Internet Sectoral Overview

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New technologies and innovation in enterprises

Adoption of the Internet of Things, cloud computing, and Artificial Intelligence: A comparison between Brazil and European countries

By Luis Claudio Kubota[1] and Leonardo Melo Lins[2]

Introduction

The 1990s and the beginning of the 2000s were marked by an intense process of adoption of management software, such as Enterprise Resource Planning (ERP) and Customer Relationship Management (CRM). As of the 2010s, the emergence of technologies connecting the physical (for example, sensors) to the digital world becomes noticeable.

In this context, this article is focused on cloud computing, the Internet of Things (IoT) and Artificial Intelligence (AI). The choice is justified due to the auction of the 5G mobile Internet frequencies, which took place recently in Brazil and which provides for the expansion in the adoption of sensing technologies (IoT), and the processing (to a great degree in the cloud) and analysis of the resulting data (through techniques, such as AI).

Each of these technologies will be analyzed in this article, both within the domestic and international contexts. Next section presents an explanation about cloud computing, AI, and IoT, while the following section brings statistical data on its enterprise dissemination, both in Brazil and in European countries, as the international comparison allows for a more critical assessment on the level of adoption of these technologies by Brazilian enterprises. Next, a discussion is placed on what was previously presented and the final remarks conclude the text.

The brave new world of new information and communication technologies

Among the several technologies investigated by the ICT usage in Enterprises survey, carried out by the Statistical Office of the European

[1] Economist, he holds a master's degree and a PhD in Management from the Federal University of Rio de Janeiro (UFRJ), and is a researcher and coordinator at the Institute for Applied Economic Research (Ipea).

[2] Master's and PhD degree in Sociology from the University of São Paulo (USP), he is a researcher at the Coordination of Research Projects at the Regional Center for Studies on the Development of the Information Society (Cetic.br), a department of the Brazilian Network Information Center (NIC.br), where he coordinates the ICT Enterprises and the ICT Providers survey projects.

Photo: Ipea/Helio Montferre

Luis Claudio Kubota
Institute for Applied Economic Research (Ipea).

Commission (Eurostat), together with the ICT Enterprises survey, conducted by Cetic.br|NIC.br, this article will focus on the technologies that allow for a comparison with European countries: cloud computing, IoT, and AI. In doing so, we seek to understand the context regarding the adoption of technologies that have general application and are capable of changing the way all enterprises operate. These technologies present the biggest potential for disruption within the digital economy paradigm.[3]

Unlike previous information and communication technologies (ICT), whose implantation was to a large degree more limited to the corporate environment, the triad of IoT, cloud computing, and AI technologies is applicable to the most diverse human activities. Among other things, it may be used, for instance, in the fields of public security (surveillance), healthcare (remote monitoring of patients), and infrastructure (pipeline monitoring); as a result, the potential gains in productivity and well-being may benefit all citizens and not just enterprises and consumers. Its use in farming activity – which was less impacted than trade and services by previous technologies – is equally optimized.

The use of analytical techniques (within the framework of what used to be called data mining) was still – up to the beginning of the 2000s – relatively restricted to high-cost proprietary software. The popularization of open-source software, such as Python and R, coupled with the evolution of database technologies, has led to the democratization in the use of data science techniques. The *cliché* that data would be the oil of the 21st century occurs within this context.

On the one hand, within the scope of data science, the use of established machine learning techniques, such as cluster analysis, is adopted; on the other hand, deep learning techniques are also used, with an emphasis on algorithms arising from computer science, such as convolutional neural networks. This second set of algorithms comprises the AI techniques, which were originally inspired in the conformation of the neurons from the human brain.

The AI techniques are present, on the daily lives of everyone, in devices, such as Alexa, from Amazon, and Siri, from Apple, in self-service robots at call centers, Internet websites, and customer service channels via WhatsApp – the so-called chatbots –, and in countless other applications.

Cloud computing is a computing infrastructure solution through which resources, such as data warehousing, are supplied as a service and may be accessible from anywhere in the world. This solution revolutionized the way computing infrastructure is developed, offered, and used by users, firms, and developers. Cloud computing gained popularity due to its scalability and elasticity, both in terms of infrastructure and costs, with many providers offering pay-as-you-go solutions for users. In addition, there are also data safety and integrity gains (Sriram, 2022).

Cloud computing structures fully warehoused in a geographic unit are called centralized, whereas structures warehoused in different locations are called decentralized. Most of the decentralized structures use blockchain technology, which, in turn, uses distributed accounting technology to encrypt, track, and ensure all transactions in the network (Sriram, 2022).

[3] According to the United Nations Conference on Trade and Development (UNCTAD), the digital economy is comprised by the bundling of the Internet infrastructure and the supply of digital products and services (UNCTAD, 2019).

At the interface between telecommunications and production, the so-called IoT is in evolution. As a result of the 5G auctions – a spectrum characterized by high speed and low latency – we are noticing an increase in the communication between sensors and devices. The massive machine type communications (mMTC) – or massive IoT – can be made possible with the new 5G radio specifications, through the use of devices with long-life batteries, and may include millions of devices within a square kilometer. Hong et al. (2021) mention some examples of using mMTC: tracking of assets; agriculture, intelligent houses and cities; monitoring of energy and remote monitoring.

It is interesting to note how several of these technologies may be integrated. Phasinam et al. (2022) show an irrigation system based on IoT and cloud computing architecture, in which the data are warehoused and analyzed through machine learning techniques.

Photo: Personal archive

Leonardo Melo Lins
Regional Center for Studies on the Development of the Information Society (Cetic.br|NIC.br).

International comparison

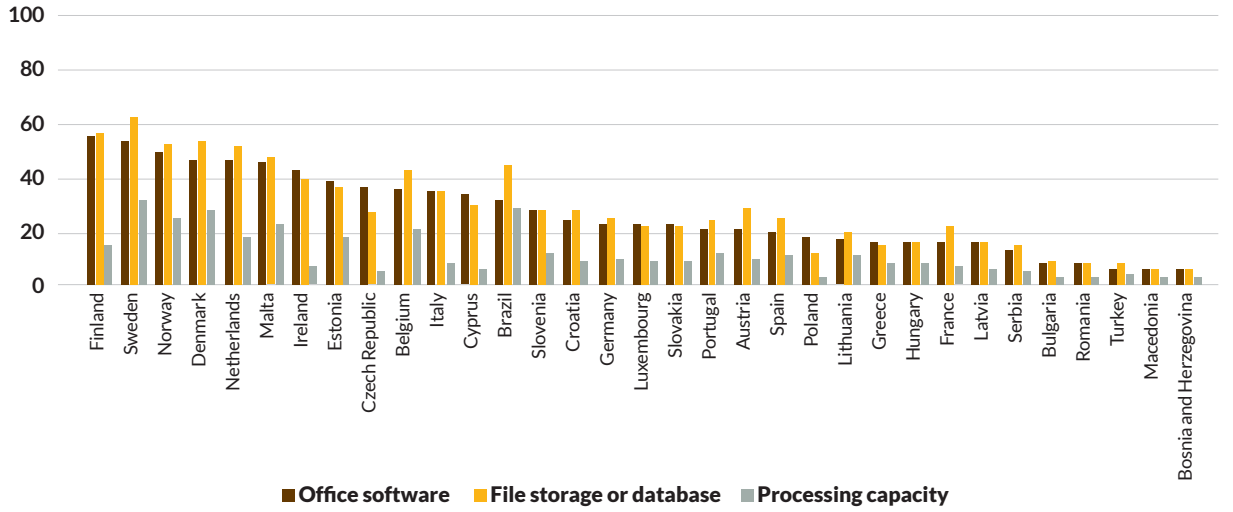
The main source of information on the use of new technologies by enterprises in Brazil is the ICT Enterprises survey, which has been carried out by Cetic.br|NIC.br since 2005.[4] In its fourteenth edition, the survey expanded the use of the framework developed by Eurostat,[5] in order to investigate, among Brazilian enterprises, the usage stage of technologies that are at the forefront of a new productive paradigm, making it possible to compare them with countries that stand out in terms of research, development, and innovation. By placing Brazil in comparison with European countries, we are able to outline bottlenecks and potentialities of the Brazilian economy *vis-à-vis* the international competition, as far as it is possible to determine its position in the use of advanced technologies in relation to countries with different productive structures.

As highlighted, cloud computing is one of the crucial infrastructures to support diverse applications that characterize the digital economy. The maintenance and manipulation of large volumes of data is only possible due to the cloud systems maintained by large datacenters, operating in a mirrored and decentralized way. In addition, the use of cloud computing provides great advantages for the companies, since the Internet connection already offers a series of services that, in the past, would demand large investments in physical equipment. Brazil ranks above various European countries in relation to the use of cloud office software, file storage or database in the cloud, and processing capacity. The Nordic countries stand out in the use of cloud services – especially data storage – but Brazil is ahead of several countries, with 29% of its enterprises using processing capacity in the cloud.

