Brazilian Universities' Profiles and The Sustainable Development Goals (2015-2023). Production and impact on Web of Science

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Note: This article can be read in its Spanish original version on:
http://www.profesionaldelainformacion.com/index.php/EPI/article/view/e330306

Recommended citation:

Del-Rio-Sánchez, Olga; **Oliveira, Andrea**; **Repiso, Rafael** (2024). "Brazilian universities' profiles and the sustainable development goals (2015-2023). production and impact on web of science". *Profesional de la información*, v. 33, n. 3, e330306.

https://doi.org/10.3145/epi.2024.0306

Article received on October 10th 2023
Approved on November 15th 2023

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Abstract

The Sustainable Development Goals as a global policy provide universities with the opportunity to offer information and innovative solutions in international forums. In recent years, scientific research on the SDGs has not only grown, but has also diversified. However, the relevant gaps in studies on the subject affect compliance with the Agenda 2030. This article aims to evaluate the Brazilian university system's research into SDGs. It also proposes a methodological objective which is to verify whether, through the analysis of scientific production, profiles can be identified, and university entities can be grouped based on their similarity in the priority they give to different topics. A bibliometric analysis is carried out where the production and normalized impact of Brazilian universities are studied, as well as multidimensional scaling. The results reveal that the Brazilian production of each SDG is concentrated in five universities and that, in general, the entities' contribution to the SDGs achieve a lower impact than the world average except for the theme "Life on Land" (SDG15). This suggests that Brazilian research into the SDGs pursues a contribution of scientific knowledge of the local geographical scope. Furthermore, the data indicate the presence of few universities with unique profiles when it comes to prioritizing scientific contributions to the SDGs. Faced with the global challenge of more diverse and plural knowledge production, Brazilian centers can take advantage to expand their scientific production on the SDGs on a more strategic scale with the purpose of influencing the universal political agenda. The study enriches the understanding of the scientific contribution to the SDGs by Brazilian universities.

Keywords

Sustainable Development Goals, Sustainable Development, Brazil; Scientific Production, Scientific Impact, Bibliometrics, Universities, Multidimensional Scaling, SDGs, Brazilian Universities, Normalized Impact, Science Communication, Agenda 2030, Science Indicators, United Nations.

1. Introduction

Science is carried out in specific historical and cultural contexts in which both internal factors of each discipline and external political, social and cultural dynamics come into play (**Smelser**, 1989; **Shapere**, 1986). Thus, interactions between scientific subsystems and politics are permanently reconfigured based on the dynamics of the social system (**Schmalzbauer; Visbeck**, 2016). In this regard, the Agenda 2030 for Sustainable Development --adopted unanimously by all countries at the United Nations Summit in September 2015 to be achieved by 2030--, is configured as a new universal political agenda that aims to ensure the future of humanity and requires the participation and collaboration of all public and private social actors (**United Nations - General Assembly**, 2015). It is a complex agenda, with 17 goals, 169 targets and 232 indicators (**United Nations - General Assembly**, 2017) for which countries, enterprise, civil society, universities, etc., must offer solutions and periodic information in the various national and international forums (**EU and UN Team Inter-Agency-Task**, 2021). The Sustainable Development Goals (SDGs) are interdependent and deal with the three dimensions of sustainable development: economic, social and environmental (**United Nations**, 2023; **United Nations - General Assembly**, 2015).

Figure 1: Sustainable Development Goals Grouped According to Sustainability Dimensions.
Source: (**Delli-Paoli; Addeo**, 2019).

The complexity of the project and the need for innovative solutions and to generate periodic information make science, technology and innovation the key means for achieving the Sustainable Development Goals (**EU and UN Team Inter-Agency-Task**, 2021). Thus, the United Nations in its *World Report on Sustainable Development 2019: The Future is Now: Science for Achieving Sustainable Development* advocated strengthening the science-policy interface for qualified and evidence-based decision-making by policymakers and other public and private actors in the implementation of the SDGs (**United Nations**, 2020). UNESCO declared 2022 the International Year of Basic Sciences for Sustainable Development and in 2023 the *Global Sustainable Development Report 2023* sought to strengthen a science-policy-society interface, adding that the production of scientific knowledge must be inclusive and plural, and also respond to the context in which this knowledge is produced and to which it seeks to provide solutions (**United Nations**, 2023).

The launch of the Agenda 2030 as a global political agenda, plus the centrality bestowed on science in order to achieve the SDGs and the various efforts made by the United Nations and other international and national organizations, have resulted in a constant and exponential increase in scientific production around the SDGs (**United Nations**, 2020; **Repiso; Segado; Gómez-García**, 2023). **Mishra *et al.*** (2023) note that between 2015 and 2022 a total of 12,176 articles related to the SDGs were published, more than half of which were published in the last two years (**Mishra *et al.***, 2023). In October 2022, **Yamaguchi *et al.*** (2023) in a simple query made through Web of Science (WoS) using the keywords "Sustainable Development Goals" obtained 37,037 hits. This proliferation of studies and the volume of existing knowledge on the SDGs offers researchers the opportunity to explore this domain from different qualitative and quantitative standpoints based on the literature generated in this field. The first reviews focused rather on qualitative approaches with different objectives such as evaluating national progress, identifying the role of ICT in achieving the SDGs or analysing the challenges of their implementation, including **Mishra *et al.*** (2023). In recent years, a stream of studies has emerged that seeks to analyze this scientific production through meta-analysis and bibliometric analysis (**Repiso *et al.***, 2023).

