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PERFORMANCE IN HIGHER EDUCATION INSTITUTIONS SUSTAINABLE OPERATIONS

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Abstract:

Study's goal: The general goal of this paper is to create a conceptual framework that allows for the assessment of sustainability practices in Higher Education Institutions (HEIs).

Methodology/approach: In order to meet the goal set, a systematic survey of the scientific literature about sustainability assessment models in HEIs was conducted, which allowed for the identification of characteristics and functionalities of the existent models. The systematic literature review developed adopts the Knowledge Development Process-Constructivist (ProKnow-C) method complemented by a procedure known as snowball sampling to create a portfolio of articles to be reviewed.

Originality/Relevance: This paper reviews a considerable number of sustainability assessment models for higher education, identifying correlated axes in existent models and contributing to further research about the theme of sustainability assessment in higher education.

Main results: The results generated a summary chart composed of 10 thematic axes that describe sustainable operations in HEIs. They are as follows: governance and policy, laws, ethics and integrity, teaching, purchases, transportation, energy, water, food, innovation, and hazardous waste.

Theoretical/methodological contributions: This paper is based on the literature review, particularly adopting systematic review techniques.

Conclusion: The systematic survey of scientific literature generated a summary chart composed of 10 thematic axes. This paper is limited to ascertaining the thematic areas that may develop criteria to assess service operations in HEIs. The thematic axes found by this paper may be employed by future studies to obtain specific criteria and their applicability in HEIs.

Keywords: Higher Education. University. Sustainability. Service operations.

FERRAMENTAS PARA AVALIAÇÃO DA SUSTENTABILIDADE NAS OPERAÇÕES DE SERVIÇO EM INSTITUIÇÕES DE ENSINO SUPERIOR

Resumo

Objetivo: O objetivo é analisar as práticas de sustentabilidade nas operações de serviço em três Instituições de Ensino Superior da Rede Federal de Educação Profissional, Científica e Tecnológica

no Brasil por intermédio de um modelo desenvolvido e aplicado denominado *Sustainability Assessment for Higher Technological Education* (SAHTE).

Desenho / metodologia / abordagem: por meio de estudos de casos múltiplos foi aplicado o modelo desenvolvido denominado *Sustainability Assessment for Higher Technological Education* (SAHTE). O *modelo* permite comparar o desempenho de sustentabilidade de operações de serviço entre instituições individuais, usando uma metodologia comum. Apresenta cinco áreas a serem avaliadas nas IES, sendo: Governança e Políticas, Pessoas, Alimentos, Água e Energia e Resíduos e Meio Ambiente, tendo um total de 134 quesitos.

Descobertas: Verifica-se a importância do apoio da alta direção das instituições em formular e desenvolver políticas sobre desenvolvimento sustentável, quando evidenciado a ausência de políticas sobre sustentabilidade nas operações de serviço, as iniciativas tendem a ser isoladas. Nos estudos de caso constata-se uma preocupação inicial com relação a resíduos químicos e coleta seletiva; a participação de alunos e professores em estudos sobre as operações diárias dos campus pode ser ampliada e mais difundida.

Limitações da pesquisa / implicações: O modelo busca avaliar práticas sustentáveis nas operações de serviço da rede federal de educação profissional, científica e tecnológica brasileira, estudos correlatos a avaliação sobre ensino de sustentabilidade é ausente e sobre a aplicabilidade do modelo em instituições privadas e em outros países se fazem necessários. O modelo foi aplicado em duas Instituições, sendo que em uma avaliou-se dois campus, proposições sobre populações não podem ser generalizadas

Implicações práticas: Os resultados obtidos com a aplicação do modelo SAHTE são úteis para a elaboração e desenvolvimento de políticas sobre desenvolvimento sustentável, principalmente nas operações de serviço das IES pesquisadas. Os resultados podem sensibilizar os funcionários e estudantes que podem refletir sobre seus papéis nas IES, bem como a comunidade e fornecedores.

Originalidade/valor: O presente estudo busca apresentar uma ferramenta desenvolvida para avaliar questões sobre sustentabilidade nas operações de serviço em instituições de ensino superior da rede federal de ensino tecnológico brasileiro.

Palavras-chave: Ensino Superior. Universidade. Sustentabilidade. Operações de serviço.

HERRAMIENTAS PARA EVALUACIÓN DE LA SOSTENIBILIDAD EN LAS OPERACIONES DE SERVICIO EN INSTITUCIONES DE ENSEÑANZA SUPERIOR

Resumen

Objetivo del estudio: El objetivo general de este documento es crear un marco conceptual que permita la evaluación de las prácticas de sostenibilidad en las Instituciones de Educación Superior (IES).

Metodología / enfoque: para cumplir con el objetivo establecido, se realizó una encuesta sistemática de la literatura científica sobre modelos de evaluación de sostenibilidad en IES, que permitió la identificación de características y funcionalidades de los modelos existentes. La revisión sistemática de la literatura desarrollada adopta el método Constructivista del Proceso de Desarrollo del Conocimiento (ProKnow-C) complementado por un procedimiento conocido como muestreo de bola de nieve para crear una cartera de artículos para su revisión.

Originalidad / Relevancia: Este artículo revisa un número considerable de modelos de evaluación de sostenibilidad para la educación superior, identificando ejes correlacionados en modelos existentes y contribuyendo a una mayor investigación sobre el tema de la evaluación de sostenibilidad en la educación superior.

Resultados principales: Los resultados generaron un cuadro resumen compuesto por 10 ejes temáticos que describen operaciones sostenibles en IES. Son los siguientes: gobernanza y política,

leyes, ética e integridad, enseñanza, compras, transporte, energía, agua, alimentos, innovación y desechos peligrosos.

Contribuciones teóricas / metodológicas: este documento se basa en la revisión de la literatura, particularmente adoptando técnicas de revisión sistemática.

Conclusión: La encuesta sistemática de literatura científica generó un cuadro resumen compuesto por 10 ejes temáticos. Este documento se limita a determinar las áreas temáticas que pueden desarrollar criterios para evaluar las operaciones de servicio en IES. Los ejes temáticos encontrados en este documento pueden ser empleados por futuros estudios para obtener criterios específicos y su aplicabilidad en IES.

