Students' perception of campus sustainability in a Brazilian University

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***Abstract**: Over recent decades, higher education institutions (HEIs) have been recognized as ideal leaders in supporting the transition to sustainable societies. Leading by example they have been embarking upon committing themselves to sustainability by incorporating sustainable development practices (SDP) into their integrated management system. As a major stakeholders' group, students play a significant role in moving this agenda forward. This study aims to develop an assessment framework to evaluate the students' perception of campus sustainability, based on a Brazilian HEI case study. A survey was assembled using 5 demographic questions, 3 dichotomous questions, and 43 items resorting to a 1-5 Likert scale and administered to a sample of 207 undergraduate technology students. Through exploratory and confirmatory factor analysis a reliable scale emerges with 31 items grouped into eight dimensions: waste; emissions/procurement; energy; quality of life in the workplace; fauna and flora; institutional framework; education/research; and, water.. The dimensions explain 68.50% of the total model variance. The lowest-evaluated dimension was emissions/procurement, with 2.26 average value, followed by water (2.27) and energy (2.28), all this three were below the scale's midpoint. The best-evaluated dimension was education/research with an average of 3.30. This research provides insight into HEI students' sustainability perception and on how the university decision-makers may improve the sustainable practices to increase the students engagement.*

Introduction

The sustainability issues in HEIs have been attracting a progressively increasing level of consideration from managers and scholars. Hundreds of applicational case studies of sustainable practices in HEI and dozens of sustainable assessment tools (SAT) were created since the emergence of the environmental crisis reported in Stockholm 1972.

Until now, much relevant knowledge has been generated on the topic of the sustainable system and SAT for HEIs. However, HEI is a complex institution composed of several interdependent subsystems, therefore its sustainable improvement requires a holistic and integrated system and assessment measures to ensure its compliance with the established goals (Leal Filho, Doni, et al., 2019; Tim & Jutidamrongphan, 2018). Despite the vast literature produced concerning sustainability in higher education, it is still acknowledged the need for the development of integrated and holistic systems to manage HEIs' efforts in assuming their role in implementing sustainability. This claim is directed both to HEIs internal routines and, from a broader perspective, to a global movement towards a more sustainable society.

In the existing literature, more attention has been given to the development of objective assessment tools rather than human-centered ones that allow the generation of knowledge about the perception of individuals that make up an HEI, such as students, teachers, or staff. To date, no stakeholder perception study on the sustainability of HEIs has been identified that would consider the possibility of integrating their assessment tools with the sustainability dimensions already consolidated in the literature.

In order that HEIs successfully achieve the sustainability goals, the cooperation and participation from all stakeholders are critical, which includes staff, faculty, students, funding bodies, government, employers, suppliers and community (Green, 2013; Leal Filho, Shiel, et al., 2019; Sammalisto, Sundström, & Holm, 2015). Among all of them, students appear as one of the key stakeholders in universities, not only for their much bigger size and HEIs main target mission but also since there is empirical evidence that they have shown willingness to support and participate in university sustainable practices (Emanuel & Adams, 2011). Many authors notice the importance of placing students engaged in the university's sustainable practices as active agents of change, although also recognize that there is still a dearth of previous studies about students' perception of sustainability in HEIs (Blanco-Portela, R-Pertierra, Benayas, & Lozano, 2018).

Nejati and Nejati (2013, p. 102) support that understanding how students evaluate the sustainability practices implemented by HEIs is crucial as it allows the decision-maker to become aware of the HEI performance from the perspective of one of their major groups of stakeholders. For these authors “the study of students’ perceptions towards sustainability remains under-researched and needs to be further explored”.

Concerning the gaps previously discussed related to the shortage of tools to assess HEI sustainability relying on stakeholder’s perceptions, and the absence of assessment tools that support its integration with the quantitative indicators of HEIs sustainability established in the literature, this study has two main goals. The first intends to contribute to the literature by designing a sustainability assessment tool to assess the students' perception of the campus’s sustainability, based on a Brazilian HEI case study. The second aims to analyse the adherence of the designed tool to assess the key dimensions of sustainability proposed in the literature.

HEIs sustainability

Since Stockholm 1972 the Higher Education Institutions (HEI) have been adapting themselves to assume their social role in supporting societies in the promotion of sustainable lifestyles. From 2015, since the development of the New Sustainable Agenda, the Sustainable Development Goals (SDGs) have been established - an expansion of the eight Millennium Development Goals (MDGs), compounded by a set of actions grouped into 17 goals which aim to end poverty in all its forms by 2030 (Leal Filho, Shiel, et al., 2019). This new agenda turns the role of HEIs into a more meaningful and convoluted challenger related to conceiving more sustainable societies.