Scientific research on the SDGs is not only growing, but is diversifying its research areas. As can be seen in Figure 2, the topics dealt with increased between 2015 and 2022, this last year being the only one that presented review articles on all the SDGs (**Yamaguchi *et al.***, 2023). However, research on the SDGs cannot yet be considered an established area given that there are significant gaps in research, especially in: SDG8 "Decent work and economic growth" (**Mishra *et al.***, 2023), SDG10 "Reduced inequalities", SDG5 "Gender equality", and SDG16 "Peace, justice and strong institutions" (**Yamaguchi *et al.***, 2023). The **UNESCO** report on Science (2021) also shows a diversification according to countries, as well as existing gaps, which affect the fulfilment of the Agenda 2030 since it requires a balance between the three dimensions of sustainable development: economic, social and environmental (**UNESCO**, 2021).

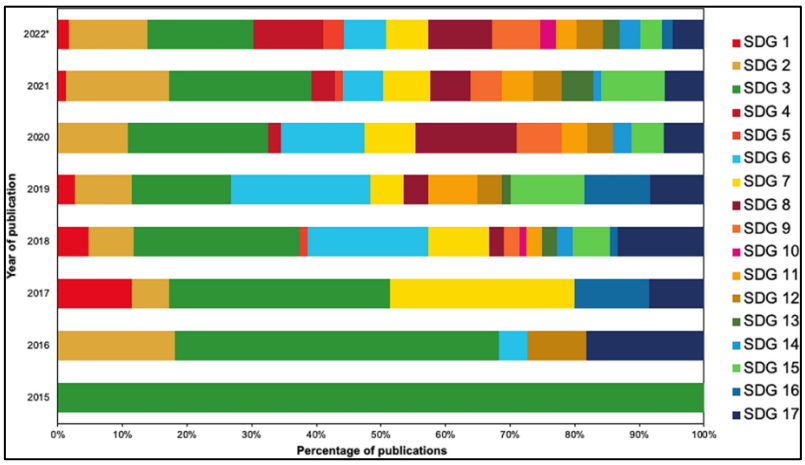

Figure 2: Distribution of Sustainable Development Goals (SDG) Review Articles Over the Years.
Source: (**Yamaguchi *et al.***, 2023)

The analysis of scientific production on the SDGs has also dealt with studies dedicated to individual SDGs or groups of SDGs. Thus, there are bibliometric analyses on SDG1 "No poverty" (**Yu; Huang**, 2021), SDG2 "Zero hunger" (**Herrera-Calderon *et al.***, 2021), SDG3 "Good health and well-being" (**Sweileh**, 2020), SDG4 "Quality education" (**Estrada-Molina; Repiso; Aguaded**, 2023; **De-La-Cruz-Ramos; Yupanqui-Villanueva; Yupanqui-Villanueva**, 2023; **Prieto-Jiménez *et al.***, 2021), on the business field such as SDG9 "Industry, innovation and infrastructure" and SDG12 "Responsible production and consumption" (**Pizzi *et al.***, 2020), SDG6 "Clean water and sanitation" (**Dibbern *et al.***, 2022).

From a geographic perspective, there are various bibliometric studies on productivity and impact according to regions and countries. According to the results of the latest bibliometric studies, research on the SDGs is greater in developed than in developing countries. In general, Western countries (especially the United States and the United Kingdom) and China are the main producers of science and therefore of work related to one or more of the SDGs (**Yamaguchi *et al.***, 2023; **Mishra *et al.***, 2023; **Garai; Roy; Pramanick**, 2023). However, in terms of impact, the difference is remarkable, with the United States and the United Kingdom, whose productivity is similar to that of China, practically tripling the impact of the latter (**Mishra *et al.***, 2023). Thematic preferences also vary from region to region. **Meschede** (2020) identifies the main SDG on which researchers focus their attention in different regions, with OSD4 "Quality education" coming second in Europe and South America and fourth in Africa, and not among the Top 5 in the rest of the regions.

Regarding scientific production on the SDGs in Latin America, publications related to the SDGs also underwent significant growth. The countries with the lowest relative development (Nicaragua, Guatemala, Dominican Republic and El Salvador) had a higher thematic concentration on the SDGs (an average of 53% for the period 2016-2019), while in the region's richest countries such as Brazil, Mexico, Argentina and Chile the concentration was 30% for the same period (**Anlló *et al.***, 2022). According to the study conducted by **Anlló *et al.*** (2022), the regional production of knowledge around the SDGs coincides with global trends of higher production of articles on the SDGs related to health and the environment. The regional particularities can be identified if we observe which are the SDGs with the highest growth in the region in terms of research for the period 2016-2019. SDG4 "Quality education" grew four times more in Latin America than in the rest of the world. Something similar happens with SDG16 "Peace, justice and strong institutions" (it grew 3.6 times more than in the rest of the world). SDG1 "No poverty" and SDG10 "Reduced inequalities" share 2.9 times higher growth in the region than globally.

The SDGs as a global policy gives universities the opportunity to contribute to them through their main missions: teaching, research and transfer. Although this connection is at an early stage in many cases (**Leal Filho *et al.***, 2019), research centers and universities are, together with national and international institutions, the largest generators of knowledge in the fields related to the SDGs (**Herrera-Calderon *et al.***, 2021). Indeed, the amount of research related to the SDGs carried out by universities affects their international classification (**Garai *et al.***, 2023). This is the case of the *Times Higher Education Impact Rankings* that recently evaluated universities based on the Sustainable Development Goals (SDGs) using indicators of production (research) and influence (citations) of each university for each SDG. This ranking includes 1,591 universities (47 Brazilian) from 112 countries/regions. For example, according to this index, the University of Brasilia had the greatest impact for SDG4 "Quality education" in the country in 2023 (position 95 overall), while for SDG9 "Industry, innovation and infrastructure" it was Sao Paulo State University (25th position worldwide) (**Times Higher Education**, 2023).

