



## TRIPLE HELIX SPACES IN BRAZILIAN UNIVERSITIES DURING THE COVID-19 PANDEMIC

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**Abstract:** The advent of the 2019 Coronavirus disease – COVID-19 has placed the global spotlight on science, research, scientific knowledge and researchers, in the search for mitigating solutions at a time when some leaders in developed and developing countries are criticizing the role of science and its ability to overcome challenges. This article presents an analysis from the perspective of the triple helix model of significant initiatives introduced

by Brazilian universities that enabled the identification of an effective response to the pandemic, highlighting the impact and adaptation to the adverse scenario, the rapid responses, the ability to establish forms of interaction that augmented the possibilities for intervention and collaboration with government, business and society in a time of crisis. The effectiveness of the triple helix (university-government-industry) movement, the spaces for consensus, knowledge and innovation during the COVID-19 pandemic, is presented in three case studies from the leading universities in the country.

**Keywords:** Entrepreneurial university. Triple helix. Triple helix spaces. COVID-19. Brazil.

## OS ESPAÇOS DA HÉLICE TRÍPLICE NAS UNIVERSIDADES BRASILEIRAS DURANTE A PANDEMIA DA COVID-19

**Resumo:** O advento da pandemia do COVID-19 colocou os holofotes globais em ciência, pesquisa, conhecimento científico e nos pesquisadores, na busca de soluções mitigadoras em um momento em que alguns líderes de países desenvolvidos e em desenvolvimento estão criticando o papel da ciência e sua capacidade de superar desafios. Este artigo apresenta uma análise, na perspectiva do modelo de tríplex hélice de iniciativas significativas introduzidas pelas universidades brasileiras que possibilitaram a identificação de uma resposta efetiva à pandemia, destacando o impacto e a adaptação ao cenário adverso, as respostas rápidas, a capacidade de estabelecer formas de interação que aumentassem as possibilidades de intervenção e colaboração com o governo, negócios e sociedade em um momento de crise. A eficácia do movimento tríplex hélice (universidade-governo-indústria), os espaços de consenso, conhecimento e inovação durante a pandemia COVID-19, é apresentada em três estudos de caso das principais universidades do país.

**Palavras-chave:** Universidade empreendedora. Hélice tríplex. Espaços da hélice tríplex. COVID-19. Brazil.

### Introduction

The advent of COVID-19 has placed the global spotlight on science, research, scientific knowledge and scientists, in the search for mitigating solutions, vaccines, tests, monitoring and management applications and other expedients that can reduce the damage caused by loss of life, sickness and the interruption of economic activities due to social distancing.

This article presents an analysis, from the perspective of the triple helix model of significant initiatives introduced by Brazilian universities that enabled the identification of an effective response to the pandemic. The activities highlight the impact and adaptation to the adverse scenario, the ability to establish forms of interaction that augmented the possibilities for intervention and collaboration with government, business and society in a time of crisis. The effectiveness of the triple helix (university-government-industry) movement, the spaces for consensus, knowledge and innovation during the COVID-19 pandemic, is presented in three case studies from the leading universities in the country.

Wars, pandemics and other crises not only create new demands that stimulate innovation, but also redirect the flow of resources, creating new markets and business opportunities. They also reveal the dark side of economic development and the inequalities resulting from that process. In this respect, they can also be an opportunity for reflection and

change to a process that prioritizes a humanistic approach towards long term sustainability, rather than a rush to obtain profits (MENTION; FERREIRA; TORKKELI, 2020).

To begin with, it is important to highlight some important aspects of the Brazilian domestic context in the previous years that affected the indispensable effort to cope with COVID-19. Since 2015, political crisis has sparked a political backlash-fuelling, for instance, economic crisis with a deep recession. The impeachment of president Dilma Rousseff brought to power a group of right-wing politicians that, among other measures, cut the budget for education and research (ALMEIDA *et al.*, 2020), disrupted the environmental protection agencies and dismantled a dedicated team at the Ministry of Health (LOPES, 2021). The president elected in 2018 continued to attack education, universities, social protection, human rights and environmental policies. Although the country had three months to prepare to manage this health emergency, between the outbreak of COVID-19 declared as an international concern by the World Health Organization and the first case confirmed in Brazil, nothing was done. The Carnival celebrations took place a few weeks beforehand, with huge crowds clustered in the streets (LOPES, 2021), the main international airports remained open for international flights and handled passengers from all over the world, including areas severely affected by COVID-19, thereby inducing the rapid spread of coronavirus to the metropolitan areas and then by the highway grid into the interior of the country (NICOLELIS *et al.*, 2021).

The COVID crisis response conducted by the federal government publicly refused to implement scientific recommendations such as national lockdowns, postponed the purchasing of vaccines, spread misinformation and oriented people to take some medicines that did not protect them (TAYLOR *et al.*, 2021). The anti-science posture of the right-wing president was considered one of the factors that increased the dissemination of the coronavirus in the country, by organizing meetings with his supporters, without masks and ignoring social distancing practices (VENTURA; REIS, 2021).

The absence of national guidance to the government was reflected in the federal administration, Health Ministry and Education Ministry, which needed to coordinate the response in their respective areas, being unable to provide guidelines to states and local governments, thusmaking room for other government levels and social agents to create alternative responses to the pandemic in a decentralized and bottom-up manner. The public education sector at all levels was greatly affected by this lack of guidance, delaying the return

of activities even in online format at most federal universities, which needed to go through a long process of discussion and definition of norms regarding how to reorganize activities during the pandemic. On the other hand, denial caused the dissemination of the coronavirus to remain high, with a high number of sick and of deaths, further affecting the normalization of and return to face-to-face activities.

