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Methodologies and tools for the study and application of Sustainability in Higher Education: A Systematic Literature Review

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***Keywords*— Sustainability in Universities, Higher Education Institution, Systematic Literature Review, Cluster maps, VOSViewer.**

***Abstract*—** *This paper brings the results of a systematic literature review, about Sustainability in Universities, solving the research gap in this area. Studies were searched in the Scopus database, with keywords and inclusion/exclusion criteria. The study resulted in 71 papers, which were fully analyzed and maps of clusters were created. Results show the evolution of academic research, dating from 2010 to 2022. Of the total number of articles selected, 28% were on Sustainability Indicators, which denotes the importance of this tool for the studied topic. Brazil has the highest percentage of publications (16.9%) in this analysis. The most relevant topic was on Sustainability/Higher Education/Indicators. These results show the research gap in the area of sustainability in universities, allowing other educational institutions to develop their environmental management and seek sustainability as a way of development of a society that is more aware and prepared for the challenges of the future.*

I. INTRODUCTION

Systematic Literature Reviews (SLR) serve to gather academic knowledge on a given subject, helping to define research gaps, to solve practical problems and include ways of applying this knowledge. (JANSEN, 2018).

The objectives of a literature review may differ depending on the study. Many reviews are aimed at developing theory or analyzing data. (Jansen, 2018). On the subject of sustainability in higher education, there are not many literature reviews that can show what has been studied over the years, in order to contribute with methodologies to implement or evaluate sustainable development in Higher Education Institutions (HEI).

In the last twelve years, several studies have been developed in relation to sustainability in HEI around the world. For example: studies comparing environmental management between universities; studies with environmental, economic, social and academic indicators; assessment of the level of sustainability of universities through international rankings; analysis of campuses as living sustainability laboratories, study of the sustainability of HEI through the Sustainable Development Goals (SDG), among others. (Ávila et al., 2017; Rosa María Brito et al., 2018; Chuvieco et al., 2018; Cogut et al., 2019; Galván et al., 2020; Ilham et al., 2020; Khalili et al., 2015; KılkıŞ, 2017; Yolanda León-Fernández et al., 2018; Lourrinx et al., 2019; Lukman et al., 2010; Paletta and Bonoli, 2019; Rosa et al., 2020; Silva and Almeida, 2019; Staniškis and Katiliute, 2016; Torabian, 2019). But only a minority presents what has been developed and applied in HEI, as a way of reviewing the literature.

The concept of a sustainable campus considers the university as an environmentally healthy space, which promotes the efficient use of natural resources, the reduction of waste generated in its processes, the recovery of local

fauna and flora, animal protection, the minimization of the use and disposal of hazardous materials and waste, sustainable and collaborative consumption practices, both in the community and in the local and regional environment. (Pérez and Gandini, 2018).

Based on this, university sustainability can be motivated by several factors, such as: strategic positioning, cost reduction, social responsibility, ethical and moral reasons, acquisition of benefits, the possibility of creating a capacity for social change, among others. (Layrargues and Lima, 2014; Pantaleão, 2017).

According to Lemos et al. (2018), a sustainable campus needs to be a living laboratory, where research, teaching and extension are connected, providing the student with an environment that allows a balance between environmental principles and sustainable development with social equality. This type of campus needs to be present in its local reality, generating knowledge that goes beyond research laboratories, transcending the results obtained for society, according to its demands.

Campus sustainability connects the operational aspects of teaching, research and institutional administration, such as: reducing energy, water, emissions, materials and improving waste management; as well as the educational aspect of sustainability education, providing opportunities for the internal and external community to learn, reflect and develop new lifestyle practices and concepts that take into account the well-being of current and future generations. (Disterheft et al., 2012).

Based on these concepts, it is important to review the literature on the methods most used today to develop, measure and compare the sustainability of HEI. Aiming to publish its means of application, studies and most relevant countries on the subject, so that other universities can use such methodologies and, still, improve what is possible for their reality, with the intention that more and more universities can develop the sustainability both on campus and in the society in which they are inserted.

II. METHODOLOGY

The method used to develop the Systematic Literature Review was based in the studies of Dresch et al. (2014).

A scientific search was developed in the Scopus database (Elsevier), with the following keywords and Boolean operators: “sustainability” AND “university” AND “sustainable” WITHIN “universities” AND “environmental” AND “indicators”; analysis of inclusion criteria (year: 2010 - 2022; studies within the theme of the study-Sustainability in Universities), and exclusion: (year <2010; studies outside the proposed theme). The research structuring strategy was performed manually, so that the keywords and Boolean operators brought a plausible number of articles to be analyzed manually. The research was considered closed when its direction reached the proposed objective and, both the keyword tree and the connectors, presented a number of articles less than five hundred. Thus, 312 articles were found and, considering the established criteria, 71 articles and their studies were analyzed entirely, manually, in Excel software.

The flowchart with the steps of the review performed is shown in Figure 1.