[4] Find out more: https://cetic.br/en/pesquisa/empresas/

[5] Find out more: https://ec.europa.eu/eurostat/cache/metadata/en/isoc_e_esms.htm

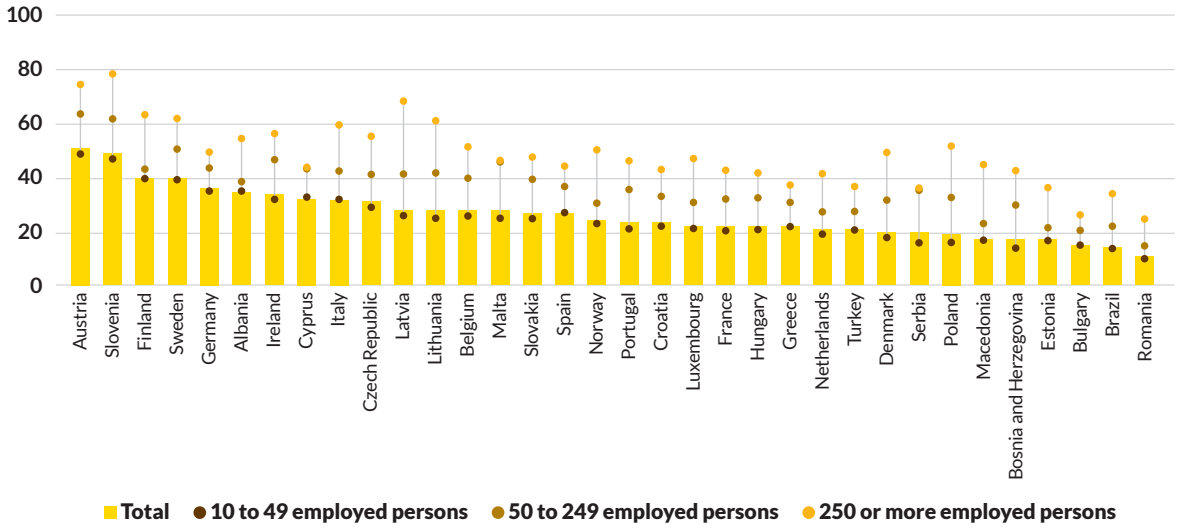
Chart 1 – ENTERPRISES THAT PURCHASED CLOUD SERVICES, BY COUNTRY (2021)
Europe: Total number of enterprises (%)
Brazil: Total number of enterprises with Internet access (%)



Source: NIC.br (2022) and Eurostat (2021).

The availability of large volumes of data is feasible, to a great degree, due to the communication of several devices connected to the Internet, allowing for the collection of data from diverse sources. As a result, it is possible to monitor diverse activities, giving rise to a variety of possibilities, ranging from increased customization of products for clients up to the improvement of machinery through a more detailed monitoring. As for the use of IoT at enterprises, it is interesting to note that it is not massively present in the Nordic countries, with Austria at the top position in its use, with 51% of its enterprises using some type of IoT technology, followed by Slovenia, Finland, Sweden, and Germany. Brazil, in turn, is at the second-to-last position in the comparison, next to countries with much less complex economies, such as Bulgaria and Romania, with 13% of its enterprises using some type of IoT technology. It is worth noting that, across all countries, the use of IoT technologies is led by large enterprises (those with 250 or more employed persons) due to their highest capacity for investment and experimentation.

Chart 2 – ENTERPRISES THAT USED SMART DEVICES OR THE INTERNET OF THINGS, BY COUNTRY AND SIZE (2021)
Europe: Total number of enterprises (%)
Brazil: Total number of enterprises[6] (%)

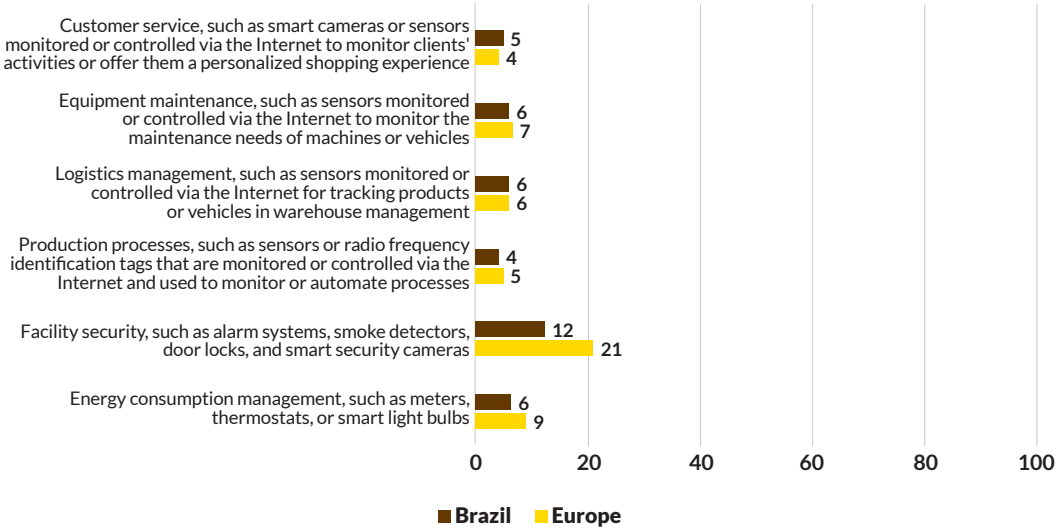


Source: NIC.br (2022) and Eurostat (2021).

Among the enterprises that use IoT technologies, it is important to investigate the purposes of their use, with a view to detailing how they have been applied in the productive processes. Both in Europe and in Brazil, the most used IoT technologies are those related to the facility security, such as alarm systems; however, in Brazil, there is a more pronounced use of energy management and logistics management systems. Technologies related to production processes are the least mentioned by European and Brazilian enterprises. These are typical of industrial plants adapted to the fourth Industrial Revolution productive paradigm. On the other hand, it is important to point out that approximately 5% of the Brazilian enterprises and 4% of their European counterparts stated they automate part of the process related to the customer, in order to explore whether this data collection is in compliance with the personal data protection principles of the legislation in force in the European continent (General Data Protection Regulation [GDPR]) and in Brazil (General Personal Data Protection Law [LGPD]).

[6] In view of the complexity of the subjects related to the IoT and AI, the ICT Enterprises 2021 survey (NIC.br, 2022) collected the new technologies module only among enterprises that informed they had an information technology (IT) area. Such choice is based on the previous knowledge about the greater structuring of this type of enterprise in relation to the other ones that comprise the survey sample. In the survey carried out by Eurostat (2021), the questions about new technologies were asked to all enterprises that used computers, while in the ICT Enterprises 2021 survey (NIC.br, 2022), the questions were only applied to those with an IT area or department, which corresponds to 44% of the enterprises. This also applies to Chart 4.

Chart 3 – ENTERPRISES THAT USED SMART DEVICES OR THE INTERNET OF THINGS (2021)
Total number of enterprises (%)



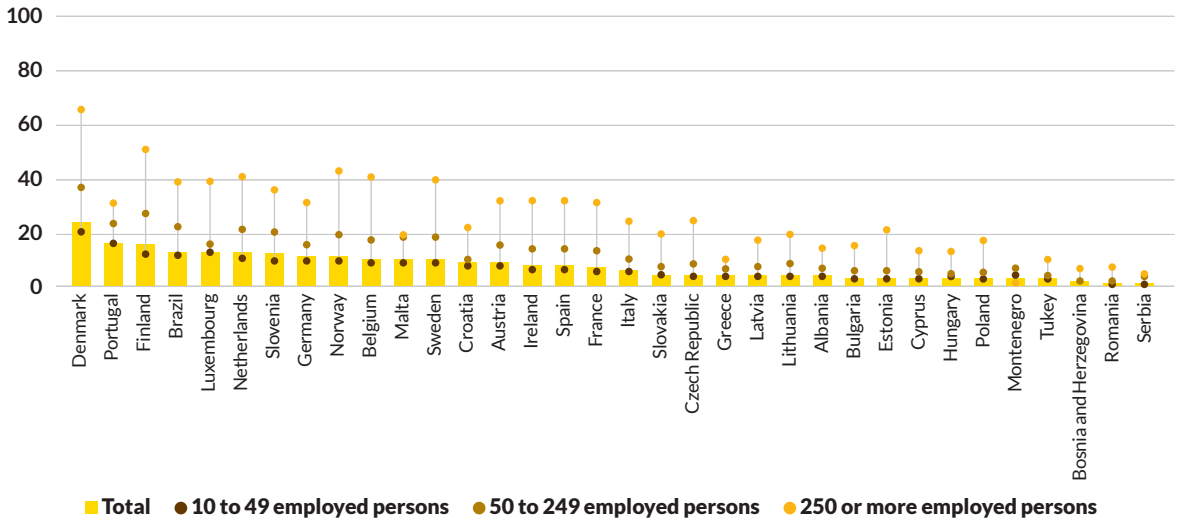
Source: NIC.br (2022) and Eurostat (2021).

Among the new technologies inserted in the productive processes, those related to AI applications promise to have the biggest impact, both for the benefits arising from their development and for the social impacts caused by their intense adoption in terms of the need for regulation and changes in labor. With a potential use in several processes across all industries, AI will bring about disruptive impacts to all economies. For that reason, it is important that countries seek to expand their capabilities to enhance the technological development and the absorption of the risks intrinsic to technologies with a wide range of uses.