In the light of this negative domestic context, universities and research institutes mobilized their organizational structures, acting as consensus spaces to define and guide the necessary actions and generate new protocols during the pandemic. If, on the one hand, the Brazilian population was thrown into a condition of helplessness and despondency, where it could count on no one, due to the government's absence from the scientific management and guidance of the pandemic response (BIRMAN, 2020), university students, professors and specialists were able to create an environment for the collective construction of a network of protection and support, so that academic activities could continue.

The crisis brought about by COVID-19 disrupted the usual models in teaching, learning, research and academic support and led to some radical changes, with the adoption of distance learning. The aim of this study is to analyse, from the perspective of the triple helix model and its underlying pillars: consensus, knowledge and innovation spaces; significant initiatives introduced by universities that enabled identification of an effective response to the pandemic. And also highlight the impact and adaptation to the adverse scenario, the rapid action that ensued, the ability to set up interaction that augmented the possibilities for intervention and collaboration with society in a time of crisis. The activities developed by universities during the pandemic were analyzed by observing the following aspects: the specific mechanisms and activities by which universities are seen to contribute to face the pandemic; the identification of potential beneficiaries of such activities; the interactions of the triple helix spheres involved in carrying out the activities.

The paper is divided into the following sections, in addition to this introduction. The first section presents the theoretical framework underpinning the concepts of the triple helix, the entrepreneurial university, the consensus, knowledge and innovation spaces and the university response to the disease that has recently appeared. The second section presents the methodology used in the study, while the third section shows the initiative categories, impacts

and responses from the Brazilian universities and three outstanding university cases, which is followed by the final considerations.

### **Theoretical framework**

This section relates the concepts of the triple helix and the entrepreneurial university to the initiatives taken by universities around the world when confronted by spreading diseases such as SARS (Severe Acute Respiratory Syndrome), MERS (Middle East Respiratory Syndrome) and the Coronavirus Disease (COVID-19).

The experience of scientists in different organizations at the time that SARS appeared is seen as stimulating innovation as it sought to find solutions and establish new networks in which cooperation transcended competition. As it occurred during a relatively short period of time, it could not be considered sufficient to bring about a cosmopolitan culture of cooperation (PALAZZO, 2005). Yet, it can be seen that this cooperation, both in the literature consulted and in the actions of the Brazilian universities, is trending once more, with the appearance and spread of Covid-19.

Analysis of the impact of SARS in Hong Kong from the perspective of emerging risk concludes that the contribution of civil society reduces the vulnerability of more fragile social groups and preserves the resilience of the community, thus indicating a new form of governance (SZE; TING, 2004). Action carried out by Chinese universities during the Covid-19 epidemic shows positive features such as measures aimed at risk management: approaching alumni to collect medical supplies and donations, support to medical care in university hospitals and conducting research aimed at understanding the pandemic, support for student mental health, control of student mobility under quarantine and innovation in online education models. Among the problems mentioned are the risk of contagion and death among the medical teams, difficulties in the use of information technology encountered by some professors and problems with distance learning for students living in remote areas (WANG *et al.*, 2020).

Similar research in other countries demonstrates that early management and safe national guidelines, both for academic activities and on combating the pandemic, provide shorter periods of interruption of in-person activities, by controlling the dissemination of the coronavirus (BOER, 2021; PEKKOLA *et al.*, 2021; AGASISTI; SONCIN, 2021).

The aforementioned examples indicate that scientific interaction in the search for solutions to the present challenges, acting through a participative university seeking social and economic development solutions and interacting with diverse social agents, has been observed worldwide in the context of the current pandemic. That is a transformational trend in the direction of adopting the concept of the Entrepreneurial University, highlighted in the literature for studies on innovation and in the development and implementation of public policies.

The concept of the entrepreneurial university has been developed from the work of two authors, Henry Etzkowitz (1983) and Burton R. Clark (1998). The theory was developed from research carried out in a number of institutions. The authors point out that although the universities studied followed their own paths, according to their own needs, they share common elements that distinguish them from institutions that followed the traditional path. And the transformational phenomenon assumes a global character, as it extends to universities on different continents. The aforementioned authors emphasize that the internal changes in organizational posture are of a systemic nature, embracing as they do departments, research centres, colleges and schools. Over the years, through organizational initiatives, new structures, processes and guidelines have been developed, leading the institution to take risks that have led to collective entrepreneurial action guided by academic values, different to those found in business, thereby preserving the academic ethos (CLARK, 1998; ETZKOWITZ *et al.*, 2000).

The emergence of knowledge-based innovation is founded upon the external influence of the entrepreneurial university, increasing the alignment of the academic functions of teaching and research by contributing to economic and social development at the regional and national levels. There is also government recognition of the university potential for helping to expand the innovative environment and establish a science-based economic development regime. The triple helix model includes this institutional configuration within the systems of innovation, the architecture of which includes agents such as university - industry - government - society in the process, with the increased importance of the university's role as an institution that produces and disseminates knowledge (ETZKOWITZ; LEYDESDORFF, 2000).

As part of a methodology for generating a Triple Helix Innovation System, Etzkowitz (2008) proposed the Triple Helix Spaces – Knowledge, Innovation and Consensus.

- Consensus Space, that establishes a point of convergence among different participants for generating new ideas and strategies to solve problems and create opportunities.

Those participants can be from the same institutional sectors or from among academia, public and private sectors;

- Knowledge Space, which highlights the critical mass of concentration of related R&D activities and other significant operations aimed at improving local conditions for innovation;
- Innovation Space, is the result of an organizational effort to integrate and connect the goals defined in the previous phase.

Some others authors are studying the creation of triple helix spaces and their activities. For example, Coelho *et al.* (2011) and Marques *et al.* (2014) analyzed in Brazil and in Portugal, respectively, Champenois and Etzkowitz (2018) and Meyer *et al.* (2019) examined the creation of triple helix organizations based on this concept.