Bizerril et al. (2018) recognize HEIs as a strategic agent in promoting sustainability. This perspective takes into account different aspects, such as the fact that they are institutions that: promote innovation (Lozano, 2006b); play a relevant role in the education of leaders, teachers and professionals from different areas of society (Cortese, 2003); have been considered responsible to ensure that the curriculum taught prepare individuals for the sustainability challenges; and also take a leading role in promoting regional sustainable development (Karatzoglou, 2013).

Hopefully, the students will become individuals prepared to understand the complexities of sustainability and to convert the knowledge acquired into systemic, anticipatory and critical thinking and actions to implement environmental management systems that support the social change to a more sustainable living standard (Brandli, Frandoloso, & Tauchen, 2011; Sammalisto et al., 2015). To overcome their challenges in the promotion of sustainability HEIs should develop skills to reduce the environmental impact of their activities (Alshuwaikhat & Abubakar, 2008; Findler, Schönherr, Lozano, Reider, & Martinuzzi, 2019). Thus, according to Ceulemans, Molderez and Van Liedekerke (2015) university institutions, due to their specificities and importance, should be considered differently from other public or corporate institutions. To meet the expectations set out in the 2030 New Global Environmental Agenda, a lot of Universities have taken on the defiance of incorporating sustainable development practices into their education, research, internal management, and community engagement processes. Higher Education Institutions taking action in this direction are being usually designated as sustainable HEIs.

Conceptualizing the Sustainable University designation is not an easy task due to the variety and diversity of activities commonly undertaken in a university campus. Velazquez, Munguia, Platt, & Taddei (2006, p. 812) compiled empirical data from sustainable programs and actions carried out by about 80 universities around the world and defined a sustainable campus as "a higher education institution, as a whole or as a part, that addresses, involves and promotes, on a regional or a global level, the minimization of negative environmental, economic, societal, and health effects generated in the use of their resources in order to fulfill its functions of teaching, research, outreach and partnership, and stewardship in ways to help society make the transition to sustainable lifestyles". This definition is mainly restricted to the minimization of negative impacts already happening. As such, it tends to shorten HEI scope focusing on concrete and limited aspects, not addressing the proactivity in anticipating other effects and concerns related to the HEI complexity, the novelty of sustainability in this kind of institution and finally the new challenges related to sustainability issues that keep coming daily.

A definition that has been recurrently used, from Sterling, Maxey, and Luna (2013, p. 23), states that a sustainable university is one that "through its guiding ethos, outlook and aspirations, governance, research, curriculum, community links, campus management, monitoring, and modus operandi seeks explicitly to explore, develop, contribute to, embody and manifest – critically and reflexively – the kinds of values, concepts, and ideas, challenges and approaches that are emerging from the growing global sustainability discourse". This latter definition might be more appropriate since the authors perceive HEI from a much broader perspective. The HEIs' sustainability practices often extrapolate the boundaries of their geographical area, bringing benefits to their local, regional and sometimes national environment.

At the beginning of this century, the work of Cortese (2003) stated that the achievement of HEI sustainability is attained by considering the following four dimensions: education, research, campus operations and reporting. Later, Lozano (2006a) and Lozano et al (2015) complemented the model including three more dimensions: institutional framework, on-campus experience and outreach and, finally uniting the existing dimension reporting with the assessment practices. Table 1 details briefly each dimension of HEIs sustainability proposed by Lozano et al. (2015).

Table 1 - Dimensions of HEIs sustainability (adapted from Lozano et al. (2015)**)**

DIMENSION	DESCRIPTION

Education	It includes propositions related to the presence of sustainability themes in the course curriculum; the development of skills and teacher training programs. This dimension relates not only to the theme of sustainable HEIs but also to a much broader scope of knowledge which includes the central role that education plays in the science of sustainability and the promotion of SD.
Research	It is related to the existence of structures and financial support for the production of knowledge and technology and innovations in sustainability.
Campus operations	It addresses the presence of sustainability practices in the day-to-day management of HEI, including resource efficiency and management of water, energy, waste and greenhouse gases, transport and accessibility, as well as access to good quality food.
Institutional framework	It deals with the commitment of the higher management and the councils of the institution with sustainable development. It considers the presence of DS in policies, missions and other official institutional documents.
On-campus experience	It considers that working groups and other sustainable practices among students, teachers and staff are indicators of the daily presence of sustainability concerns in the academic community.
Outreach	It refers to actions related to the integration of the university with society, which includes other universities, governments, companies, schools, civil society organizations and the local community.
Assessment and reporting	It involves the implementation of an integrated environmental management system to monitor and control the environmental impacts of campus operations, processes and routines, as well as the internal and external dissemination of the results of this monitoring and the adoption of continuous improvement principles.