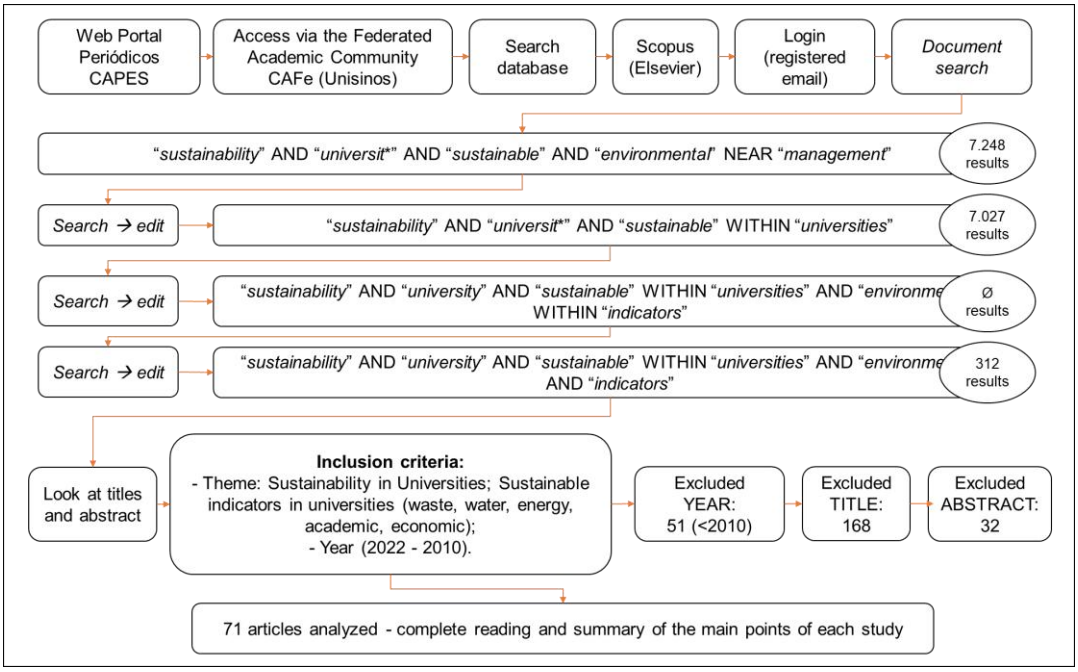

Fig.1 – Flowchart of the systematic literature review

After searching the database, maps of clusters were obtained, using the VOSViewer Software, version 1.6.13, which point out the characteristics of greater and lesser impact, according to the strength of the relationship between the studies. The larger the size of the node (circle), the greater the number of articles by each author, or the number of citations, or the repetition of the same keyword, for example.

The maps were developed from:

a) co-authorship networks (when an author cites another, even without being cited, or when both are cited) – the node size means the number of articles by each author; clusters with more nodes mean there is greater collaboration between authors and authors are highlighted;

b) keyword co-occurrence networks (works with the same keywords in related topics, whether in the title, abstract or keyword list) – the node size means the frequency of occurrence and, the closer the nodes are, the stronger the relationship; words with greater frequency determine the central theme of a group of documents; and

c) bibliographic coupling networks (two publications are bibliographically coupled when a third author is cited by the first two) – the size of each node means the number of documents of each author in the analyzed database; the closer the nodes, the greater the number of authors cited by both and, consequently, the greater the coupling between them.

III. RESULTS

First, the cluster maps developed based on the 71 selected studies are presented to determine the groups of authors, keywords and citations found in the research. Afterwards, a summary table and graphs containing the studies and management tools used by universities and their countries are presented.

3.1 Cluster maps

As one of the results of the review, cluster maps were developed to identify the main networks and, from this, guide the study of the methodologies presented in the 71 analyzed articles.

3.1.1 Co-authorship networks

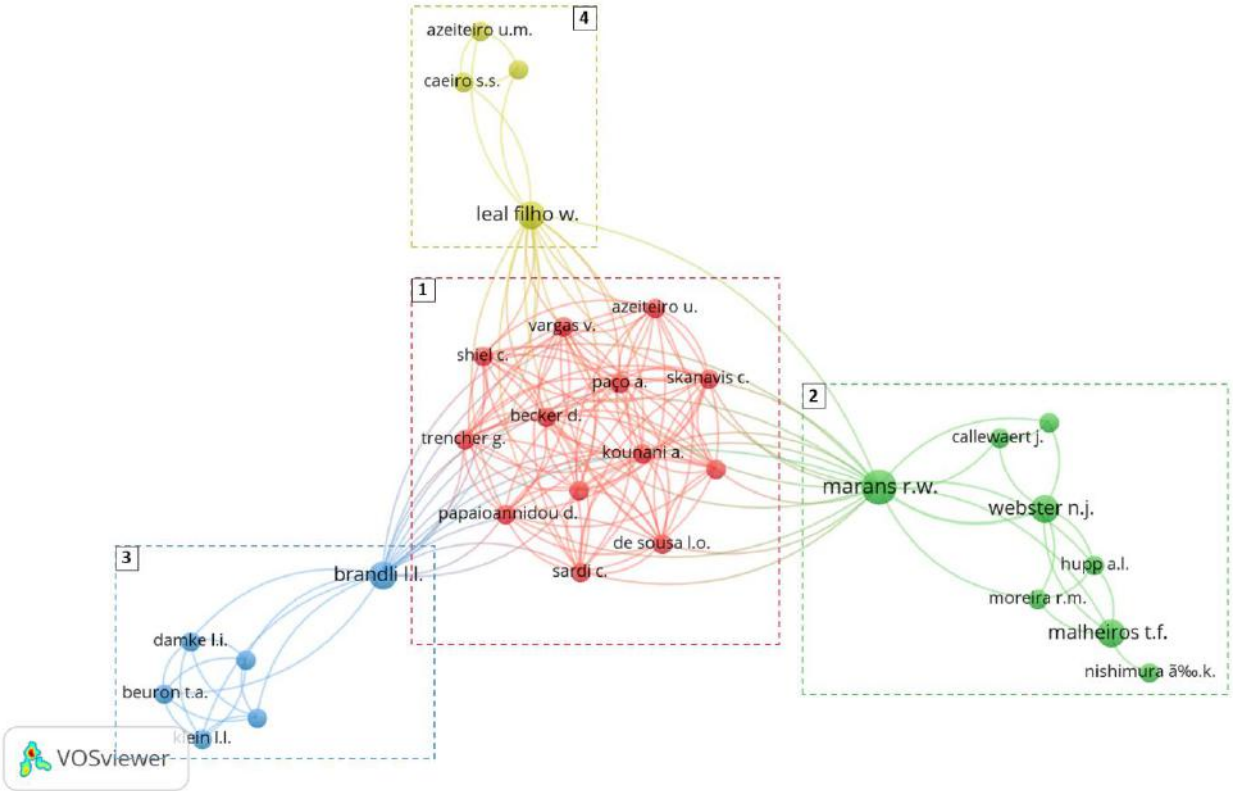

Fig.2 – Co-authorship network map

In the map of co-authorship networks (Figure 2), visually, through the node size, the author with the highest number of studies is Marans R.W., from the University of Michigan, who in this review has a total of three publications, not necessarily being the first author. This is

interconnected with several other studies, which cited it at least once.

The largest network of co-authorships is located in the center of the map, in cluster 1, where there is a strong connection, since the authors cite each other more than once, as can be seen. This cluster is surrounded by studies developed by Leal Filho W. (University of Hamburg), Brandli L.L. (University of Passo Fundo), and Marans R.W. (University of Michigan) that are occasionally cited by most other studies, showing their importance in the topic of Sustainability in HEI.