When it comes to technologies that still do not have wide applicability, we note that even developed countries are at an incipient level of AI adoption. Denmark is the leader in the European continent, with 24% of its enterprises saying they use some type of AI technology, followed by Portugal and Finland. In this respect, Brazil is no different than most of its counterparts, with 13% of its enterprises using some type of AI. The low adoption level in countries such as Germany, Norway, and Sweden may indicate that the AI development frontier is not in the European continent, but in countries that seek to dominate the research and development of its uses, as well as to promote their companies across the global economy – that is, the United States and China (Lee, 2018).[7]

[7] Data from the OECD AI Policy Observatory and the AI Index Report from the Stanford University show that the United States and China concentrate the largest part of the scientific and AI research and development publications, as well as the largest number of enterprises that invest in technologies related to AI. The OECD data may be accessed at: https://oecd.ai/en/data?selectedArea=ai-research. The data from the Stanford University report may be accessed at: https://aiindex.stanford.edu/report/

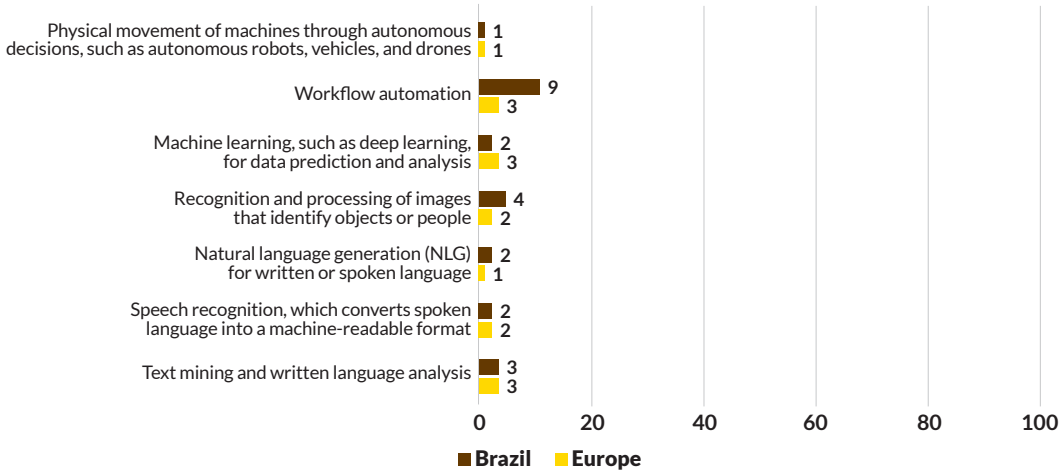
Chart 4 – ENTERPRISES THAT USED AI TECHNOLOGIES, BY COUNTRY AND SIZE (2021)
Total number of enterprises (%)



Source: NIC.br (2022) and Eurostat (2021).

Albeit incipient, we note that the use of AI is present in diverse countries, with different levels of technological maturity and economic complexity; therefore, it is important to determine the characteristics of this use. In this respect, Brazil stands out with a larger number of companies that used AI for workflow automation, followed by image recognition and processing. In the European continent, the different types of AI use are more distributed, although in very small proportions.

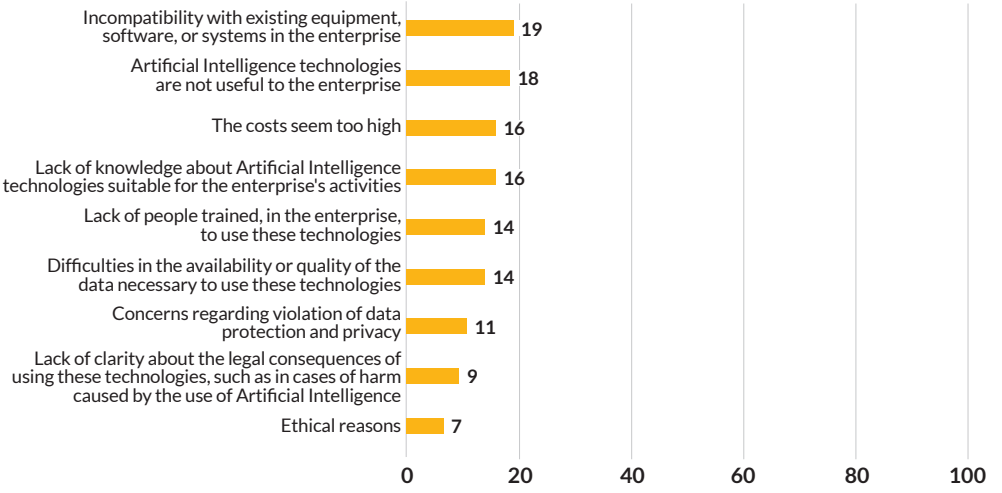
Chart 5 – ENTERPRISES THAT USED AI TECHNOLOGIES, BY TYPE (2021)
Total number of enterprises (%)



Source: NIC.br (2022) and Eurostat (2021).

Finally, it is worth analyzing the difficulties faced by the enterprises to insert AI in their routines. When it comes to technologies that, to a great extent, are still in their development phase, several uncertainties may get in the way for a market use that may actually be useful for enterprises, or that may even be an innovation (Frey, 2019). In the case of Brazil, the most mentioned reason for not using any AI application was the incompatibility with existing equipment, software, or systems in the enterprise (19%), followed by the idea that AI technologies are not useful to the enterprise (18%).

Chart 6 – ENTERPRISES THAT DID NOT USE ARTIFICIAL INTELLIGENCE, BY TYPE OF BARRIER (2021)
Total number of enterprises that did not use AI (%)



Source: NIC.br (2022).

Discussion

The comparison between Cetic.br|NIC.br and Eurostat data evidence that there is a need among Brazilian enterprises of all sizes of accelerating the adoption of the infrastructure required to promote the development of more advanced digital economy technologies, as shown by the cloud services usage indicator. In terms of technologies related to the digital economy, we may note that, despite the IoT being the most disseminated one among large Brazilian and European enterprises, they are very concentrated in security devices and less in devices directly related to the productive processes.

There is a small proportion of enterprises using some type of AI, even in Germany and in the Nordic countries, with no significant differences between these and Brazil. Everything suggests that most of the countries are going through an adaptation period regarding the use of AI, with the adoption of these technologies more prevalent among large enterprises, due to their capacity for allocating financial and technical resources for the development of their own solutions. However, just as seen with the use of IoT, the use of AI is more associated with some auxiliary process, and it is not decisive for the core business of the enterprise.

The data presented call into question the role of developing economies, such as Brazil, and developed ones, such as the Nordic countries, in the development of future-oriented technologies. All the analyzed countries need to

accelerate the technological maturity of their enterprises by fostering a wider dissemination of digital economy-related technologies. Most countries are still seeking to accelerate the process for the technological implementation of basic infrastructure for the most modern uses, while they have few enterprises operating at the forefront of research and development.

Among the improvements, it is possible to ascertain that in Brazil there are extremely advanced examples of IoT use. For example, Vale has used self-driving mining trucks at the Brucutu mine, in São Gonçalo do Rio Abaixo (in the state of Minas Gerais), since 2016, and, since 2019, all 13 trucks in operation have been self-driving vehicles: the initiative allowed for the increase in the security and efficiency of mining activities (Federação das Indústrias de Minas Gerais [FIEMG], 2020). Another example was the development by the Wernher von Braun Advanced Research Center of the ultra-high frequency tag used by millions of vehicles in the Brazilian toll plazas, as well as the sensors for identifying, tracking, and validating goods produced in Brazil (The Technology Headlines, 2019). One of the main challenges is expanding the adoption of these emerging technologies by small and medium enterprises (SME), since the adoption by large companies only is not enough to ensure the productivity gains required by a country such Brazil.

Final remarks

The Cetic.br|NIC.br and Eurostat data indicate a still incipient adoption scenario of the main technologies that comprise the new digital economy in Brazil and in European countries. In the Brazilian case, we perceive an intermediary scenario in the adoption of technologies. The South American country is gaining an advantage over its more developed European counterparts regarding some indicators.

In most cases, IoT-related technologies and AI applications are used in subsidiary processes and are not a decisive factor for creating competitive differentials for enterprises. On the other hand, it is important to highlight that, although these technologies – especially AI developments – promise several disruptive consequences for society and the economy, there is an initial maturation stage for the majority of their uses, with some applications limited to the productive processes.

It is important that crucial aspects of the digital economy infrastructure, such as the use of cloud services, advance further among Brazilian enterprises, empowering them for the adoption of more complex technologies. As much as a continuous improvement in the connectivity of enterprises is observed,[8] there are still issues involving the insertion of digital technologies in their routines, which may bring about efficiency and productivity gains. Regarding this aspect, the comparison between the ICT Enterprises 2021 survey (NIC.br, 2022) data with the Eurostat (2021) survey points to a similar scenario between Brazil and Europe, in which we observe a period of experimentation with advanced technologies, especially among large enterprises.

All the analyzed countries need to accelerate the technological maturity of their enterprises by fostering a wider dissemination of digital economy-related technologies.

[8] The ICT Enterprises 2021 survey has shown that fiber optics is the most used Internet-access technology by enterprises, reaching 87% of the them, a 20% increase in relation to the 2019 survey (NIC.br, 2022). As a result, the Internet connection speed of Brazilian enterprises increased, with 53% of the enterprises reporting speeds over 100 Mbps.

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Interview I

Digital transformation in enterprises

Johannes Bauer is a professor at the Media and Information Department and director of the Quello Center at Michigan State University. In this interview, he discusses the challenges for the digital transformation of enterprises, the role of emerging technologies for the digital economy and their implications for digital security and the promotion of an environment conducive to innovation.