The model of Lozano et al. (2015), presented in Table 1, has been broadly cited by many authors because it captures the core facets of HEI sustainability and, as shown later, its adherence to SAT was empirically tested.

Sustainability Assessment Tools in HEIs

To endorse the effectiveness of HEIs sustainability practices various Sustainability Assessment Tools (SAT) were created and are considered a crucial element to enable the path towards sustainability. They support the HEIs decision-makers on the improvement of their plans and policies toward a sustainable higher education institution and make it possible to publish the sustainability reporting of HEIs (Berzosa, Bernaldo, & Fernández-Sanchez, 2017).

The work of Lambrechts (2015), which provides an overview of existing sustainability assessment tools, identifies the SAT contribution to the HEIs sustainability process highlighted as threefold. According to this work SATs usually contribute to 1) policy development; 2) to mainstreaming sustainable development in higher education, and finally, 3) to improve transparency and communication.

Fischer et al. (2015) studied 12 sustainability assessment tools in HEIs to analyze the understandings of a sustainable university that are underpinning contemporary sustainability assessment tools. Their research findings showed that these SATs comprised at least three different monitoring purposes, from affording compliance to predetermined standards, to

determine the state of internal processes, and to provide data for competitive performance comparisons. Several other authors carried out also comparative SATs analysis.

Yarime and Tanaka, (2012) used a mixed-method approach and analyzed 12 SATs, and the results showed that most tools indicators were focused on operations (44%), governance (39%) and education (8%). Berzosa et al. (2017) applied simultaneously 3 SATs to compare on real case study, namely to assess the sustainability of the Universidad Europea de Madrid (UEM) in Spain. The authors analyzed advantages and differences between tools and concluded that it may be feasible to use more than one tool for diagnosis and planning. In another study by Asmuss & Kamal (2013) four tools were reviewed to select the best benchmarking tool for the purposes of the University of Saskatchewan (UofS) in Canada. This work considered the following five areas of campus life: education, operation, governance, research and community engagement. After analyzing the strengths and weaknesses of each of the following tools: Sustainability Assessment Questionnaire (SAQ), the Campus Sustainability Assessment Framework (CSAF), the College of Sustainability Report Card (CSRC), and the Sustainability Tracking Assessment and Rating System (STARS), the last one was chosen. STARS was considered by the authors the best benchmarking tool to satisfy the UofS needs for assessing sustainability in all designated areas of campus life – education, research, operations, governance and community engagement.

Finally in the work carried out by Findler et al. (2018), it was analyzed to what extent SATs are capable of measuring the impact that HEIs have on sustainable development. To achieve the purpose of their study, the authors performed the analysis of 19 SATs and 1,134 indicators for sustainability assessment. According to the adopted methodology, each indicator was exclusively assigned to one of the Lozano et al. (2015) sustainable development dimension. Those indicators related to administrative structure and broad-scale policies were assigned to the institutional framework, while indicators addressing assessment and reporting processes were categorized into the "assessment and reporting" dimension. Further, indicators related to the HEIs on an institutional level were related to the new category "higher education institution (HEI)", such as demographic effects on the region through student in-migration. The column "not applicable (NA)" included those that did not fit in any of the other dimension of the Lozano et al. (2015) model. Table 2 presents these SAT and its relation to the seven Lozano et al. (2015) sustainable development dimensions and, also the new categories, HEI and NA as proposed by Findler et al. (2018).

Table 2 - Adherence between Lozano et al. (2015) sustainability dimensions and SAT

Sustainability Assessment tools (SATs)	Institutional Framework	Education	Research	Outreach	Campus Operations	Campus Experiences	Assessment & Reporting	HEI	NA
AISHE[1], AMAS[2], BSIS[3], CSA[4], CSAF[5], D-SiM[6], DUK[7], GASU[8], GMID[9], P&P[10], PENN[11], SAQ[12], SCE[13], SPT[14], STARS[15], STAUNCH®,[16] TUR[17], UIGM[18], USAT[19]									

[1]Auditing Instrument for Sustainability in Higher Education; [2]Adaptable Model for Assessing Sustainability in Higher Education; [3]Business School Impact System; [4]Campus Sustainability Assessment Review Project; [5]Campus Sustainability Assessment Framework; [6]Driving force-pressure-state-exposure-effect-action; [7]Deutsche UNESCO Kommission; [8]Graphical Assessment of Sustainability in Universities; [9]Graz Model of Integrative Development; [10]People and Planet's University League; [11]Penn State Indicators Report; [12]Sustainability Assessment Questionnaire; [13]State of the Campus Environment; [14]Sustainable Pathways Toolkit; [15]Sustainability Tracking, Assessment and Rating System; [16]Sustainability Tool for Auditing for University Curricula in Higher-Education; [17]Three-dimensional University Ranking; [18]UI GreenMetric World University Ranking; [19]Unit-based Sustainability Assessment Tool
Source: adapted from Findler et al. (2018).