Palabras clave: Educación superior. Universidad Sostenibilidad Servicio de operaciones.

1 Introduction

At the beginning of the 1990s, universities started to engage in pro-sustainability movements, signing joint declarations and making commitments to sustainable development. The declarations of Tbilisi, Talloires, Halifax, Swansea, and Thessaloniki are examples of that commitment via the willing attitudes of HEIs (TARAH, 2002; CLARKE, 2006; ALSHUWAIKHAT & ABUBAKAR, 2008; FONSECA et al., 2011).

The Tbilisi Declaration was one of the most meaningful moments in the evolution of international declarations on sustainability in education. The conference, endorsed by the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the United Nations Environment Program (UNEP), is regarded as one of the starting points for formal environmental education and global recommendations concerning it. In Talloires, France, October of 1990, over 300 universities from more than 40 countries signed the Talloires Declaration, a document for the development, creation, support, and maintenance of sustainability, written by and for presidents of HEIs (TARAH, 2002).

Although the declarations contain valuable guidelines for higher education, they are notably lacking in the formulation of concrete prescriptions at the operational level of institutions, which could, according to Shriberg (2002), maximize their commitment to sustainable development. Urbanski & Leal Filho (2015) point out that “the movement toward sustainability in higher education has grown considerably over the last 15 years” and this growth has brought on assessment tools regarded as significant for the operationalization of the letters and political declarations about sustainability.

Maragakis & Van Den Dobbelsteen (2015) observe that sustainability assessment tools were created to assess a wide range of international, national, professional, and personal initiatives. However, Fonseca et al. (2011) stress that, even though they allow for

the propagation of sustainability reports, few models address the perspectives of higher education.

According to Lukman & Glavic (2007), a set of criteria must be planned and developed to enable a university to conduct a sustainability assessment. The same authors state that the sustainability criteria of a university must encompass all of the three dimensions of sustainable development, that is, the environmental, economic, and social aspects.

The literature contains models developed for corporations, such as the Global Report Initiative (GRI) and ISO 14000. They served as inspiration for models such as the Graphical Assessment of Sustainability in Universities (GASU) and Higher Education 21.

Specific models, such as the Auditing Instrument for Sustainability in Higher Education (AISHE), the Campus Sustainability Assessment Framework (CSAF), the Sustainability Assessment Questionnaire (SAQ), and the Sustainability Tracking, Assessment and Rating (STARS), are more recent and have been developed in either North America or Europe. “The exposed reality confirms the importance, the opportunity, and the need for studies concerning the incorporation of sustainability to HEIs focusing on the three sustainability pillars: the economic, the social, and the environmental” (Termignoni, 2012, p. 21).

The need for standard metrics is not new; it has been a point of debate since the beginning of the 2000s. However, reliable tools to assess the progress of sustainability are still scarce (Urbanski & Leal Filho, 2015, p. 210). Moreover, to go beyond a fragmented comprehension of sustainability in different campuses and fully understand the enigma of how HEIs have been advancing in their sustainable goals, more comparative studies are required (Lidstone et al., 2015, p. 262).

Shi & Lai (2013) identified key sustainability issues in HEIs based on models such as the Green Report Card, the Sustainability Tracking, Assessment and Rating (STARS), and the American Colleges and Universities Presidents’ Climate Commitment (ACUPCC). In Brazil, Pasinato & Brião (2014) developed indicators that complement the GRI, applying a structure of specific indicators to a case study. Termignoni (2012) employs a similar approach, introducing a framework of operations based on GRI guidelines to university campuses of community HEIs. More recently, Góes (2015) proposed a comparative analysis of sustainability assessment tools in universities intending to find a project for Brazil.

Based on the previously mentioned studies, this research paper justifies itself by comprising a greater array of sustainability assessment tools for higher education and identifying correlated axes in existent models, contributing to future works about sustainability assessment in higher education. This paper’s central goal is to devise a

conceptual framework composed of the principal thematic axes found in the assessment models applied to HEIs. In order to achieve that, a systematic literature review was conducted to find the leading models in the scientific literature, as well as the foremost authors and journals.

2 Research Plan

This paper conducted a literature review that employed the systematic techniques of the Knowledge Development Process-Constructivist (ProKnow-C) method. The ProKnow-C method was developed and patented at the Federal University of Santa Catarina (UFSC) by Ensslin et al. (2010) and has been utilized by Bortoluzzi et al. (2011a), Bortoluzzi et al. (2011b), Afonso et al. (2012), Ensslin et al. (2012), and Bortoluzzi et al. (2015).

Freitas et al. (2012) have also employed the ProKnow-C method to investigate sustainability-related matters in HEIs. According to Lacerda et al. (2012, p. 64), the ProKnow-C method "starts at the researcher's interest in a certain theme and its intrinsic restrictions and limitations within the academic context, seeking to build up the researcher's knowledge so that they are able to initiate scientific research on solid ground".

After the application of the ProKnow-C method, the articles published in all the editions of the International Journal of Sustainability in Higher Education (IJSHE) were read, as shown in Figure 1.

Figure 1 - Stages of the literature review

Source: The authors.

The third stage in the literature review comprised the snowball sampling, procedure researched and applied by Wasserman & Faust (1994). Regarding the approach to the problem, this research paper is both qualitative and quantitative: qualitative due to the content analysis of each article and quantitative due to the bibliometric data analysis (Bolaño et al., 2008).

This paper addressed sustainability assessment in higher education and sought to answer the following question: What are the principal tools and correlated thematic axes in the assessment models mentioned in the scientific literature and applied to higher education institutions?

3 Systematic Literature Review

The first step in the systematic literature review was the application of the ProKnow-C method, which comprises three stages: the search process, bibliometrics, and systemic analysis.

This paper applied only the first two stages of the ProKnow-C method. It discarded the systemic analysis stage due to the need for developing a conceptual framework for the assessment of sustainable operations in HEIs, taking into account the existent methods in the literature. The snowball sampling method replaced the systemic analysis stage.

