Universidade do Minho
Escola de Engenharia

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Integration, Monitoring, and Assessment of Sustainability in Higher Education Institutions

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Doctoral Thesis
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Work performed under the supervision of
Professor Paula Varandas Ferreira
Professor Maria Madalena Araújo

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Statement of Integrity

I hereby declare having conducted this academic work with integrity. I confirm that I have not used plagiarism or any form of excessive use of information or falsification of results along the process leading to its elaboration.

I further declare that I have fully acknowledged the Code of Ethical Conduct of the University of Minho.

Integration, Monitoring, and Assessment of Sustainability in Higher Education Institutions

Abstract

Since the onset of the environmental crisis, global education systems have been tasked with devising alternatives that align more effectively with ecological limits. Consequently, Higher Education Institutions (HEI) worldwide have assumed leadership roles to inspire and expedite societal transformation. They have integrated sustainable development initiatives (SDI) into their strategies, systems, processes, and routines while participating in networks of sustainable HEI. However, this continuous process encounters notable challenges and barriers. The government has instituted intricate regulations in Brazil to guide public institutions in standardising their integration. Brazilian federal public HEI have grappled with meeting these legal requirements. In light of this context, this PhD research aims to establish a comprehensive framework supporting action plans for integrating, monitoring, assessing, and reporting sustainability in Brazilian federal public HEI. The framework, rooted in a complex adaptive system and a deductive approach to modelling a solution, was validated through a typical case study— the Federal University of Paraíba. The cross-sectional study utilised a mixed-method approach, encompassing a literature critical review, interviews, desk research, and direct observation to gather data. Strategies for analysing the collected data included a systematic literature review, content analysis, descriptive statistics, and process and mathematical modelling. This investigation contributes significantly to existing literature, providing a comprehensive and critical assessment of HEI commitments to SDI, along with the models and tools used for fulfilment and efficacy evaluation. Broadly, the study offers valuable insights into the practical implementation of a holistic approach to integrating SDI within HEI. Furthermore, it proposes a systematic methodology, the Framework to Integrate, Monitor, Assess, and Report Sustainability in HEI (FIMARSHEI), designed to aid Brazilian federal public HEI in effectively integrating SDI into their policies and practices. Beyond the specific case study, the significance of this work lies in the adaptability and expansiveness of the proposed framework, applicable to various institution types. Thus, this research makes meaningful contributions to the scientific community by providing insights on developing and implementing a comprehensive approach to incorporating SDI in diverse educational settings.

Keywords: Brazil; Higher Education Institutions Sustainability; Holistic Approach to Sustainability; Sustainability assessment; Sustainable Development Integration.

Integração, Monitoramento e Avaliação da Sustentabilidade em Instituições de Ensino Superior

Resumo

Desde o início da crise ambiental, os sistemas globais de educação foram encarregados de elaborar alternativas alinhadas aos limites ecológicos. Instituições de Ensino Superior (IES) assumiram papéis de liderança para inspirar e acelerar a transformação societal, integrando iniciativas de desenvolvimento sustentável (IDS) em suas estratégias, sistemas, processos e rotinas, participando também de redes de IES sustentáveis. No entanto, esse processo contínuo enfrenta desafios notáveis. No Brasil, o governo instituiu regulamentações para orientar instituições públicas na integração, representando um desafio substancial para as IES na região. Diante desse contexto, esta pesquisa de doutorado visa desenvolver um *framework* que apoie planos de ação para integrar, monitorar, avaliar e relatar a sustentabilidade nas IES federais públicas brasileiras. O *framework*, fundamentado em sistemas adaptativos complexos e na abordagem dedutiva, modelou uma solução validada por meio de um estudo de caso típico - a Universidade Federal da Paraíba. O estudo transversal utilizou métodos mistos, incluindo revisão crítica da literatura, entrevistas, *desk research* e observação direta para coletar dados. Estratégias para analisar os dados incluíram revisão sistemática da literatura, análise de conteúdo, estatísticas descritivas e modelagem matemática e de processos. Esta pesquisa contribui significativamente para a literatura, oferecendo uma avaliação abrangente e crítica dos compromissos das IES em incorporar IDS, juntamente com os modelos e ferramentas usados para o cumprimento e avaliação de eficácia. O estudo oferece insights valiosos sobre a implementação prática de abordagem holística para integrar IDS nas IES, propondo uma metodologia sistemática, o *Framework to Integrate, Monitor, Assess, and Report Sustainability in HEI* (FIMARSHEI), para auxiliar as IES federais públicas brasileiras na integração de IDS. A importância deste trabalho reside na adaptabilidade e abrangência do *framework* proposto. Assim, esta pesquisa oferece contribuições e insights significativos à comunidade científica, sobre como desenvolver e implementar uma abordagem abrangente para incorporar IDS em diversos ambientes educacionais.

Palavras-chave: Abordagem Holística para a Sustentabilidade; Avaliação da Sustentabilidade; Brasil; Integração do Desenvolvimento Sustentável; Sustentabilidade de Instituições de Educação Superior.

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List of Acronyms

Acronym	Description
AISHE	Assessment Instrument for Sustainability in Higher Education
AMAS	Adaptable Model for Assessing Sustainability in Higher Education
BIC-AUA	Benchmarking Indicators Questions – Alternative University Appraisal
BPMN	Business Process Management Notation
CAPES	Coordination for the Improvement of Higher-Level Personnel (CAPES in Portuguese)
CAS	Complex Adaptive Systems
CERES	Coalition for Environmentally Responsible Economies
CGE	Conférence des Grandes Ecoles
CI	Composite indices
CISAP	Interministerial Commission for Sustainability in Public Administration (CISAP in Portuguese)
CMPN	Committee on Management Procurement Network
CNPq	National Council for Scientific and Technological Development (CNPq in Portuguese)
CONSUNI	Superior University Council (CONSUNI in Portuguese)
CPU	Conférence des Présidents d'Université
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DESD	UN Decade of Education for Sustainable Development
EE	Environmental Education
EEA	European Environment Agency
EMC	Environmental Management Committee
EMS	Environmental Management System
ESD	Education for Sustainable Development
FAPESQ	Foundation for the Support of Research in the State of Paraíba (FAPESQ in Portuguese)
FCCC	Framework Convention on Climate Change
FFD	Fossil Fuels Divestment
FIMARSHEI	Framework to Integrate, Monitor, Assess and Report Sustainability in HEI
FINEP	Financier of Studies and Projects (FINEP in Portuguese)

GASU	Graphical Assessment of Sustainability in University
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GMEF	Global Monitoring and Evaluation Framework
GPI	Global Performance Indicators
GPP	Green Public Procurement
GRI	Global Reporting Initiative
HEI	Higher Education Institutions
IDP	Institutional Development Plan
INEP	National Institute of Educational Studies and Research Anísio Teixeira (INEP in Portuguese)
IS	Infrastructure Superintendence
JIF	Journal Impact Factor
LabESC	Laboratory of Engineering Sustainability and Consumption (LabESC in Portuguese)
LEDC	Less economically developed countries
MAF	MDG Acceleration Framework
MDGs	Millennium Development Goals
MEDCs	More economically developed countries
MPOG	Brazilian Ministry of Planning, Budget and Management
NI10, 12/11/12	Normative Instruction No. 10, of 12 November 2012
NSERC	Natural Sciences and Engineering Research Council
PNEA	National Environmental Education Policy (PNEA, in Portuguese)
PNMA	National Environmental Policy (PNMA, in Portuguese)
PRODEMA	Environmental Postgraduate Program (PRODEMA in Portuguese)
SAF	System Approach Framework
SAQ	Sustainability Assessment Questionnaire
SAT	Sustainability Assement Tools
SCAS	Sustainability Campus Assessment Systems
SD	Sustainable Development
SDI	Sustainable Development Initiatives
SINAES	National System for Higher Education Evaluation