According to Table 2, the dimension with the highest number of indicators is Campus Operation, followed by Institutional Framework (20.9%), Education (16.04%) and Research (7.85%). The results are in line with the works of Fischer et al. (2015). The study of Findler et al. (2018) is particularly relevant because it highlights the possibility of a relationship between the sustainability indicators of the 19 studied SATs with the key dimensions of the sustainability proposed in the Lozano et al. (2015) model (Table 1).

Much of the attention of sustainability research focusing on HEIs has been directed towards the dimensions of education and research. Moreover, considerable attention has been given to isolated aspects of the campus sustainability operations dimension, such as green building (Hopkins, 2016), waste (Zen et al., 2016) and carbon emission (Altan, 2010; Larsen, Pettersen, Solli, & Hertwich, 2013; Ramos et al., 2015). Nejati and Nejati (2013, p. 102) asserts that "sustainability practices within the academic setting need to be understood and practiced by all members of the organization at various levels. Only then can a collective force for achieving the sustainability mission be mobilized successfully".

While literature concerned with Sustainable Assessment Tools (SAT) in HEI recognize that most of those are focused on inside impacts, authors like Findler et al. (2019) and Beynaghi et al. (2016) have noticed that HEI sustainable development efforts have an effect that reflects beyond its organizational boundaries. The HEI SD impacts might emerge from a variety of contrasting areas such as economy, societal challenges, natural environment, policy making, culture, and demographics (Findler et al., 2018).

Students' perception of sustainable HEIs

Although tools that use perception measurement to assess sustainability in HEIs differ from traditional ones, which often use objective measurement variables such as energy consumption in kWh, water consumption in m3, tons of selective waste collection, among others, they contribute to a better understanding of HEIs sustainability. The SAT performed by the subjective approach of assessing service users' perceptions of their sustainability effectiveness may complement a more holistic perspective, by bringing new insights to the assessment process. As a complementary approach, it would concur to a better understanding of HEIs effort to become more sustainable.

The use of subjective tools to measure sustainability in HEIs may induce an improvement of social control in managing the HEIs system, which is a gain in terms of governance, and, in addition, would improve the students' engagement, as key stakeholders, to achieving the institution's sustainability goals.

Description of the Study Areas and Methodology

Case study

The Federal University of Paraíba is a national public university located at the Northeast of Brazil. It is the biggest of the Paraíba State. It has 127 undergraduate and 111 postgraduate courses that enroll 38,880 students. For this study, the sample was composed of students from two of the 16 HEI study centers, namely the Technology Center and the Renewable Energy Center. These two centers comprise most of the engineering courses offered by the HEI.

Research Methods - Scale design

In line with Malhotra, Nunan, and Birks (2018, p. 378) methodological proposal, a new multi-item quantitative tool was designed to measure students' perception of HEIs, following the steps shown on Figure 1.

Step 1: Extensive literature review →	Identify the main dimensions of HEIs sustainability; Item generation (40 items).
Step 2: Survey design and pre-validation →	Final questionnaire survey (40 items and 10 variables); Pilot-test with a reduced sample of undergraduate students.
Step 3: Data collection →	Survey administration to a sample of technology undergraduate students (207 questionnaires were administered)
Step 4: Data analysis →	Item extraction through principal component analysis; Reliability analysis through Cronbach's Alpha and validity analysis (composite reliability, convergent and discriminant validity); Gender, income and education impact on sustainability perception through T-test/Anova.

Figure 1 - Questionnaire development and validation process

The first step encompassed an extensive literature review to identify the main dimensions of sustainability in Higher Education Institutions. As presented in the introduction session the sustainability of HEI is composed of the seven following dimensions: 1) Education; 2) Research; 3) Campus Operations; 4) Institutional Framework; 5) On-campus Experience; 6) Outreach; and, 7) Assessment and Reporting. 43 items were generated through literature review, based on the works of Findler et al. (2019), Emanuel and Adams (2011), Lozano (2006a), Lozano and Young (2013), Nejati and Nejati (2013), Luiz, Pfitscher and Rosa (2015), Savelyeva and Douglas (2017) and Thomashow (2014).