3.1 Search Process

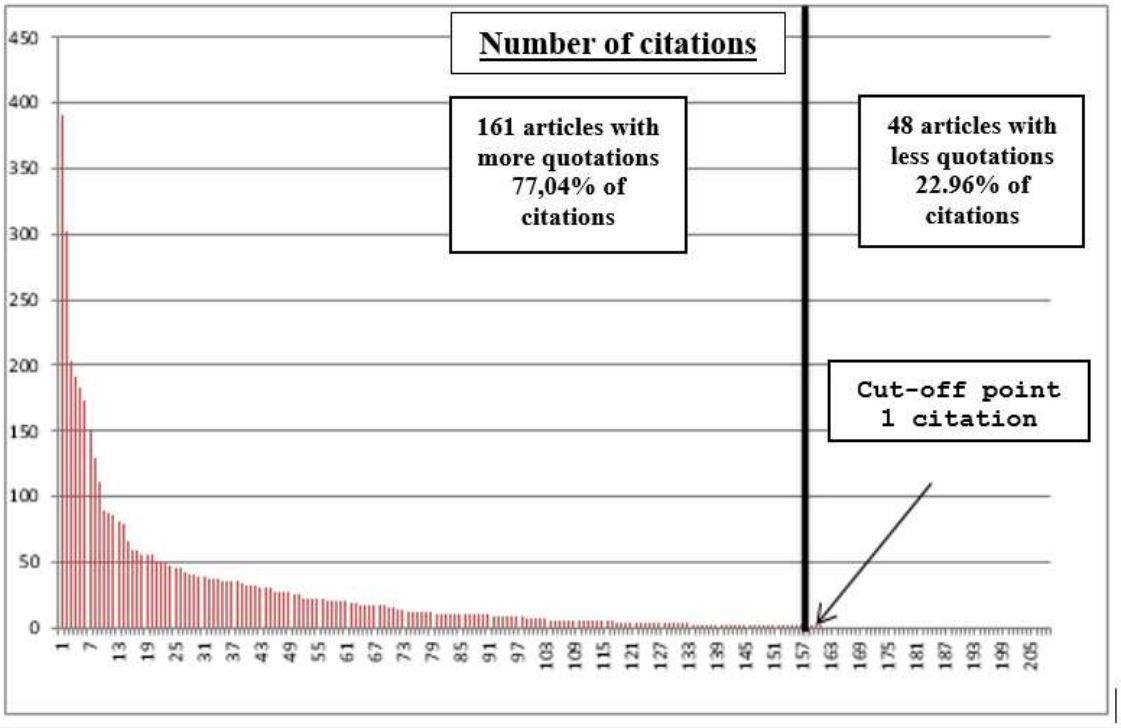
The first step in the search process was to define the databases of scientific articles. The ones selected were Web of Science and Scopus, both accessed through CAPES (*Coordenação de Aperfeiçoamento de Pessoal de Nível Superior* - Coordination for the Improvement of Higher Education Personnel) in December of 2016. The process then defined three thematic axes: higher education, sustainability, and assessment. Finally, it selected the search queries.

The higher education axis contained the search queries *higher education* and *university*. The sustainability axis held the queries *environmental* and *sustainability*. Finally, the assessment axis included the queries *report, evidence, assessment, tools, indicators, auditing, quality standards, operations, analysis, management,* and *framework*. Seeing that the research does not encompass curriculum-related matters, it applied the logic operator *not* to the search query *curricula*. Crossing the keywords defined for each axis returned a total of 44 combinations.

The keyword search in the databases applied filters to return only articles with no date restriction, finding a total of 31,784 articles. The software Endnote was employed as a management tool to find duplicate results caused by keywords overlapping. A total of 16,849 duplicate entries were found, creating an initial portfolio of articles with 14,935 items.

The next step consisted of reading the title of each article to find results thematically aligned with this review, obtaining 209 articles. The Google Scholar platform was then employed, jointly with the spreadsheet editor Microsoft Office Excel, to ascertain the number of citations per publication. Graph 1 displays the number of citations of each article in ascending order.

Graph 1 - Alignment in terms of scientific recognition



Source: The authors.

The results above generated two databases. The first one comprised the 161 most cited articles on Google Scholar, with 77.04% of the citations. Their abstracts were read to find results aligned with the theme, leading to the selection of 46 articles.

The second database comprised the 48 least cited articles, with 22.96% of the citations. They were submitted to analysis criteria related to the date of publication (whether they were published in the last two years) and authorship (whether the author was also present in the first database). None of the 48 articles satisfied those criteria, leading to their dismissal.

The final procedure consisted of reading the articles in their entirety. Of the 46 previously selected items, three were not available on the CAPES portal. Chart 1 displays the 25 studies selected after reading the 43 remaining articles.