SLMP	Sustainable Logistic Management Plans
SOP	Standard Operating Procedures
SPP	Sustainable Procurement Practices
SR	Sustainability Reporting
SSHRC	Social Science and Humanities Research Council
STARS	Sustainability Tracking Assessment and Rating System
SUM	Sustainable University Model
UEMS	University Environmental Management System
UEPB	Universidade Estadual da Paraíba
UFPB	Universidade Federal da Paraíba
UIGM	UI Green Metrics
UKKI	UK Research and Innovation
UKRI	UK Research and Innovation
ULSF	University Leaders for a Sustainable Future
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNCT	UN Country Teams
UNEP	UN Environmental Programme
WOS	Web of Science Core Collection
WSSD	World Summit on Sustainable Development

Part 1

The first part of this doctoral work constitutes a significant contribution to sustainable development in higher education. It comprises four chapters that explore the critical aspects of the research topic and lay the foundation for the subsequent empirical investigation. Chapter 1 introduces the study and sets the stage by providing a comprehensive overview of the research problem, questions, and the rationale behind the study. This chapter also offers a clear roadmap for the entire thesis, highlighting the key themes and ideas explored in subsequent chapters.

Chapters 2 and 3 delve into the literature review of sustainable development in higher education institutions (HEI). The two chapters present a detailed analysis of the existing literature in the field, aiming to identify gaps in the literature, theoretical frameworks, and conceptual models for integrating sustainable development into HEI. Chapter 2 examines the leading management models for integrating sustainable development into HEI and explores the best practices and strategies for promoting sustainable development in higher education. Chapter 3 explores the various sustainability assessment tools (SAT) used to evaluate HEI performance and presents a detailed analysis of the strengths and weaknesses of these tools.

The method chapter is the final chapter in this part of the thesis and outlines the research design, methodology, and methods employed in the study. This chapter guides the research process and provides a detailed description of the steps taken to address the research questions and achieve the research objectives. It explains the research methods, including data collection techniques, data analysis methods, and the criteria for selecting study participants.

In summary, the first part of this doctoral work provides a comprehensive review of the existing literature on sustainable development in higher education, examines the leading management models and sustainability assessment tools, and outlines the research design, methodology, and methods employed in the study. The subsequent empirical investigation aims to provide an in-depth analysis of the evolution of implementing sustainable development initiatives in Brazilian federal public higher education institutions and provide a conceptual model as a starting point to forge a framework to support the selection, collection, and analysis of indicators that enable the integration, monitoring, assessment, and reporting of sustainability in Brazilian federal public HEI.

Chapter 1. Introduction

Since the emergence of the environmental crisis, global higher education systems have been called upon to assist society in devising alternatives better aligned with ecosystemic limits (Miller & Spoolman, 2017).

The integration of sustainability into HEI can be traced back to the 1972 Stockholm Conference when HEIs began to commit themselves to facilitating social transformation towards more sustainable styles (Lopes & Vieira, 2021). Over the past five decades, significant progress has been made in developing technologies to mitigate systemic imbalances. However, much more work remains to attain the Sustainable Development Goals.

Many authors, such as Baker-Shelley et al. (Baker-Shelley et al., 2017), Farinha et al. (2019), Leal Filho (2011), Lozano et al. (2013), Lozano & Barreiro-Gen (2019), and Son-Turan & Lambrechts (2019) acknowledge that HEI has been impelled to assume the profound and unprecedented duty of acting as leaders to inspire and accelerate the societal transformation that will enable humanity to tackle the global sustainability crisis.

The leading role was formally taken in 1990, through the Talloires Declaration, in which HEI committed themselves to "set an example of environmental responsibility by establishing institutional ecology policies and practices of resources conservation, recycling, waste reduction and, environmentally sound operations" (ULSF, 1990, p. 1). Therefore, in this PhD research, it is argued that becoming a leader means not only being a pioneer in properly institutionalising sustainable development initiatives (SDI) in their systems as a whole but also influencing other HEI and other societal institutions to do so (Dagiliūtė et al., 2018; W. Horan et al., 2019).

It is reasonable to assume that the obstacles faced by HEIs in integrating SD are not homogeneous. The challenges differ from HEI to HEI and are influenced by various factors, such as the institution's size, the focus on the degree of study offered, and the geographical location (Kahle et al., 2018).

Considering the argument presented above, authors such as Kapitulčinová et al. (Kapitulčinová et al., 2018), Baker-Shelley et al. (2017), and Giesenbauer and Müller-Christ (2020) have sought to analyse the degree of integration of HEI on the path they embrace to become sustainable universities.

In order to operationalise the main international vows taken to promote sustainable development, several HEIs have drawn up their institutional policies, agendas and plans to foster sustainable development in all spaces that make up the complex institutional entanglement (Budihardjo et al., 2021; Gómez et al., 2015; Shawe et al., 2019). From the emergence of this claim, as will be shown in chapters 2 and 3, the HEI worldwide have evolved in the process of integrating sustainable development initiatives (SDI) into their strategies, systems, processes and routines, and have also forged various networks of sustainable HEI, which aim at accelerating the process of integration (Dlouhá et al., 2018; Sasson, 2019).

According to Lagouvardou et al. (2020), one way to reduce environmental impacts caused by anthropic action is to improve control over available resources. The Brazilian government has gradually improved control by creating laws to regulate the use of natural resources and pollution generation. Brazilian concern is noticed even in the text of the Brazilian National Constitution (1988), which has Chapter 6 and Article 225, which are wholly devoted to the care of the environment and establishing policies for the use of available resources. The Brazilian laws related to the environment and promoting of sustainable development go beyond the Federal Constitution. They are extensive, among which the most important are the National Environmental Policy (PNMA, acronym in Portuguese); the National Solid Waste Policy; the National Urban Policy; the National Water Resources Policy; the National System of Conservation Units and the National Environmental Education Policy (PNEA, acronym in Portuguese), to cite a few (Abessa et al., 2019; Fonseca et al., 2017; Miola et al., 2019; R. Perlingeiro & Schmidt, 2022).

Notably, in the context of public administration, and more significantly in the context of federal public HEI, this PhD research takes a glance at the consequences of implementing the Normative Instruction No. 10 of 12 November 2012 (NI10, 12/11/12), created by the Ministry of Planning, Budget, and Management (MPOG), which institutes a new management model for public agencies: the Sustainable Logistic Management Plan (SLMP). The SLMP is defined as a set of planning and management tools "with defined objectives and responsibilities, actions, targets, execution deadlines and monitoring and evaluation mechanisms, which allows the organ or entity to establish sustainability practices and rationalisation of spending and processes in the Public Administration" (Normative Instruction No. 10, 2012). In summary, this law determines the creation of a complex management system that demands compliance with 24 labyrinthine requirements and the cataloguing and integration of more than three dozen indicators of sustainable performance.

Since 2013, Brazilian federal public HEIs have been spending significant energy on operationalising normative instructions by creating SLMPs that meet the legal requirements. In chapter 5 of this PhD research, a representative sample was studied to report on the current status of the implementation of the NI10, 12/11/12, while highlighting the main barriers and drivers related to the process. The study revealed that HEIs still need to satisfactorily overcome the obstacles associated with implementing the Normative Instruction. Many HEIs have needed help drawing up their plans, mainly producing the required follow-up reports.