Internet Sectoral Overview (I.S.O.)_ In terms of technology infrastructure, what advances are needed to support digital transformation in enterprises at the global level? How do the digital gaps between Global North and South countries affect digital transformation in enterprises?

Johannes M. Bauer (J.B.)_ Digital transformation refers to multiple developments that unfold in parallel and intertwined with each other. Most practitioners define digital transformation as the broad adoption and integration of digital technolo-

gies across all areas of an organization. Based on an integrative vision, embedding digital technologies across business processes and organizational units will deeply change value creation and relationships with suppliers, customers, and other stakeholders. Although less frequently emphasized, digital transformation also implies the leveraging of technology to create new opportunities for innovation, to drive value generation to the next frontier. This requires a cultural transformation that goes beyond technological transformation.

The coexistence of these two aspects of digital transformation creates new challenges for the enabling technological infrastructure. Broad digital transformation requires the availability of high-speed, mobile and fixed, Internet connectivity. Empirical research shows that the benefits of connectivity for individuals, organizations, and communities happen at levels close to universal technology adoption. Advanced digital services require complementary assets and functionality, such as the availability of cloud storage, and computing power for increasingly demanding machine learning applications. In addition to widely available connectivity and digital resources, broad-based digital transformation requires the availability of appropriate devices to access services.

To drive digital transformation to the next level, and unlock new innovation opportunities, the technological infrastructure also must support the provision of new experimental services to selected user groups. Examples include massive online synchronous experiences that are designed for the future metaverse, telehealth applications, and new immersive approaches to education. This will likely require the ability to provide specialized connectivity services with quality-of-service (QoS) specifications that cannot be readily supported by the current public Internet. Initially, these infrastructure capabilities will need to be available to early adopters, but eventually many of them will have to be widely deployed.

Digital gaps between countries in the Global North and South have ambiguous effects on the digital transformation in enterprises. On the one hand, they create competitive disadvantages as the domestic market may impose certain constraints that may slow down the development of forward-looking digital economy competencies. This may weaken their ability to compete in markets in the global North. At the same time, enterprises have the opportunity to develop a set of digital economy solutions that work in markets with the unique infrastructure characteristics found in the Global South. This may allow the development of innovative solutions and services that provide a competitive edge in similarly situated foreign markets.

I.S.O._ What is the role of innovation and emerging technologies, such as the Internet of Things (IoT) and Artificial Intelligence (AI), in the movement towards the digital economy? What are the main challenges that enterprises face to implement and adopt these technologies?

J.B._ IoT, sometimes referred to as the Internet of Everything (IoE), and AI are important components of the emerging digital economy. Cyber-physical systems that connect objects from our material, habitable environment – such as cars and trucks, appliances, medical devices, or agricultural equipment – with a computational environment, promise significant efficiency gains and innovations. AI is a necessary complement to IoT as the massive amounts of data from the network of devices will require automated processing to extract relevant insights. Other technologies will also come into play, including the families of technologies currently discussed under web3 and the metaverse.

Photo: Quello Center, Michigan State University

Johannes M. Bauer
Professor at the Department of Media and Information and director of Quello Center, at the Michigan State University.

The biggest anticipated gains will occur in business-to-business (B2B) transactions, including manufacturing operations, equipment optimization, smart city services, health and fitness, transportation coordination, and retail. If properly adopted, most of these gains will benefit low- and middle-income countries. IoT and AI will contribute to improve the efficiency of agriculture and the provision of infrastructure services. These technologies will also be critical to facilitate a transition toward sustainable growth. To take advantage of these benefits, enterprises will have to overcome technical, economic, and organizational obstacles. Developing the technical and practical knowledge to integrate IoT technology with existing management systems and practices is a major obstacle.

Additional skills in data curation, analysis, and interpretation must be developed in the workforce. There is a temptation to look at machine learning and AI as a substitute for strategic thinking rather than as one of its tools. Both technologies will help describe, explain, and predict developments in the relevant business ecosystems of enterprises. Their role will be more limited in recommending forward-looking decisions. To this end, human interventions need to ensure that emerging technologies and services are inspired by a human-centric, rather than a machine-centric design approach. Such human oversight also must address potential unintended consequences of AI, including multiple forms of bias and discrimination.

Enterprises will have to develop capabilities to recognize and address these concerns internally and in their external environment. In addition to these operational and management challenges, enterprises also face strong social and political headwinds, driven, among others, by concerns about privacy, the appropriation of data by dominant digital platforms, and concerns over national control of data. For enterprises operating on an international scale, this may imply that the business and regulatory environment in the digital economy is increasingly fragmented. This will result in higher costs of adapting business practices and services to multiple regions and countries. It will also increase the complexity of operations.

"(...) human interventions need to ensure that emerging technologies and services are inspired by a human-centric, rather than a machine-centric design approach. Such human oversight also must address potential unintended consequences of AI, including multiple forms of bias and discrimination."

I.S.O._ What are the implications for digital security arising from the adoption of emergent technologies by enterprises?

J.B._ A proliferation of devices that are in use, and of the heterogeneity and diversity of hardware and software will increase the attack surfaces for cybercriminals. Although the costs of securing information systems decrease as digital technology becomes more efficient, hackers also take advantage of such technological advances to launch increasingly sophisticated attacks. In this technology race, some level of risk will have to be accepted from a rational management perspective due to the costs of cybersecurity. Not all the risks related to the adoption of emergent technologies can be managed by the adopting enterprise. Ideally, hardware manufacturers and developers would address device and software vulnerabilities.

However, the influx of large numbers of manufacturers and a winner-takes-all mentality among many players creates a significant risk that insecure devices and software are released to the marketplace. From the perspective of a device manufacturer, these costs are externalized to the broader community of users. While the manufacturer faces a loss of reputation as a result of manufacturing insecure equipment, this cost may not be sufficient

to improve security practices across the entire IoT sector. Many of the new manufacturers do not participate or participate to a limited extent in official standardization bodies. In addition, individual users of IoT devices typically are not aware of the security risks related to them.
Consequently, enterprises face additional demands to manage the security of networks and services. Some practices are simple to change. For example, encrypting the networks running IoT devices would reduce the risk of exposure to man-in-the-middle attacks or digital eavesdropping. IoT devices are targeted by an increasing amount of malware that can deploy additional attacks. Enterprises may need to design and segment their networks in ways that minimize the total impact of such attacks. Other risks that will need to be addressed include outdated and unsupported operating systems embedded in IoT devices, weak passwords, and insecure web interfaces used with IoT devices.
The reliance on emerging technologies also tends to increase the amount of sensitive and personally identifiable data that needs to be protected from security breaches. The corresponding increasing demand for data management need to be addressed with several strategies. Securing devices and communications are necessary measures. Enterprises must also decide which data to collect and, where possible, minimize the collection of sensitive information. Such information is often not needed for the development of better services and business models and it can be deleted at the source where it is initially collected. For the retained data, it is mandatory to develop secure data storage and access policies that follow emerging data protection regulations and laws.

I.S.O._ How can public policies foster an innovation-friendly ecosystem in the context of the digital economy?

J.B._ Public policy plays an important direct and indirect role in fostering a favorable ecosystem for digital innovation. Most importantly, public policy must set the broad conditions and the legal and regulatory framework that is needed for digital markets to work well. A critical area for public policy is to improve access to basic infrastructure, both fixed and mobile. In addition, public policy can contribute to improving digital literacy and develop programs that can help upskilling the workforce. Although digital technology itself is neither good nor bad, it is also not neutral. Thus, public policy can establish guardrails to ensure that digital innovation develops in directions that avoid discrimination by race, ethnicity, and socio-economic criteria.
Public policy also plays important roles in the supply side of the digital economy. Here is it important to eliminate bureaucratic obstacles to entrepreneurship and to create conditions that facilitate access by private sector enterprises and entrepreneurs to investment capital, for example, with loan guarantees. As a major user of information technology services, governments could leverage their procurement to support domestic, digital innovation. Historically, governments have played a vital role in helping the development of basic technology. In the digital economy, such mission-oriented approaches could be structured as public-private partnerships with both domestic and international technology companies.
One challenge faced by countries in the Global South is that the currently dominant technology companies are located in the Global North, in the United States and in China. This opens opportunities for intergovernmental collabora-

"The corresponding increasing demand for data management need to be addressed with several strategies. Securing devices and communications are necessary measures."

tion and private sector collaboration with players from these countries. It also creates a convergence of interest with other nations, for example, the European Union, to engage in collaborative technology development projects. Public policy also can support the ability of small and medium enterprises (SME) to work with digital platforms. The European Union has chartered its own pro-regulatory course in Europe. Whereas this model has many potential downsides, government policies have other, more market-compatible, tools available to create a favorable digital innovation ecosystem.

Among these measures is a general obligation to players with considerable market power, such as dominant network operators and dominant platforms, to negotiate in good faith with smaller enterprises seeking access to their technology. Such an obligation should be backed up by the possibility to appeal to a regulatory agency to step in as a mediator, if no agreement can be reached in negotiations. In addition, the obligation to negotiate in good faith could be combined with the so-called "most-favored-nation obligation", the duty of a large player to offer comparable conditions already negotiated to other operators seeking access. More stringent obligations for dominant enterprises to provide access to the data they collect, either *in situ* or via a data portability mechanism, would also facilitate innovation in the digital ecosystem. Finally, more agile forms of regulation, including regulatory sandboxes and experimental regulation, would stimulate digital innovation.

