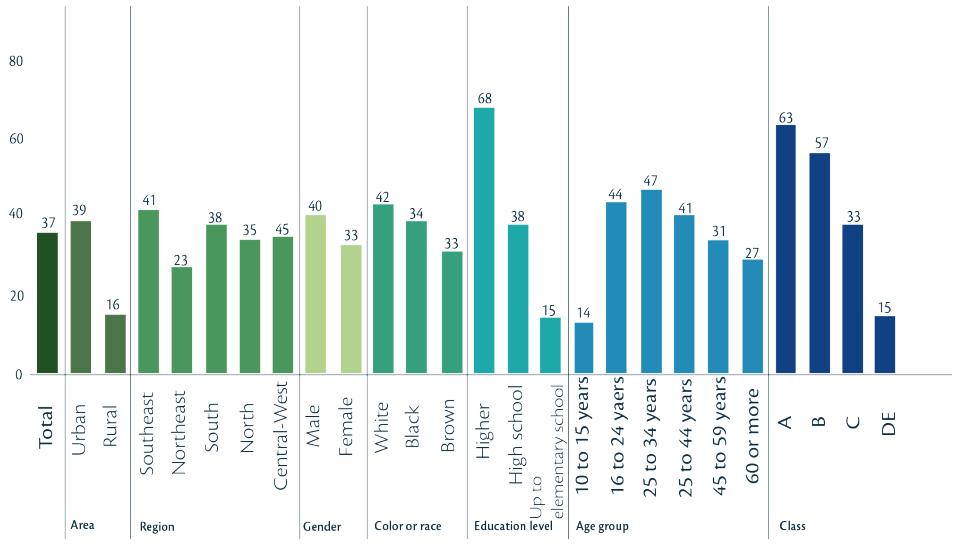
9 For more information on govtcehs, see the New Business Models theme axis

The Conecta (Connect) program (BRASIL, 2022h) provides a data services infrastructure [Application Programming Interface (API)] that enables automatic communication between government systems, eliminating the need for citizens to submit documents and data, with security and traceability in data sharing.

According to the UN's E-government Development Index (EGDI), the development of digital government in Brazil still lacks special attention to infrastructure. In the Americas, Brazil is now in 6th place in the ranking, behind only the United States, Uruguay, Canada, Argentina, and Chile, respectively.

Moreover, e-Participation, also called digital participation or online participation, refers to interactions mediated by digital technologies between the civil society sphere and the formal political sphere, and between civil society and the public administration, aiming at the influence of citizens - individually or collectively - on the outcomes of public decisions (FGV, 2017). Thus, Brazil was ranked 18th in the E-Participation Index (EPI), contained in the UN E-government Development Index (EGDI) (UN, 2020), among countries classified as very high level.

In the general classification, Brazil is in the 54th position among all the member countries, with a human capital index[10] of 0.7803. In relation to the open government data index, Brazil has reached an expressive 1, that is, the maximum indicator. The relevance of digital government also emerged in the ICT Household Survey 2020 (CGI, 2021a), done during the Covid-19 pandemic with adapted methodology. The survey showed an exponential increase in demand (14 p.p. increase) and in the use (9 p.p. increase) of online public services , with 37% of the total accesses and searches by type of service. However, the greatest demand is concentrated among the urban population, more educated and among classes A and B, according to Graph 11.



Graph 11 - Percentage of Internet users who used public services online

10 The index is from 0 to 1.

Source: ICT Households 2020

The data point out that there are many groups to be reached with digital public services, mainly the rural population, people with elementary school education, and the D and E social classes. The digital inclusion of these groups can start, precisely, by means of access to public services, since these have spread throughout the country. However, it is necessary to pay special attention to the barriers faced by groups that have greater difficulty in accessing the digital mean, such as illiterate citizens and the elderly, among others.