The two most crucial challenges identified in integrating the NI10, 12/11/12 on the HEI sector are (i) the normative instruction was not explicitly designed for HEI but for all public agencies (A. C. S. Moreira, 2018). In this sense, it is required to adapt the SLMP to incorporate the specificities inherent to an HEI without altering the rationale of the norm; (ii) the requirement of collecting and reporting data on multiple indicators, whose information, when available, is in fragmented databases, making the collection, treatment, and unification process quite laborious (Moura-Leite et al., 2022).

In addition to the two challenges related to the operationalisation of the Brazilian NI10, 12/11/12, which could be associated with more practical issues, there is a third, even more, significant obstacle of a theoretical nature that is not specific to the Brazilian context insofar as it has been reported by specialists on the subject in many different parts of the world. Authors such as Amaral et al.(2015), Bizerril et al. (2018) and Lozano et al. (Lozano et al., 2013) realised that many published works on university campus sustainability have considered one or only a few of the dimensions of HEI sustainability. This attitude disregards the importance of integrating all dimensions in a holistic management and assessment system that allows the integral assessment of the sustainable performance of a given HEI and the comparative analysis of the performance of similar HEI towards sustainability.

Berzosa et al. (2017) suggest that sustainability assessment is pivotal to enabling institutional sustainability achievement. However, despite its benefits, the authors reckon that researchers need to pay more attention to what these tools conclude about HEI sustainability.

It is reasonable to assume that the complexity and amount of work involved in developing studies that analyse the sustainability of HEI from a genuinely holistic perspective would act as barriers to the emergence of such studies in the specialised scientific literature. Holistic analysis can be understood as one that incorporates the significant campus dimensions of sustainability in its examination, among which are research, teaching, campus operations governance procurement, outreach, and on-campus experience.

A further inhibitor is that scholars need to give more importance to the procedural and systematic structure that would enable the integration of planning, monitoring, and reporting activities to analyse HEI sustainability. This approach would facilitate data generation to enable holistic analysis.

Based on the previous contextualisation, the development of an integrated approach that considers the main components, dimensions, indicators, and metrics to build a holistic framework that provides a method to plan, monitor, assess and report sustainability in HEI is essential and imperative, and it is far from being thoroughly addressed in the literature.

1.1. Research Questions

Against the background presented, this PhD thesis is devoted to contributing to the body of knowledge on SDI implementation in HEI by addressing the identified gaps in the literature and answering the following three research questions:

Research Question 1: *How can a sustainable assessment framework be conceptualised given the relationship between HEI organisational strategies and the implementation of SLMPs in Brazilian federal public universities?*

Research Question 2: *How can NI10, 12/11/12 be effectively operationalised in HEI to promote sustainability, considering key dimensions, actions, indicators, and integration of multiple sectors while addressing incongruences and conflicts and aligning with international literature?*

Research Question 3: *How can a methodology for data collection and systematisation be developed to integrate different dimensions mathematically and utilise a benchmarking approach to compare the progress of every Brazilian federal public HEI?*

Considering the required formulation of answers to the three previously formulated research questions and the framework development, a methodology is proposed and extensively detailed in chapter 6. Namely, the first of the five stages of the System Approach Framework called "Issue Identification", which requires highlighting the fundamental issues related to implementing regulations that determine the systematic integration of sustainability practices in public agencies (T. S. Hopkins et al., 2011; Støttrup et al., 2019).

At the end of this step, eight issues were identified to be addressed in designing the proposed framework. These identified issues are imbricated with the research questions and, therefore, may assist in solving these research questions. In other words, one solves the research questions by answering the eight issues formulated in chapter 6 of this PhD research. Thus, Table 1-1 illustrates the relationship between the research questions and the issues identified.

Table 1-1 - Connexion between the research questions and the issues identified.

RQ1	**How can a sustainable assessment framework be conceptualised given the relationship between HEI organisational strategies and the implementation of SLMPs in Brazilian federal public universities?**
Issues related	(a) To what extent do organisational strategic documents support the development of a SLMP in HEI? (b) What is the current status of SLMP implementation in Brazilian federal public universities?
RQ2	**How can NI10, 12/11/12 be effectively operationalised in HEI to promote sustainability, considering key dimensions, actions, indicators, and integration of multiple sectors, while addressing incongruences and conflicts and aligning with international literature?**
Issues related	(c) What are the key dimensions, actions, and indicators required to effectively operationalise the normative instruction and develop a coherent and feasible structure for planning, assessing, and reporting the sustainability of HEI in an integrated manner that aligns with international literature on planning and Sustainable Assessment Tools (SAT) for promoting SDI in HEI? (d) What are the incongruences and conflicts of the normative instruction, which was created with a general spectrum, when applied to HEI?
RQ3	**How can a methodology for data collection and systematisation be developed to integrate different dimensions mathematically and utilise a benchmarking approach to compare the progress of every Brazilian federal public HEI?**
Issues related	(e) What is the most effective and credible methodology for data collection? (f) How can multiple sectors within each university be integrated into the process of developing the plan, monitoring indicators, and preparing semi-annual and annual reports? (g) How can different dimensions be integrated to formulate a single system? (h) Can a benchmarking approach be utilised to develop a system for comparing the progress of every Brazilian federal public HEI?

1.2. Research objectives.

Within the backdrop presented, the main aim of this study is to establish a holistic framework based on Complex adaptive systems that support action plans for integrating, monitoring, assessing, and reporting sustainability in Brazilian federal public HEIs. The three research objectives can be summarised as:

Objective 1: To conduct a literature review on SDI in HEI, analyse the changes related to the implementation of SDI in Brazilian federal public HEI, and develop the conceptual model of the proposed framework.

Objective 2: To develop the detailed procedural structure of the proposed framework and formulate the integration model according to the Brazilian normative regulations.

***Objective 3**:* To test the framework's effectiveness evaluating the sustainability performance of a typical Brazilian federal public HEI.

The methodological characterisation of this thesis was developed based on the model of Saunders et al. Following this model, this research adopts pragmatism as philosophy and the deductive approach as a research strategy employed in the case study, and action research was developed. Finally, the instruments used for data collection were the systematic literature review, interview, diary, and direct observation. These were structured and analysed through content analysis, bibliometric analysis, reference mapping, and BPMN. The methodological aspects of this thesis are detailed in chapter 4.

In support of the objectives, eight tasks were planned to provide answers to the formulated research questions, thus ensuring the accomplishment of the main objective of this doctoral thesis. Figure 1-1 shows the schematic representation of the articulation between the research questions, the objectives, and the tasks, methods, and chapters in which the text is presented.

1.3. Outline of the manuscript

The overall structure of this PhD thesis takes the form of nine chapters, as it is shown in Figure 1-2 below:

MAIN AIM OF THIS STUDY
To establish a holistic framework, based on Complex adaptive systems, that supports actions plans for integrating, monitoring, assessing, and reporting sustainability in Brazilian federal public HEI.