Chart 1 - Articles selected via the ProKnow-C method

VIEBAHN, P.	An Environmental Management Model for Universities: From Environmental Guidelines to Staff Involvement.	2002
PRICE, T. J.	Preaching What We Practice: Experiences from Implementing Iso 14001 at the University of Glamorgan	2005
VELAZQUEZ, L., N. MUNGUIA; M. SANCHEZ	Deterring Sustainability in Higher Education Institutions: An Appraisal of the Factors Which Influence Sustainability in Higher Education Institutions.	2005
WOOLLIAMS, J., M. LLOYD; J. D. SPENGLER	The Case for Sustainable Laboratories: First Steps at Harvard University.	2005
DAUB, C. H.	Assessing the Quality of Sustainability Reporting: An Alternative Methodological Approach	2007
LI, G. J, Q. WANG, X. W. GU, J. X. LIU, Y, DING, Y.; LIANG, G.	Application of the Componential Method for Ecological Footprint Calculation of a Chinese University Campus	2008
TADDEI-BRINGAS, J. L., J. ESQUER-PERALTA, A. PLATT-CARRILLO	ISO 14001 and Sustainability at Universities: A Mexican Case Study	2008
CLARKE A.; KOURI, R.	Choosing an appropriate university or college environmental management system.	2009
FONSECA A; MACDONALD A; DANDY E; VALENTI P	The state of sustainability reporting at Canadian universities.	2011
LOZANO, R	The State of Sustainability Reporting in Universities	2011
WAHEED, B., F. I. KHAN; B. VEITCH.	Developing a Quantitative Tool for Sustainability Assessment of HEIs.	2011
BRANDLI LL; FRANDOLOSO MAL; FRAGA KT; VIEIRA LC; PEREIRA LA.	Avaliação da presença da sustentabilidade ambiental no ensino dos cursos de graduação da Universidade de Passo Fundo Education of Undergraduate Programs at the University of Passo Fundo	2012
KAMAL, A. S. M. AND M. ASMUSS	Benchmarking Tools for Assessing and Tracking Sustainability in Higher Educational Institutions: Identifying an Effective Tool for the University of Saskatchewan	2013
SHI, H. AND E. LAI.	An Alternative University Sustainability Rating Framework with a Structured Criteria Tree.	2013
VELAZQUEZ, L., N. MUNGUIA; M. OJEDA	Optimizing Water Use in the University of Sonora, Mexico	2013
DE CASTRO R.; JABBOUR, C.J.C.	Evaluating Sustainability of an Indian University. .	2013
LAMBRECHTS W; VAN LIEDEKERE L	Using ecological footprint analysis in higher education: Campus operations, policy development and educational purposes.	2014
WHITE, S. S.	Campus Sustainability Plans in the United States: Where, What, and How to Evaluate?	2014
GÓMEZ, F. U.C. SÁEZ-NAVARRETE, S. R. LIOI AND V. I. MARZUCA.	Adaptable Model for Assessing Sustainability in Higher Education	2015
LANG, T.	Campus Sustainability Initiatives and Performance: Do They Correlate?	2015
LIDSTONE, L., T. WRIGHT; K. SHERREN	An Analysis of Canadian Stars-Rated Higher Education Sustainability Policies	2015
LO, K.	Campus sustainability in Chinese higher education institutions.	2015
MARAGAKIS, A. VAN DEN DOBBELSTEEN, A.	Sustainability in higher education: Analysis and selection of assessment systems.	2015
ROMOLINI, A., S.; FISSI, S.; GORI, E.	Quality Disclosure in Sustainability Reporting: Evidence from Universities.	2015
URBANSKI, M; FILHO W. L.	Measuring Sustainability at Universities by Means of the Sustainability Tracking, Assessment and Rating System (STARS): Early Findings from STARS Data.	2015

Source: The authors.

Therefore, a few factors limited the selection of articles: the specific thematic axes (higher education, sustainability, and assessment), the access to only two scientific databases, and the restriction to items available on the CAPES platform.

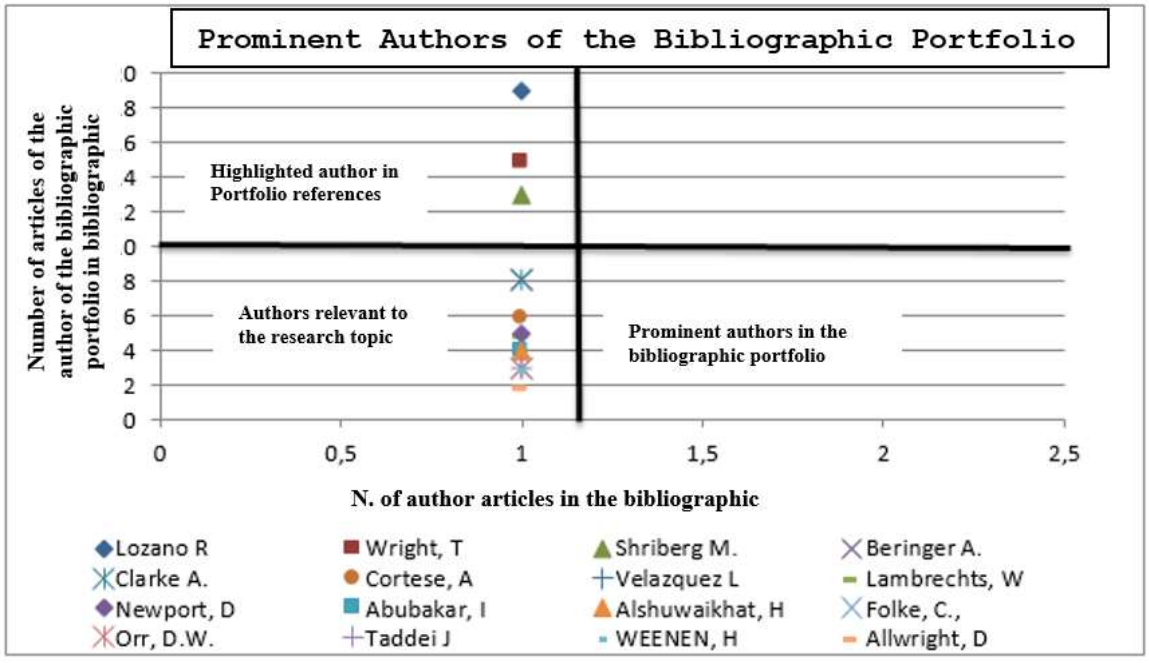
3.2 Bibliometric Stage Procedures

Within the portfolio of 25 articles selected, Luis Velazquez, member of the Industrial Engineering Department at the University of Sonora in Mexico, stands out with two published studies, as shown in Graph 2.

The bibliographic references contained in the portfolio were employed to create a second database of articles containing 353 papers and 492 authors. The names that stood out in this second selection were Rodrigo Lozano, Tarah Wright, and Michael Shriberg.

The author Rodrigo Lozano has a bachelor's degree in Chemical Engineering, a Ph.D. in Management of Organizational Change for Corporate Sustainability, and created the tool Graphical Assessment of Sustainability in Universities (GASU). Tarah Wright is an Environmental Science professor at the University of Dalhousie, has a master's degree in Environmental Studies and a Ph.D. in Studies on Educational Policy. Michael Shriberg is the Regional Executive Director of the National Wildlife Federation's Great Lakes Regional Center and has a master's degree and a Ph.D. in Politics and Behavior at the University of Michigan. Graph 2 displays them and other authors of note present in the references of the portfolio.