The spread of digital public services needs to occur at the municipal and state levels as well. The Brazilian Association of State ICT Entities (Abep-TIC) (BRASIL, 2021g) conducted a survey in 2021 pointing out the new ranking among state and district governments regarding the supply of digital services and the regulation on modernization for the supply of public services. Rio Grande do Sul, Bahia and Paraná were first in offering digital public services, while Rio Grande do Sul, Santa Catarina and Minas Gerais stood out in terms of regulation.

However, it can be noted that no state had a poor level of digital service provision, and in relation to the modernization regulation of service provision, three of those who responded to the survey had a poor level. They are: Maranhão, Tocantins and Sergipe.

Finally, the ICT Survey - e-Government 2019 (CGI, 2019)[11] brings relevant data to reflect on the necessary articulation between government entities of all levels with other public and private institutions, since, in this survey, it is evidenced the fact that the apparatus in terms of access and equipment is full (100%) throughout the territory in public institutions. According to the survey:

- In 2019, optical fiber was consolidated as the most cited form of internet connection by both federal and state public agencies (94%) and city halls (73%). The proportion of city halls in municipalities with up to 10,000 inhabitants that had this type of connection rose from 32% in 2017 to 63% in 2019. Among the municipalities with more than 10,000 to 100,000 inhabitants, the use of optical fiber rose from 52% to 79% in the same period;

- The adoption of citizen service tools in real time via the Internet is still low. Less than 10% of federal and state agency websites made real-time customer service available, either through live chat agents (6%), chatbots or virtual assistants (7%). Among the city halls, 13% had a chat service on their website, and 16% had their accounts on social networks;

- Two out of ten city halls (21%) had an operations center for situations such as traffic, security, or emergencies. Among the municipalities with operations centers, the main monitoring areas were public security (86%), traffic (73%), and municipal assets or public buildings (71%);

11 The updated version of the ICT e-Government Survey had not been published by the time this report was completed. Data from the latest version of the ICT e-Government Survey 2019 (CGI, 2019) were used .

- There has been an increase in the proportion of federal and state public agencies that have contracted cloud email services (from 25% in 2017 to 36% in 2019) and cloud office software (from 12% to 20%). Among those agencies with an Information Technology department, 23% performed Big Data analysis in the 12 months prior to the survey.

Table 12 - Proposed Strategic Actions for the 2022-2026 quadrennium - Digital Transformation Axis G

Strategic Action
Discuss limits of transparency, open government, social control and social participation.
Enhance the open data policy of the Federal Executive Branch, involving all federal entities and civil society; encouraging and funding interoperability and processes based on data and the co-creation of tools, systems and platforms; and promoting the standardization of forms of access and supply of public data.
Monitor the implementation of digital public services, seeking compliance with the principle of non-retrogression and non-stagnation, in order to ensure the necessary resources so that the benefits and facilities already achieved with the digitalization of public services are not taken away from citizens.
Improve the Digital Government Strategy and monitor its implementation.
Encourage bodies and entities of the federal public administration, as well as states and municipalities, to adopt programs for implementing and monitoring digital governance policies.
Fostering the participation of govtechs to overcome challenges in various areas, such as health, education, agriculture, environment, and infrastructure.
Promote actions to adapt government platforms to the Brazilian General Data Protection Law (LGPD), noting that the government is the holder, not the owner, of citizen data.

Some results from the actions taken for the Digital Transformation Axis G in the 2018-2022 quadrennium

- In E-Digital 2018-2022 (BRASIL, 2018b), the Digital Transformation: Citizenship and Digital Government axis had 11 actions. Most were rewritten after the establishment of the Digital Government Strategy (EGD) in 2020, and many have already been completed or are in progress. As an example of the deliveries of the EGD, besides those mentioned in the axis, the new version of the gov.br platform (BRASIL, 2021h), launched in 2021, deserves to be highlighted.