The clusters are presented by dotted lines, in order of number of studies and number of co-authorships. The cluster with the most co-authors, number 1, contains studies dating from 2017 to 2019. Cluster number 3 contains the most current studies, from 2019 and 2022.

3.1.2 Keyword co-occurrence networks

In Figure 3, the map of keyword co-occurrence networks is shown. The map features 194 keywords and 22 clusters. The keywords “Sustainability, Higher Education, Environmental Management, Indicators” stand out due to the size of the node, which means that these are the words with the highest occurrence in the studies, determining their central theme. These also stand out for having a greater relationship with the other interconnected keywords, forming different clusters, identified by the colors on the map.

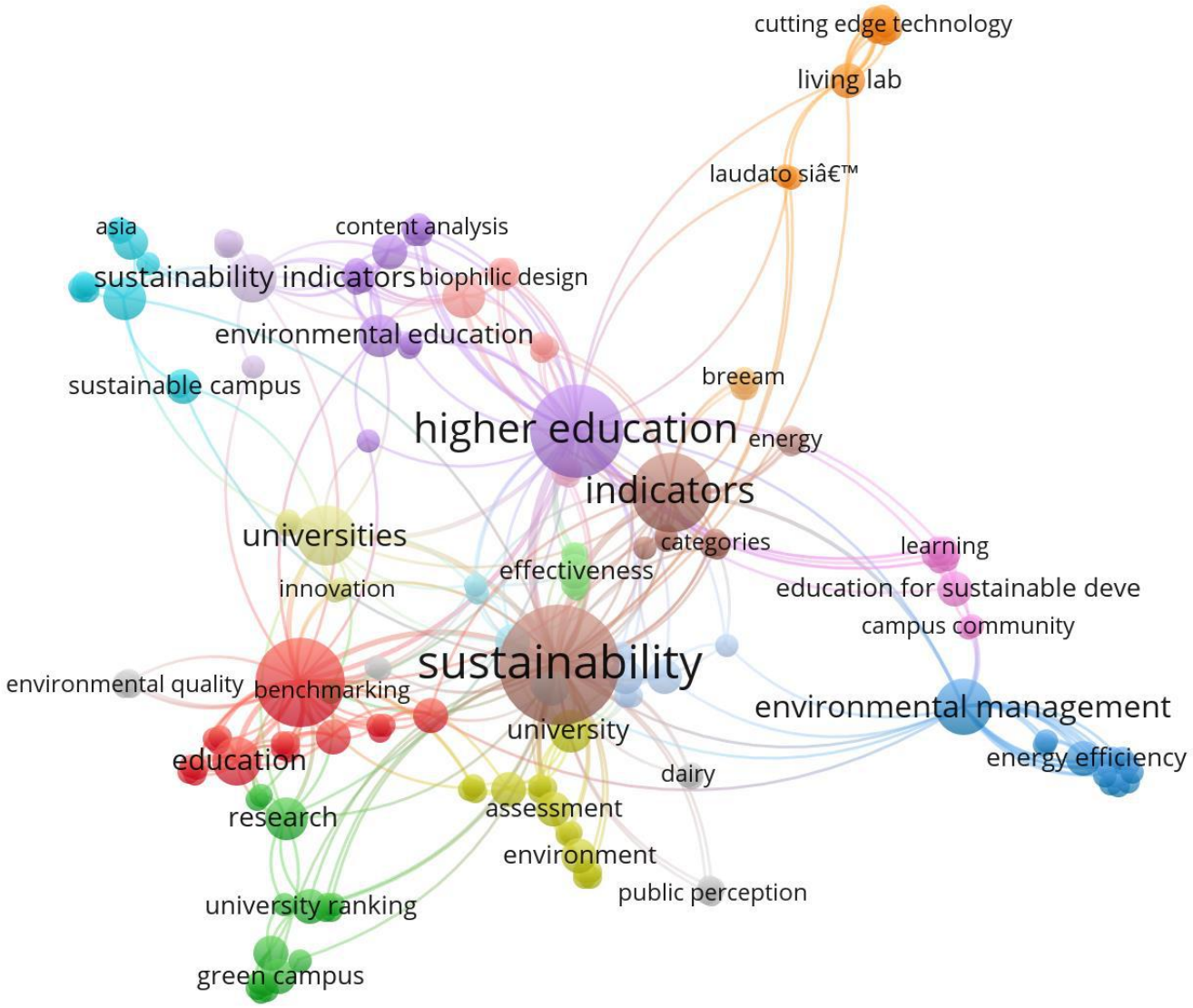

Fig.3 – Keyword co-occurrence networks map

In brown, there is a relationship with the cluster “Sustainability”, with the highest occurrence in this group of studies, which is directly linked to all the most frequent clusters and, indirectly, to some examples of related words, which are: Higher Education, Indicators, Universities, Benchmarking, Environmental management, among others.

The second highest occurrence cluster that can be highlighted is "Higher Education", in purple. This is directly linked to the "Sustainability", "Indicators" and "Environmental Education" clusters. And indirectly linked to keywords such as: Education for Sustainable development, Evaluation, Environmental Management, Universities.

Another cluster worth mentioning is "Indicators", in a shade of brown. This is directly linked with the "Sustainability" and "Higher Education" clusters, and with other less frequent clusters, such as "Energy" and "Effectiveness". Other highlighted words are: Learning, Living lab, Assessment, Categories.

Considering the keywords that were used in the search for studies in the database, all the other words identified in the map are related in some way to those chosen at the time of the research, whether in the title, in the list of keywords or in the abstract, showing that these sub-themes are as important as the central theme. It is evaluated, then, that for the good development of a study it is necessary to analyze several areas of knowledge, as they all contribute in some way to reach the final result of the research, always considering the triad of sustainability: economy, environment and society.

3.1.3 Bibliographic coupling networks

The map in Figure 4 presents 48 authors who formed 8 clusters.