Issues (Why)	Task (What)	Method (How)	Chapter (Where)
Research Question (1): How can a sustainable assessment framework be conceptualized given the relationship between HEI organisational strategies and the implementation of SLMPs in Brazilian federal public universities?			
Objective (1): To conduct a literature review on SDI in HEI, analyse the changes related to the implementation of SDI in Brazilian federal public HEI, and develop the conceptual model of the proposed framework.			
(a) To what extent do organizational strategic documents support the development of a SLMP in HEI? (b) What is the current status of SLMP implementation in Brazilian federal public universities?	(1) Assess the evolution of the integration of SD initiatives in Brazilian federal public HEIs.	A sample comprising 35 federal public HEIs, was assembled. It represents 55% of the total. Desk research was employed with a twofold aim. The first is to analyse the support of the strategic documents in implementing SDI; The second is to examine the adherence of SDI undertaken by HEIs with the requirements of the Brazilian NI no. 10/2012.	CH 5
Research Question (2): How can NI10, 12/11/12 be effectively operationalised in HEI to promote sustainability, considering key dimensions, actions, indicators, and integration of multiple sectors, while addressing incongruences and conflicts and aligning with international literature?			
(c) What are the key dimensions, actions, and indicators required to effectively operationalize the normative instruction and develop a coherent and feasible structure for planning, assessing, and reporting the sustainability of HEI in an integrated manner that aligns with international literature on planning and Sustainable Assessment Tools (SAT) for promoting SDI in HEI?	(2) Inventory of extant literature related to frameworks of sustainable universities. (3) Inventory of dimensions, indicators and metrics assessment of HEIs sustainability.	Review the extant literature to establish a broader theoretical and conceptual perspective based on the central thesis assumptions. Review the literature on university institutions' dimensions, indicators and sustainability metrics and analysis the indicators contained in Normative Instruction No. 10, 2012.	CH 2 CH 3
(d) What are the incongruences and conflicts of the normative instruction, which was created with a general spectrum, when applied to HEI?	(4) Analyse the adherence between the NI requirements and the SDI models, available in the literature to design the conceptual model to integrate, monitor, assess and report the sustainability in Brazilian HEIs.	Compare the NI requirements with the SDI models, indicators, metrics and SATs compiled in chapters 2 and 3 and, employing the System Approach Framework (SAF), develop the conceptual model of the proposed framework.	CH 6
Research Question (3): How a methodology for data collection and systematising can be developed to integrating different dimensions mathematically, and utilising a benchmarking approach to compare the progress of every Brazilian federal public HEI?			
Objective (2): To develop the detailed procedural structure of the proposed framework and formulate the integration model according to the Brazilian normative regulations.			
(e) What is the most effective and credible methodology for data collection?	(5) Validate the framework data collection and analysis process with experts (preliminary validation).	Development of data collection procedures: 1) Identification of the sector responsible for the generation of data; 2) Interviewing the critical staff of the sector to understand the processes related to the generation and storage of the data of each indicator and carry out the preliminary assessment of the conceptual model.	CH 5
(f) How can multiple sectors within each university be integrated into the process of developing the plan, monitoring indicators, and preparing semi-annual and annual reports?	(6) To elaborate on the procedural structure of the framework.	Employing the prescriptions of SAF step 3 (system formulation) and BPMN, define the scope of analysis, components, dimensions, objectives and action plans; and design the assessment protocols and reporting guidelines of the proposed framework.	CH 6 CH 7
(g) How can different dimensions be integrated to formulate a single system? (h) Can a benchmarking approach be utilized to develop a system for comparing the progress of every Brazilian federal public HEI?	(7) To formulate the mathematical model of integration.	Define weights for quantitative and qualitative indicators, dimensions, and components based on existing SATs and formulate the framework integration equation.	CH 7
Objective (3): To test the effectiveness of the framework by evaluating the sustainability performance of a typical Brazilian federal public HEI.			
	(8) Assessment of usability with the test of application in the typical case	Collect, systematize and integrate data using the proposed framework to assess the HEI sustainability performance in compliance with the NI.	CH 8
Output: Proposed Framework tested by applying to the typical case study			

Figure 1-1 - Schematic representation of the PhD research.

Parts	Chapters	Description of contents
Pre-textual documents		
Pre-textual	(i)	The pre-textual part of a thesis is the section that comes before the main body of the thesis. It includes the Copyright, the Acknowledgements, the Statement of Integrity, the Abstract, the Table of contents, the List of figures, the List of tables, the List of equations, and the List of acronyms.
Core documents		
PART 1	**Chapter 1** – Introduction **Chapter 2** - HEIs commitments to Sustainable Development **Chapter 3** - Sustainability Assessment tools for HEIs **Chapter 4** - Method	The introduction to this PhD research provides a clear roadmap by contextualising the study, articulating scientific gaps, the RQ and RO, and previewing the content of subsequent chapters. Chapters Two and Three present two systematic literature reviews aimed at furnishing content for the conceptual design of the proposed framework and examine relevant literature on HEIs' commitment to promoting SD, the leading management models for integrating SD into HEIs, and prominent SATs used to evaluate HEI performance. The method chapter outlines the research design, methodology, and methods employed in the study, clearly explaining the steps taken to address the RQ and achieve the RO.
PART 2	**Chapter 5** - Evolution of the integration of SD initiatives in Brazilian federal public HEIs **Chapter 6** – Integration, monitoring and assessment: the frameworks' conceptual model **Chapter 7** – System formulation	Part Two of this study, comprised of three chapters, endeavours to present the current state of the integration of sustainable development (SD) into the routines and processes of Brazilian federal public universities in accordance with normative instruction. This is followed by the conceptualisation of a framework to address identified gaps. Finally, in Chapter Seven, the procedural and mathematical modelling of the proposed framework is developed to offer a solution to the theoretical and practical challenges presented.
PART 3	**Chapter 8** – System assessment and output **Chapter 9** – Conclusions	The third part of this study, comprised of Chapters Eight and Nine, seeks to evaluate the practical application of the framework developed. In Chapter Eight, the framework is tested through a pilot case study of a typical Brazilian federal public university (UFPB), where the institution's performance in integrating sustainable development (SDI) is analysed, and the efficacy of the proposed framework in addressing the previously identified gaps is further evaluated.
Post-textual documents		
Post-textual	(ii)	This part comprises supplementary materials that are included after the main text of the thesis and provides additional information to support the research presented. Furthermore, this thesis includes supplementary figures that depict the results of the systematic literature review, as well as a comprehensive collection of action plans, assessment protocols, and reporting templates for the components of the proposed framework. These post-textual materials serve to provide further insight into the research and its findings, offering a more complete understanding of the proposed framework.

Figure 1-2 - Overview of the structure of parts and chapters of the PhD research presented.

Chapter 1 is the introduction chapter. Therefore, it explains the context and relevance of the research, followed by the description of the scientific gaps, research questions and objectives of the thesis, and finally, an overview of the chapters that compose this PhD research.

The literature review of this work was developed in **chapters 2 and 3** through two independent systematic literature reviews.

Chapter 2 corresponds to the first systematic literature review, performed in the Web of Science database, and identifies the most prominent clusters of authors and journals dedicated to the study of the integration of SDI in HEI through the signing of institutional commitments and redesigning the organisational management structure and frameworks to include sustainable development aspects as a response to the promises made. Additionally, it lists and comments on the evolutionary web of environmental commitments made by HEI since Stockholm 1972 and presents the main models of sustainable development integration in HEI reported in the literature. Finally, as a novelty, this chapter offers a new perspective on the holistic approach to HEI integrating SDI, achieved through vertical and horizontal integration.

Chapter 3, written from a second systematic literature review, analyses a wide range of sustainability assessment tools designed for application in HEI and the conceptual and mathematical modelling methodologies that structure the tools analysed.