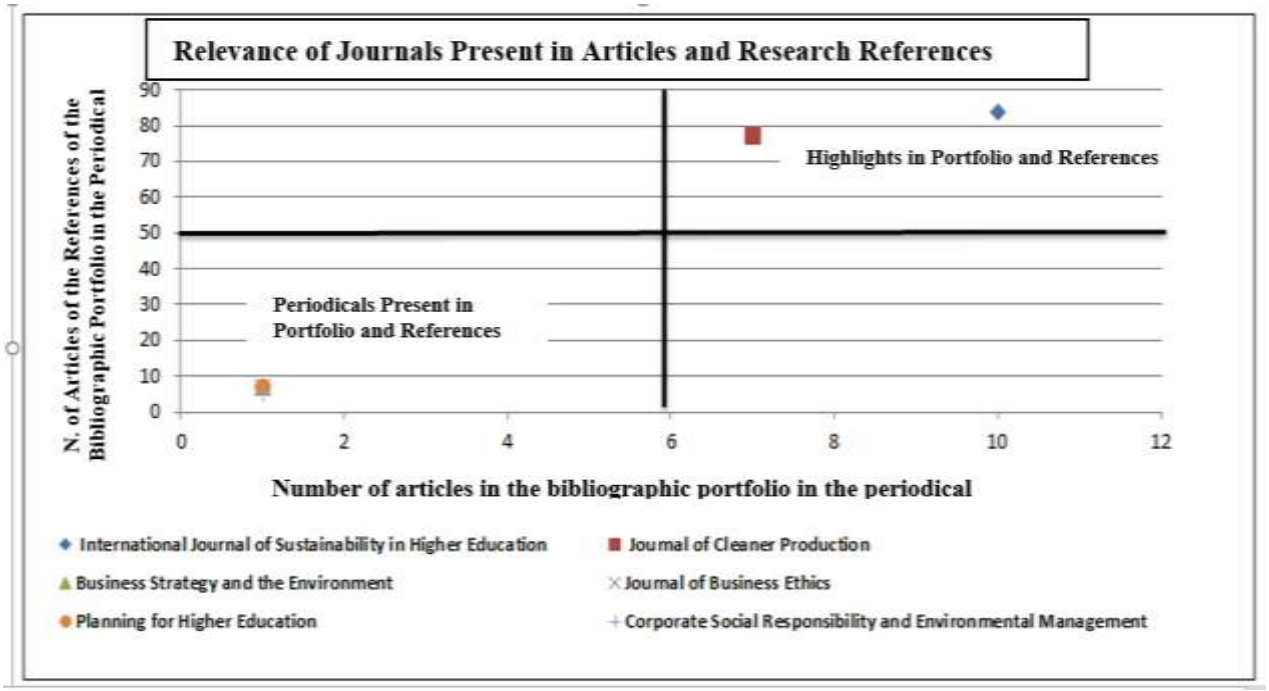
Graph 2 - Authors of note in the portfolio of articles and in their references



Source: The authors

The next step after identifying the authors that compose the portfolio of articles and their references consisted of investigating the journals that published them. From the 25 articles, ten were published in the International Journal of Sustainability in Higher Education and seven in the Journal of Cleaner Production. They were the most relevant journals within the portfolio, as shown in Graph 3. Considering the 353 papers found in the references, the same two publications maintained their relevance, having published 84 and 77 articles, respectively.

Graph 3 - Relevance of the journals within the portfolio of articles and their references



Source: The authors.

The Journal of Cleaner Production aims to incentivize innovation and creativity, new and improved products, and the implementation of new structures and cleaner technologies, systems, processes, products, and services. The International Journal of Sustainability in Higher Education (IJSHE) is the first international academic publication that issues research papers, studies and projects related to sustainability matters in HEIs, presenting studies in areas such as environmental management systems, sustainable development, curriculum innovation, campus greening, operational systems in universities, energy, water, recycling, waste management, campus project and planning, environmental reports, environmental policy and action plans. The development of journals like the IJSHE is a reflection of the growth in sustainability studies in HEIs (White, 2014).

Due to the relevance of the journal for the articles selected and their references, the entire catalog of articles published in the IJSHE was read, since its first edition in 2000. The

journal has seventeen volumes and a total of 462 articles; of those, 14 were selected after the reading, as shown in Chart 2.

Chart 2 - Articles selected after reading the IJSHE

AUTHORS	TITLE	YEAR
FILHO, W. L.	Dealing with misconceptions on the concept of sustainability	2000
VAN WEENEN, H.	Towards a vision of a sustainable university	2000
FLINT, K.	Institutional ecological footprint analysis – a case study of the University of Newcastle, Australia	2001
VENETOULIS, J.	Assessing the ecological impact of a university; the ecological footprints for the University of Redlands	2001
SHRIBERG, M.	Institutional assessment tools for sustainability in higher education	2002
TARAH, S.A. W.	Definitions and frameworks for environmental sustainability in higher education	2002
FISHER, R.M.	Applying ISO 14001 as a business tool for campus sustainability	2003
NEWPORT, D; CHESNES, T; LINDNER, A.	The “environmental sustainability” problem: Ensuring that sustainability stands on three legs	2003
COMM CL; MATHAISEL DFX.	A case study in applying lean sustainability concepts to universities	2005
VELAZQUEZ, L, MUNGUIA, N. SANCHEZ, M.	Deterring Sustainability in Higher Education Institutions: An Appraisal of the Factors Which Influence Sustainability in Higher Education Institutions.	2005
BARDATI, D.R.	The integrative role of the campus environmental audit: Experiences at Bishop's University, Canada	2006
BERINGER, A.	Campus sustainability audit research in Atlantic Canada: Pioneering the Campus Sustainability Assessment Framework	2006
CLARKE, A.	The campus environmental management system cycle in practice: 15 Years of environmental management, education and research at Dalhousie University	2006
CONWAY, T.M.; DALTON, C.; LOO, J.;	Developing ecological footprint scenarios on university campuses: A case study of the University of Toronto at Mississauga	2008

Source: The authors.

3.3 Snowball sampling procedures

After employing the ProKnow-C method to construct the portfolio of articles and reading the 462 articles published by the International Journal of Sustainability in Higher

Education, the snowball sampling method was applied to find the original versions of sustainability assessment models utilized in HEIs.

"Snowball sampling is often employed to find and recruit 'hidden populations', that is, groups that are not readily available to researchers through other sampling strategies" (Mack et al., 2005, p. 6). The first group of articles brings to light new papers, books, and assessment models via their references, which in turn indicate further studies and so on, consecutively.