## Methodology

The methodology was chosen for the research with a view to enabling a two-stage analysis of the impact of COVID-19 on the Brazilian universities.

The first stage involved the surveying and monitoring of the action taken by universities, governments, industry and civil society in facing the COVID-19 challenge, performing using different types of media gathered on the Triple Helix Association's Brazil Chapter website (THA BR, 2020), which is an open access platform since march 2020. Study of the characteristics of those activities enabled the characterization of six groups, from which the authors selected some more representative examples to clarify the change in the organizational context of the Brazilian universities, whose impacts and responses are analysed in the third section of this paper.

In the second stage, three case studies were performed to analyze the conformity of the spaces for consensus, innovation and knowledge at three important Brazilian universities. These institutions are among the highest rated in the Ministry of Education rankings and private rankings in the country, as well as among the highest in Latin America in international rankings. Our objective is to observe the adaptations and changes in the internal environment and the interaction with the external environment, in view of the impact caused by COVID-19. The characteristics of the selected universities are shown in Table 1 below.

**Table – 1:** Characteristics of the University case studies

Characteristics	University of São Paulo	Federal University of Rio de Janeiro	Federal University of Minas Gerais
State	São Paulo	Rio de Janeiro	Minas Gerais
Year Founded	1934 <sup>(a)</sup>	1920 <sup>(b)</sup>	1927 <sup>(c)</sup>
Number of Students	82,961 <sup>(a)</sup>	65,000	44,039 <sup>(c)</sup>
Number of undergrad courses	183 <sup>(a)</sup>	176 <sup>(b)</sup>	77 <sup>(c)</sup>
Number of Master's and PhD courses	239 <sup>(a)</sup>	232 <sup>(b)</sup>	80 <sup>(c)</sup>
THE Ranking World Ranking <sup>(d)</sup>	201-250	801-1000	601-800
THE Latin America University Ranking <sup>(e)</sup>	2	10	5
Center for World University Ranking (CWUR) 2021-2022 <sup>(f)</sup>	102	360	503
Brazil - CWUR World University Rankings 2018-2019 <sup>(f)</sup>	1	3	6
General Course Index <sup>(h)</sup>	-	5	5

**Sources:**<sup>(a)</sup> <https://www5.usp.br/institucional/a-usp/><sup>(b)</sup> <https://ufrj.br/a-ufrj/sobre-a-ufrj/><sup>(c)</sup> <https://ufmg.br/a-universidade><sup>(d)</sup> [https://www.timeshighereducation.com/world-university-rankings/2021/world-ranking#!/page/0/length/25/locations/BR/sort\\_by/rank/sort\\_order/asc/cols/scores](https://www.timeshighereducation.com/world-university-rankings/2021/world-ranking#!/page/0/length/25/locations/BR/sort_by/rank/sort_order/asc/cols/scores)<sup>(e)</sup> [https://www.timeshighereducation.com/world-university-rankings/2021/latin-america-university-rankings#!/page/0/length/25/sort\\_by/rank/sort\\_order/asc/cols/undefined](https://www.timeshighereducation.com/world-university-rankings/2021/latin-america-university-rankings#!/page/0/length/25/sort_by/rank/sort_order/asc/cols/undefined)<sup>(f)</sup> <https://cwur.org/2021-22/country/brazil.php><sup>(g)</sup> <http://portal.inep.gov.br/web/guest/educacao-superior/indicadores-de-qualidade/resultados>

These are public institutions, the first sustained by the government of the state of São Paulo, the other two by the federal government. The universities have a technology park, business incubators and social incubators, technology transfer office and teaching and support structures for the population, such as university hospitals, in addition to developing several outreach projects. They are located in the Southeast region, the most populous, with the greatest economic activity.

**Impacts and responses of the brazilian universities**

The institutions that comprise the triple helix, university-industry-government, in collaboration with civil society, were involved in multiple activities to combat the disease and the consequences arising from the serious social inequality existing in the country. Table 2 shows the number of activities by region within the country.

Students on the Public Policy Management course at EACH (School of Arts, Sciences and Humanities at USP) developed the Popular Science project to disseminate all the activities carried out by Brazilian federal universities and institutes to combat the effects of the Covid-19 pandemic throughout Brazil.

**Table – 2:** COVID-19 - Number of activities in universities and public research institutes, by region of Brazil.

Region	Southeast	South	Centre-West	North	Northeast	Total
Number of activities	1,153	451	422	291	758	3,075

**Source:** CIÊNCIA POPULAR (2021), FERREIRA (2020).

These activities in the period March/2020 - July 2021 come to a total of 3,075, at a total of 265 universities and institutes.

### Typology of activities

The mapping and analysis of those initiatives is important to emphasize the significance and strengthen the role of the agents involved in the production of scientific and technological knowledge, through the various forms of interaction, the establishing of networks and technological solutions that can have a direct impact, both on the process of innovation and on public policies aimed at knowledge-based economic and social development. Examples of activities and partnerships and the interaction networks of the Brazilian universities, in dealing with the challenge of COVID-19, are described in Table 3.