Article II

Photo: OECD/Andrew Wheeler

Sandrine Kergroach
Organisation for Economic Co-operation and Development (OECD).

Small and medium enterprises going digital: Policy challenges and recommendations[9]

By Sandrine Kergroach[10]

Emerging digital technologies have the potential to spur innovation, enhance productivity, and improve well-being. Combined together, the Internet of Things (IoT) (which supports machine-to-machine communication and enables the generation of unprecedented volume of data through the hyper-connectivity of devices, sensors, and systems), data analytics (which leverages machine

[9] This material builds on the Organisation for Economic Co-operation and Development (OECD) work titled: Kergroach, S. (2021), SMEs Going Digital: Policy challenges and recommendations, *OECD Going Digital Toolkit Notes, No. 15*. Paris: OECD Publishing, available at: https://doi.org/10.1787/c91088a4-en. The opinions expressed and arguments employed herein are entirely those of the authors and should not be attributed in any manner to the OECD or its Member countries.

[10] Head of small and medium-sized enterprises (SME) and Entrepreneurship Performance, Policies and Mainstreaming at the OECD Centre for Entrepreneurship, SME, Regions and Cities. She leads work on innovation and internationalization, and the conditions that could enable SME and startups to drive a more sustainable, resilient, and inclusive growth. She has a PhD in Economics (TU Berlin), a master's degree in Strategy and Management, a master's degree in Applied Economics and Statistics (Paris Dauphine PSL), and a master's degree in Modern History (Paris Sorbonne).

learning and new algorithms for data exploration and market intelligence), and cloud computing (which allows storing and processing more information at more affordable cost) are likely to increase enterprises' capacity for simulation, prototyping, decision making, and automation, and keep the promise for the next production revolution (OECD, 2017d).

Many small and medium enterprises (SME) stand to benefit from new digitally enhanced practices and tools which create unprecedented opportunities for them to overcome the size-related barriers they typically face in innovating, growing, and going global (OECD, 2019b). Yet, SME lag in their capacity and capability to undertake the digital transition, and the smaller an enterprise is, the less likely it is to adopt new digital enhanced business practices.

The digital uptake of SME is to a large extent still confined to basic services, and adoption gaps compared to large enterprises increase as digital technologies become more sophisticated (OECD, 2021). Although most businesses are connected to the Internet, information and communication technologies (ICT) are still primarily seen as a communication tool. Having a website has become a common practice (73% of small firms to up to 94% of large firms in 2018) and using social media for business purposes is frequent (48%-71% of firms) (OECD, 2020c). However, fewer enterprises use more advanced ICT, including data analytics (10%-33%) (OECD, 2020c).

Digital transformation is also occurring at different speeds, reflecting the large heterogeneity of the SME population. The greatest acceleration in digital diffusion in recent years has been in the conduct of Big Data analysis (albeit from low levels) and the purchase of cloud computing services. The adoption of business intelligence and supply-chain management software have progressed little, especially among the smallest enterprises.

SME must be better prepared for digital transformation. The stakes are high, not only because SME comprise most of the business and industrial fabric in most countries and regions, but also because they are strategic players in large companies' supply chains and play a key role in building inclusive and resilient societies. At an aggregate level, the SME digital gap has been proven to diminish national productivity performance and to contribute to increase inequalities among individuals, enterprises, communities, and places.

The COVID-19 outbreak is providing a striking example of the role SME play in ensuring resilience and sustainability, and how digital technologies can help them improve their business processes and services.

Business surveys conducted worldwide since the beginning of the pandemic converge in highlighting a rapid uptake of teleworking and digital sales channels among SME, signaling an acceleration in their digital transformation. Some countries have taken additional action to help those enterprises speed up the transition, as reflected in the OECD's monitoring of policy responses to the crisis (OECD, 2020a). Such policies are framed as more structural approaches to strengthen SME post-crisis competitiveness and ability to address environmental and societal challenges ahead.

This article identifies the challenges that governments face in enabling SME to benefit from digital transformation and some key policy recommendations, including: 1) encouraging digital uptake by SME, 2) supporting SME training and upskilling, 3) strengthening management skills in SME, and 4) leveraging financial technology (Fintech) and alternative funding sources for SME.

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Smaller businesses often face more difficulties in adapting to changing regulatory frameworks, dealing with digital security and privacy issues or simply accessing quality digital infrastructure.

Benefits for SME in going digital

Digital technologies change the conditions under which SME do business and these changing market conditions are likely to benefit smaller and more responsive businesses. Emerging technologies, such as Big Data analytics, Artificial Intelligence (AI), blockchain, and 3D printing, enable greater product differentiation, better integration of supply chain systems, and new business models that leverage shorter distance and time to markets.

At the same time, these technologies can enable the production of bespoke products that require more flexibility and responsiveness in supply. Digital technologies also enable the reduction in transaction costs associated with market activities, i.e., access to information, communication, and networking, reducing *de facto* incentives for enterprises to internalize such activities. This implies that digital technologies may reduce the minimum efficient firm size required for high performance and productivity.

Digital technologies can also help SME integrate with global markets, as they reduce the costs associated with transport and border operations, increase the tradability of many services, and reduces some hidden costs brought by fragmented global value chains (additional management, logistics, and operations) (Contractor, 2010).

Digital technologies change the conditions under which SME access strategic resources. It creates a range of innovative financial services for businesses that traditionally face greater difficulties in accessing funds. Technology-enabled innovation in financial services (also known as Fintech) is increasingly central to the SME finance landscape, including peer-to-peer lending, alternative risk assessment tools, blended financing models, and initial coin offerings (ICO) issuing crypto-assets. Digitalization also makes it easier for SME access to skills through job recruitment platforms, outsourcing, and online task hiring, or by connecting them with knowledge partners.

Policy challenges and recommendations

The SME digital lag arises from a range of factors and barriers, including SME's lack of information and awareness, skills gaps, insufficient capital or missing complementary assets such as organizational practices or digital technology itself (OECD, 2019b). Smaller businesses often face more difficulties in adapting to changing regulatory frameworks, dealing with digital security and privacy issues or simply accessing quality digital infrastructure.

There is a broad-based focus among OECD countries on accelerating digital innovation diffusion to SME and ensuring they keep pace with the digital transformation (OECD, 2019b, 2020a). However, policy approaches vary and, in some areas, diverging viewpoints exist on how to account for the great heterogeneity of the SME population and the diversity of their business ecosystems. While some countries have sought to mainstream SME policy considerations into other policy agendas, others specifically target SME with tailor-made instruments, often combined with place-based or sector-wide policy mixes.

ENCOURAGING DIGITAL UPTAKE BY SME

Small enterprise owners are often unaware of the potential new digital tools could offer for improving their business, or they consider the upfront costs of upgrading towards more sophisticated digital technologies too high (OECD, 2017a). Policy makers have been active in providing SME with targeted financial support and technical assistance in diagnosing problems or implementing new digital business solutions, often through small-scale and local initiatives. In some cases, financial and technical support is supplemented with training and guidance on the skillset and organizational changes that are required to support technological change.

Government-funded technology extension programs seek to expand the absorption and adaptation of existing technologies (for example, equipment, new managerial skills) in businesses and to increase their absorptive capacity. While this type of support is not new, the use of technology extension programs that are targeted at SME has expanded over the last decades (Shapira et al., 2011).

SME TRAINING AND UPSKILLING

SME typically have greater difficulty in attracting and retaining skilled employees than large firms, both because they tend to lack capacity and networks to identify and access talent, and because they tend to offer less attractive remuneration and working conditions (Eurofound, 2016). SME also offer fewer training and development opportunities (OECD, 2013), often due to the lack of internal capacity to organize training, and lower levels of management skills to anticipate needs (OECD, 2015). In addition, the financial costs of tailored training are relatively higher for SME because they have less scope to release people from revenue-generating activities for training and because fixed costs are greater per employee. Furthermore, SME tend to experience higher job turnover, which reduces their willingness to invest in skills development when there is a risk that an upskilled employee will leave shortly after training (OECD, 2019a).

ENGAGING SME IN TRAINING AND EDUCATION

The policy initiatives deployed to support the development of workforce skills in SME (OECD, 2012) mainly focus on reducing training costs for businesses and promoting the benefits of workplace training. Many OECD countries offer tax incentives to reduce the costs that firms incur for training their employees. Smaller firms are also frequently targeted by direct training subsidy schemes. Training vouchers, for example, help SME purchase training hours from accredited individuals or institutions.

Countries aim to raise awareness of the importance of training and skills development in SME through various channels, including public and stakeholder organizations. Employer networks and associations can promote skills upgrading in the workplace and foster trust-based relationships among enterprises that support knowledge-sharing and pooled investments in training. Collaborations between enterprises can also foster the diffusion of innovation within regional supply chains, potentially integrating enterprises into global value chains, which also reduces regional vulnerability to automation (OECD, 2018).

Countries are also investing more in “brokers” or intermediary bodies such as group or collective training offices to organize training for groups of SME and shift the burden away from individual employers. These organizations often sign

apprenticeship contracts with the government while also providing pastoral care and practical assistance to individual apprentices. They are particularly useful for SME that would otherwise not be able to meet the national minimum apprenticeship training quality standards.