It is relevant to point out that the snowball sampling took place after the selection of articles for the portfolio via the ProKnow-C method and the reading of the articles published by the IJSHE in their entirety, so as not to interfere or alter the systematic literature review. It is applicable in this research because of the need for finding the original forms of sustainability assessment models employed in HEIs, free of the interpretations and reports that articles may contain. This procedure leads to clear, reliable information and goals.

The ProKnow-C method and the reading of articles published by the IJSHE enabled the discussion about the evolution of sustainability studies in HEIs in this research. The snowball sampling procedure, based on the references found by the ProKnow-C method and the IJSHE articles, led to the original version of the sustainability assessment models, allowing for the analysis of their thematic axes, indicators and similarities.

4 The Evolution of Sustainability Studies in HEIs

Universities can get involved with sustainable development in their planning, management, education, research, operations, community services, material acquisitions, transportation, and infrastructure (Brandli et al., 2012). Assessment models generate criteria able to measure and enhance the performance of HEIs. The Agenda 21's report makes it clear that governments and international organizations, jointly with the private sector, must develop criteria and methodologies for assessing the environmental impacts and resource requirements over the life cycle of products and processes. The results of these assessments must become clear criteria that provide consumers and decision makers with information (UNCED, 1992).

Commonly, assessment tools measure eco-efficiency instead of sustainability. In general, eco-efficiency criteria assess environmental performance and legal affairs, whereas sustainability criteria emphasize matters related to the environment, society and economy; their tools are intimately linked to decision-making regarding the mission and process-related results (Shriberg, 2002). Seeking to understand the sustainability assessment tools in HEIs, the models and standards found in the literature review were analyzed, as shown in Chart 3.

Chart 3 - Presentation of the assessment tools

Assessment Tool	Description/Level or Focus	Higher Education Institutions Assessed
Global Reporting Initiative (GRI)	Sustainability report. The GRI guidelines offer principles, contents, and an implementation manual so that different organizations are able to employ them.	University of Calgary (Canada) University of Florida (USA)
Ecological Footprint	Methodology that assesses the pressure caused by human consumption on natural resources.	Northeastern University (China) Newcastle (Australia) University of Redlands (USA) University of Toronto (Canada)
Graphical Assessment of Sustainability in Universities (GASU)	This tool graphically presents the sustainability efforts in universities, which facilitates their analysis, longitudinal comparison and benchmarking with other universities.	University of Leeds (United Kingdom)
Auditing Instrument for Sustainability in Higher Education (AISHE)	This tool was specifically designed for universities and presents a set of indicators.	University of Passo Fundo (Brazil)
Higher Education 21. (HE 21)	Its purpose is to spread good sustainability practices in higher education, presenting a set of indicators for universities.	University of Brighton (United Kingdom)
Campus Ecology	The book encompasses eco-efficiency and social and economic themes.	University of Wisconsin–River Falls (USA)
Sustainability Tracking, Assessment and Rating (STARS)	Its purpose is to understand the environmental performances of HEIs.	Vancouver Island University (Canada) California State University, Los Angeles (USA)
ISO 14000	Set of standards employed for the environmental certification of corporations in general.	University of Glamorgan (United Kingdom) University of Vale do Rio dos Sinos (Brazil)
Campus Sustainability Assessment Framework (CSAF)	This tool was specifically designed for universities and offers support, resources, and assistance in the development of solutions for HEIs.	University of Prince Edward Island (Canada)
Sustainability assessment Questionnaire (SAQ)	Qualitative questionnaire designed to aid in the assessment of sustainability-related matters in universities.	University of Hawaii at Manoa (USA)
Report Card	It assesses the sustainability activities on campus in an independent manner.	Yale University; Butler University (USA) University of Waterloo; University of Toronto (Canada)
GreenMetric	Its purpose is to rank universities in terms of sustainable actions.	Pontifical Catholic University of Rio Grande do Sul (Brazil) Voronezh State University (Russia) University of Kwazulu-Natal (South Africa)

Source: The authors.

One of the first publications that arose to achieve the goals proposed in the declarations signed by HEIs was the book Campus Ecology (Smith, 1993). The book has

four sections: waste and risks, resources and infrastructure, the education business, and immediate action, covering a total of 200 questions.

Another way to study the ecological impact of universities is through the ecological footprint analysis (Venetoulis, 2001; Flint, 2001; Conway et al., 2008; Klein-Banai et al., 2010; Lambrechts & Van Liedekerke, 2014). This approach has been applied to countries, cities, families and, more recently, university campuses. The ecological footprint measures the amount of land and water needed by a given population to maintain their consumption and absorb their waste over a year employing current technology (Venetoulis, 2001; Conway et al., 2008).

The University of Newcastle was the first HEI in Australia to conduct an ecological footprint study (Flint, 2001). A study at the University of Toronto, in Mississauga, Canada, investigated its ecological footprint and found it almost 100 times larger than the campus extent (Conway et al., 2008). However, Lozano (2006) argues that the ecological footprint does not fully cover all sustainability issues, due to the complexity of the social and economic dimensions.

Comm & Mathaisel (2005) conducted studies in five public universities and 13 private universities in the United States with the purpose of verifying whether they were implementing lean practices toward sustainability. “Employing lean tools and techniques may reduce waste to a desirable level” (Lo, 2015, p. 258).

Certain HEIs, concerned with developing and maintaining their environmental policy, have adopted Environmental Management Systems in their organizational structure, such as the set of standards ISO 14000. The International Organization for Standardization (ISO) started developing the ISO 14000 series of volunteer standards on environmental management systems in 1991, publishing its first standards in 1996 (Harrington, 2001).

Alshuwaikhat & Abubakar (2008) identified a limitation in the ISO 14000 series in the lack of social dimension. According to the authors, it emphasizes environmental dimensions and is too generic to prescribe specific environmental performances as goals, leaving that role for the organizations to define internally.

Regarding HEIs, there is scarce information about the execution of the ISO 14001 framework. However, it is possible to learn the experiences of institutions all over the world through their websites or research papers on the topic (Taddei-Bringas et al., 2008).

The University of Vale do Rio dos Sinos (UNISINOS) was the first university in Latin America certified according to the ISO 14001. It received the certification in December 2004, engaging its entire academic community in the process of environmental conservation, including the staff, faculty, providers, and students. As a result, the university was able to save 35% in its budget of 2005 (UNISINOS, 2005).