In some cases, university scientific production on the SDGs was taken into account: **Körfgen *et al.*** (2018) carried out a study to identify relevant articles published by 13 Austrian universities, **Machado and Davim** (2022) carried out a bibliometric analysis on universities' scientific production based on the concept of "higher education for sustainability" on a global level, **Repiso *et al.*** (2023) carried out a bibliometric analysis on the scientific production published by Spanish universities on the

SDGs in general and on SDG4 in particular. Other global bibliometric studies on scientific production for the SDGs also incorporate in their analyses the production and impact according to universities such as the ones by **Yamaguchi *et al.*** (2023), **Garai *et al.*** (2023), **Mishra *et al.*** (2023), and **Indana and Pahlevi** (2023). The results of these studies coincide in placing North American and British universities at the top in terms of scientific production for the SDGs and, in some of them, the University of Sao Paulo (Brazil) ranks in the Top 10 (**Mishra *et al.***, 2023; **Indana; Pahlevi**, 2023).

Regarding bibliometric studies of scientific production on the SDGs in Brazil, several articles have been identified that focus on partial aspects. Such is the case of **Rohrich and Takahashi** (2019) who carried out a bibliometric study on the scientific production of Brazilian universities on environmental sustainability; **Silva-de-Oliveira; Rosa-Georges, and Mina-Falsarela** (2020) analyzed the scientific production on sustainability for small businesses; **Assunção *et al.*** (2022) studied the articles indexed in Brazil on sustainable development in the Amazon and **Di Napoli *et al.*** (2023) on Brazilian scientific production around tourism and the SDGs. However, no bibliometric analyses have been carried out on the scientific production by Brazilian universities around the SDGs.

The objective of this study is to characterize the Brazilian university system in research on the SDGs, hence the production and impact of each university on the 16 SDG is studied. Secondly, a methodological objective is proposed to see whether through the study of this production we can identify profiles and group university centers according to their similarity in the priority they give to the different topics.

2. Methodology

This study is a bibliometric analysis of the scientific production on Sustainable Development Goals of Brazilian universities in the Web of Science Core Collection during the period 2015-2023 (until June 2023). Thus, the filters implemented by Clarivate Analytics on the InCites platform in February 2022 were used. To identify the works concerning each SDG, Clarivate Analytics creates a set of *Micro Citation Topics* carefully identified by analysts from the company's *Institute of Scientific Information*™ (ISI) based on a combination of bibliometric analysis and manual curation (**García**, 2022). This production identification methodology has been used in other studies such as **Repiso *et al.*** (2023) who perform a similar study, applied to Spanish universities. It should be noted that SDG 17 is conceptualized as the conjunction of the search for two or more objectives, therefore neither Web of Science nor Scopus identifies the latter, which is why it is not considered in this study or in the existing literature.

The present study performs a descriptive analysis of the production of Brazilian universities for each of the 16 SDGs and also identifies their Normalized Impact, which allows not only seeing the involvement of each university measured by number of works produced but the average scientific impact of each area. The Normalized Impact calculated by InCites contextualizes the citations received by each article according to the category to which it belongs and the year in which it was published (**Bornmann; Leydesdorff; Mutz**, 2013).

In addition, taking advantage of the diversity of SDGs (16), the universities are characterized. For this, we show how Multidimensional Scaling allows us to see how the centers resemble each other in relation to the SDG themes they study. Multidimensional Scaling is a tool that allows researchers to obtain quantitative estimates of the similarity between groups of elements, allowing a visual appreciation of the underlying relational structures contained in the system studied (**Hout; Papesh; Goldinger**, 2013). Kendall's correlation coefficient was used as it was the one that best discriminated the results. This coefficient analyzes the ordinal element of the cases, to analyze the order of preferences of each university for each of the 16 SDGs as if it were a ranking (**Field**, 2005). Multidimensional scaling orders the elements studied on a Cartesian plane, in this case the Brazilian universities, according to their similarity.

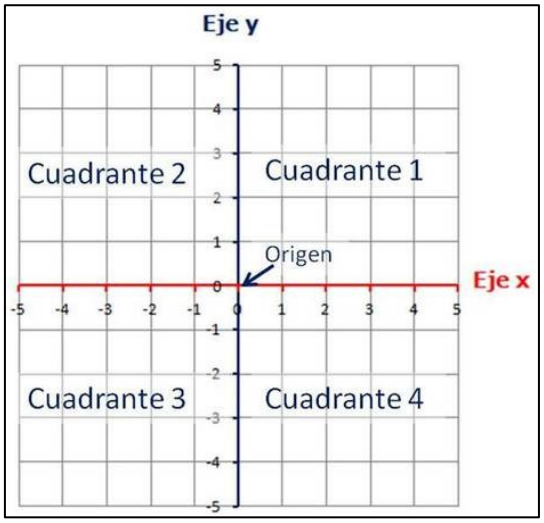

Figure 3: Cartesian Plane Ordered by Quadrants.

Table 1: Phases of Data Loading and Analysis of the Production of Brazilian Universities in SDG.

Work Phases
1. Identification of Brazilian universities in Web of Science (176 universities are identified, the tables only show the Top 25 most productive, but the values for the whole set can be consulted in the data set).
2. Search for and identification of the production of Brazilian universities for each of the 16 SDGs (InCites 16 values for 176 universities = 2,816 identified values).
3. Calculation of the Normalized Impact for each of the sets (InCites 16 values for 176 universities = 2,816 calculated values.).
4. Multidimensional Scaling, a comparative study of the similarity between the Top 25 most productive universities in SDGs, using the 16 values as elements of analysis. Software Xlstat (**Addinsoft**, 2022). Kendall's correlation coefficient is used. Visualization has been carried out using Tableau.