**Table – 3:** Activities and partnerships and the interaction networks of the Brazilian universities, in dealing with the challenge of COVID-19

Type of Activity	Examples	Interaction and partnerships
1. Development of research and technology in support of addressing Covid-19 and its consequences.	The Federal University of Rio de Janeiro (UFRJ) received US\$ 111,000 from the Ministry of Science, Technology and Innovation (MCTI) to carry out clinical studies on a tuberculosis vaccine and on resistance to COVID-19 (MCTI, 2020a).	University, Government

	<p>Brazilian universities have been certified by Brazilian Health Regulatory Agency (ANVISA) to support the government and the private sector in human testing to validate internationally developed vaccines against COVID-19.</p>	<p>University Government, Industry</p>
	<p>The Ministries of Health (MH) and Science, Technology &amp; Innovation (MCTI) established the Emergent Viruses Network (RedeVirus MCTIC), with the participation of Institutes of Science and Technology, universities, agencies and laboratories, for the purpose of assisting the ministry to coordinate development of diagnostics, treatments, vaccines and generate knowledge about the virus (MCTI, 2020b). The Federal University of Minas Gerais (UFMG) joined the Oswaldo Cruz Foundation and the Federal University of Rio de Janeiro (UFRJ) in developing studies to create new vaccines against COVID-19 (BIERNATH, 2021).</p>	<p>University, Government, Civil Society</p>
	<p>Research and development of artificial respirators: 1) Inspire Project (CARNEIRO, 2021) financial resources donated by companies for development, with the equipment adopted by several hospitals in the country; 2) Federal University of Rio de Janeiro (UFRJ) received financial and technical support from Eletrobras Electrical Energy Research Centre CEPEL), Petrobras, Whirlpool, Rio de Janeiro State Research Support Foundation (FAPERJ) and the Rio de Janeiro State Legislative Assembly (UFRJ, 2020a).</p>	<p>University, Government, Industry, Civil Society, private organizations and donors</p>
<p>2. Development of technology in support of frontline personnel in the Health System and the production of PPE.</p>	<p>The Smart Society Project brings together initiatives from four educational institutions: Lorena Engineering School, at University of São Paulo (USP); Teresa D'Ávila University Centre (UNIFATEA); Serra Dourada College; and the São Paulo College of Technology (FATEC) (under the Paula Souza State Centre</p>	<p>University, Industry, local government and volunteers</p>

	<p>for Technological Education – CEETEPS), alongside companies in the Paraíba Valley region and the São Paulo metropolitan area, and local government (Lorena municipal government). The project received a number of donations from companies and public space for production and dissemination, as well as volunteers for the production of equipment, alcohol gel, delivery of baskets of basic items to needy families, and students and professors from the institutions engaged in dozens of surveys in addition to conducting research into plastic recycling for the manufacturing of protective equipment, as well as other innovative research, donating all of its production to public hospitals and philanthropic entities in the region or to locations in need (LAB4SOCIETY, 2020).</p>	
	<p>Several universities started to produce alcohol gel and liquid soap for use in the university hospitals and distribution to public bodies (health clinics, municipal schools, police stations, etc.). The five state universities may be cited as an example (AGÊNCIA DE NOTÍCIAS DO PARANÁ, 2020).</p>	<p>University, Government</p>
	<p>Production Engineering and Software Engineering professors at the Federal University of Amazonas (UFAM) participate in the "Inova Covid-19 Brasil" network making personal protective equipment (PPE) – face shields – for distribution among public health professionals in the municipality of Itacoatiara (COELHO, 2020). The "Inova Covid-19 Brasil" network comprises professors at Federal University of Amazonas (UFAM), Federal University of Santa Catarina (UFSC), Univasf (Federal University of the São Francisco Valley (Univasf), Federal Institute of Sergipe (IFSE), Federal Institute of Santa Catarina (IFSC) and Federal Institute of São Paulo (IFSP) (COELHO, 2020).</p>	<p>Universities in different parts of the country, Government and Civil Society</p>

3. Outreach activities, courses, lectures and the arts. Dissemination of materials about the disease.	On its website, the Federal University of Pernambuco (UFPE) developed a number of instruction booklets to educate the population and various target audiences about subjects such as: "Kitchen, shopping and food", "Delivery of purchases", "Health professionals", "Low-income workers", "Worker Rights and Safety during the Pandemic" (UFPE, 2021).	University
	Federal University of Amazonas (UFAM) developed the campaign “Stay within the community”, producing material for the guidance of the indigenous Ticuna people and appealing for them to remain within their communities. The campaign involves teachers and indigenous and non-indigenous students, in addition to Special Department for the Health of Indigenous Peoples (SESAI), National Foundation for Amerindian Affairs (FUNAI) and civil society (FASUBRA, 2020).	University, Government, Civil Society (indigenous Ticuna people)
	Federal University of the State of Rio de Janeiro (UNIRIO) organized a program of artistic activities involving art course students and professors, as well as cultural promoters and performers from the Rio de Janeiro city, as a way to publicize action already developed at the institution for internal and external audiences, as entertainment during the period of social distancing, when such activities were not allowed (UNIRIO, 2020).	University, Industry, Civil Society
	In the Northeast, the governors of nine states established a support network – Scientific Committee of the Northeast Consortium - to fight the pandemic, coordinated by the scientists Miguel Nicolelis and Sergio Rezende. The Mandacaru Project, created by Miguel Nicolelis, is a virtual network that has 2,000 volunteers (specialists and researchers from different fields) and a number of institutions seeking solutions to combat the	University, Government, Industry and Civil Society

	pandemic using scientific know-how (C4NE, 2020).	
4. Seeking financial support among students, alumni, civil society and government tenders for research and innovation.	Universities with university hospitals received help from their respective support foundations and organized campaigns among their students, alumni and civil society to renovate facilities and purchase equipment, with a view to increasing the number of ICU beds, acquiring PPE for medical staff, etc. (CONFIES, 2020).	University, Industry, voluntary donors and Civil Society
	Researchers at several universities participated in calls to tender aimed at stimulating research in relation to COVID-19, issued by state institutions such as Rio de Janeiro State Research Support Foundation (FAPERJ), São Paulo Research Foundation (FAPESP), and Minas Gerais Research Funding Foundation (FAPEMIG), among others, as well as federal organizations supporting research, such as the Brazilian National Council for Scientific and Technological Development (CNPq), Coordination for the Improvement of Higher Education (CAPES), Brazilian Innovation Agency (FINEP), Ministry of Science, Technology and Innovation (MCTI) and Ministry of Health (MH).	University, Government and Civil Society
5. Support activities for students during the pandemic (psychological, financial, equipment and other support).	Free online psychological assistance for university students, technicians and professors has been offered by a number of institutions, including the Federal University of the Parnaíba Delta (UFDPAr) (in the state of Piauí), where volunteer psychologists participate, in addition to the professors (UFDPAr, 2020). At the Federal University of Goiás (UFG), the service was extended to health professionals at the university hospital (ARAÚJO, 2020). At the Federal University of Minas Gerais (UFMG), support was extended to exchange students that included cultural and entertainment tips (UFMG, 2020a). The State	University