The Global Reporting Initiative (GRI) is an independent international organization that helps corporations, governments and other organizations to understand and communicate their impact on critical sustainability matters, such as climate change, human rights, corruption, and many others. Founded in Boston in 1997, the GRI was a pioneer in the creation of sustainability reports.

The University of Florida was the first university in the world to apply GRI guidelines. The publication of the GRI sustainability report is a crucial step for the HEI to acknowledge its roles both within and out of the academic community and have a starting point to identify possible improvements (Newport et al., 2003).

The GRI was the inspiration for models adapted to universities, such as the Graphical Assessment of Sustainability in Universities (GASU), which presents, graphically, the sustainability efforts in universities, facilitating their analysis, longitudinal comparison, and benchmarking with other universities. The GASU automatically generates nine graphs that can be employed to analyze the current situation of the university, identifying dimensions and categories in which it stands out and flagging the areas that need improvement (Lozano, 2006). GASU's greatest asset is the ability to compare different universities and their development each year. However, seeing that it was adapted from the GRI, it has similar limitations.

The Auditing Instrument for Sustainability in Higher Education (AISHE) is based on a quality management model, developed by the European Foundation for Quality Management and reinforced by the Institute for Quality in the Netherlands (INK). The model was originally intended for commercial firms, in the industry, for instance (Roorda, 2001). The author explains that the model went through adaptations and, instead of approaching production-related matters, it developed questions for educational processes.

The AISHE consists of 24 criteria assessed over five development stages that employ the Deming Cycle. The "plan" section involves vision, policy, and internal environmental management; the "do" section approaches goals and teaching methodology, as well as curriculum-related matters; finally, the "check" section involves the assessment encompassing students, personnel, and society (Roorda, 2001).

Higher Education 21 (HE-21) is a program that started in 1997 with the purpose of spreading good sustainability practices in higher education. Focusing on continuous improvement, it enabled the development of indicators based on the triple bottom line (Weenen, 2000), that is, encompassing the environmental, social, and economic aspects of sustainability. Lozano (2006, p. 965) states that many of the indicators are not relevant for a campus, but the methods and approaches are useful nonetheless.

Among the tools developed specifically for HEIs, the Campus Sustainability Assessment Framework (CSAF) model stands out. It was designed to defend policies in the higher education sector, to compare sustainability performances employing a common methodology and a set of indicators, and to facilitate the communication and comprehension about sustainability among the faculty, staff, and students (Cole & Wright, 2005). Cole (2003) reports that the CSAF contains over 170 different indicators classified into ten main categories or dimensions: water, materials, air, energy, land, health and welfare, community, knowledge, governance, economy, and wealth.

"Launched in 2009, the Sustainability Tracking, Assessment and Rating (STARS) is a transparent self-report tool for colleges and universities" (Urbanski & Leal Filho, 2015, p. 210). According to the authors, the system measures sustainability performance in operations, administration, and curriculum through parameters. In 2014, it was employed to rate over 300 institutions.

The STARS model comprises not only long-term sustainability goals for institutions but also starting points for universities that are taking their first steps toward sustainability (Stars, 2014). It provides a structure for understanding sustainability in HEIs, allows for comparability, provides incentives for continuous improvement, strengthens sustainability on campuses, and spreads good sustainability practices (Urbanski & Leal Filho, 2015).

The STARS tool encompasses five prominent areas. The first area concerns scholars and approaches questions related to curriculum and research. The second area concerns the engagement of the public and campus. The third, named operations, seeks to assess the air, climate, energy, food services, buildings, transportation, waste, landscape, and water. The fourth area, named planning and management, concerns investments, planning, and governance. Finally, the last group addresses innovation.

Another model specifically developed for HEIs is the GreenMetric World University Ranking, created and managed by the University of Indonesia (UI). It ranks universities in terms of their sustainable actions, encompassing institutions both in developed and developing countries (Lauder et al., 2015). The tool comprises six thematic axes: Environment and Infrastructure, Energy and Climate Change, Waste, Water, Transportation, and Education. Until 2015, over 350 universities around the world were ranked by the model, providing each one with the opportunity of examining their strengths and weaknesses regarding sustainability (Suwartha & Sari, 2013).

Similarly to the Green Metric, the Green Report Card tool assesses, independently, sustainability activities on campuses of colleges and universities in the United States and Canada. Its goal is to provide accessible information to schools so that they may learn from experience and establish more effective sustainability policies (Green, 2015). The Green

Report Card was developed by the Sustainable Endowments Institute (SEI), a non-profit organization founded in 2005 in Cambridge, Massachusetts (Shi & Lai, 2003).

Overall, the Green Report Card has 52 indicators organized into nine categories. Contrarily to other models, it does not include teaching, research or other academic aspects concerning sustainability. It focuses on policies and practices in nine main categories: Management, Climate Change and Energy, Food and Recycling, Green Building, Student Engagement, Transportation, Transparency, Investment Priorities, and Shareholder Engagement (Green, 2015). “Regarding the indicators, their weakness is to emphasize only environment-oriented indicators, and some of them are based on qualitative definitions that are hard to assess” (Lukman et al., 2010, p. 622).

The Sustainability Assessment Questionnaire (SAQ) for colleges and universities is a qualitative questionnaire conceived to help them assess their sustainability level. It contains 25 questions divided into seven major areas: Curriculum, Investigation and Scholarships, Operations, Faculty and Staff Development and Rewards, Outreach and Services, Student Opportunities, and Institutional Mission, Structure and Planning.

The SAQ has the purpose of raising awareness and encouraging the debate about what sustainability means for higher education, checking the state of sustainability in a HEI to promote a discussion about its next steps (SAQ, 2015). “It is a good tool to generate discussion and report progress to the campus’s scholars and professionals” (Kamal & Asmuss, 2013, p. 455).

Having presented the bibliometric stage and the sustainability assessment tools employed in higher education institutions that stand out in the scientific literature, this work will now describe the principal axes of each model.

5 Analysis of Results

After surveying, reading, and analyzing the foremost sustainability assessment tools, it was possible to identify prevalent thematic axes among the models, which led to the development of an alternative chart of sustainability assessment for university operations.

The chart provides a glimpse of the principal thematic axes related to campus operations. Its purpose is to present the areas that stand out in the models, as shown in Chart 4.