3. Results

3.1. Scientific Production on SDG Topics

Most of the Brazilian production of each SDG is concentrated in five universities, the most productive being the University of Sao Paulo, Sao Paulo State University, the State University of Campinas, the Federal University of Rio de Janeiro, the Federal University of Rio Grande do Sul and the Federal University of Minas Gerais (Table 2). Large, generalist universities are notable for the number of works published on the SDGs. Hence it is important to identify the elements in which these centers do not stand out. The University of Sao Paulo is the benchmark in all areas, followed by Sao Paulo State University, which also stands out in most areas, but with lower production in SDG8 and SDG10, both social items. After fifth position we find significant differences between the universities, which allows us at the end of this article to outline the similarities between centers based on the differences and the patterns they generate.

Generally speaking, it is noted that the goals related to natural sciences have greater scientific production, the SDG with the highest number of works, SDG3 "Good health and well-being", accounts for 46% of the production by the centers. In contrast, SDGs related to the social sciences generally generate lower production, with the exception of SDG2 "Zero hunger" and SDG 5 "Gender equality", which ranks as the sixth most developed goal (3.9%). SDG 16 "Peace, justice and strong institutions" and SDG 8 "Decent work and economic growth" have almost testimonial production (together they account for 0.8%). Other areas that yield diminished results, proportionally in Brazilian research, are SDG 10 "Reduced inequality" and SDG1 "No poverty".

The University of Brasilia ranks among the five universities with the highest scientific production for SDGs 1, 8, 10 and 16, while the Federal University of Minas Gerais does so for SDGs 1, 6, 7, 10, 11 and 16. Likewise, the Federal University of Santa Catarina stands out on three occasions (for SDGs 4, 9 and 11), and the Federal University of Viscosa and the Federal University of Paraná do so on two occasions (for SDGs 2 and 13 and SDGs 14 and 15, respectively). The Federal University of Pernambuco is one of the five Brazilian institutions with the highest scientific production for SDG 16 and the Federal University of Lavras for SDG2.

With the exception of the University of Sao Paulo, all the universities that are in the top five for scientific production, fall below this level for research on five SDGs. Sao Paulo State University for SDGs 8, 9, 10, 11 and 16, the State University of Campinas for SDGs 2, 10, 13, 14 and 16, the Federal University of Rio de Janeiro for SDGs 2, 4, 5, 6 and 16, and the Federal University of Rio Grande do Sul for SDGs 1, 7, 14, 15 and 16. SDG 16, however, shows other prominent centers in addition to the University of Sao Paulo, such as the University of Brasilia, the Federal University of Minas Gerais, the State University of Rio de Janeiro and the Federal University of Pernambuco.

Table 2: Scientific Production on SDG Topics in Brazil (2015-2023 Top 25 Universities).

	SDG1	SDG2	SDG3	SDG4	SDG5	SDG6	SDG7	SDG8	SDG9	SDG10	SDG11	SDG12	SDG13	SDG14	SDG15	SDG16
Uni. of Sao Paulo	809	4658	60640	1570	5164	2293	3186	366	1472	431	5601	2296	9675	3075	9088	360
Sao Paulo State Uni.	218	3567	18100	654	1339	1327	1539	35	430	60	1274	1086	4780	1696	5172	57
State Uni. of Campinas	218	1312	17854	651	1818	1090	1700	159	858	116	2316	1196	2559	616	2676	79
Fed. Uni. of Rio de Janeiro	268	704	14150	453	1072	841	1095	202	793	194	2029	856	2863	1218	3181	94
Fed. Uni. of Rio Grande do Sul	195	1608	14336	578	1289	1089	601	165	615	153	2245	850	2890	750	2509	119
Fed. Uni. of Minas Gerais	280	926	15919	570	1244	939	776	157	449	179	1582	542	2127	460	2435	153
Fed. Uni. of Sao Paulo	97	315	18006	366	1844	210	170	32	72	21	373	179	650	417	660	63
Fed. Uni. of Parana	105	1372	7656	322	564	607	627	73	372	97	830	622	2434	854	2890	72
Fed. Uni. of Santa Catarina	143	875	7448	687	734	743	924	78	606	142	1319	840	1745	913	1471	81
Uni. of Brasilia	322	1066	6346	486	532	416	495	168	379	216	1009	329	2214	362	2211	217
Fed. Uni. of Pernambuco	116	684	6548	332	567	490	444	55	382	104	695	236	1532	825	1978	125
Fed. Uni. of Vicosa	132	3045	3447	71	187	499	315	46	84	53	440	275	3347	184	2641	8
Fed. Uni. of Santa Maria	81	1513	5335	172	250	680	650	42	187	30	831	298	1665	332	1129	31
Fed. Uni. of Ceara	115	883	6161	266	530	498	407	53	288	58	672	331	1430	438	939	
Fed. Uni. of Sao Carlos	92	706	4745	340	394	810	798	43	411	56	553	1017	1066	317	1659	45
Fed. Fluminense Uni.	158	208	6377	288	507	303	477	152	528	129	958	341	1159	553	632	77
Fed. Uni. of Rio Grande do Norte	112	411	4709	292	412	567	438	30	286	60	758	217	1082	491	1204	41
Fed. Uni. of Goias	97	866	5110	203	454	293	277	36	119	90	373	111	1235	199	1601	37
Fed. Uni. of Bahia	102	239	5963	280	409	294	285	40	251	48	439	180	1120	469	908	49
State Uni. of Rio de Janeiro	107	210	5551	186	626	292	186	78	124	91	831	147	1067	499	916	135
Fed. Uni. of Pelotas	94	1171	5103	103	574	171	118	11	53	36	411	115	1166	96	458	54
Fed. Uni. of Paraiba	95	601	3803	238	336	271	569	73	160	109	378	192	1081	316	1106	65
Fed. Uni. of Lavras	49	1996	1845	63	78	310	190	18	76	21	277	172	2069	133	1891	5
Fed. Uni. of Espirito Santo	49	530	3353	172	331	276	305	46	114	55	440	165	961	416	1169	57
State Uni. of Maringa	47	788	3315	101	235	562	156	28	82	59	337	170	1072	298	1035	24