Along with an inventory of commitments to sustainable development integration, the analysis of changes in organisational management structures, and insights from a conceptual and mathematical modelling study, another significant outcome from **chapters 2 and 3** is the preliminary mapping of metrics, indicators, dimensions, and components. This mapping is presented in Table 6-4 and serves as the foundation for designing the proposed framework. *Therefore, **chapters 2 and 3** shed light on tackling research question two, issue c.*

Chapter 4 details the methodological procedures undertaken to carry out the needed research for the design of the proposed framework. *This chapter addresses research question three, issue e*.

Chapter 5 presents the general structure of the Brazilian public higher education system and reports the results of a comprehensive study that analyses the evolution of the integration of sustainable development in HEI, through the implementation of Normative Instruction 10/2012, *answering research question one, issue b*, and finally analyses the support given *by strategic documents in implementing SDI in Brazilian federal public HEI, as required in research question one, issue a.*

Chapter 6 uses a Complex adaptive system perspective and system approach framework (SAF) to design the conceptual aspects of the proposed framework. To this end, it analyses the connexion between SLMP and the dimensions of HEI sustainability reported in the literature to draw the conceptual model of the proposed framework. Performing these actions, ***chapter 6** addresses research question two, issue d*.

Chapter 7 elaborates on the framework's procedural structure, employing system formulation to define the scope of analysis, components, dimensions, objectives, and action plans; and designing the assessment protocols and sustainability reporting (SR) guidelines. *It addresses the research question three, issue f*. Additionally, this chapter formulates the mathematical integration model, defining weights for quantitative and qualitative indicators, dimensions, and components based on existing SAT and formulating the framework integration equation. *By doing so, this chapter answers the research question three, issue g*.

As outlined previously, a complementary relationship exists between **chapters 6 and 7**. **Chapter 6** is dedicated to the conceptual model design of the framework, while **chapter 7** focuses on its operationalisation. Specifically, **chapter 7** establishes the procedural structure and mathematical models required to integrate all the elements that comprises the framework. By conducting an extensive, systematic, and detailed literature review on the integration of development in HEI, with an emphasis on their core commitments, management models, and sustainability assessment tools, the integrated solution emerged in the form of a Framework to Integrate, Monitor, Assess and Report Sustainability in HEI (FIMARSHEI). This proposed solution has unique characteristics, particularly in relation to the modularised creation process, which utilises the adaptive complex systems approach that allows for constant updating and adaptation to the specificities of other HEI. Another specificity of this framework is that it is the only one created to meet the specific requirements of legislation applied to Brazilian public HEI, facilitating compliance with current national regulations while still paying attention to the nuances of the international scenario regarding the integration of sustainable development initiatives in HEI.

Chapter 8 ends up by testing the application of the FIMARSHEI to support the selection, collection, and analysis of indicators that enable the integration, monitoring, assessment, and reporting sustainability in Brazilian Federal Public HEI through its application in the Federal University of Paraíba (UFPB, Acronym in Portuguese) a typical case of Brazilian federal public HEI, *addressing research question three, issue h*. Therefore, this contributes to some level of validation, namely operational and external validity (Aken, 2004; Shoar & Chileshe, 2021).

Chapter 9 serves to synthesise the various strands of the thesis and present its principal conclusions. A set of recommendations is subsequently proposed, drawing on the key lessons gleaned from the research and highlighting potential avenues for future inquiry.

In addition, this final chapter includes a discussion of deliverables produced during the doctoral studies period, which included a 15-month internship at the Hamburg University of Applied Sciences (Germany). During this time, the PhD candidate had the opportunity to collaborate with an Anglo-German network of researchers studying various aspects related to campus sustainability. As outlined in the conclusion section, these deliverables include a co-edited book of compiled articles, co-authorship of a book chapter, 13 co-authorships in international peer-reviewed journals, and 5 co-authorships in articles or extended abstracts published in conference proceedings.

The **References section** is presented along with a relevant **Appendix,** which offers further information regarding the systematic literature review and mapping research conducted. Moreover, the Appendix includes action plans, diagrams, standard operating procedures (SOPs), and templates that can facilitate the implementation of the designed framework in other Brazilian federal public HEI. The provided templates can also offer insights that may be useful in implementing sustainable development initiatives (SDI) in HEI from other geographic or administrative contexts as well as other types of public or private institution.

Chapter 2. HEI Commitments to Sustainable Development

The first subsection of this chapter deals with a systematic literature review on the sustainable development of HEI. Its purpose is to obtain a structural overview of the most prominent sources, documents, authors, keywords, and regions on the production of scientific knowledge through HEIs' sustainable development initiatives carried out. The second subsection of this chapter will describe a set of events, declarations, and commitments made by Social Institutions worldwide and Education Systems. Those events, signed by their leaders, and specifically by leaders of HEI, can be considered the foundational actions that have supported the emergence of the theoretical approach now called Education for Sustainable Development (ESD) (Huckle & Wals, 2015; Pauw et al., 2015). The ESD has led to the incorporation of sustainable development principles into the academic, managerial, and operational structures of the HEI and the interconnection among HEI formed by institutional networks. Finally, throughout the text, an effort has been made to identify and detail the evolutionary thread that exists in the process of HEIs' incorporation of sustainable development policies, initiatives, and practices.

Further, some sustainable campus concepts will be presented, together with a set of isolated, or nearly isolated, experiences of sustainable development applications and practices in HEI. The sustainable campus concept and experiences will be complemented by the description of the main dimensional structures of HEI sustainability, reported in the literature, enabling the operationalisation of sustainability initiatives. As will be shown, the formation of those dimensions can be understood as a response from both HEI management practitioners and scholars to the call to promote the integration of programs that support the implementation of sustainable development into a cohesive and systematic framework that facilitates the application, management, and control of SDI on university campuses.

The last subsection of this chapter evolves from the previous subsections and presents the benefits of deploying the holistic approach to higher education institutions' management. This PhD thesis presents a logical path to deliver the recommended holistic approach, according to which holistic management is achieved by applying vertical and horizontal integration strategies (Pellinen et al., 2016; Pérez-Lara et al., 2020). Vertical integration consists of bringing together all the sustainability programs and initiatives of an institution in an entire subsystem for the management of sustainable development at HEI, as well as the integration of this newly created system with those conventional management systems, such as the financial, the administrative, the operational, and people management systems, to cite a few. Considering that the focus of vertical integration is directed to internal activities and procedures of a given HEI, the horizontal integration aims at connecting different HEI and stakeholders through a network that offers a baseline to accelerate the necessary changes, allowing HEI to assume their deserved and expected role in leading society to more sustainable lifestyles.

2.1. Bibliometric Analysis on SD in HEI

A bibliometric review was carried out through a science mapping approach in order to review research on sustainable development applied at HEI. Based on Hallinger and Chatpinyakoop (2019, p. 1), “research review grounded in bibliometric methods do not examine the substantive finds of studies. Rather, their value extends from the capability to document and synthesise broad trends that describe the landscape, composition, and intellectual structure of a knowledge base”. Thus, the scientific mapping approach was incorporated into the research method tools employed in this PhD thesis as a prior stage with the aim of illuminating trends in knowledge building on the subject researched. This preliminary stage is intended to pave and strengthen the way that will allow elaborating an accurate and robust literature review by offering worthwhile insights concerning the most prominent journals, authors, articles, and keywords that must be considered as core knowledge, and therefore a target to be examined in a further conventional literature review, like the ones shown on the subsections of this chapter.