	University of Rio de Janeiro (UERJ) offered a short online course that provided a space for support and exchanges, including the sharing of integrative health practices, such as breathing techniques, meditation and mindfulness (UERJ, 2020).	
6. Remote teaching and work organization.	The maintaining of classes in remote format was immediate at private universities, after the pandemic began. In the great majority of public universities, remote education was delayed, due to concern that the progress in social inclusion over the last two decades would be compromised by accessibility problems, due to a lack of computers and internet access for students with lower purchasing power. The resumption of classes, using the remote model, has been seen at some institutions, such as Federal University of Rio de Janeiro (UFRJ), University of Brasilia (UnB), Federal University of Minas Gerais (UFMG) and Federal University of Pernambuco (UFPE) (COSTA, 2020), following almost four months of planning and adapting of subject matter, investigation into student internet access and the provision of data packages.	University, Government, Industry and Civil Society

7. Innovative action by incubator companies and technology parks	Incubator companies and technology parks have developed products suitable for combating COVID-19, in some cases in partnership with researchers from university research groups. There have been some interesting experiences, such as the Supera Innovation and Technology Park in Ribeirão Preto, in São Paulo state, which in a joint endeavour with the local government gathered the companies' laboratories to carry out COVID-19 diagnostic tests, since there were no organizations in the municipality for that purpose and the exams performed in the city of São Paulo took a long time to deliver the results, due to the high demand (OXFORD, 2020). Farmacore, a USP spin-off company incubated at the Supera Innovation and Technology Park in Ribeirão Preto, is developing a vaccine alongside University of São Paulo (USP) professors (BIERNATH, 2021).	Spin-off companies, university and government.
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**Source:** The authors, 2021.

One of the principal effects is the redefining of the organization and the workplace as a feature of the post-Covid-19 restructuring process. The pandemic accelerated the death of the traditional office (NIXEY, 2020), as the digital revolution made it possible to work remotely, online, along with the reorganizing of society on the basis of knowledge resources and decentralization (RORIZ, 2019). The coexistence or transition between the two models (face-to-face and remote) will involve tension within organizations.

It has also brought about the redesigning of higher education activities in Brazil. This has had an impact on teaching at both undergraduate and graduate levels, as well as on other activities performed by professors, who have been profoundly affected by the need for social distancing, resorting in many cases to digital platforms to hold work meetings, proceed with research and participate in virtual conferences and conventions. The reaction of the universities in Brazil to the pandemic has given rise to an enormous amount of specific activities that bear a resemblance to those of universities abroad, according to studies by Wang *et al.* (2020) and Sze and Ting (2004).

However, a distinguishing feature of the Brazilian context is that the suspension of face-to-face activities in March/2020, when the state governments decreed social lockdown, had two distinct effects: universities that continued their classes, moving them online, and universities that suspended their classes, but continued their research and outreach activities. The organizational context of those institutions, particularly in regard to financial autonomy, was one of the main reasons for the different responses.

When it comes to university qualifications, the graduation process has considerable potential for exclusion, especially at the public universities. The progress that has been achieved over the last couple of decades could be seriously compromised through lack of access to computers and to the internet. Unequal access to university qualifications has the potential to exclude low-income and special quota students.

The majority of the country's 59 federal and state public universities have in recent years undergone an organizational change in terms of student access, with the enactment of Federal Law No. 12,711/2012, popularly known as the Quotas Law, which allocates 50% of the places per course and class to Afro-descendant and indigenous students and those who have completed public secondary schooling and are from a family with a gross income that is less than or equal to one and a half minimum wages per capita. These universities have relative autonomy under the federal law, as it is written into aspects of their administrative rules, but they do not have financial autonomy, so their operations depend on federal government resources. This major social inclusion project would be threatened if the continuation of classes did not take into consideration that half of the students might not be able to participate in the classes because of a lack of equipment, difficulty in accessing the internet and no suitable place for home study. In the case of the federal universities, the resumption of classes in undergraduate and graduate courses occurred, in the online format, following decisions taken by senior committees at the universities, approving a special timetable and providing for classes to begin after the student beneficiaries of the aforementioned legislation had been supplied with computer equipment (PCs or tablets and a chip for internet access), as well as food and housing assistance, where necessary. That way, it was possible to continue the teaching activities and preserve the hard-won social inclusion.

The impact and concerns raised by Covid-19 led to redirected and renewed government investment in ST&I, centred on the universities and institutes of science and technology, the

hub of scientific production in a country where R&D activities in industry still tend to be inadequate. The R&D budget, which had been reduced annually since 2016, was increased with resources earmarked for research into COVID-19, its impacts and means of combating it.