3.2. Impact of Brazilian Universities According to SDG

When the normalized impact by specialty and university (Table 3) of the previously studied publications (Table 2) are analyzed, we find that most of the contributions by Brazil's Top 25 universities to the SDG achieve an impact below the world average (below 1). In total, in the Top 25 universities only 81 times (out of 400) has it been possible to match or surpass the world average of citations (1 out of 5 cases). By far the area with the poorest results is SDG4, "Quality education", where no university approaches the world average for citations, followed by SDG9 ("Industry, innovation and infrastructure") where only one center (Fed. Uni. of Rio Grande do Sul) surpasses the world average. A similar thing happens with SDG16 ("Peace, justice and strong institutions"); only one center scores above the world average (Fed. Uni. of Pelotas), however, three of the universities added for their high impact exceed the average, notably the Fed. Uni. of ABC with an Average Impact of 2.42. Another notably negative SDG is SDG5 ("Gender equality"), for which only four universities equal the world average.

At the other extreme, we should stress that the area in which Brazilian universities are positioned above the world average is SDG15 ("Life on land"), where of the Top 25, 17 centers achieve scores above the world average. Moreover, we should highlight the scores of underproductive centers such as the Pontifical Catholic University of Rio de Janeiro (IN= 2.62) and Vega de Almeida University (IN 2.86)

The impact of universities' contributions to research on the Sustainable Development Goals is heterogeneous by areas, although this influence is concentrated in 12 institutions. The University of South Santa Catarina has the highest impact index for three of the SDGs (SDG3/1.7; SDG6/1.17; SDG11/2.77) while the State University of Campinas (SDG2/1.09; SDG4/0.82), Veiga de Almeida University (SDG1/5.4; SDG15/2.86), the Federal University of ABC (SDG14/3.02; SDG16/2.42), and the Federal University of Pelotas (SDG5/1.72; SDG7/1.29) have the highest index for two SDGs. Seven universities have the highest impact index for a single SDG: the Federal University of Sao Carlos for SDG8 (1.17), the Federal University of Minas Gerais for SDG9 (1.06), the Federal University of Rio Grande do Sul for SDG9 (1.06), the Pontifical Catholic University of Rio de Janeiro for SDG13 (1.47), the Federal University of Rio Grande do Norte for SDG10 (1.55), and the Federal University of Ceará for SDG12 (1.48). It is worth noting that only these latter universities are located in the north-north-east axis of Brazil, while all the other institutions are located in the south-south-east axis of the country.

Table 3: Normalized Impact of Top Brazilian Universities According to SDG (2015-23).

	SDG1	SDG2	SDG3	SDG4	SDG5	SDG6	SDG7	SDG8	SDG9	SDG10	SDG11	SDG12	SDG13	SDG14	SDG15	SDG16
Uni. of Sao Paulo	1.14	1.08	1.21	0.77	1.06	0.82	0.88	0.78	0.78	0.8	1.17	0.99	1.09	0.98	1.19	0.78
Sao Paulo State Uni.	0.73	0.69	0.87	0.4	0.85	0.76	0.71	1.02	0.89	0.56	0.87	0.87	0.78	0.85	1	0.36
State Uni. of Campinas	0.99	1.09	1.07	0.82	0.94	0.93	0.92	0.82	0.94	0.41	1.1	1.02	1.13	0.93	1.32	0.82
Fed. Uni. of Rio de Janeiro	1.22	0.82	1.03	0.52	0.83	0.85	0.84	0.75	0.92	0.57	1	0.92	0.95	0.96	1.07	0.58
Fed. Uni. of Rio Grande do Sul	1.25	0.9	1.4	0.59	0.97	1.02	0.78	0.62	1.06	1.11	1.3	1.08	0.93	0.93	1.11	0.6
Fed. Uni. of Minas Gerais	1.65	0.97	1.31	0.6	0.87	0.75	0.75	1.16	0.75	1.15	1.06	0.79	0.94	0.93	1.24	0.38
Fed. Uni. of Sao Paulo	0.77	0.85	1.21	0.56	0.96	0.87	0.65	0.52	0.54	0.39	0.93	0.92	0.99	1.11	1.05	0.48
Fed. Uni. of Parana	0.54	0.65	0.96	0.45	0.82	0.7	0.88	0.73	0.6	0.36	0.6	0.77	0.72	0.81	0.87	0.48
Fed. Uni. of Santa Catarina	0.76	0.72	1.52	0.56	0.87	0.83	0.81	0.45	0.64	0.49	0.97	1.14	0.98	0.97	1.05	0.39
Uni. of Brasilia	1.01	0.87	1.33	0.41	0.79	0.81	0.72	0.95	0.6	0.55	0.94	0.69	0.93	0.82	1.08	0.48
Fed. Uni. of Pernambuco	0.73	0.92	0.83	0.66	0.65	0.71	0.8	0.79	0.68	0.6	0.7	0.55	0.89	0.8	1.11	0.72
Fed. Uni. of Vicosa	0.64	0.88	0.83	0.51	0.57	0.78	0.69	0.28	0.45	0.28	0.87	0.81	0.83	0.65	0.93	0.62
Fed. Uni. of Santa Maria	0.66	0.76	0.88	0.32	0.55	1.09	0.69	0.22	0.53	0.44	0.99	0.74	0.58	0.85	0.74	0.17
Fed. Uni. of Ceara	1	0.66	0.87	0.45	0.61	0.88	0.61	0.36	0.87	0.49	0.71	1.48	0.67	0.83	0.84	0
Fed. Uni. of Sao Carlos	0.81	0.79	0.89	0.48	1.04	0.79	0.79	1.17	0.83	0.37	0.72	1.14	0.77	0.76	1.01	0.77
Fed. Fluminense Uni.	0.99	0.76	0.89	0.39	0.85	0.69	0.95	0.9	0.86	0.55	0.75	1.08	0.89	0.87	1.01	0.39
Fed. Uni. of Rio Grande do Norte	1.04	0.77	0.85	0.81	0.76	0.83	1.02	0.68	0.82	1.55	0.71	0.79	1.02	0.98	1.18	0.75
Fed. Uni. of Goias	1.35	0.78	0.96	0.43	0.91	0.69	0.56	0.34	0.69	0.9	0.79	0.61	0.89	1.07	1.11	0.45
Fed. Uni. of Bahia	0.82	0.78	1.38	0.54	0.85	0.77	0.86	1.08	0.99	1.08	0.98	0.72	0.79	0.78	1.09	0.41
State Uni. of Rio de Janeiro	0.79	0.83	0.96	0.48	0.88	0.73	0.63	1.07	0.46	0.21	0.79	0.57	0.91	0.88	0.89	0.59
Fed. Uni. of Pelotas	1.8	0.94	1.27	0.36	1.72	0.82	1.29	1.06	0.56	1.11	0.87	0.68	0.68	0.77	0.79	1.22
Fed. Uni. of Paraiba	0.69	0.55	0.77	0.48	0.8	0.88	0.82	0.43	0.36	0.72	0.9	0.74	0.8	0.99	0.97	0.44
Fed. Uni. of Lavras	0.51	0.72	0.75	0.71	1.06	0.67	0.76	0.4	0.46	0.2	0.6	0.58	0.73	0.73	1.09	0.22
Fed. Uni. do Espirito Santo	0.26	0.57	1.19	0.36	0.74	0.75	0.74	0.34	0.44	0.11	1.04	0.74	0.69	0.99	0.87	0.47
State Uni. of Maringa	0.73	0.59	0.84	0.58	0.67	1	0.63	0.67	0.36	1.12	1.1	0.66	0.7	0.73	1.02	0.46
Fed. Uni. of ABC	1.73	0.84	0.99	0.74	0.89	0.66	0.96	0.28	0.73	0.47	1.08	0.65	1.05	3.02	1.09	2.42
Pont. Cat. Uni. of Rio de Janeiro	0.82	0.96	0.91	0.76	0.81	0.73	0.65	0.94	0.75	0.83	0.9	1.1	1.47	1.69	2.62	1.1
Uni. of South Santa Catarina	0.55	1	1.7	0.34	0.89	1.17	0.29	1.1	0.88	0.04	2.77	1.01	1.16	0.94	1.24	1.06
Vega de Almeida Uni.	5.4	0.14	0.75	0.68	0.31	0	0	0.63	0.05	1.16	2	0.16	1.44	0.44	2.86	0