Once the set of items derived from the literature review was identified, the next step was the design of a final questionnaire comprising 51 items of which 5 were demographic (course, age, gender, income, education); 3 dichotomous questions to measure student connexon with sustainability in the course; and the 43 items identified on step 1. For the 43 multi-item scale responses were provided using a five-point Likert-type scale from (1) strongly disagree to (5) strongly agree with a (3) neutral response option. Thus, the survey was refined through a pilot-test applying it to a reduced sample of 12 individuals to evaluate the following criteria: (a) assess respondent's reaction and understanding of the items and variable allocated on the questionnaire; (b) obtain feedback with regard to content, length, arrangement, wording accuracy and relevance. As a result of this phase, two items were rewritten to improve wording accuracy.

In the 3rd step, the final questionnaire was administered by a structured and assisted survey to a sample of 207 undergraduate students of 12 courses of engineering provided by the case study Brazilian university.

Table 3 Demographic profile of respondents

Demographics	Frequency	Percentage (%)
Gender (Valid N= 207)		
Male	138	66.7
Female	69	33.3
Age (N= 207)		
Below 20 years old	29	14
20 – 22 years old	77	37.2
23 – 25 years old	71	34.3
26 – 28 years old	18	8.7
Over 28 years old	12	5.8
Monthly Familiar Income (N= 184)		
Lowest thru 500€	90	43.5
500€ thru 999€	50	24.2
1000€ thru 1499€	30	14.5
1500€ thru 2000€	14	6.8
Over 2000€	23	11.1
Course (Valid N = 202)		
Industrial Mechanical Engineering	27	13.4
Mechanical Engineering	30	14.9
Renewable Energy Engineering	35	17.3
Environmental Engineering	34	16.8
Civil Engineering	20	9.9
Industrial Engineering	19	9.4
Industrial Chemistry	5	2.5
Chemical Engineering	15	7.4
Electrical Engineering	14	6.9
Food Engineering	2	1.0
Materials Engineering	1	.5

After data collection, a statistical analysis of the results was conducted in step 4. In this phase, as will be demonstrated in the results section, other items were discarded due to their lack of statistical adherence to the proposed tool. Finally, the methods adopted present some limitations. For instance, the sample size and composition, although allowing the analyses performed, limit the possibility of generalizing the results to other HEIs and to students other than engineering; the survey was designed to be comprehensive for the majority of respondents, however it may be challenging for some respondents to have enough knowledge about all topics addressed in the survey.

Results and Discussion

Principal Component Analysis

For grouping the items into their specific dimensions, the principal component analysis (PCA) was performed on the 43 items of the scale. To assess the factorability of the data and ensure the adequacy of the sampling, Bartlett's Test of Sphericity and the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy were applied. The Bartlett's Test of Sphericity analyses if the correlation matrix has significant correlations among at least some of the variables and should be significant ($p < 0.05$) for the PCA to be considered appropriate (Field, 2009; Hair, Black, Babin, & Anderson, 2014; Nejati & Nejati, 2013). The KMO corresponds to a measure of sampling adequacy (MSA) that looks not only at the correlations but also at patterns between variables. It ranges from 1 to 0 and its accepted values are equal to or above 0.6 (Hair et al., 2014). Further, the component loadings were analyzed. Based on sample size, a loading of 0.6 or greater on one component was considered significant (Hair et al., 2014). The values ranging from 0.609 to 0.850, as shown on the 4th column of Table 5, were considered achieving the accepted threshold. To solve the cross-loading issues the criteria adopted by Nejati & Nejati (2013) was used, whereby items having a loading difference across components less than 0.10 were removed.

The final model was composed of 30 items, grouped into 8 components with eigenvalues higher than 1, explaining 68.504% of the variance. The 30 items model obtained a significant Bartlett's Test of Sphericity ($p \approx 0.000$) and also collectively meets the necessary threshold of sampling adequacy, measured through KMO, with an MSA value of .860. The individual MSA of each item was also measured and it ranged from 0.709 to 0.933.

Table 4 Rotated component loading matrix (VARIMAX)

Sum of squares
(eigenvalues)
% of trace
Cumulative % of
trace

The items included in each component were considered, relating to the literature, and labeled as: 1- Waste (6 items), 2 - Emissions/procurement (3 items), 3 - Energy (4 items), 4 - Quality of Life in the Workplace (4 items), 5 - Fauna and Flora (4 items), 6 - Institutional Framework (4 items), 7 - Education/Research (3 items) and, 8 - Water (2 items). The eigenvalue percentage of the trace of each component is presented in Table 4.