### Universities and Triple Helix Spaces

In previous studies on consensus spaces, the greatest emphasis was on liaison between the university and other agents, such as companies and government, in the establishing of a Consensus Space that would enable the development of activities aimed at triple helix organizations, innovation and regional development, making use of existing capabilities in the realm of knowledge and innovation. In this article, the structure of the Brazilian universities permits a detailed analysis of the building of internal consensus. According to the federal constitution, federal public universities have relative autonomy: administrative autonomy, but not financial autonomy, as the determining of the annual budget occurs at the national level, proposed by the federal government and approved by the national Congress. In the case of state public universities, this pattern is repeated, with the exception of the state of São Paulo, where due to legal definitions the institutions have administrative and financial autonomy. With regard to administrative autonomy, in terms of general decisions that affect the institution as a whole, these are made by the University Council, comprising representatives of the various faculties elected by the professors, administrative staff and students, while the other decisions are taken by intermediate bodies, the councils, departments and specialized entities such as university hospitals, technology parks and incubators, among others. According to Brazilian legislation, universities only have emergency plans for emergencies and floods, and no emergency actions are covered for events such as the COVID-19 pandemic. For this reason, a great effort was directed to internal decisions on how to conduct activities during the pandemic. Traditional decision centers at various levels have been triggered, such as university councils, chambers or research councils, or sectoral units such as centre boards and departmental councils. Thus, the internal decision-making structures that already acted as spaces of consensus within these institutions remained spaces of consensus during the pandemic. This fact is fundamental in the analysis of the activities of universities in the face of the pandemic due to the lack of a central coordinated action by the Ministry of Education during the pandemic due to the negacionist position adopted by the president that influenced the entire central administration of the country.

At public universities and public research institutes, their consensus, innovation and knowledge spaces are not necessarily centralized under the Chancellor's office or at the level of the senior administration. In many cases the consensus spaces are multiple and share their needs and wants, in order to serve as consensus spaces, with the support of the higher levels. Some areas, departments and institutes enjoy a certain degree of internal autonomy and upon finding themselves in an emergency situation, they are certainly driven by feelings of solidarity, showing willingness to conduct a variety of activities to fight the coronavirus, using what was available at the time. In the case of certain research laboratories that were carrying out research projects in other health-related areas, with the pandemic, they began to use their physical resources, knowledge and innovative efforts to come up with strategies to combat the COVID-19 pandemic.

Analysis of the Consensus Space is enriched by the building of an institutional consensus based on consensus at the local or micro level. The tensions created by different opinions, worldviews and political opinions are considerable, but in times of crisis or threat to science or institutions, internal alliances are built and consolidated according to the circumstances. It is on the basis of this internal consensus that has been built that institutions move towards liaison with outside organizations, so that an external consensus can be developed and that Knowledge and Innovation Space activities can be determined for the development of triple helix relationships with the other spheres and for the university to participate in the process of regional development and support, as well as, in the case studied, in activities for the control and combating the spread of COVID-19. Analysis of the spaces mentioned will be presented below for each of the chosen institutions.

#### Federal University of Rio de Janeiro

The Chancellor's office set up a Crisis Emergency Committee at the UFRJ, in March/2020, just as COVID-19 was beginning to spread, for the purpose of evaluating and determining action and procedures to be adopted within the institution in order to deal with the crisis. The suggested norms were approved by the University Council, comprising elected representatives of the university's various faculties, to create an internal consensus regarding how internal activities and relations with outside institutions should be conducted, within the context of the crisis. Safeguarding the university's autonomy and the peculiarities of each

entity, those norms provided a basis to guide the other decision-making bodies within the university's organizational structure. The Chancellor's office was responsible for coordinating the risk management activities within the scope of UFRJ, in relation to the COVID-19 pandemic, working together with the Crisis Emergency Committee and the multidisciplinary working groups (UFRJ, 2020b).

In a strategic move, a Multidisciplinary Working Group was also set up at the UFRJ to focus on the Coronavirus Disease (COVID-19). It brought together specialists from various different areas and entities at the UFRJ, for the purpose of developing activities that would provide better conditions for responding to COVID-19. Subsequently, a Multidisciplinary Working Group was set up at the UFRJ to focus on the Post-pandemic, so as to contribute towards the development of strategies and action plans for a progressive recovery in the wake of the COVID-19 crisis (UFRJ, 2020c).

A Contingency Plan, which expresses the activities updated in response to COVID-19, was jointly prepared by the Chancellor's office, the senior administration, administrative staff, the hospital complex and the communication coordinators. The final review was performed by the coordinators of the multidisciplinary working group. Autonomy was allowed for the faculties and entities, as well as the Macaé and Duque de Caxias campuses, to organize their own emergency plans so as to meet specific demands not provided for in the Contingency Plan (UFRJ, 2020d).

Risk management measures were developed by the UFRJ and strategically coordinated by the Crisis Emergency Committee and working groups bringing together various agents from within the university community and involving social commitment and collaborative efforts, both internal and with other agents and outside sectors. This was possible because the university's Consensus Space had already been consolidated and integrated, allowing quick decision-making that facilitated the action that needed to be carried out on behalf of society during this period.

The university's innovation and knowledge spaces, for product development, are concentrated in COPPE (Alberto Luiz Coimbra Engineering Post-Graduation and Research Institute), which is the largest centre for engineering teaching and research in Latin America, with engineering education at the undergraduate level taking place at the Polytechnic School and School of Chemistry and postgraduate studies and research at COPPE. It is a simultaneous

research/knowledge and consensus space that makes it possible to finance its own projects and liaise with companies, through the Coppetec Foundation, with convergence of teaching and research and interaction with the external sphere, with companies.

This aforementioned structure benefited from the agility provided by the Multidisciplinary Working Group at UFRJ, in dealing with the Coronavirus Disease (COVID-19). The development of equipment and other products to address the COVID-19 crisis is clearly the result of previous research. However, the mobilization to make it viable cannot be separated from this fusion of spaces.