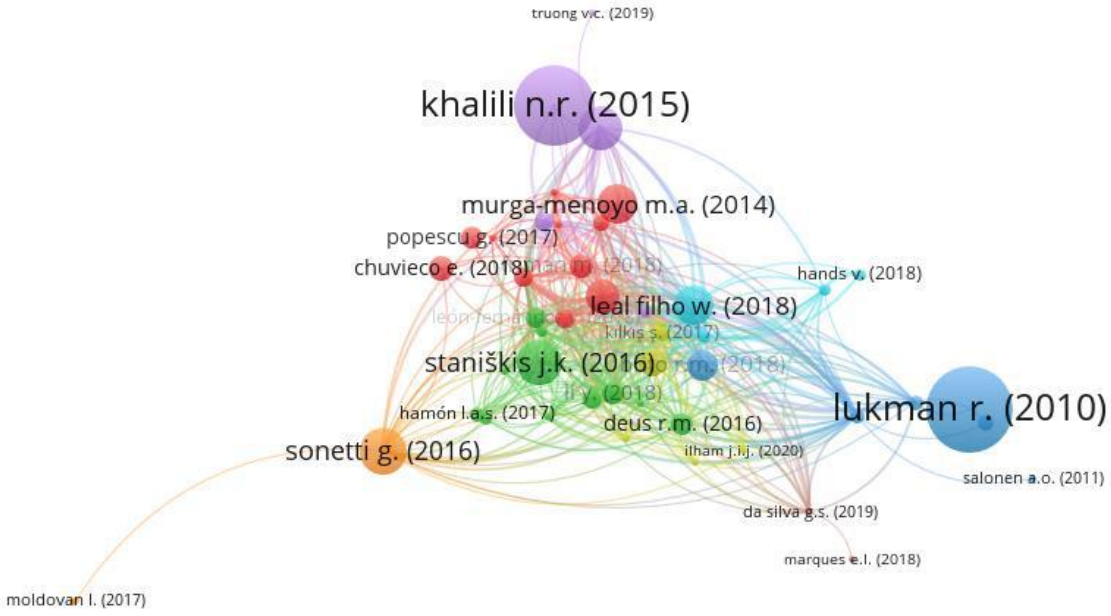

Fig.4 – Bibliographic coupling networks map

Analyzing the map by the size of the nodes, it appears that the authors with the largest number of documents in the analyzed database are: Lukman (2010) – University of Maribor, Khalili (2015) – Illinois Institute of Technology and Sonetti (2016) – Polytechnic University of Turin. Evaluating the proximity of the nodes in this map, it can be seen that the authors with the greatest bibliographic coupling (who cite each other) are: Leal Filho (2018) – Hamburg University, Chuvieco (2018) – University of Alcalá, Staniškis (2016) – Kaunas University of Technology, Popescu (2017) – The Bucharest University of Economic Studies, Murga-Menoyo (2014) – Universidad Nacional de Educación a Distancia, Deus (2016) – São Paulo State University. And the other highlighted authors, with smaller node size and further away from the center of the map, are related to each other, but to a lesser extent.

In this matter, it is concluded that authors usually cite each other frequently, mainly considering the relationship of their studies, usually on the same theme and, many times, certain authors have the habit of develop studies together, which makes their closer research relationship and brings as a consequence the co-citation and affinity of studies.

3.2 Studies evaluated

To carry out a complete analysis of the selected studies, a summary table was developed. Table 1 contains authors, year of publication, title, place of study, theme, type of study and sustainability tool used (if applicable).

As can be seen in this table, the studies are dated from 2010 to 2022, with the main theme involving Sustainable Development in Higher Education Institutions and Sustainability Indicators.

Table 1 – Summary of studies evaluated in the Systematic Literature Review

Authors	Year	Title	Country	Theme	Type of study	Sustainability Tools
Liu, Q., Wang, Z.	2022	Green BIM-based study on the green performance of university buildings in northern China	China	Energy, Sustainability and Society	Case study	Green BIM framework
Verdejo, Á., Espinilla, M., López, J.L., Jurado, F.	2022	Assessment of sustainable development objectives in Smart Labs: technology and sustainability at the service of society	Spain	Sustainable Cities and Society	Literature review and case study	SDG
Lima, C.S., Kieling, D.L., Veiga Ávila, L., Paço, A., Zonatto, V.C.S.	2022	Towards sustainable development: a systematic review of the past decade's literature on the social, environment and governance and universities in Latin America	Brazil, Portugal	Sustainable development in universities	Systematic Review	-
Mann, D., Kwon, J., Naughton, S., Boylan, S., Chan, J., Charlton, K., Dancey, J., Dent, C., Grech, A., Hobbs, V., Lamond, S., Murray, S., Yong, M., Sacks, G.	2021	Development of the university food environment assessment (Uni-food) tool and process to benchmark the healthiness, equity, and environmental sustainability of university food environments	Australia	Development of the University Food Environment Assessment	Literature review and input from an expert advisory panel.	Uni-food
Hasim, M.S., Ali, A.S., Safiee, L.S., Halil, F.M., Abdullah, A.S.	2021	Indicators of environmental sustainability in facilities management practices: Experiences of Malaysian universities	Malaysia	Environmental sustainability in facilities management practices	Case study	Questionnaire survey
Kurniawati, M., Naimah, Z., Wurjaningrum, F.	2021	Priorities of Education Quality Service with Higher Education for Sustainable Development (HESD) Dimensions	Indonesia	Education Quality Service in HEIs	Case study	Questionnaire survey
Perchinunno, P., Cazzolle, M.	2020	A clustering approach for classifying universities in a world sustainability ranking	Italy	Assessing the sustainability of universities	Research	GreenMetric

Serban, E.-C., Hristea, A.-M., Curea, S.-C., Cretu, R.-F.	2020	Sustainable universities, from indifference to joint action-A panel data analysis	Indonesia	Sustainability level of Universities	Case study	GreenMetric
Galván S.L., Faitani N.G., Sosa L.V., Lopez de Munain D.N., Bielsa R.O.	2020	Comparative Analysis of the Environmental Performance of Latin American University Campuses: Methodological Approaches	Argentina México Chile	Solid waste management programs (SWMPs)	Case study	Sustainable indicators
Ilham J.I.J., Zaihan M.H., Hakimi S.M., Ibrahim M.H., Shahrul S.	2020	Mobilising the Sustainable Development Goals Through Universities: Case Studies of Sustainable Campuses in Malaysia	Malaysia	The role of IES in ensuring the SDGs are met and education for sustainable development	Case study	-
Mascarenhas K.L., Peyerl D., Weber N., Mouette D., Cuellar W.O.S., Meneghini J.R., Moretto E.M.	2020	Sustainable Development Goals as a Tool to Evaluate Multidimensional Clean Energy Initiatives	São Paulo, Brazil	Actions developed for the 2030 Energy Agenda in Brazil.	Case study	SDG
Pessotto A.P., Macke J., Frankenberger F.,	2020	Sustainability Practices: The Role of University in Forming Master Students Perspectives	Brazil	Determinants of sustainable education and practice at Universities	Qualitative, descriptive and exploratory crosssectional study	Indicators
Rosa F., Kern A., Braganca L.	2020	Comparative Analysis of Sustainable Development Environmental Indicators between Worldwide, Portugal and Brazil and between two Universities within these Countries	Brazil Portugal	Sustainable indicators	Comparative Analysis	ISO 14001 Global Reporting Initiative (GRI)
Cogut G., Webster N.J., Marans R.W., Callewaert J.	2019	Links between sustainability -related awareness and behavior: The moderating role of engagement	-	Sustainability awareness and behavior	Research	-
Silva G.S., Almeida L.A.	2019	Sustainability indicators for higher education institutions: A proposal based on the literature review	-	Sustainability indicators that comprise its three dimensions (social, environmental, and economic)	Literature review	-