Table 5 Descriptive statistics, loadings (VARIMAX), reliability and validity tests of constructs

ITEM

COMPONENT 1: WASTE

The implemented composting system is efficient (39)
UFPB encourages, through campaigns, the correct disposal of its waste
(36)
UFPB has an efficient selective waste collection program (35)
UFPB performs proper disposal of its chemical waste (37)
UFPB promotes reverse logistics of cartridges and toners used by the
Institution (38)
Recycling bins scattered around campus motivate students to discard

waste properly (40)

COMPONENT 2: EMISSIONS/PROCUREMENT

UFPB prioritizes the use of biofuels in its vehicle fleet

UFPB monitors greenhouse gas emissions from its fleet

UFPB has procedures to optimize the use of its vehicle fleet

UFPB cleaning, safety and telephone contracts take into account sustainability issues

COMPONENT 3: ENERGY

UFPB invests in renewable energy generation strategies

UFPB embraces energy efficiency principles by replacing LED lighting

UFPB adopts practices committed to reducing non-renewable energy use

UFPB promotes campaigns to rationalize the use of electricity

COMPONENT 4: QUALITY OF LIFE IN THE WP[e]

UFPB encourages respectful treatment among students

UFPB encourages respectful treatment between students and lecturers

The UFPB workload required for course activities are adequate

My rights as a student are respected

COMPONENT 5: FAUNA AND FLORA (FF)

UFPB performs proper wildlife management on its campuses

UFPB takes care of its forest areas

UFPB performs the correct management of domestic fauna on its campuses

The institution complies with environmental legislation

COMPONENT 6: INSTITUTIONAL FRAMEWORK

UFPB's portal and social media detail the institution's sustainability initiatives

UFPB has a specific sector to address the environmental issues of its campuses

Overall, sustainability issues are adequately addressed at UFPB

Important decisions related to campus sustainability are made in a participatory manner on university councils

COMPONENT 7: EDUCATION/RESEARCH

The course offers institutional research and extension programs with themes related to sustainability

The institution's postgraduate programs related to my field of study offer sustainability-themed lines of research

The Course offers enough sustainability subjects for my education

COMPONENT 8: WATER

The drinking water distributed by UFPB is of high quality

UFPB has a good drinking water supply

Overall score for Student Perception of HEI's Sustainability (SPHEIS)*

[a]SD: Standard Deviation; [b]CR: Composite Reliability; [c]AVE: Average Variance Extracted; [d]α: Cronbach's alpha; [e]WP: WORKPLACE

* Average value obtained from scores of the items included in each category

Reliability and validity analysis

To assess reliability, Cronbach's alpha was computed for each subscale. A commonly accepted rule of thumb for describing the internal consistency calculated by Cronbach's alpha is as follow: $\alpha \geq 0.9$: excellent; $0.7 \leq \alpha < 0.9$: Good; $0.6 \leq \alpha < 0.7$: Acceptable; $0.5 \leq \alpha < 0.6$: Poor; $\alpha < 0.5$: unacceptable (Hair et al., 2014; Jorge, Madueño, Cejas, & Peña, 2015). As shown in the last column of Table 5 values of Cronbach's alpha (α), for each component range between acceptable and good.

Finally, to ensure the quality of measurement the composite reliability, convergent validity and discriminant validity were also tested. Composite reliability (CR) is a robust measure of internal consistency in scale items (Byrne, 2016). Thresholds for composite reliability is above 0.60 to authors like Fornell and Larcker (1981). The values of CR, shown in Table 5, exceeds the limits established in the literature. The average variance extracted (AVE) for each component surpass the recommended level of 0.5 (Hair et al., 2014), thus, it is possible to conclude that convergent validity was achieved.

Table 6 summarizes the measured coefficients for discriminant validity. The diagonal elements, in bold, are the square root of the average variance extracted (AVE). Off-diagonal elements are the correlation among components. To examine discriminant validity, diagonal elements should be larger than off-diagonal elements (Nejati & Nejati, 2013).

Table 6 - Discriminant validity coefficients

Component
C1 - Waste
C2 - Emissions/Procurement
C3 - Energy
C4 -Quality of Life in the Workplace
C5 - Fauna and Flora
C6 - Institutional Framework
C7 - Education/Research
C8 - Water

Gender, secondary education and income analysis

Despite the gender difference between male (66.7%) and female (33.3%) in the number of inquired students, the test T results show that there isn't statistical evidence to confirm gender influence on the perception of campus sustainability ($t(205)=0.297$; $p=0.767$), with male mean equals to 2.67 and female 2.65. This result is in line with the work carried out by (Meek & Sullivan, 2018) which developed a new measure of sustainability orientation among entrepreneurs. Further, the gender result is similar to the study carried out by Dagiliūtė, Liobikienė, & Minelgaitė (2018) that compared students' attitude towards sustainability in two Lithuanian universities. Although the study of Zhang, Liu, Wen, & Chen (2017) found that gender is influential on sustainable perception, using a sample of 509 undergraduate students from 10 university campus in Beijing, China, we could not find evidence of gender differences on perception towards sustainability for the case of these Brazilian students.