Thus, development of a respirator design for the treatment of patients involved the ability to obtain financing through the establishing of a COPPETEC Pulmonary Ventilator Support Fund (VExCO) for dealing with COVID-19 at the UFRJ. It must be emphasized that this project was made possible at a time of considerable restrictions on access to respirators, in both the domestic and international markets (UFRJ, 2020e).

The designing of rapid tests for the diagnosis of COVID-19 involves two entities from different fields of knowledge, namely COPPE and the Carlos Chagas Filho Biophysics Institute at the Health Sciences Centre. The product, called the S-UFRJ, is a low-cost device for the detection of antibodies (UFRJ, 2020f).

In the area of outreach, at the HSC's College of Pharmacy, 70% proof alcohol was produced to meet the needs of the university's internal entities and for outside requirements (hospitals and clinics).

### University of São Paulo

In March/2020, soon after the first cases of COVID-19 were identified in Brazil, USP began the reorganization of its activities, through a gathering that brought together the University Council and directors from all the university campuses. Among the decisions taken were the continuation of essential activities, including classes that would become remote, encouragement for the research programs to monitor the developments of the epidemic and seek improvements in diagnosis and treatment, as well as the establishing of a technical committee to monitor the situation (JORNAL DA USP, 2020a). Note that the organizational structure, meeting as the university council, was expanded to include the other managerial figures.

The chancellor's office set up a USP Covid-19 Standing Committee, with the aim of constantly monitoring the evolution of the viral presence among students, professors and technical and administrative staff at the university, on all the USP campuses, as well as periodical updates on the recommendations of the state and federal health authorities (USP, 2020).

This broad regulation of operations during the pandemic shows the Consensus Space outlining the organization of activities on the various campuses in different municipalities where USP operates within the state of São Paulo. It was subsequently updated and followed by other norms that addressed the specifics of activities in research (laboratories) and innovation (incubators, technology parks) spaces, in an effort to create security for the various groups at the university (professors, researchers, students, specialists). This also made the state government and civil society aware that the university was continuing to perform, including seeking to resolve challenges brought about by the pandemic itself, in addition to the projects that were already in progress.

Within the Knowledge Space, USP stood out for not having interrupted classes due to the pandemic, having moved classes to the remote format in March and thereby serving as a parameter for other institutions across the country, providing equipment and internet access kits for socially vulnerable students (JORNAL DA USP, 2020c).

Similar to all the country's public universities, USP has been developing activities to quickly combat COVID-19, since the beginning of the pandemic. Two days after the announcement of the first reported case in Latin America, on February 26, 2020, researchers from the USP Institute of Tropical Medicine (IMTSP-USP), in partnership with the Adolfo Lutz Institute and Oxford University (United Kingdom), published data on the cultivation and sequencing of the SARS-CoV-2 virus, on February 28, 2020, on the Virological.org website. These data were made available to researchers around the world, who were able to use them in essential research, such as diagnostic tests and the development of vaccines (TOLEDO, 2020).

Even with an 11% cut in the 2020 budget, due to the sharp commercial decline caused by the pandemic, since funding depends on the collection of the 9.75% ICMS (value-added tax) by the state, working through its consensus spaces, mainly represented by the Chancellor's office and senior administration, USP continued to encourage its researchers to open their laboratories for research in relation to Covid-19 (CAFARDO, 2020).

### Federal University of Minas Gerais

Notable among the activities to mitigate the effects of Covid-19 at the UFMG were the following: more than 120 studies carried out, development of a Brazilian vaccine, testing of vaccines and medications in international partnerships involving the acquisition of 1.5 million health supply items, 42,000 diagnostic tests performed and 1,500 litres/month of alcohol gel produced.

Analyzing the activities developed according to the Triple Helix Spaces proposition of Etzkowitz (2008), it was noted that the UFMG established a Consensus Space, which was first developed internally, bringing together its departments and the departmental chamber and setting up the Standing Committee for Monitoring the Treatment and Prevention of the New Coronavirus, to analyze the epidemiological situation of SARS-COV-2. This example includes “micro-consensus” space, as there were important decisions that involved the senior administration, coordinators, professors, student representatives and community representatives. Out of this internal Consensus Space, significant activities emerged, such as approval of the plan for resuming classes, assisting needy students with a plan for the use of mobile phones and other equipments.

To develop the external Consensus Space, the UFMG participates in a network of researchers under the aegis of the Ministry of Health and the Ministry of Science, Technology and Innovation, contributing to research in virus laboratories and in the determining of guidelines for combating Covid at other research and health institutions.

The UFMG conducted validation tests on the Coronavac vaccine, produced by the Chinese company Sinovac Biotech. This partnership involved 12 Brazilian centres, including the Butantan Institute in São Paulo, and was coordinated by the Brazilian government and the state government of São Paulo (UFMG, 2020c). This activity represents what the Triple Helix theory calls Innovation Space, that is, a space within which the action of the three spheres (government-university-industry) generates innovative products.

The UFMG/Ebserh Hospital das Clínicas, next to the UFMG Medical College, is one of the 20 Brazilian centres that had participated in the testing of another vaccine candidate for use against the new coronavirus, by the American company Johnson & Johnson (J&J) (UFMG, 2020a). This case is another example of the university's participation in the Innovation Space, through its partnership with J&J to validate the vaccine production.

Furthermore, researchers at the UFMG are studying the development of a double vaccine against Covid-19. The idea is to produce a vaccine derived from the popular BCG, which protects against tuberculosis, to also fight SARS-CoV-2. The research is being carried out in the UFMG Biochemistry and Immunology Department of the Institute of Biological Sciences (ICB) and also involves the Federal University of Santa Catarina, the Butantan Institute in São Paulo and the National Institute of Science and Technology for Tropical Diseases.