Finally, regulation can encourage skills development. Some countries have introduced statutory rights for employees for training leave. However, their take-up is generally not high (less than 2% of employees benefitting from the measure) (OECD, 2019b).

STRENGTHENING MANAGEMENT SKILLS IN SME

Governments have several tools at their disposal to help build management skills in SME, ranging from the provision of specific training and workshops, the use of digital diagnostic tools to help SME identify their management deficiencies, and other, more intensive approaches such as management coaching. Most programs and initiatives tend to cover business strategy, operating models, process management, performance management, leadership, governance, agility, and innovation. An important component of management skills is financial planning and management (G20 & OECD, 2015). This includes the ability to conduct risk planning and provide relevant financial information in business plans and investment projects.

One of the greatest challenges for governments is to create demand for existing support services since many programs have low take-up rates. This is due to a range of reasons, including a lack of awareness of existing programs, legitimacy issues around public support operators, doubts on the usefulness of the advice, and limited ambitions for business development and growth.

LEVERAGING FINTECH AND ALTERNATIVE SOURCES OF FINANCE FOR SME

Across all stages of their life cycle, SME face structural barriers in accessing appropriate sources of funding that are critical to innovate and grow (OECD, 2019). Internal barriers include a lack of collateral to be provided to lenders and investors as guarantees, insufficient financial skills, and a lack of knowledge and awareness about funding options and alternatives. Market barriers include information asymmetries between financial institutions and SME management, and relatively higher transaction and lending costs for funding institutions to serve SME. These challenges are typically more pronounced in some segments of the business population, especially new firms, start-ups, and innovative ventures with high growth potential, businesses in remote and rural areas, or those led by groups underrepresented in entrepreneurship, such as women, youth, the elderly, and migrants (OECD & European Union [EU], 2017).

One of the greatest challenges for governments is to create demand for existing support services since many programs have low take-up rates.

Online alternative finance activity has been increasingly included in SME finance policies (OECD, 2020b). Using technologies such as digital identity verification, distributed ledger technologies (DLT), Big Data, and marketplace lending, finance suppliers are offering an array of innovative services with the potential to revolutionize SME finance markets. Mobile banking, (international) mobile payments, and the use of alternative data for credit risk assessment can significantly reduce information asymmetries and transaction costs, enabling SME to access finance. Fintech, defined as technology-enabled innovation in financial services, is becoming more and more important in offering more convenient and accessible services, more effective credit risk assessments, and lower transaction costs.

IMPROVING SME CAPACITY TO MANAGE AND PROTECT THEIR DATA AND INTELLECTUAL PROPERTY RIGHTS

SME tend to privilege trade secrecy as their default mode of data protection. Past surveys have showed that small businesses consider trade secrecy as an important means of protecting innovation (Cohen et al., 2000; Jankowski, 2012; Hall et al., 2014). Trade secrecy can help SME ensure they have a lead time advantage – which is a primary mechanism of intellectual property appropriation in some industries. Trade secrecy can also protect complex product designs, which can discourage competitors from engaging in counterfeiting (Rujan & Dussaux, 2017; Hughes & Mina, 2011).

However, the protection of trade secrets is becoming increasingly difficult. Digitalization and the revolution in data codification, storage, and exchange (i.e., cloud computing, emails, USB drives) are prime drivers of a rise in trade secret infringements (Almeling, 2012). Increasing value given to intellectual property (IP) (and *de facto* its misappropriation), staff mobility and changing work culture and relationships (for example, temporary contracts, outplacement, teleworking), and the fragmentation of global value chains (with more foreign parties involved within more diverse legal frameworks and uneven enforcement conditions) also contribute to increase exposure and risk of disclosure.

SME data protection is being reinforced while efforts are made to harmonize legislations across jurisdictions and help smaller enterprises navigate through different regulatory frameworks.

SME are acquiring and managing growing data stocks in a context of increased regulatory scrutiny, particularly with regard to data protection and confidentiality. Concerns about data privacy are likely to raise new barriers to smaller enterprises that have less internal capacity to deal with a complex regulatory environment. The General Data Protection Regulation (GDPR) introduced by the EU in May 2018 intends to harmonize data privacy laws across Europe with the explicit goal of protecting and empowering EU citizens' data privacy and reshaping the way organizations approach the issue.

RAISING SME DIGITAL SECURITY PROFILE

SME often do not have the resources or expertise to effectively assess cyber-risks and implement appropriate prevention and management measures (OECD, 2019b). Hyper-connectivity makes digital infrastructure more vulnerable, adding layers of complexity, volatility, and dependence to existing infrastructures (OECD, 2017b). Digital security threats appear to be increasing in terms of sophistication, frequency and magnitude, and unintentional breaches can also result from misuses of personal data.

Although SME are a "smaller target" for cyber-attacks, the risk of security incidents is likely to increase with the wider use of IoT, the rise of e-commerce, the proliferation of Big Data, and the use of data analytics for mining data. On the positive side, SME that can demonstrate robust digital security and privacy practices may have a competitive edge in setting business partnerships, especially with larger corporations. SME' ability to include digital security risk management in their operational protocols will therefore become increasingly important for their integration into the global economy.

Governments are increasingly focusing on the promotion of digital security among SME. In a 2017 OECD survey, 82% of the reviewed countries saw digital security risk awareness by SME as a specific objective. However, only 46% of them have developed specific incentives (rewards and/or sanctions) for promoting digital security risk management.

SME often do not have the resources or expertise to effectively assess cyber-risks and implement appropriate prevention and management measures (...).

DEPLOYING HIGH-QUALITY COMMUNICATIONS INFRASTRUCTURE AND PLATFORMS

Communications infrastructure is critical for sustaining digital diffusion among SME. Accessing high-speed networks allows SME and entrepreneurs to connect to suppliers and customers, obtain real-time information, and respond in real-time to fast-evolving markets and supply chains. High speed digital networks also enable smaller-scale businesses to build digital capacity, for example, through cloud computing services. Although enterprises are increasingly moving towards high-speed fixed broadband, stimulated by more affordable access prices, there are wide and growing cross-country and cross-firm divides in connection, with smaller enterprises losing ground in the transition (OECD, 2019b).

Many countries have engaged in comprehensive strategy exercises, with a strong focus on strengthening public-private dialogue and private sector participation in infrastructure development (OECD, 2017c; International Transport Forum [ITF], 2017). In addition, subnational governments play a vital role in the infrastructure landscape, and regional and municipal infrastructural policies are likely to grow in relevance as cities and regions are increasingly responsible for policy design and implementation.

Governments are also encouraging SME to access key network infrastructure and platforms through the establishment of facilities which provide a physical environment for the exchange of knowledge and expertise and contribute to networking, information dissemination, and collaboration. Clusters' premises, facilities, and activities can give SME access to technologies that they might not otherwise be able to afford. Moreover, SME operating in clusters might be able to benefit from other agglomeration effects, such as improved access to a pool of skilled labor, or more visibility to capital venture investors. The joint use of research equipment to leverage cutting-edge equipment, or the access to super-computing capabilities to harness the potential of Big Data analytics are examples of policy options in place.

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Interview II

Photo: Personal archive

Georgina Núñez
Technical adviser at United Nations Economic Commission for Latin America and the Caribbean (UN ECLAC).

Micro, small, and medium enterprises and digital technologies

In this interview, Georgina Núñez, technical adviser to the United Nations (UN) Economic Commission for Latin America and the Caribbean (ECLAC), and Filipe Da Silva, research assistant to the UN ECLAC, address the digital economy within the context of micro, small, and medium enterprises (MSME) and the advances in the use of digital technologies, the obstacles to innovation, and the recommendations for the digital transformation of this audience.

Internet Sectoral Overview (I.S.O.)_ What are the main advances in the use of digital technologies by micro, small and medium enterprises (MSME)? How did the COVID-19 pandemic affect their process of digital transformation?

Georgina Núñez (G.N.) and Filipe Da Silva (F.S.)_ There are several ways in which MSME can benefit from the use of digital technologies. First, they can boost consumer reach and successful sales rates. Putting this statement into context, let's consider MSME engagement in digital platforms and marketplaces as an example of adopting or incorporating digital technologies. The main benefit of such act would be the possibility of profiting from the effects of network, which digital companies widely enjoy, without being responsible for the curation of such complex networks (balance between consumers, providers, and advertisers). In other words, the business model of digital platforms makes these companies responsible for attracting more consumers to the marketplaces (therefore more clients for the MSME), regardless of whether or not MSME advertise.

Another example would be the possibility of incorporating new technologies that otherwise would have been beyond their reach if only rely on their technological or financial resources. This mainly impacts the effectiveness of their business models. To give some context, MSME can go after target consumers in each market by taking advantage of the algorithm-powered advertising campaigns so commonly used in the digital economy, i.e., it increases the sales success rate of these companies.

Regarding the second part of the question, the digitization of Latin America and the Caribbean (LAC) has accelerated exponentially during the pandemic, as we have witnessed the creation of numerous e-commerce websites or marketplaces, the greater participation in marketplaces, and the adoption digital technologies. In this scenario, governments in the region have played an important role by tackling connectivity gaps, as well as providing different kind of incentives and capacity building to MSME, in order to extend their life amidst the pandemic.