To perform the bibliometric review, though scientific mapping strategies, 2,853 articles published in English, were retrieved from the core collection of Web of Science – WoS, between 2010 and January 20, 2021. In the search, the source of documents was left open-ended to identify the most recurrent journals, which are published articles related to the subject of this chapter. The bibliometric analysis comprises the study of (a) co-occurrences in keywords, (b) the most prominent journals, (c) and the most active authors. The method section describes the bibliometric review steps through scientific mapping using VOSviewer software. Table 4-6 on chapter 4 summarises the procedure employed to conduct the systematic literature review, highlighting the date of data collection, the database included, the string words, the tracked reference fields, and the number of references collected.

2.1.1. Analysis of co-occurrence of keywords

The co-occurrence of keywords shows as the most common keywords used in the analysed search and a visual representation of the network connections of keywords that appear more frequently in the documents analysed (Cancino et al., 2017, p. 620; J. Shi et al., 2019).

As Guo et al. (2019) explained, keywords bursts refer to those keywords that rise sharply in citations. Burst detection is a convenient analytic method for discovering keywords that take particular attention from the related scientific communities in each period. Examining hot-spot keywords could identify the dynamics and directions of research about sustainability in HEI.

On the sampled documents, a total of 9,238 keywords emerged. The condition of considering only keywords with equal or greater than five appearances on all collected literature was applied to uncover the relationship among the documents. The screening result was that a total of 709 qualified keywords were considered. Those keywords were grouped into 11 clusters. The size of the circles represents occurrences of keywords. The large a circle, the more a keyword has been co-selected in the SD on HEI publications (van Eck & Waltman, 2010). For Figure 1-2(a), Circles on the same colour cluster suggest a similar topic among the sampled publications analysed; Figure 1-2(b) indicates the year of significant occurrence. The strategy commonly used to assign keywords in a document can be understood from two parallel actions. The first includes more generic keywords that make the search algorithms, designed by the databases, extend the document indexing to a higher number of searches. The second involves only more specific keywords that allow the document to be located in more detailed investigations (Cancino et al., 2017).

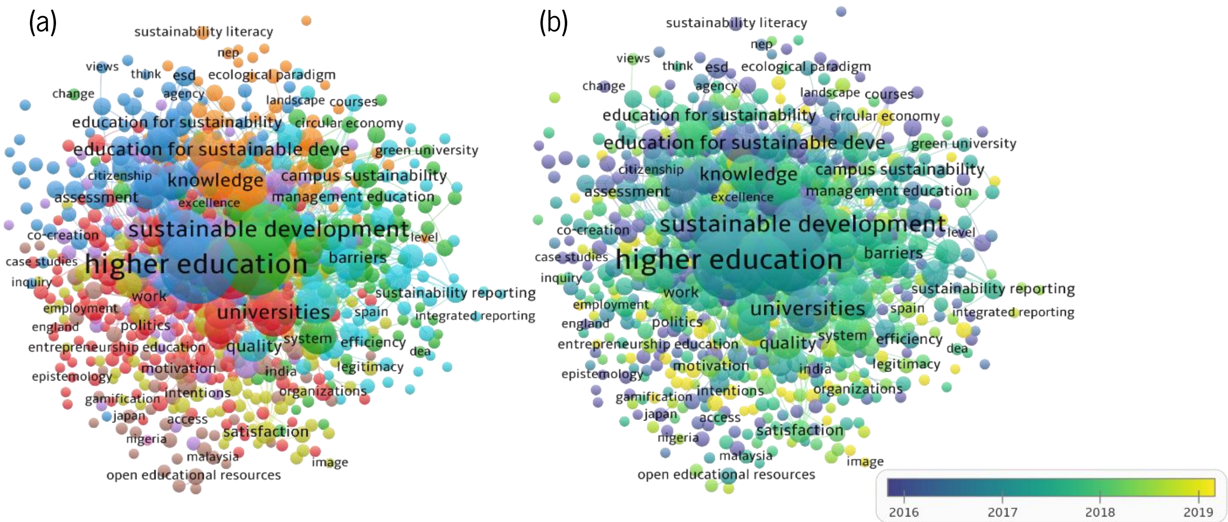

Figure 2-1 - Co-Keyword network visualisation on SD and HEI.

Note: (a) Keyword network visualisation on SD and HEI was based on occurrences; (b) co-keyword overlay visualisation was based on the occurrences and average publication per year scores.

The keywords with occurrences greater than or equal to 50 were grouped in 8 clusters and are presented in Table 2-1. We can observe significant overlaps and interconnections among clusters, which shows similarities among different research topics. This outcome confirms that SDI embraced by HEI are a cross-disciplinary research field.

All clusters may have additional keywords, since only those having 50 or more occurrences are listed. For example, he first, besides the keywords listed in Table 2-1, has other keywords, such as satisfaction (36), engagement (52), students' engagement (44), teachers (34), motivation (31), which highlights aspects of students' engagement. This perspective, focusing on analysing a segment of the academic community, is aligned with Achuthan, Nedungadi, Kolil, Diwakar, and Raman (2020), and Alamri Almaiah and Al-Rahmi (2020), to cite a few.

Table 2-1 - Eight main clusters with occurrences of keywords greater than or equal to 50

Cluster 1	Cluster 2	Cluster 3 - Green	Cluster 4
Higher education (1,212); students (169); framework (148); challenges (94); perceptions (84); Quality (79); Engagement (52);	**Sustainability** (674); performance (128); innovation (92)	**Sustainable Development** (386); science (120); impact (91)	**Education** (300); management (177); knowledge (151); education for sustainable development (148); attitudes (91); behaviour (71); policy (62); education for sustainability (60)
Cluster 5	**Cluster 6**	**Cluster 7**	**Cluster 8**
University (298); Universities (227); State (50)	**Model** (119); higher education institutions (88); implementation (72); design (70); future (61); environment (58); systems (55); barriers (52)	**Curriculum** (111); sustainable development goals (62); pedagogy (61);	**Competences** (109); sustainability education (96); key competences (74); leadership (54)

Note: in brackets (#) is described the number of occurrences of each co-keyword.

Regarding the time frame (Figure 1-2, b), keywords such as "higher education", "sustainable development", and "sustainability", illustrated in wide dark blue circles, are considered consolidated and mature terms due also to their breadth to designate broad studies in the field of sustainability in HEI. On the contrary, keywords, like "sustainable development goals" and "circular economy", which has 62 and 17 occurrences, respectively, are the smallest ones, in yellow, evidencing the novelty of the use of those keywords. Finally, the keywords illustrated in median size, shades of green represent items at the median stage of maturation and adoption as the keywords for the analysed field of study.

Thus, the analysis of the different sizes and colours of the circles presented in Figure 2-1, (b), for instance, provides valuable insights into the dynamics, relevance and evolution of the subjects studied in the analysed period. The software used to map the references allows visualisation of each node and their interconnections between distinct clusters. Figure 9-1, in , illustrates a detail of the nodes of the keyword "sustainable development goals" and its interconnections.

2.1.2. Analysis of the journals published in SD in HEI

The sample comprises 2,853 publications in 897 different journals, from which 286 sources meet the minimum number of two documents of a source. Albeit many sources supported a wide range of research themes and the multidisciplinary perspective of sustainable development at HEI, 90% of the total sources analysed had published no more than two articles.