- Four universities are included that, without being among the Top 25 productive universities, stand out for having a great international impact on some of the SDG studied. In red, scores below 1, barring exceptions for reasons of contrast.

Multidimensional scaling, as a technique used to observe similarities and groups, places the most generic elements in the center of the graph; in fact, the average of the position of all the elements represented corresponds to the value 0.0, the intersection of the X and Y axes, which means that the Federal University of Minas Gerais, the Federal University of Ceara and the University of Rio Grande do Sul are the universities that have the most generic profiles (Figure 1). It is noted that usually, the universities with the highest total production (larger in size) are positioned around the center,

whereas the universities with low production and more unique scientific profiles are usually in the periphery, with the Federal University of Pelotas being one of the centers with more unique profiles and curiously, at the other extreme, the Federal Fluminense University, which indicates that both are especially antagonistic (or complementary).

Although in general terms the distribution of universities' production is similar, there are slight nuances that allow us to group the universities clearly. The similarity matrix shows that the SDG that occupies a higher number of positions among the universities studied is by far SDG2 "Zero hunger", followed at some distance by SDG16 "Peace, justice and strong institutions" and SDG8 "Decent work and economic growth". Conversely, SDG9 "Industry, innovation and infrastructure" is the most similar to the rest of the SDGs and therefore does not especially discriminate. An example of how universities are grouped according to priorities would be the Fed. Uni. of Viçosa, the Fed. Uni. of Santa Maria and the Fed. Uni. of Lavras, that have a very similar distribution to the rest, but resemble each other as they share low production for SDG4 "Quality education" and SDG5 "Gender Equality". Coincidence in a few SDGs is the dynamic that generates the positioning and grouping in the multidimensional scaling graph.

The universities that are located in the first quadrant have a similar distribution of scientific production in SDGs 1, 3, 5, 7, 8, 13, 15 and 16, with an outstanding contribution in SDGs 1, 2 and 13. Likewise, the entities' production is average for SDGs 5, 7, 13 and 15 and low for SDGs 8 and 16. The institutions that make up this group are located in the south (2) and south-east (3) of Brazil. Moreover, the institutions that are located in the second quadrant have a similar distribution of the scientific contribution in a few SDGs, specifically in 5, 7, 8, 11 and 15. It is observed that they tend to yield average production for SDGs 5, 7 and 11, and low production for SDG8 (with the exception of the State University of Rio de Janeiro and the Federal University of Bahia) and SDG15 (with the exception of the Federal University of Pernambuco and the Federal University of Minas Gerais). The institutions that make up this group are located in the north-east (3) and south-east (2) of Brazil. However, the universities that are located in the third quadrant show a distribution of convergent scientific production for many SDGs, specifically 1, 2, 3, 6, 8, 10, 11, 12, 13, 14, 15 and 16. They are seen to comprise an notable contribution for SDGs 2, 13 and 15 and that all the universities have the highest production for SDG3. However, their production is low for SDGs 1, 8, 10, 12 and 16. The institutions that make up this quadrant are located in the north-east (1), south-east (3), center-west (2), and south (1) of Brazil. Finally, the universities that are accommodated in the fourth quadrant have a comparable distribution of their scientific contributions for SDGs 1, 6, 7, 8, 13, 15 and 16, with average production for SDGs 6 and 7, and low production for SDGs 8 and 16. In addition, they have outstanding production for SDGs 1, 13 and 15. The universities that make up this quadrant are located in the north-east (1), south-east (3), center-west (2), and south (1) of Brazil.