Similarly to the gender result, no statistical evidence was found to assert that secondary education in public (mean 2.71) or private (mean 2.62) schools influence the perception of sustainability of the surveyed sample ($t(203) = -0.240$; $p=0.216$). Lastly, there was also no statistically significant difference regarding income as a predictor of the perception of

sustainability (F(3;180) = -0.127; p=0.944). This result regarding income is congruent with the work of Bosona & Gebresenbet (2018).

Model performance and sustainability perception for the case study

As a result of the principal component analysis, the thirty-one remaining items of the final model (Table 5) are related to five of the eight dimensions of the higher education sustainability model designed by Lozano et al. (2015), described in Table 1.

The components C1 – Waste, C2 – Emissions/Procurement, C3 – Energy, C5 – Fauna and flora and C8 – Water, are congruent with the dimension Campus Operation. The component C4 – Quality of life in the workplace has similarities with the dimension On-campus experience; likewise the component C6 – Institutional framework is consistent with the analogous Lozano dimension. Component 7 (education/research) has items compatible with the dimensions Education and Research on Lozano model. The items related to the dimension Outreach and Assessment report did not stand in the refinement phase of principal component analysis. The adherence between the performance of the Student perception of HEI's Sustainability (coined now as SPHEIS), which is the proposed model, and the one designed by Lozano et al. (2015) is illustrated on Figure 2.

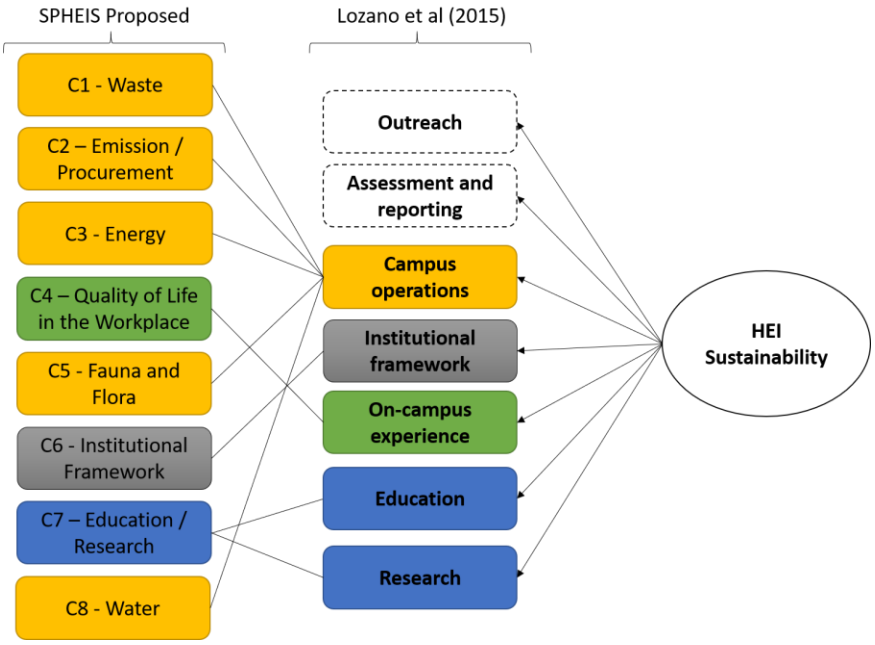

Figure 2 - Adherence between the proposed model SPHEIS and Lozano et al. (2015)'s model

Results of the analysis indicate the following: first, five components obtained average scores above the midpoint of the scale (mean = 2.5). These are: C1 - Waste (mean = 2.52); C4 - Quality of life in the workplace (QLW) (mean = 2.86); C5 - Fauna and flora (mean = 2.82); C6 - Institutional Framework (mean = 2.82); and C7 - Education / Research, which had the highest score obtaining mean equal to 3.30. In contrast, the three following components achieved scores below the midpoint of the scale: C2 - Emissions / procurement which obtained the lowest score, with mean equal to 2.26, C3 - Energy (mean = 2.28); followed by C8 - Water (mean = 2.27); second, students' overall perception of campus sustainability was weak to moderate, with a score of 2.67 (SD=0.56), as shown in Figure 3.