Genta C., Favaro S., Sonetti G., Barioglio C., Lombardi P.	2019	Envisioning green solutions for reducing the ecological footprint of a university campus	Italy	Green solutions	Case study	-
Iacobuta A.-O., Mursa G.C., Mihai C., Cautisanu C., Cismas L.M.	2019	Institutions and sustainable development: A cross-country analysis	132 countries around the world	Relationship between institutions and sustainable development	Research	-
Kinoshita A., Mori K., Rustiadi E., Muramatsu S., Kato H.	2019	Effectiveness of incorporating the concept of city sustainability into sustainability education programs	Indonesia	Education for city sustainability	Research	City sustainability index (CSI)
Lourrinx E., Hadiyanto, Budihardjo M.A.	2019	Implementation of UI GreenMetric at Diponegoro University in order to Environmental Sustainability Efforts	Indonesia	Implementation of I GreenMetric program	Qualitative research	UI GreenMetric
Mawonde A., Togo M.	2019	Implementation of SDGs at the University of South Africa	South Africa	Implementation of SDGs	Case study	Interviews
Moggi S.	2019	Social and environmental reports at universities: a Habermasian view on their evolution	Italy	Sustainable development evolution	Case study	Global Reporting Initiative guidelines
Paletta A., Bonoli A.	2019	Governing the university in the perspective of the United Nations 2030 Agenda: The case of the University of Bologna	Italy	Rethinking to join the 2030 Agenda	Case study	UI GreenMetric
Torabian J.	2019	Revisiting Global University Rankings and Their Indicators in the Age of Sustainable Development	-	International university ranking systems	Qualitative research	Academic Ranking of World Universities (ARWU), Times Higher Education (THE) and QS
Truong V.C.	2019	Measuring sustainable development level in vietnam by using a comprehensive index	Vietnam	Indicators of sustainable development	Qualitative research	Indicators
Aristizábal-Alzate C.E., González-Manosalva J.L.	2018	Effectiveness analysis of the ITM environmental programs: Saving and efficient use of electric energy and water, and comprehensive solid	Colombia	Environmental Programs	Case study	ISO 14040-14044, ISO 14064 and Carbon Footprint

		waste management. A case study				
Brito R.M., Rodríguez C., Aparicio J.L.	2018	Sustainability in teaching: An evaluation of university teachers and students	Mexico	Indicators of sustainability	Quantitative and qualitative analyses	Sustainability Assessment Questionnaire (SAQ)
Brito R.M., Rodríguez C., Aparicio J.L., Paolacci J., Sampedro M.L., Beltrán J.	2018	Indicators of sustainability in educational practice: Perception of teachers and students of UAGro-Mexico	Mexico	Indicators of sustainability	Qualitative, quantitative and exploratory analyses	Indicators
Chuvieco E., Burgui-Burgui M., Da Silva E.V., Hussein K., Alkaabi K.	2018	Factors affecting environmental sustainability habits of university students: Intercomparison analysis in three countries (Spain, Brazil and UAE)	Brazil Spain United Arab Emirates (UAE)	Analysis on the environmental habits	Research	Sustainability indicators
Freidenfelds D., Kalnins S.N., Gusca J.	2018	What does environmentally sustainable higher education institution mean?	-	Environmental indicators	Qualitative research	UN Sustainable Development Goals Indicators, World Bank Indicators, UI Green Metric Indicators and Sustainability Index
Friman M., Schreiber D., Syrjänen R., Kokkonen E., Mutanen A., Salminen J.	2018	Steering sustainable development in higher education – Outcomes from Brazil and Finland	Brazil Finland	Formulation of national and international sustainable development policies	Case study	-
Guerra J.B.S.O.A., Garcia J., de Andrade Lima M., Barbosa S.B., Heerdt M.L., Berchin I.I.	2018	A proposal of a Balanced Scorecard for an environmental education program at universities	Brazil	implementing and monitoring environmental education programs	Literature review	Indicators
Hands V., Anderson R.	2018	Local Sustainability Indicators and Their Role in the Implementation of the Sustainable Development Goals in the HE Sector	United Kingdom	Sustainability indicators	Analysis and literature review	Sustainability indicators (SIs) in parallel with policies
Leal Filho W., Brandli L.L., Becker D., Skanavis C., Kounani A., Sardi C.,	2018	Sustainable development policies as indicators and pre-conditions for sustainability efforts at	Brazil, Germany, Greece, Portugal,	Sustainable development policies	Qualitative research	Universities polices