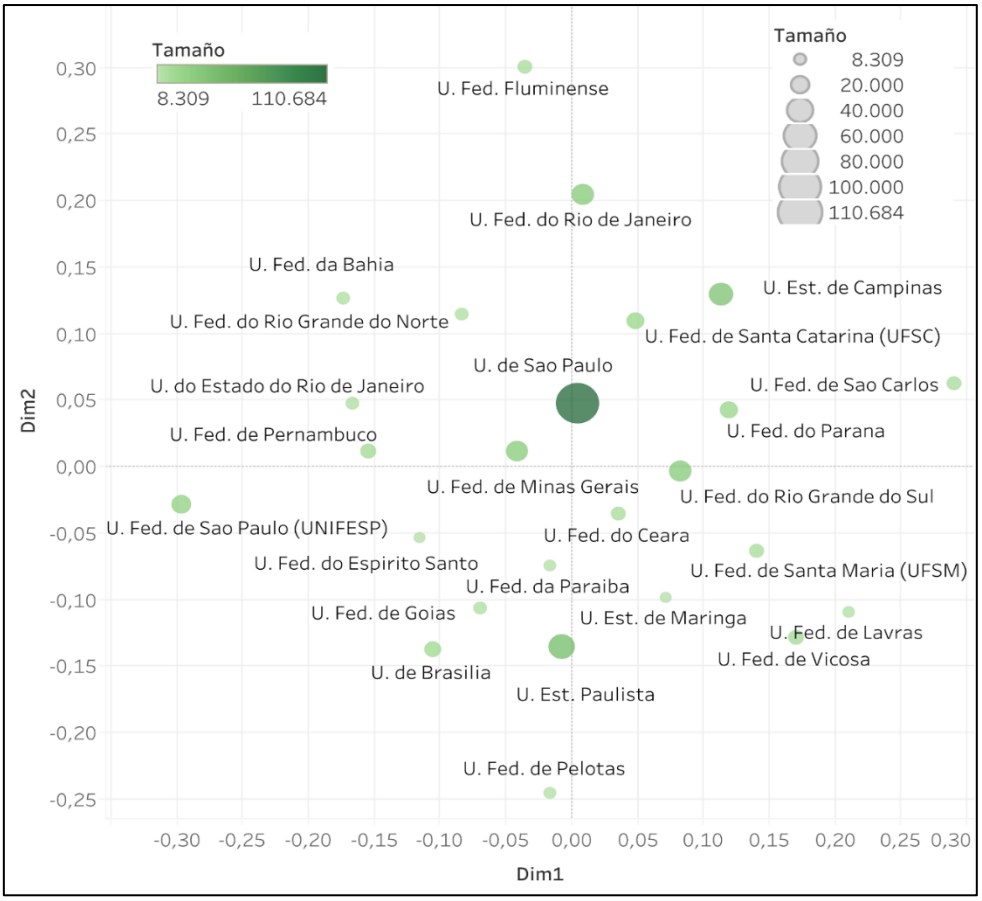

Figure 1: Multidimensional Scaling of the Top 25 Brazilian Universities According to their Scientific Production in SDGs (2015-2023).

4. Discussion and Conclusions

> Multidimensional Scaling allows us to see how Brazilian universities are similar to each other in relation to the SDG topics they study

The most developed SDG in Brazilian universities is SDG3 ("Good health and well-being") with 46% of production, followed in second place by SDG13 ("Climate action") and in third place by SDG15 ("Life on land"), both with just over 10% of production each. The fourth goal with the highest production in universities is SDG2 ("Zero hunger") with 6.3% of production, followed in fifth and sixth place by SDG5 ("Gender equality") and SDG7 ("Affordable and clean energy") with 3.9% and 3.1% respectively. These values change slightly if instead of all the universities we only take into account the Top 25, where, for example, the production in "Gender equality" exceeds that of "Zero hunger" in many centers. The four goals on which Brazilian universities produce fewer works would be in thirteenth position "No poverty" (SDG1) with 0.8% of the total, "Reduced inequalities" (SDG10) with 0.48%, and in penultimate and last place "Peace, justice and strong institutions" (SDG16) and "Decent work and economic growth" (SDG8) each with 0.4%, respectively.

> Most of the Brazilian production of each SDG is concentrated in five universities

In general, Brazilian universities do not stand out for their impact in any of the SDGs, except for small peripheral universities where low production achieves a high impact. In most cases, the impact is below the global average. This seems to be contributed to by the national nature of much of Brazilian research, published in national journals on national issues (**Strehl *et al.***, 2016). In other words, much of the production is focused on having local impacts. However, there is a national issue that seems to have an impact above the world average and that is "Life on land" (SDG15), followed by "Health and well-being" (SDG3).

> The impact of universities' contribution to research on the Sustainable Development Goals is heterogeneous by area, although this influence is concentrated in 12 institutions

The thematic profiles of the Brazilian universities studied through their production differ in terms of quantity, especially, and their normalized impacts are similar, below 1 in most cases. Likewise, the distribution by SDGs is very similar among them, hence the need to use the Kendall coefficient to highlight the differences of the elements, which are displayed in the graph not in a general distribution but in the priority that each university gives to the 16 SDGs as a whole. The large universities tend to be the most similar to the set, again the University of Sao Paulo stands out, while the small universities are positioned at the extremes, with unique profiles where the Federal Fluminense University, the Federal University of Sao Carlos, the Federal University of Pelotas and the Federal University of Sao Paulo would stand out, the four occupy the least common production distributions.