- The new platform, available as an application and website, simplified the Brazilians' access to public services. In addition to the unification of channels, the new version also includes the history of service use; information about which agencies had access to citizen data, in compliance with the LGPD; and the inclusion of new digital documents, such as: the Technical Qualification Certificate (CHT) of the National Civil Aviation Agency (Anac), a document required for pilots, mechanics, flight attendants and dispatchers; and five documents issued by the Brazilian Army, which were previously paper-based: Military Enlistment Certificate (CAM), Certificate of Dispensation from Military Incorporation (CDI), Alternate Service Dispensation Certificate (CDSA), Reservist Certificate, and Military Status Certificate.

- The strategy of unifying the digital channels for offering public services has resulted in a great deal of support from Brazilian society. At the beginning of 2019, the gov.br digital ID platform had only 1.7 million registered accounts. By March 2022, there were 126 million accounts created, 57 million unique monthly accesses, and about 245 million authentications per month. The possibility of using a single digital ID to access the platform's public services has brought much more confidence and convenience to the citizen. Moreover, with the use of biometrics, thousands of beneficiaries of public services now have the possibility to prove their lives, one of the requirements to continue receiving some benefits, without the need to go to the public offices.

- It can be said that the axis in which there were more advances was the one related to digital government. The Digital Government Strategy (EGD) has proven successful in improving access to basic services, as well as increasing the number of projects that make data available about administrative activities. Some points need to be improved, such as promoting the implementation of state and municipal digital public services, as well as the need to advance in the interoperability of government data, in order to produce a datalake that can serve as a basis for the formulation of public policies. Thus, it is necessary to monitor and contribute to the improvement of the EGD.

Acronyms and abbreviations found in this publication

ABDI | Brazilian Agency for Industrial Development
Abep-TIC | Brazilian Association of State ICT Entities
Abragames | Brazilian Association of Digital Game Developers
Abranet | Brazilian Internet Association
ACT | Technical Cooperation Agreement
AI | Artificial Intelligence
Anac | National Civil Aviation Agency
Anatel | National Telecommunications Agency
Ancine | National Film Agency
ANPD | National Authority for Data Protection
Apex | Brazilian Trade and Investment Promotion Agency
API | Application Programming Interface
Bacen | Central Bank of Brazil
BRICS | Brazil, Russia, India, China and South Africa
BNCC | Common National Curricular Base
BNDES | National Bank for Economic and Social Development
CAAs | Conduct Adjustment Agreements
Cade | Administrative Council for Economic Defense
Caged | General Cadastre of Employed and Unemployed
CAM | Military Enlistment Certificate
CATI | Information Technology Area Committee
CBL | Challenge Based Learning
CCGD | Central Data Governance Committee
CDI | Certificate of Dispensation from Military Incorporation
CDIO | Conceive Design Implement Operate
CDSA | Certificate of Dispensation from Alternative Service
Cefets | Federal Centers of Technological Education
Cetic | Center for Studies on Information and Communication Technologies
CGEE | Center for Strategic Studies and Management
CGI.br | Brazilian Internet Steering Committee
CHT | Technical Qualification Certificate
CITDigital | Inter-ministerial Committee for Digital Transformation
CNPq | National Council for Scientific and Technological Development
CoNCienciA | National Consortium For Open Science
DCN | National Curriculum Guidelines
DT | Digital Transformation
EaD | Distance Education
EBIA | Brazilian Artificial Intelligence Strategy
E-Ciber | National Cybersecurity Strategy
ECLAC | Economic Commission for Latin America and the Caribbean
E-Digital | Brazilian Digital Transformation Strategy
EGD | Digital Government Strategy