Papaioannidou D., Paço A., Azeiteiro U., de Sousa L.O., Raath S., Pretorius R.W., Shiel C., Vargas V., Trencher G., Marans R.W.		universities: Fact or fiction?	South Africa and the UK and the USA			
Lemos M.F.C., Rego L.F.G., Antunes M.C., Lopes R.A., de Abreu T.C.C.	2018	Socio-environmental Agenda: A Planning Instrument to Improve Sustainable Development in University Campi	Brazil	Socio-environmental agenda	Action research	Qualitative and quantitative Survey
León-Fernández Y., Gomera A., Antúnez M., Martínez-Escrich B., Villamandos F., Vaquero M.	2018	Enhancing environmental management in universities through participation: the case of the University of Córdoba	Spain	Institution's environmental management	Case study	Participatory approach
Li Y., Gu Y., Liu C.	2018	Prioritizing performance indicators for sustainable construction and development of university campuses using an integrated assessment approach	Australia	Indicators for sustainable using an integrated assessment approach	Literature review	-
Marques E.L., Verona L.A., Tortato U.	2018	Sustainable Brazilian Universities: Composition of Characteristics, Indicators and Performance Parameters	Malaysia, Turkey, Mexico, Peru, China, Thailand	Sustainability characteristics, based on the analysis of the practices of the universities	Research	International Sustainable Campus Network (ISCN), AASHE / STARS
Moreira R.M., Malheiros T.F., Marans R.W., Webster N.J., Hupp A.L.	2018	Assessing Sustainability Culture at the University of São Paulo - São Carlos	Brazil	Sustainable behavior	Case study	Sustainability Culture Indicators Program (SCIP)
Nishimura É.K., Malheiros T.F.	2018	Inclusion of Sustainability in Higher Education Institutions: A Comparative Study of São Carlos School of Engineering—University of São Paulo and the Leuphana University of Lüneburg	Brazil, Germany	Sustainability in Higher Education	Comparative study (Case study of two universities)	-
Pérez L.H., Gandini M.A.	2018	Sustainability in motion at UAO: Integrated waste management	Colombia	Integrated waste management of the	Case study	GreenMetric

				University's Sustainable program		
Chiong K.S., Mohamad Z.F., Abdul Aziz A.R.	2017	Factors encouraging sustainability integration into institutions of higher education	Literature review	Factors that encourage sustainability integration into Institutions of Higher Education	Literature review	ProQuest, Science Direct e Google Scholar
Davey E.	2017	Recapturing the learning opportunities of university sustainability indicators	USA	University sustainability indicators	Qualitative case study	STARS, Sustainability indicators
Finnveden G., Egan E.-D., Sandberg T., Strömberg E.	2017	A Holistic Approach for Integration of Sustainable Development in Education, Research, Collaboration and Operations	Sweden	Sustainable development	Case study	ISO 14001
Hamón L.A.S., Aldaz C.E.B., Rodríguez Pomeda J., Sánchez Fernández F., Fernández De Navarrete F.C.	2017	From Ecocity to Ecocampus: Sustainability policies in university campuses	Spain	Sustainability policies of universities	Qualitative case study	-
Hands V., Anderson R.	2017	Benchmarking sustainability research: A methodology for reviewing sustainable development research in universities	United Kingdom	Sustainable development research	Research	Content Analysis
Hoque A., Clarke A., Sultana T.	2017	Environmental sustainability practices in South Asian university campuses: an exploratory study on Bangladeshi universities	Bangladesh	Sustainability practices	Research	Campus Sustainability Assessment Framework (CSAF)
Jain S., Agarwal A., Jani V., Singhal S., Sharma P., Jalan R.	2017	Assessment of carbon neutrality and sustainability in educational campuses (CaNSEC): A general framework	India	Sustainability assessment	Research	Indicators
KılkıŞ Ş.	2017	Comparative analyses of sustainable campuses as living laboratories for managing environmental quality	-	Sustainable campuses	Research	Common indicators (CIs)

Moldovan L.	2017	The environmental pillar assessment in vocational education	Romania	Institutional sustainability	Research	-
Nen M., Ştefan E.	2017	International dimension of higher education on environmental issues. EEA programme in Romania	Literature review	Environmental studies related to higher education and international mobility	Literature review	-
Popescu G., Boboc D., Stoian M., Zaharia A., Ladaru G.R.	2017	A cross-sectional study of sustainability assessment	105 countries	Association between the human development index and the environmental performance	Research	AIT Climate Data Explorer and the United Nations Energy Statistics Yearbook.
Veiga Ávila L., Beuron T.A., Brandli L.L., Damke L.I., Pereira R.S., Klein L.L.	2017	Barriers to innovation and sustainability in universities: an international comparison	Across all continents	Barriers for innovation and sustainable development	Research	-
Deus R.M., Battistelle R.A.G., Silva G.H.R.D.	2016	Sustainability insights from the mission statements of leading Brazilian Universities	Brazil	Mission statements	Research	-
Disterheft A., Caeiro S.S., Leal Filho W., Azeiteiro U.M.	2016	The INDICARE-model - Measuring and caring about participation in higher education's sustainability assessment	-	Sustainability assessment	Research	INDICARE Model
Sadrykia S., Medghalchi L., Mahdavinejad M.	2016	Sustainability assessment, rating systems and historical buildings. Case study: Rehabilitated construction in a university site	Iran	Sustainability assessment	Case study	-
Sonetti G., Lombardi P., Chelleri L.	2016	True green and sustainable university campuses? Toward a clusters approach	Italy Japan	Structure of sustainable universities	Case study	"Green Metric" ranking (based on quantitative metrics) and the "ISCN report" (Based on individual and qualitative exposure of sustainability initiatives)

Staniškis J.K., Katiliute E.	2016	Complex evaluation of sustainability in engineering education: Case & analysis		Integration of sustainability issues to education	Research	QUESTE-SI (Quality system of European Scientific and Technical Education for Sustainable Industry)
Turan F.K., Cetinkaya S., Ustun C.	2016	A methodological framework to analyze stakeholder preferences and propose strategic pathways for a sustainable university	Turkey	Sustainable university	Case study	Analytic hierarchy and network processes (AHP/ANP)
Khalili N.R., Duecker S., Ashton W., Chavez F.	2015	From cleaner production to sustainable development: The role of academia	-	Cleaner Production, and Sustainability	Research	Questionnaire
Silva D.A.L., De Oliveira J.A., Saavedra Y.M.B., Ometto A.R., Rieradevall I Pons J., Gabarrell Durany X.	2015	Combined MFA and LCA approach to evaluate the metabolism of service polygons: A case study on a university campus	Spain	Industrial ecology	Case study	Material Flow analysis (MFA) and Life cycle assessment (LCA)
Mamat L., Basri N.E.A., Zain S.M., Rahmah E.	2015	Determining the level of environmental sustainability practices at campus dormitories using green indicators	Malaysia	Sustainability Practices at Campus Dormitories	Research	Sustainable indicators
Murga-Menoyo M.A.	2014	Learning for a sustainable economy: Teaching of green competencies in the university	Spain	Green economy	Research based on CRUE: Conference of Chancellors of Spanish Universities	-
Hundzinski L.N., De Lima E.P., Gouvea Da Costa S.E., Machado C.G., Cestari J.M.A.P., Kluska R.A.	2013	Sustainability standards and guidelines requirements for integrated management	-	System of sustainability measurement	Research	BPM Suite (BPMS)
Alba Hidalgo D., Barbeitos Alcántara R., Barral Silva M.T., Benayas Del Álamo J., Blanco Heras D., Domènech Antúnez X., Fernández Sánchez I., Florensa I	2012	Sustainability and social responsibility strategies at Spanish Universities: an assessment tool	Spain	System of sustainability indicators	Action research	UI GreenMetric