Chart 4 - Principal areas approached by sustainable assessment models in HEIs

PRINCIPAL CATEGORIES	A	B	C	D	E	F	G	H
POLICY		X	X	X		X		
INNOVATION				X				
GOVERNANCE				X		X		
ETHICS AND INTEGRITY	X	X		X	X			
LAWS	X	X		X	X	X		
LETTERS AND PRINCIPLES					X		X	
HEALTH	X							
WORK HEALTH AND SAFETY	X		X	X	X			
GREEN PURCHASES						X		
GREEN INVESTMENTS		X		X				
FOOD						X		
ENVIRONMENTAL MANAGEMENT SYSTEM		X			X			
TEACHING	X	X	X	X			X	X
AIR	X	X	X	X	X			X
WATER	X	X	X	X	X	X	X	X
ENERGY	X	X	X	X	X	X	X	X
LAND	X							
HAZARDOUS WASTE			X		X			X
TRANSPORTATION				X		X	X	X
DINING HALLS		X		X				
GREEN BUILDINGS						X	X	
CIVIL CONSTRUCTION WASTE				X		X		
LIFE-CYCLE ANALYSIS				X				
BIODIVERSITY			X	X	X		X	

A- Campus Sustainability Assessment Framework (CSAF); B - Auditing Instrument for Sustainability in Higher Education (AISHE); C- CAMPUS ECOLOGY, D- Sustainability Tracking, Assessment and Rating (STARS); E- Global Reporting Initiative (GRI); F- Green Report Card, G - Sustainability Assessment Questionnaire (SAQ), H- GreenMetric.

Source: The authors.

The Global Report Initiative is not specifically designed for higher education. However, it contemplates similar aspects to specific tools, including ethics, legislation, water, energy, land, and waste. “Measures related to ecological use of resources (for instance, saving energy and water, reducing traffic, construction methods, or nature protection) are conducted on a volunteer basis” (Viebahn, 2002, p. 3).

Regarding ecological use of resources, Maistry and Annegam (2016) report the efforts of the University of Johannesburg, South Africa, to examine energy efficiency in HEIs, finding that the academic calendar has profound effects on energy consumption. Zen et al. (2016) describe studies on waste management and reduction conducted by the University of Technology Malaysia, while Sharma and Garg (2017) view vermicomposting as an eco-friendly alternative in recycling.

It is understandable to include criteria related to natural resources. Usually, HEIs consume significant amounts of resources and so they need to manage them (Velazques et al., 2013). The GRI is one of the best available tools to assess and generate sustainability reports for corporations; with modifications, it may help universities on their path toward sustainability (Lozano, 2006).

Heilmayr (2006) found that the GRI lacks adaptability in the unique setting of university campuses due to it not considering social and biophysical factors. Filling in this blank by adding new criteria or inserting indicators from other models in the literature, specifically for HEIs, is an approach that has been investigated by other authors (Fonseca et al., 2011; Pasinato & Brião, 2014).

The Campus Sustainability Assessment Framework (CSAF) has indicators inherent to operations like the GRI. The model lacks indicators related to transportation and fossil fuels. Moreover, Beringer (2006) observes that, due to its size, it could be unfeasible to apply the CSAF in a semester.

The models AISHE, Campus Ecology, STARS, and Green Report Card have indicators concerning university policies, which are essential to consolidate sustainability goals. “Even a few years ago, policies concerning sustainability-related initiatives were scarce in universities” (Velazquez et al., 2005, p. 388).

The STARS model has indicators concerning innovation and governance, which are required for the strategic management of operations. However, one inconvenience in the model is that it requires information from several interested parties in the entire campus” (Lidstone et al., 2015).

The GreenMetric tool lacks indicators of policies and goals for the university or even structures of university governance. The different missions and perspectives make it difficult to find indicators that are equally fair for all (Lauder et al., 2015). The authors also point out

that the ranking may not consider differences in mission, values and regionality, which leads to the indicators being unbalanced among HEIs.

The aforementioned models bring to light thematic axes of sustainability in service operations in higher education, as shown in Chart 5.

Chart 5 - Thematic axes for sustainability assessment in HEIs

Thematic axes for sustainability assessment in HEIs	
Governance and Policy	Transportation
Ethics and Integrity	Energy
Laws	Water
Teaching	Food
Purchases	Hazardous Waste

Source: The authors.

Similarly to the study of Shi & Lai (2013), this work identified key sustainability issues for HEIs, allowing for a flexible inclusion of relevant criteria for the university environment. Having identified the major areas of sustainability development in operations in HEIs, it is possible to develop conducive criteria for each one, which in turn may generate specific criteria for sectors like libraries, laboratories, dining halls and classrooms, benefitting the university.

6 Final Conclusions

This work's main purpose was to devise a conceptual framework composed of the foremost thematic axes in sustainability assessment models applied to higher education institutions, finding the following areas: governance and policy, ethics and integrity, laws, teaching, purchases, transportation, energy, water, food, and hazardous waste. Several models were analyzed in this review, from those created for the corporate environment at large like the Global Report Initiative and the ISO 14000 and their adaptations, like the GASU and Higher Education 21, to models specifically designed for higher education, such as the Auditing Instrument for Sustainability in Higher Education (AISHE), the Campus Sustainability Assessment Framework (CSAF), the Sustainability Assessment Questionnaire (SAQ), and the Sustainability Tracking, Assessment and Rating (STARS).

The identification of key sustainability issues for HEIs allows for the flexible inclusion of relevant indicators for the university environment. The alternative chart enables a performance comparison based on economic, environmental, and social perspectives. Social thematic axes include work health and safety, letters and principles, and ethics and integrity;

green building and investments, energy, and green purchases correspond to the economic perspective; finally, criteria such as air, water, land, waste, and biodiversity belong to the environmental scope.

The process of systematic literature review found the leading journals in the field: the International Journal of Sustainability in Higher Education and the Journal of Cleaner Production. Moreover, it identified the researchers Rodrigo Lozano, Tarah Wright and Michael Shriberg as the principal authors in the references of the articles selected and reviewed.

This research is limited to ascertaining the thematic areas that may develop criteria to assess service operations in HEIs. Future works may employ the thematic axes identified to obtain specific criteria and their applicability in HEIs.

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