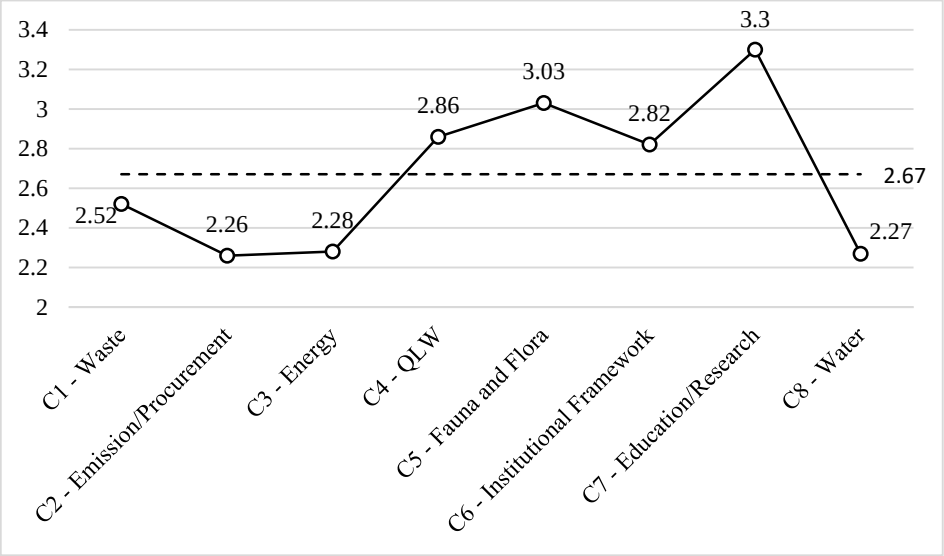

Figure 3 - Score of the Student perception of HEI's Sustainability (SPHEIS) in each component

This low score obtained in the assessment of the sustainability performance perceived by the surveyed students needs to be considered through the analysis of each of the items that make up the developed scale, by those responsible for the implementation of sustainability practices. In this way, it will be possible to conclude whether the results are due to low investment in some sustainability practices implemented by the institution or if it is due to the lack of communication channels between the Institution and its students that would allow the latter to become aware of institutional efforts towards sustainability.

Conclusion and recommendation

This section offers a concise and comprehensive conclusion of the study's findings. This study was carried out to achieve two main objectives. The first objective was to contribute to the literature by designing a sustainable assessment tool to assess the students' perception of HEI campus's sustainability, based on a Brazilian HEI case study. This objective was achieved through the development and application of a multi-scale survey composed of 31 items grouped into eight components that cover the main aspects of campus sustainability as perceived by students. The validation procedure adopted statistical measures to ensure results consistency and therefore acceptable statistics scores that demonstrate a valid and reliable tool. The proposed instrument would work as a complementary tool to assess HEIs sustainability performance and assist managers in improving their efforts to increase the students commitment to building a sustainable HEI able to face and accomplish the new society requirements towards sustainable development. Taking into account the performance obtained through the collected data it may exist a gap between the implementation of sustainable practices and their perception by the students. This gap may be overcome with an effort for improving communication towards sustainability practices by using the available social media channels to inform about achievements pertinent to sustainable development on Campus.

The second objective of the study intended to evaluate the adherence of the proposed tool, Student Perception of HEI's Sustainability (SPHEIS), in relation to the dimensions of HEI sustainability designed by Lozano et al. (2015). The proposed tool was partially adherent to the

Lozano et al. (2015) model once the eight components of the SPHEIS were related to five dimensions of the Lozano et al. (2015) model. In fact, 5 of the 8 components were found adherent to the Campus operation dimension which is in line with the work of Findler et al. (2018), who analyzed 19 SATs and concluded also the analyzed tools include more items focused on Campus operation. Table 2 showed that the highest amount of the analyzed items, 34.48%, were grouped into this dimension. A justification for the dimensions Outreach and Assessment and Reporting not being considered in the proposed SPHEIS model would be that these two dimensions tend to be less perceived by the students, since usually students are more focused on activities related to campus operation, education and research.

Considering the results, implications and recommendations could be designed for university planners and decision-makers to increase sustainability in HEIs and correlated institutions. As an illustration a few of them are presented below. (1) Future studies may expand the sample and include more items, such as those related to assessment and reporting as well as outreach, in order to comply with all dimensions of HEIs sustainability and provide results that are more representative. (2) Another research may examine the validity of the introduced assessment tool in another regional context. (3) The assessment tool may be adapted to other correlated institutions, like hospitals or secondary schools, to measure customer/users perception of sustainability. (4) Besides, due to time limitations, this study was applied in a cross-sectional approach, therefore it is suggested for future research to adopt a longitudinal approach as a way to control the sustainability performance and implement the principles of continuous improvement.