Botines A., García Orenes F., López Álvarez N., Ysern Comas P.						
Bell S., Morse S.	2012	Sustainability indicators: Measuring the immeasurable? Second edition	-	Sustainability	Book	Sustainability indicators
Waheed B., Khan F.I., Veitch B., Hawboldt K.	2012	Ranking Canadian universities: A quantitative approach for sustainability assessment using uD-SiM	Canada	Comparison between universities based on sustainability indicators	Research	uD-SiM
Ku C.-K., Chen Y.-W., Kao T.-S., Chien S.-C.	2011	The environmental education strategy of integration of universities, NGOs and elementary schools to develop Taiwan's energy education program	Taiwan	Indicators	Literature review	-
Salonen A.O., Åhlberg M.	2011	Sustainability in everyday life: Integrating environmental, social and economic goals	Finland	Implementation of sustainable development	Research	-
Lukman R., Krajnc D., Glavič P.	2010	University ranking using research, educational and environmental indicators	-	Indicators	Comparative study	-

Analyzing Table 1, it is observed that the studies dated in descending order, from 2022 to 2010, were developed in several countries around the world, on the most varied topics, and most of them used some environmental tool. More specifically, speaking of the themes, it appears that there have been studies developed on environmental indicators, comparison between the Environmental Management Systems of universities, sustainable university, barriers to innovation and implementation of sustainability, sustainability assessment, sustainable development objectives and green economy, among others. The types of studies developed vary between research, literature review, comparative studies, case studies and qualitative and quantitative studies. Somehow, always involving one or more universities where the study was applied.

The studies were carried out in 31 countries, with the highest occurrence, with 16.9%, Brazil. In second place, with 9.9%, is Spain, in third place, with 7.0%, Italy and in fourth place, with 5.6%, Mexico, Malaysia and Indonesia. The other countries have a percentage of 2.8% and 1.4%, as can be seen in Figure 5.

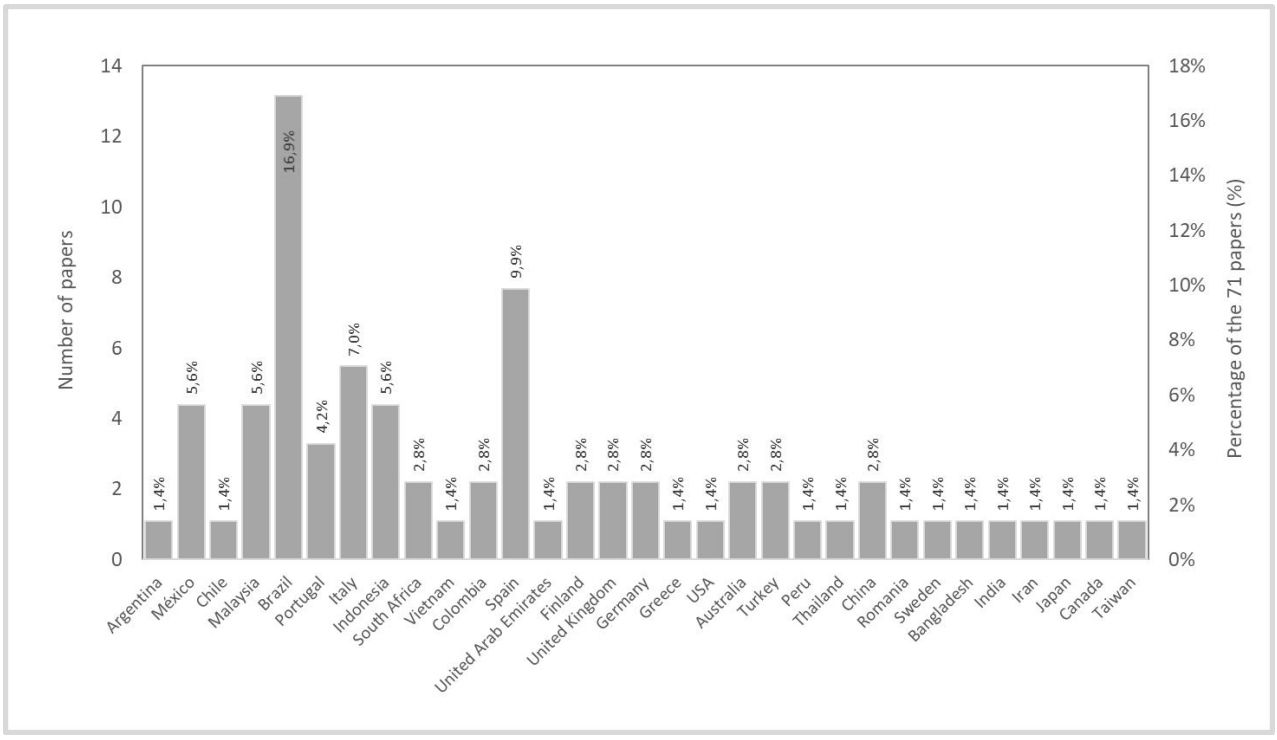

Fig.5 – Countries in the 71 analyzed studies

Figure 6 presents the types of tools used to measure, evaluate and study sustainability in the 71 studies evaluated.