EGDI | E-government Development Index
EJA | Youth and Adult Education
eMBB | Enhanced Mobile Broadband
Embrapa | Brazilian Agricultural Research Corporation
Embrapii | Brazilian Industrial Research and Innovation Company
Enap | National School of Public Administration
ENCTI | National Science, Technology and Innovation Strategy
EPI | E-Participation Index
eRAC | Enhanced Remote Area Communications
ETEC | Technology Order
Finep | Funding Authority for Studies and Projects
FIs | Federal Institutes of Education, Science and Technology
Fiocruz | Oswaldo Cruz Foundation
Funttel | Fund for the Technological Development of Telecommunications
FUST | Fund for the Universalization of Telecommunication Services
GCI | Global Cybersecurity Index
GDP | Gross Domestic Product
GGE | Group of Governmental Experts
GIZ | Deutsche Gesellschaft für Internationale Zusammenarbeit
GSI/PR | Institutional Security Office of the Presidency of the Republic
HEI | Higher Education Institutions
HPC | High performance computing
IBICT | Brazilian Institute for Information in Science and Technology
IBGE | Brazilian Institute of Geography and Statistics
IBJD | Brazilian Digital Games Industry
IBSA | India-Brazil-South Africa Dialogue Forum
ICMS | Value-Added Tax on Sales and Services)
ICT | Information and Communication Technologies
IEG | Intergovernmental Expert Group
I&J | Internet & Jurisdiction
IGF | Internet Governance Forum
IMD | Institute for Management Development
Inep | Anísio Teixeira National Institute for Educational Studies and Research
Inpi | National Institute of Industrial Property
IoT | Internet of Things
ISP | Internet Service Provider
ITU | International Telecommunications Union
LGPD | Brazilian General Data Protection Law
LNCC | National Laboratory for Scientific Computing
MCOM | Ministry of Communications
MCTI | Ministry of Science, Technology and Innovations
MCS | Multimedia Communication Service
ME | Ministry of Economy
MEC | Ministry of Education

MEI | Individual Micro-Entrepreneur
MFA | Ministry of Foreign Affairs
MH | Ministry of Health
MHLB | Multistakeholder High-level Body
M2M | Machine to Machine
NFT | Non-Fungible Token
NSF | National Science Foundation
OAS | Organization of American States
ODIN | Open Data Inventory
OECD | Organization for Economic Cooperation and Development
OEWG |Open-Ended Working Group
Pais | Integrated and Sustainable Amazon Project
PBL | Problem Based Learning
PCS | Personal Communications Service
PERT | Structural Telecommunication Network Plan
Piec | Connected Education Innovation Program
PjBL | Project Based Learning
PNLD | National Textbook Plan
RaaS | Robot as a Service
Rais | Annual Social Information Report
RD&I | Research, Development and Innovation
Regic | Federal Network for Cyber Incident Management
RHAE | Human Resources in Strategic Areas Program
RIIA | MCTI/Embrapii Network for Innovation in Artificial Intelligence
RITD | MCTI/Embrapii Network for Innovation in Digital Transformation
RNP | National Education and Research Network
SaaS | Software as a Service
SDGs | Sustainable Development Goals
Sebrae | Brazilian Service of Support to Micro and Small Enterprises
Senai | National Service of Industrial Learning
S&T | Science and Technology
SGD/ME | Digital Government Secretariat of the Ministry of Economy
SinDigital | National System for Digital Transformation
SME | Small and Medium-sized Enterprises
SNCTI | National System of Science, Technology and Innovation
STIs | Science and Technology Institutions
ST&I | Science, Technology and Innovation
STEM | Science, Technology, Engineering and Mathematics
STFC | Fixed Commuted Telephone Service
SUS | Unified Health System
UFRGS | Federal University of Rio Grande do Sul
UN | United Nations Organization
UNCTADstat | Statistics of United Nations Conference on Trade and Development
UNESCO | United Nations Educational, Scientific and Cultural Organization

URLLC | Ultra-Reliable, Low Latency, Efficient Communications
USDA | United States Department of Agriculture
VoD | Video on Demand
WG-CAS | Working Group of the Conditional Access Service of the Ministry of Communications
WIPO | World Intellectual Property Organization
WSIS | World Summit on the Information Society
WTO | World Trade Organization

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