However, the COVID-19 pandemic delayed the progress of some normative agendas that affect MSME and consumers. For instance, one of the main topics of the digital economy is taxation. As digital-native companies compete with MSME, this feature widens the existing gap between the produc-

tivity of the latter and the former. Another relevant issue is the increase in acquisitions of technological startups during the pandemic, which has increased the concentration of digital markets. Therefore, although the pandemic has accelerated digital transformation and forced small businesses to innovate, it also adjourned the discussion and implementation of agendas that could positively impact the MSME sector.

I.S.O._ What are the main barriers to innovation through digital technologies among MSME in the Latin-American and the Caribbean context? How can they be addressed?

G.N. and F.S._ In LAC, when talking about the use of digital technologies for innovation, the main problems are still infrastructure, connectivity, and digital inclusion. These issues represent relevant challenges for increasing the productivity rates of the region's industries, and service sectors for their sustainability in the long run. In fact, the UN ECLAC,[11] believes these gaps are restraining the region's development. Access to broadband and digital inclusion is not only vital for a company's survival anymore, but is a determining factor in people's quality of life. Today's access to basic goods and services, as well as the connection between people, government institutions, and the private sector, depend on access to broadband.

Unfortunately, it is easier to diagnose the issue than to solve it. Possible solutions depend on several factors such as political agendas, allocation of financial resources, and circumstantial factors, among others. As for the physical part of the problem, investments in infrastructure that improve access to the internet and digital technologies to both companies and individuals, even if they are still insufficient, can foster the development of innovation in the region. The lack of fiscal space in the region, inherited from the pandemic, makes government investments in infrastructure even more difficult.

On the other hand, the intangible part of the problem may need to be tackled through public innovation. By the intangible part we mean the role data plays in today's economy. Although investment in technology and capital accumulation are still important for the development of innovation, in the digital economy we can also foster innovative capabilities by promoting access to data. Most people are still unaware that data is as important for digital platforms as for manufacturing processes. In an economy where global value chains are key, the production of a single product requires data as an input for every stage of the production process: control and coordination, pre-production, supply chain management, production, and post-sales. Data is useful for monitoring processes (data from sensors), delivering services, personalization of services and products, and robots and AI training, to mention a few. As technologies, such as the Internet of Things (IoT), spread, the flow of data will grow even more. In this sense, cross-border data flows – a theme not much developed in our region – are necessary in an economy that is dependent on global value chains and digitalized.

Since innovation increasingly depends on the availability of data and the combination of datasets, the idea of data marketplaces where governments and other actors make a variety of data available to the public for public innovation

Photo: Personal archive

Filipe Da Silva
Research assistant at UN ECLAC.

[11] Available at: https://www.cepal.org/es/publicaciones/45938-universalizar-acceso-tecnologias-digitales-enfrentar-efectos-covid-19

"The participation of women as leaders of MSME is still low and countries could improve this by focusing on providing incentives and funding for enterprises led by women."

becomes necessary. For instance, this is an initiative that Colombia is implementing in partnership with the World Economic Forum: the first of its kind in the region, setting up an innovative path for the Colombian economy.[12]

I.S.O._ What are the best practices for digital capacity-building among MSME? What are the main policy recommendations to support them in the post-pandemic economic recovery?

G.N. and F.S._ Since the very beginning of the pandemic (2020), governments in the region have acted in various key policy areas to foster domestic and cross-border e-commerce and it seems that they will continue to do so. E-commerce has the potential to generate significant benefits for MSME and consumers, by enabling access to a wider variety of goods and services, making transactions more convenient and secure, and reducing search and transportation costs.

Governments around the world continue to develop policies and improving normative frameworks aimed at supporting the adoption of the e-commerce business model by MSME. Some examples are the formulation of national strategies for the digital transformation of these enterprises, the promotion of cross-border e-commerce, trade facilitation programs, and the measurement of e-commerce. Regarding the latter, it is important to have accurate, reliable, and up-to-date data and information on e-commerce and its degree of penetration among MSME to be able to develop and implement solid evidence-based public policies.

It is necessary to deepen the penetration of the Internet and encourage the adoption of technology-based business models by MSME. In addition, the countries of the region should become more involved in international cooperation initiatives to measure the digital economy.

The implementation of digital technologies, new business practices, and new business models can improve the efficiency and productivity of companies in the LAC region and boost the economic activity in this post-pandemic period. The implementation of digitalization programs for MSME has proven to be successful in the region. For instance, Chile's program "Digitaliza tu PYME" has provided guidance to more than 50 thousand companies and implemented more than 400 thousand initiatives.

It is also important to create opportunities for disadvantaged segments of the economy in this process. Initiatives like "Mujer Exportadora" found in some LAC countries are good examples of policies aimed at these segments. The participation of women as leaders of MSME is still low and countries could improve this by focusing on providing incentives and funding for enterprises led by women.

I.S.O._ How to allow the insertion of regional MSME in the digital economy in a competitive way, considering the market concentration around Big Techs?

G.N. and F.S._ The significant market share of Big Techs and the participation of MSME in the digital economy are not mutually exclusive. When Big Tech companies practice fair competition, they can be considered as allies of the

[12] Available at: https://c4ir.co/economia-de-intercambio-de-datos-data-marketplaces-conceptualizacion-para-su-implementacion-en-colombia/

MSME sector development. As mentioned, digital platforms can help with the digitization of that sector, their technological upgrade, and consumer reach. Moreover, the platforms are solely responsible for ensuring the balance of participants in their marketplaces (consumers, advertisers, and suppliers), which, in certain ways, guarantees a flow of customers to MSME. Therefore, it is important for these enterprises to learn how to seize the opportunities brought up by these companies in order to increase their competitiveness. On the other hand, when unfair means and practices are on the rise in digital markets, these companies should no longer be considered allies, mainly because their anticompetitive practices affect, above all, small players. In this sense, the role of competition regulation and policy of the digital sector is crucial to certify that the MSME sector benefit from the platforms' presence. Despite the lack of digital sector regulators in the LAC region, competition authorities have played their role, regulating competition in different markets in the past few years. Brazil, Mexico, and Chile are among the countries in the region that already have some experience in investigating platform anticompetitive practices, and market concentration. At the same time, several other agencies have developed studies and tools to face the challenge of guaranteeing competition in digital markets.

Domain Report

Domain registration dynamics in Brazil and around the world

The Regional Center for Studies on the Development of the Information Society (Cetic.br), department of the Brazilian Network Information Center (NIC.br), carries out monthly monitoring of the number of country code top-level domains (ccTLD) registered in countries that are part of the Organisation for Economic Co-operation and Development (OECD) and the G20.[13] Considering members from both blocs, the 20 nations with highest activity sum more than 89.55 million registrations. In September 2022, domains registered under .de (Germany) reached 17.34 million, followed by China (.cn), the United Kingdom (.uk) and Netherlands (.nl), with 9.77 million, 7.73 million and 6.27 million registrations, respectively. Brazil had 5.01 million registrations under .br, occupying 5th place on the list, as shown in Table 1.[14]

[13] Group composed by the 19 largest economies in the world and the European Union. More information available at: https://g20.org/

[14] The table presents the number of ccTLD domains according to the indicated sources. The figures correspond to the record published by each country, considering members from the OECD and G20. For countries that do not provide official statistics supplied by the domain name registration authority, the figures were obtained from: https://research.domaintools.com/statistics/tld-counts. It is important to note that there are variations among the date of reference, although the most up-to-date data for each country is compiled. The comparative analysis for domain name performance should also consider the different management models for ccTLD registration. In addition, when observing rankings, it is important to consider the diversity of existing business models.