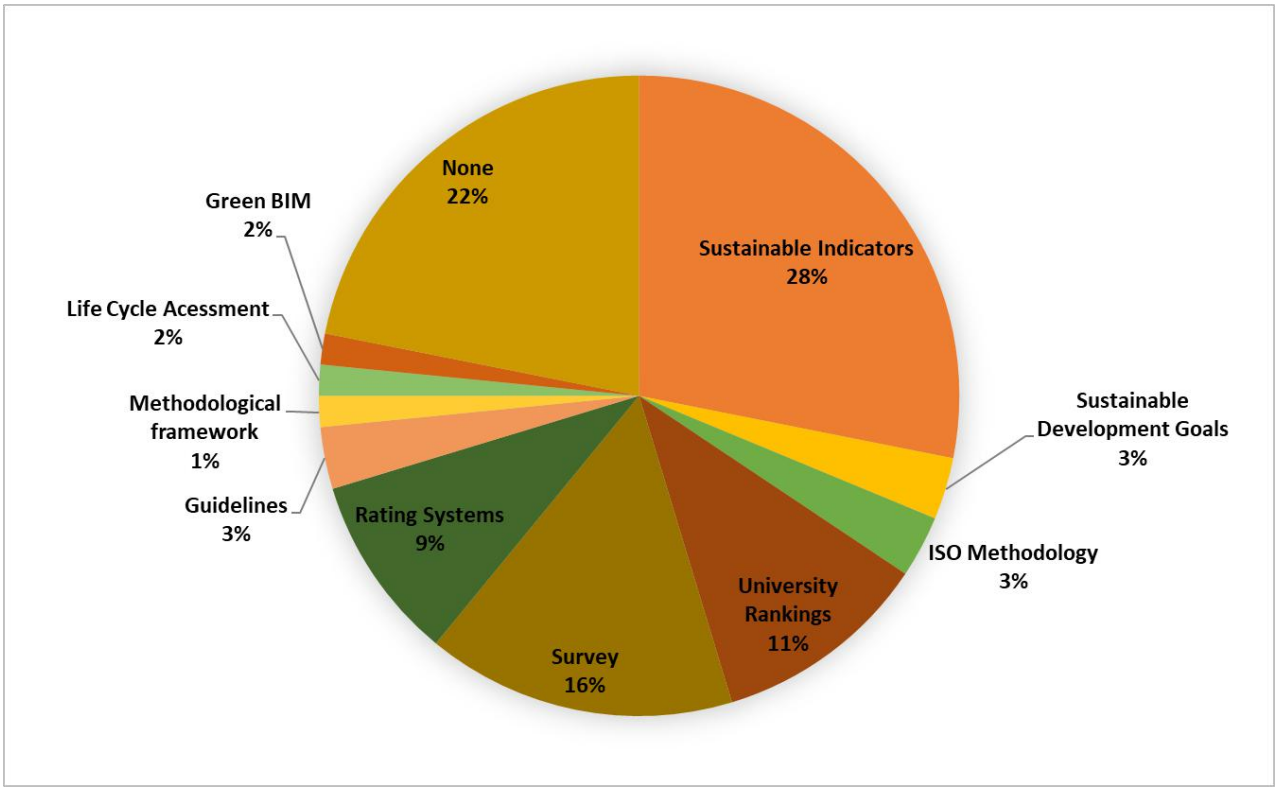

Fig.6 – Types of sustainability tools distributed in the 71 studies

Among the 11 tools distributed in the studies, one of the categories being "none" (studies that did not use sustainability tools), the one with the highest occurrence was Sustainability Indicators (SI), with 28%. In second

place, 22%, are the studies that did not use any tool (these can be seen in Table 1). Third, 16% of the studies used the research tool (with interviews and questionnaires). Fourth, 11% of studies used University Rankings to evaluate their work. In 9% of the studies, some tool of the Sustainability Rating System was used in universities. In 3% of the works, some ISO methodology was used and, with the same percentage, studies with sustainability Guidelines and Sustainable Development Goals. With 2%, the studies used tools such as Life Cycle Assessment (LCA) and Green BIM, and with 1%, Methodological Framework.

IV. DISCUSSION

In the 71 studies analyzed in full, after searching the database, it was found that the type of study developed usually follows the same pattern, being case study, literature review or research (Survey). Thus, it is considered that for studies involving Sustainability in Universities, these are the most coherent ways to develop research and obtain positive and useful results.

An important point observed is that there are several countries interested in the theme of Sustainability applied to Higher Education, proving to be an attractive object of study and showing the potential to obtain useful results for society, since so many universities already have some system, policy or sustainable way of acting.

Regarding the types of tools used in the research, the importance of Sustainability Indicators was verified, since they can bring quantitative results to analyze the university system as a whole, considering its environmental, economic and social axis. The importance of Survey studies for the knowledge of an institution is also highlighted, where it is possible to obtain, in addition to quantitative results on the functioning of the university, the opinion of the academic community involved with the university. For a survey to bring more complete results, you can combine the analysis tools of the Sustainability Indicators with Survey, for example. The University Rankings also provide valuable information about their functioning, considering the sustainability categories that each institution proposes to acquire and, as it makes improvements to its system, increasing its ranking score. The other tools are still important; however, it was found, in this study, that they are not preferred by HEI when it comes to the application of sustainability.

Currently, as can be seen from the analysis of the studies, the environmental tool of Sustainability Indicators, which brings quantitative results, is the most used by institutions. It is a tool that requires planning and constancy to obtain information and search for results. In other words, defining an evaluation frequency, and complying with it, is fundamental for an information history, which will result in an adequate database. On the other hand, according to the authors studied, the use of Sustainability Indicators is one of the preferences, given that data analysis can be done in a practical and impartial way.

Many universities still do not use tools to measure sustainability (22% in this study) and, at this point, this is where the research gap was found. Based on the studies presented, it was settled that universities that have one or more tools to measure sustainability have the means to find management failures, propose continuous improvements to the Institution's environmental system and seek effectiveness in the Organization's sustainable development.

V. 5. Conclusion

A systematic literature review study opens the way for several possibilities for further research, considering that, from this, one can have a perspective of the path followed in a given topic, considering a specific period of time and imposing variables and inclusion and exclusion criteria that may or may not influence the study.

This work sought to highlight the path that the theme of Sustainability in Universities has been taking in a recent period (2010-2022); which authors are most published and with which they usually publish; what are the most discussed and relevant issues in the topic in question; which places in the world prefer these discussions; and, finally, and perhaps most importantly, which sustainability analysis tools are being used in these researches.

With these data, the study aimed to contribute to future research on the subject, so that other researchers can base their work on what has been studied over the years and on how this topic has been studied. These results also open the door to new and innovative ideas, inspired by what is already known in the academic area, but with the aim of bringing new perspectives and, probably, even more positive results so that sustainability continues to be considered, both in the academic environment, when in society in general.

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