> The Federal University of Pelotas and Fluminense Federal University are the centers with the most unique profiles and the Federal University of Minas Gerais, Federal University of Ceara, and University of Rio Grande do Sul are those that have more generic profiles

The results of various works aimed at measuring and comparing the scientific production dedicated to each of the SDGs have coincided in the major trends. Most research has addressed this object of study from the disciplines of life sciences and biomedicine (**Meschede**, 2020), the natural sciences and engineering/technology (**Yeh *et al.***, 2022), and the interdisciplinary field of environmental sciences (**Yamaguchi *et al.***, 2023). The social sciences come second, both in terms of productivity (**Sianes *et al.***, 2022) and impact (**Sianes**, 2021). Likewise, the main studies agree that scientists have focused their attention on two main themes: SDG3 "Health and well-being" (**Garai *et al.***, 2023; **Diaz-Lopez *et al.***, 2021; **Meschede**, 2020; **Sweileh**, 2020) and SDG13 "Climate action" (**Salvia *et al.***, 2019) and other SDGs linked to the "driving theme" of climate change (**Mishra *et al.***, 2023) which is also operational in SDG7 "Affordable and clean energy", SDG11 "Sustainable cities and communities", and SDG12 "Responsible consumption and production", which concentrate a significant presence in scientific production (**Yamaguchi *et al.***, 2023; **Garai *et al.***, 2023; **Yeh *et al.***, 2022).

> The universities identified in the Top5 of scientific production on the SDGs by this study coincide significantly with world rankings

The universities identified by this study in the Top 5 of scientific production on the SDGs coincide significantly with the world rankings. In all of them, as in the present research, the University of Sao Paulo is the first Brazilian university in the rankings consulted (**Times Higher Education**, 2023; **QS World University Rankings**, 2023; **SCImago Institutions Rankings**, 2023). In addition, the coincidence with the **SCImago Institutions Rankings** (2023) is absolute in the first four positions: Sao Paulo, UNESP, Campinas, and Federal Uni. of Rio de Janeiro. They also match in terms of presence in four of them, but the position varies with the **QS World University Rankings** (2023) which includes "sustainability" among its evaluation parameters, with the result for this index as follows: Sao Paulo, Campinas, Federal Uni. of Rio de Janeiro, and UNESP. With regard to

Times Higher Education (2023), when taking into account the overall ranking, the coincidence with the results is also high, with three of the Top 5 universities: Sao Paulo, Campinas and the Federal Uni. of Rio Grande do Sul. However, when compared to the Times Higher Education Impact Rankings (which include the production and impact of university research on the SDGs), coincidence occurs in four of the universities, although in a different order: Sao Paulo, Campinas, the Federal Uni. of Rio Grande do Sul, and UNESP. The notable difference is that the University of Brasilia comes in second position in the Impact Rankings and tenth in this study.

> "The SDGs have been subjected to critical reviews since their birth due to their ambition, their content, their goals both in their formulation and their achievability, their indicators or their financing"

The SDGs have been subject to critical revisions since their inception, exacerbated by the slow progress in the goals set in terms of: their ambition (many in a very short time for some and unambitious in structural terms for others) (**Easterly**, 2015); their content (among others due to the weak presence of human rights and the weakening of global governance and democracy specifically in SDG16 "Peace, justice and strong institutions") (**Gómez-Gil**, 2018; **Sengupta**, 2018); their goals, both insofar as their formulation and their achievability (**Nature**, 2020); their indicators (**ICSU-ISSC**, 2015) or their funding (**Sachs; Schmidt-Traub; Lafortune**, 2020). They are also widely reviled as a global public agenda by the Trumpist right, national-populist parties, climate change deniers, some multinationals dissatisfied with the accountability mechanisms and the role assigned to companies and, even, by governments of developed countries reticent to allocating the necessary resources to fund the SDGs and included in SDG17 and the Addis Ababa Action Agenda (**Naciones Unidas-Asamblea General**, 2015) on financing for development. In short, a reactionary *status quo* (**Sachs *et al.***, 2020). Furthermore, there is broad consensus that the Agenda 2030 faces systemic risks (humanitarian, economic, environmental and governance) that must be managed on/by the planet as a whole (**Gómez-Gil**, 2018; **Sachs *et al.***, 2020; **United Nations**, 2023). Thus, the SDGs are an imperfect tool, but they define a way of understanding the world, with a long-term, multilateral vision and global cooperation that should endure, because the alternative is isolationism, autocracy and short-termism that are gaining strength in half the planet (**Sachs *et al.***, 2023). Therefore, we cannot be oblivious to these criticisms if we use the scientific production on the SDGs to characterize a university system and the universities that comprise it.

> "The SDGs are an imperfect tool that should endure because they define a way of understanding the world, with a long-term, multilateral and global cooperation vision"

The bibliometric analyses allow us to understand the evolution of research on the subject, provide an overview, identify trends, gaps and imbalances between the SDGs researched (Mishra *et al.*, 2023). However, the databases used (**Bordignon**, 2021; **Armitage; Lorenz; Mikki**, 2020), the keywords chosen, the tools used, as well as the approach (**Rafols *et al.***, 2021) or the method used (**Purnell**, 2022), can lead to different results and inconsistencies (**Armitage *et al.***, 2020), and even to reproducing the inequalities according to countries' level of development, the capacity of their scientific systems to be present in the main journals and databases, as well as the overrepresentation of countries, languages and approaches (**Meschede**, 2020; **Diaz-Lopez *et al.***, 2021) and also the underrepresentation of countries or development objectives.

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