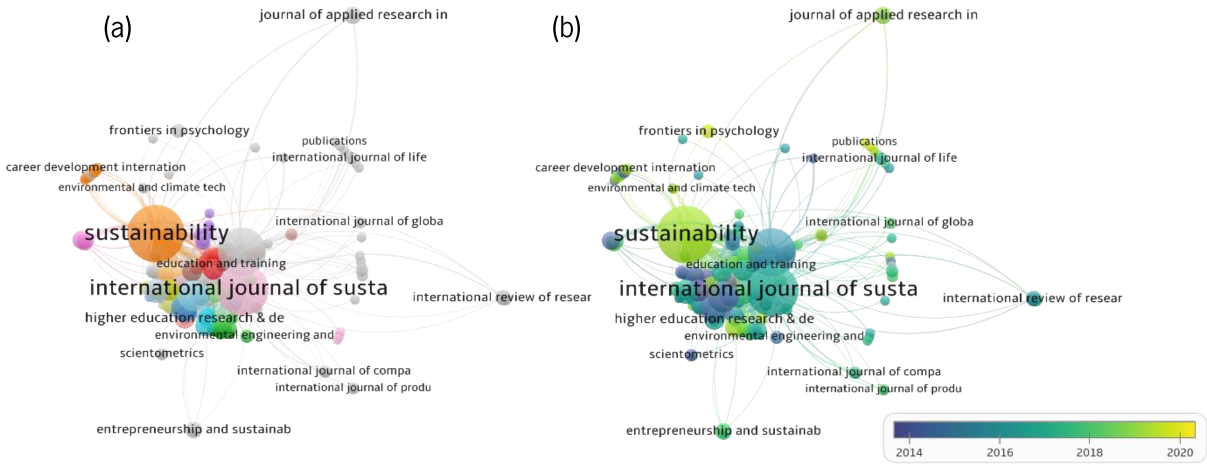

Figure 2-2 - Visualisations of the sources of publication.

Note: (a) source network visualisation on SD and HEI was based on occurrences; (b) source overlay visualisation was based on the occurrences and average publication per year scores.

Table 2-2 shows the list of 10 leading journals publishing articles regarding sustainable development and HEI. The ten most productive journals analysed published 1,229 documents, corresponding to 43% of all references analysed from 2010 to January 2021; together, these Journals could be considered core journals of sustainable development related to HEI.

The software VOSviewer considers two standard weight attributes: links and total link strength attributes. The latter, total link strength attribute, included in the fifth column of Table 2-2, means the total strength of the links of an item with other items (Eck & Waltman, 2020), i.e. the power of a given journal's influence on the other journal that comprises the studied network. Additionally, in the last column, the impact factor of each journal was retrieved from the Journal of Impact Factor (JIF), from WoS, for all indexed Journals. Scopus H Index scores have been assigned for those not indexed in the JIF. The impact factor indicated in Table 2-2 corresponds to the month of January 2021. Finally, the documents correspond to the number of articles published by a source, and the citations attribute indicates the total number of citations received by all documents published by the sources.

The scientific journal that stands out regarding the number of documents published is Sustainability, which corresponds to 15.32% of all production. The second most active journal is the International Journal of Sustainability in Higher Education, with a total of 10.93%, followed by the Journal of Cleaner Production, responsible for 9.01% of all documents published.

Finally, it draws attention to the fact that although the Journal of Cleaner Production ranks third in the number of documents received, it ranks first in the number of citations (8,439) and the total link strength (2,666).

Table 2-2 - The ten most active journals publishing on SD in HEI ranked by number of articles indexed.

Ranking	Source Title	doc[a]	Citations	TLS[d]	IF (JIF)[b]
1	Sustainability	437	1858	1622	2.576
2	International Journal of Sustainability in Higher Education	312	3596	2076	2.000
3	Journal of Cleaner Production	257	8439	2666	7.246
4	Environmental Education Research	66	1068	409	2.266
5	Engineering	36	631	118	6.495
6	Frontiers of Architectural Research	29	492	130	19[c]
7	Studies in Higher Education	26	84	0	3.000
8	Higher Education	23	175	0	2.856
9	Amfiteatru Economic	23	293	59	1.625
10	Assessment Evaluation in Higher Education	20	65	83	76[c]

Note: a) Doc: Number of documents published; b) JIF: Journal Factor Impact, WoS; c) H Index Scopus; d) TLS: total link strength.

Two observations can be made, considering the data in Table 2-2. The first is to reinforce the argument that sustainable development related to HEI is a cross-disciplinary field of study, evidenced by the variety of Journals that publish most of the articles on the subject.

The second observation concerns that among the top five Journals, there are three remarkable and high scored journals. The average Impact Factor of these journals, namely, Sustainability, Journal of Cleaner Production, and Engineering, are equal to 5,439, which indicates the importance of sustainability in higher education in the technology/engineering knowledge area.

2.1.3. Analysis of influential authors publishing in SD in HEI

The co-authorship analysis in VOSviewer was applied to examine the cooperation pattern of the authors and their influential strength on publications in the area of SD related to HEI. The analysed sample of 2,853 articles is composed of 7,857 co-authors and only 58 of these meet the thresholds of being co-authors of a minimum number of documents equal to or greater than five.

This citation analysis shed some light on the influential scholars in producing knowledge on SD in HEI. In Figure 2-3, lines among authors represent their cooperation links, while the eight different colours represent the collaboration cluster of the authors.

The most productive author on the analysed period is Leal Filho, from Manchester Metropolitan University and the Hamburg University of Applied Science, with 30 documents. The author is also the one who has the most robust total link strength (74) and 20 connexions. The author has also demonstrated a high capillarity among clusters since he interacts with authors from four of the eight identified clusters. Leal Filho, as a more active author in his cluster, light blue, has been collaborating with authors from other three clusters, namely on the red cluster he collaborates with Adomssent and Shiel; among with on the dark blue mostly with Vargas, Frankenberguer, Emblen-Perry, Molthan-Hill, and Mifsud; among with on the yellow cluster with Caeiro, Brandly, Paço and Trencher; finally, the author interacts mainly with Veiga, Mac-Lean and Huge from the purple.