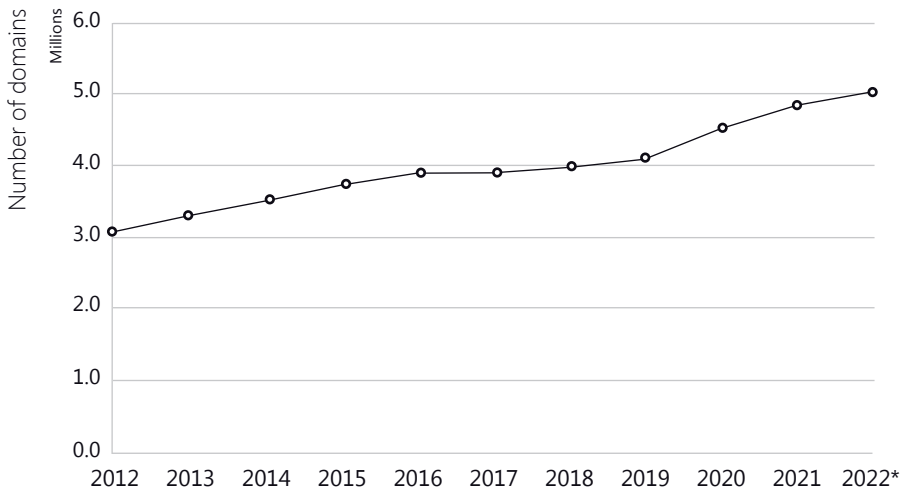
Table 1 – TOTAL REGISTRATION OF DOMAIN NAMES AMONG OECD AND G20 COUNTRIES

Position	Country	Number of domains	Date of reference	Source (website)
1	Germany (.de)	17,345,535	30/09/2022	https://www.denic.de
2	United Kingdom (.uk)	9,777,315	01/07/2022	https://www.nominet.uk/news/reports-statistics/uk-register-statistics-2022/
3	China (.cn)	7,735,067	30/09/2022	https://research.domaintools.com/statistics/tld-counts/
4	Netherlands (.nl)	6,276,402	30/09/2022	https://api.sidn.nl/rest/counters/domains
5	**Brazil (.br)**	**5,017,284**	**30/09/2022**	**https://registro.br/dominio/estatisticas/**
6	Russia (.ru)	4,978,655	30/09/2022	https://cctld.ru
7	Australia (.au)	4,004,052	30/09/2022	https://www.auda.org.au/
8	France (.fr)	3,977,799	29/09/2022	https://www.afnic.fr/en/resources/statistics/detailed-data-on--domain-names/
9	European Union (.eu)	3,679,166	30/09/2022	https://research.domaintools.com/statistics/tld-counts/
10	Italy (.it)	3,461,546	30/09/2022	http://nic.it
11	Colombia (.co)	3,396,309	30/09/2022	https://research.domaintools.com/statistics/tld-counts/
12	Canada (.ca)	3,304,305	30/09/2022	https://www.cira.ca
13	India (.in)	2,750,409	30/09/2022	https://research.domaintools.com/statistics/tld-counts/
14	Poland (.pl)	2,526,525	30/09/2022	https://www.dns.pl/en/
15	Switzerland (.ch)	2,506,887	15/09/2022	https://www.nic.ch/statistics-data/domains_ch_monthly.csv
16	Spain (.es)	1,994,633	28/09/2022	https://www.dominios.es/dominios/en
17	United States (.us)	1,902,771	30/09/2022	https://research.domaintools.com/statistics/tld-counts/
18	Belgium (.be)	1,747,140	30/09/2022	https://www.dnsbelgium.be/en
19	Japan (.jp)	1,709,815	01/09/2022	https://jprs.co.jp/en/stat/
20	Sweden (.se)	1,464,815	30/09/2022	https://internetstiftelsen.se/en/domain-statistics/growth-se/?chart=active

Collection date: September 30, 2022.

Chart 1 shows the performance of .br since 2012.

Chart 1 – TOTAL NUMBER OF DOMAIN REGISTRATIONS FOR .BR – 2012 to 2022*



* Collection date: September 30, 2022.
Source: Registro.br
Retrieved from: https://registro.br/dominio/estatisticas/

In September 2022, the five generic Top-Level Domains (gTLD) totaled more than 190.95 million registrations. With 159.42 million registrations, .com ranked first, as shown in Table 2.

Table 2 – TOTAL NUMBER OF DOMAINS AMONG MAIN gTLD

Position	gTLD	Number of domains
1	**.com**	159,429,133
2	**.net**	13,048,007
3	**.org**	10,636,000
4	**.xyz**	4,189,382
5	**.info**	3,650,837

Collection date: September 30, 2022.
Source: DomainTools.com
Retrieved from: research.domaintools.com/statistics/tld-counts

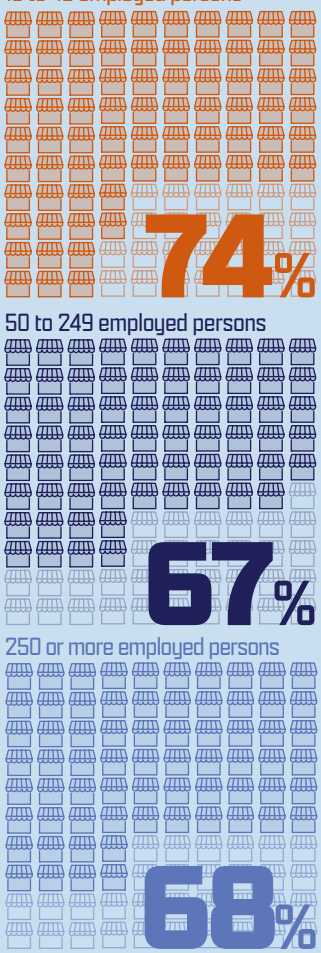
E-COMMERCE BY BRAZILIAN ENTERPRISES

E-commerce has become an increasingly more disseminated practice among enterprises. In the context of the COVID-19 pandemic, the possibility of purchasing and selling online was essential for the transactions to be carried out during a period in which social distancing was necessary.

The following indicators[15] provide a snapshot of e-commerce in Brazil.[16] Despite the increase in the number of enterprises that sold on the Internet (which went from 57% in 2019 to 73% in 2021), there is a clear contrast between enterprises of different sizes in relation to the online channels in which they sell their goods and/or services.

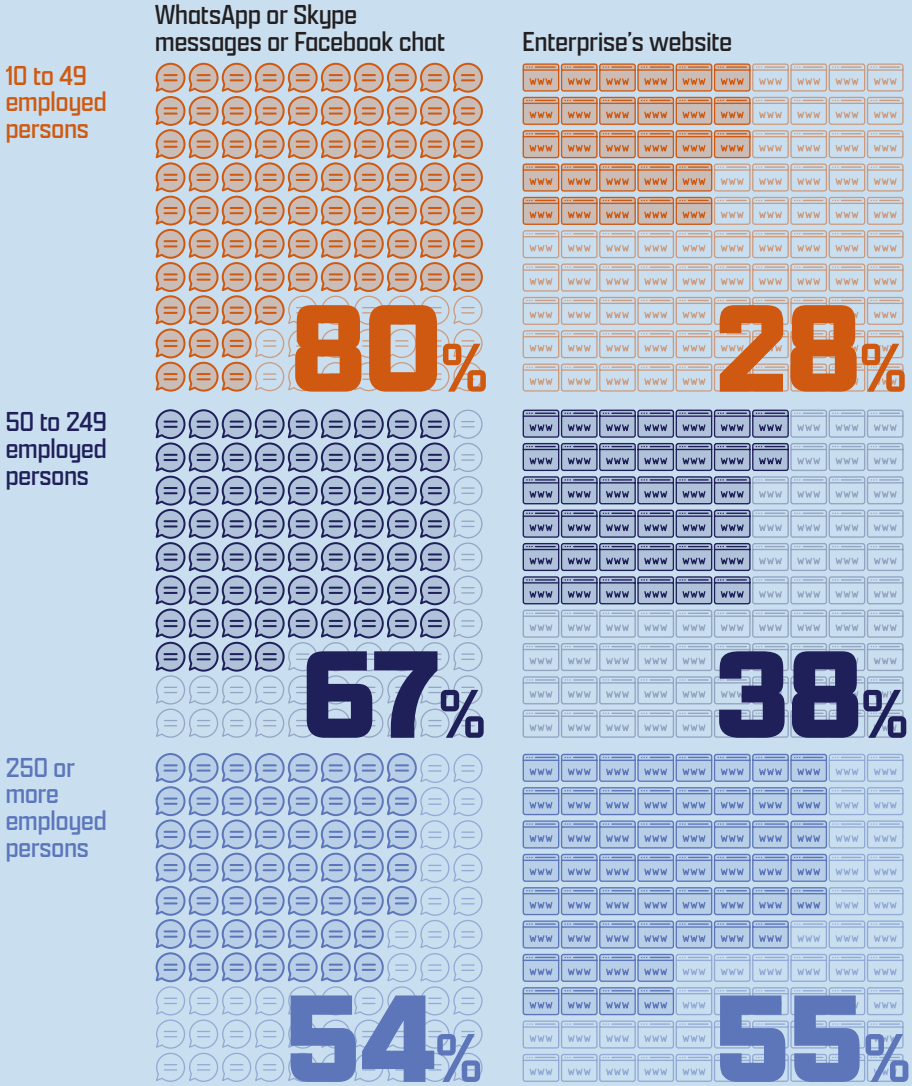
BRAZILIAN ENTERPRISES THAT SOLD ON THE INTERNET

Total number of enterprises with Internet access, by size (2021):



MAIN ONLINE CHANNELS USED FOR SELLING[17]

Total number of enterprises that sold on the Internet, by size (2021):



[15] Data from the ICT Enterprises survey, from the Cetic.br|NIC.br. Available at: https://cetic.br/en/pesquisa/empresas/

[16] The reference period for both indicators presented are the 12 months prior to the survey.

[17] Other types of online channels listed by the ICT Enterprises survey may be found at: https://cetic.br/en/tics/pesquisa/2021/empresas/E2C/

/Credits

TEXT

ARTICLE I
Luis Claudio Kubota (Ipea)
Leonardo Melo Lins
(Cetic.br|NIC.br)

ARTICLE II
Sandrine Kergroach (OECD)

DOMAIN REPORT
Thiago Meireles (Cetic.br|NIC.br)

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Giuliano Galves and Maricy Rabelo (Comunicação|NIC.br)

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ENGLISH REVISION AND TRANSLATION

Ana Zuleika Pinheiro Machado, Robert Dinham, and Luís Henrique Kubota

EDITORIAL COORDINATION

Alexandre F. Barbosa, Tatiana Jereissati, and Javiera F. Medina Macaya (Cetic.br|NIC.br)

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Luciana Portilho (Cetic.br|NIC.br)
Luis Claudio Kubota (Ipea)
Sandrine Kergroach (OECD)

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