The UFMG acted within the Knowledge Space in a number of other activities that disseminated important knowledge and were aimed at mitigating the effects of the Covid-19 pandemic. These activities involved setting up a specific social network to communicate with students and the academic community, providing online classes and guidelines for remote work, as well as the distribution of masks and other personal protective equipment, such as alcohol gel, for the academic community. The UFMG defined a biosafety protocol, drawn up by specialists, for adapting spaces and monitoring Covid, with guidance on the management of essential activities (UFMG, 2020b). When the recommencement of in person classes is authorized by the health authorities, the protocol will be followed for maximum security. The protocol can also provide a benchmark for other teaching and Knowledge Space based on scientific evidence.

### **Final considerations**

The Covid-19 pandemic created an emergency scenario that tested the consensus, knowledge and innovation spaces of universities and public institutes in Brazil, as there was no time for preliminary preparation. The response of those institutions to the crisis has shown great potential for dealing with similar scenarios that may arise.

The theoretical review showed that several authors had conducted analysis: 1) observing the agents who performed various roles in the interaction and forming of innovation networks; 2) focusing on regional strategies for innovation; and 3) analyzing the setting up of organizations along the lines of the Triple Helix model. However, the distinctive feature of this article is research institutions, with its structured guidelines, acting as a reflected in its contribution to the theory. The analysis encompass the Triple Helix Spaces, considering the individual role of each agent involved, the building of internal consensus at the universities,

through their various forums. It also includes the study of the innovation network, comprising national and international agents, in large collaborative university-industry-government projects, such as those mentioned in the case studies.

The three case studies demonstrate the universities studied have similarities in the performance by the following aspects: 1) managerial autonomy (consensus), which was possible due to organizational flexibility, which is linked to the consensus space of those institutions, owing to the democratic leanings of the senior management; 2) existing intellectual capital (knowledge); 3) the ability to come up with new technological solutions (innovation), capable of providing responses to local and regional needs. The last is predominantly linked to the development of new technology with low complexity and low cost (treatments, diagnosis, PPE, respiratory equipment, etc.). The main difference refers to the return to teaching activities. While the University of São Paulo started classes in online format in April 2021; the Federal University of Minas Gerais and Federal University of Rio de Janeiro began to offer online classes in September 2020, both demonstrating a greater difficulty in building consensus due to: 1) budgetary difficulty in the acquisition of equipment for students in situations of economic vulnerability; 2) questioning of teachers and students under quality of teaching and the impact on the training of students because there was no training and prior preparation for the transformation of classroom teaching into online in a course of time.

The steps taken by the universities in response to COVID-19 reflect certain characteristics of those organizations. Autonomy in the organizing of teaching, research and outreach activities enabled a rapid bottom-up response in diverse formats. Similar to what occurred in the health field, there was a lack of a coordinated national policy in the field of education, with collegiate bodies, teachers' associations, students and local governments playing a leadership role over the measures to be taken. The public universities, strongly affected by federal/state government funding cuts, criticism of science and disdain for professors and students alike, were able to build bridges with government, industry and society in order to participate in the efforts to combat the pandemic. The bottom-up approach is linked to potential entrepreneurial development, due to the accumulated expertise of their highly qualified human resources.

The organizational bodies of the Brazilian universities accumulate functions that can be described as the convergence of consensus, knowledge and innovation spaces, because it is in

those places that management decisions regarding the body and its participants are made, but also where R&D projects and innovation are discussed. The convergence of these spaces within a single environment facilitates decision-making and stimulates activity, alongside outside agents from the different spheres of the Triple Helix, such as other universities, governments and companies.

The knowledge and innovation spaces, inside and outside the universities, spread beyond their campuses, with the resulting knowledge leading to solutions for the problems that arose with regard to the pandemic. The joint efforts among the universities enabled ongoing research to be redirected to combating Covid-19, resulting in important innovations over a short period of time. All of this was only possible because the consensus spaces were already established and organized, allowing the universities to act, with positive outcomes for society.

Based on the triple helix model, the university sphere assumed functions that were previously reserved for industry and government. University laboratories became production units, manufacturing products such as alcohol gel, soap, masks and personal protective equipment and playing the role of industry and government by providing these materials to workers. They also promoted public policies in support of the disclosure of reliable scientific information to the population and playing the government role in public health campaigns. As for the research laboratories and INCTs (National Institutes for Science and Technology) studying virology and epidemiology, their research into the diagnosis, treatment and prevention of emerging and re-emerging diseases has gained greater prominence. One should also highlight the initiatives of engineering laboratories in developing equipment such as respirators, in a country that is undergoing a process of deindustrialization.

Bilateral or trilateral interaction networks, involving institutions in different, national and/or international spheres, were quickly developed, based on varied objectives, such as research projects, student support and the treatment of patients, revealing that the threat posed by the pandemic increased the level of collaboration, instead of competition. New forms of public health governance, which was previously under the strong influence of the federal government, were established, with emphasis on interstate and intra-state alliances among municipalities, with a significant role played by the universities and researchers within those networks, as has been the case in other times of national mobilization. Across different states, regional contexts and degree of research density, the Brazilian universities have shown that the

concept of the entrepreneurial university, concerned about social and economic development, augments the possibility of intervention and collaboration with society in times of crisis.

This paper shows that COVID-19 has highlighted the relevance of the results of university research to innovation, particularly in the field of health. It also confirms that the universities have been working for decades in this area of research, as it would not have been possible to respond so quickly without that sound knowledge base. The accumulated knowledge in the university laboratories for virus studies allowed the researchers to fast act in alternatives for diagnostics and treatment.

It is hoped that the government will be able to draw on the evidence and experience of the universities and formulate new policies to promote university-industry-government interaction through physical and financial support structures. And furthermore, that the private sector can approach the universities to carry out collaborative research and development and to promote local development in the social and technological spheres.

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