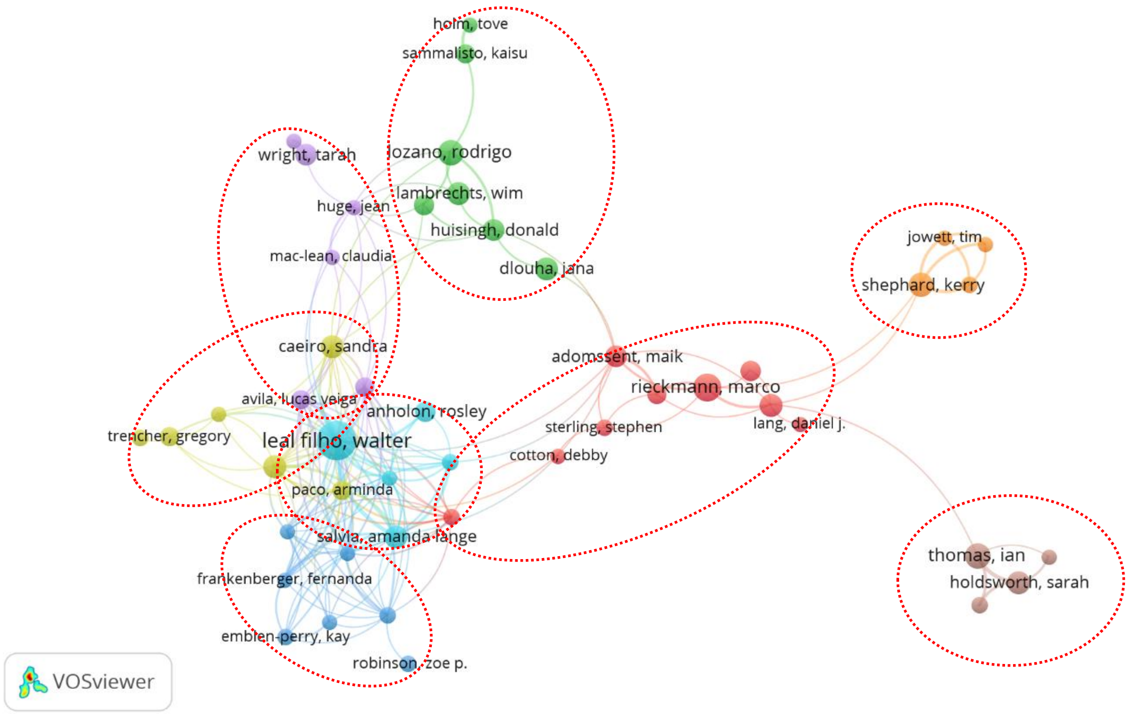

Figure 2-3 - Author's cooperation network in SD in HEIs

Distance-based maps are maps in which the distance between two items reflects the strength of the relation between the items. A smaller distance generally indicates a more substantial relation, and on the contrary, a more considerable distance is associated with a weak relation. For instance, Thomas, who works in the field of sustainable learning and technics tools, although working on the analysed field, has almost no interaction with the other authors. In Table 2-3 the top ten cited authors are listed with their main indicators: the number of documents published, the total link strength (TLS), the h-Index, from Google Scholar, and the country in which the authors work. The author with more citations is Lozano, with 1,222 citations, followed by Huising with 1,073 citations.

Table 2-3 Top 10 strong citated authors and number of publications

Ranking	Author	Citations	doc	TLS	h-Index	Country
1	Lozano, Rodrigo	1222	13	13	43	Sweden
2	Huisingh, Donald	1073	9	13	-	USA
3	Lambrechts, Wim	895	11	7	17	Netherlands
4	Rieckmann, Marco	689	15	13	21	Germany
5	Leal Filho, Walter	651	30	74	54	Germany
6	Ceulemans, Kim	617	8	9	18	France
7	Caeiro, Sandra	469	10	21	34	Portugal
8	Trencher, Gregory	398	7	6	17	Germany
9	Barth, Matthias	384	10	10	21	Germany
10	Adomssent, Maik	334	9	14	-	Germany

Note: the h-Index was collected in December 2021.

As shown in Table 2-3, Germany is considered the most referenced authors' country of the sample, with more than 58% of the total documents published. The authors working in Germany are also at the forefront of the TLS, accounting for 36.48%, followed by Sweden, which has 18.15% of the total link strength.

2.2. **Events, declarations, and commitments on SD for HEI**

The global reflection on the impact of anthropic action on the environment emerged just over four decades ago. Since then, society has been struggling to understand better the fundamentals and interconnections of nature and assess the pressure of human activity on the planet to develop more harmonious alternatives with nature and allow for humankind's sustainable survival (Miller & Spoolman, 2012). Since Stockholm 1972, through multilateral governance bodies, like the United Nations (UN), national governments have made efforts to develop alternatives to the existing socio-economic model.

A widely accepted definition of sustainable development was constructed in 1987 in the Brundtland Report, whereby it is the "development that meets the needs of present generations without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987, p. 44). This definition sets up a shared commitment towards steady economic growth, given that this economic growth neither compromises the load-bearing capacity of available environmental resources nor social equity. Since the 1970s, international initiatives have been emerging to address the incorporation of the SD approach on HEI and in society as a whole (Casarejos, Frota, et al., 2017).

As Aleixo, Leal and Azeiteiro (2016) highlighted, the role of education and, consequently, HEI, was matured and consolidated throughout a wide range of UN, UNESCO and HEIs' networks, events conferences, declarations and commitments, among the most relevant ones are: Stockholm 1972, Belgrade Conference 1975, Tbilisi Conference 1977, Talloires Conference 1992, Rio 1992, Johannesburg 2002, Nagoya 2014 (see Figure 2-4 for their timeline and brief description) . The list of conferences, declarations and events that somehow relate sustainable development to education or specifically higher education is quite broad and continues to grow over time. In the following paragraphs, we will outline only some of these momentums, with priority being given to those events that are more related to the framework proposed in this PhD thesis.

Figure 2-4 – Main events and declarations for sustainable development in higher education.

Source: (Aleixo et al., 2018; Berzosa, Bernaldo, & Fernández-Sánchez, 2017; Beynaghi et al., 2016; Casarejos, Gustavson, et al., 2017; Lozano et al., 2015; UN, 1987; UNEP, 1975; UNESCO, 2014; UNESCO & UNEP, 1977)

Stockholm 1972 was the first UN conference to focus on human interactions with the environment. It is considered the starting point of the process of greening society. Stockholm 1972 UN Conference paged various social actors, such as cities and educational institutions, to incorporate sustainability practices into their daily actions since they have been considered as critical elements for the global promotion of sustainable development (Berzosa, Bernaldo, & Fernández-Sánchez, 2017; Fischer et al., 2015; Tiyarattanachai & Hollmann, 2016).

The 19th Principle of the **Stockholm Declaration** is stated that environmental education is essential to achieving sustainable development. The following Principle of this Declaration, the 20th, addresses the importance of promoting scientific research and development and the free flow of up-to-date scientific information to facilitate the solution of environmental problems (Grindsted, 2011; Sohn, 1973; Tiyarattanachai & Hollmann, 2016; UNEP, 1972). Although there is already an understanding of the multidimensionality of the crisis faced, the early declarations that have emerged in that period emphasise the environmental dimension, to the detriment of a concern with a holistic perspective that enables the incorporation of the other dimensions of the triple bottom line (economic and social). This restraint in education can be illustrated by the adoption of the term "environmental education", recurrently used in early statements.

The first world Intergovernmental Conference on Environmental Education, organised by UNESCO and UN Environmental Programme (UNEP), was convened in Tbilisi in 1977. As a result, the **Tbilisi Declaration** was produced that is outlined as one of the most effective declarations to pave the way to institutionalise the commitment of educational institutions to sustainable development (Garcia et al., 2017; Hungerford, 2009). The Tbilisi Declaration was the first that directly boosted the educational sector to consider its role in promoting sustainable development (Grindsted, 2011). On its sixth principle, it is stated that

> environmental education should provide the necessary knowledge for interpretation of the complex phenomena that shape the environment, encourage those ethical, economic, and aesthetic values which [...] will further the development of conduct compatible with the preservation and improvement of the environment. It also provide a wide range of practical skills required in the devising and application of effective solutions to environmental problems (UNESCO, 1977, p. 25).

The **Talloires Declaration**, featured in Table 2-4, is organised by University Leaders for a Sustainable Future (ULSF). It was the first commitment made by HEI, and it is considered the prominent expression of a HEI engagement towards sustainable development (Adlong, 2013). This Declaration recognises a set of environmental impacts that threaten the survival of humans and living species and call for urgent actions to create an equitable and sustainable future for all humankind in harmony with nature. This ten-point Declaration has highlighted the urgency of "all universities engage in education, research, policy formation and information exchange on the population to move towards global sustainability and build an institutional culture of sustainability"(ULSF, 1990, p. 1).

Table 2-4 - The ten-points action plan of the Talloires Declaration

TALLOIRES DECLARATION – 10 Points Action Plan	
1) Increase Awareness of Environmentally Sustainable Development	Use every opportunity to raise public, government, industry, foundation, and university awareness by openly addressing the urgent need to move toward an environmentally sustainable future.
2) Create an Institutional Culture of Sustainability	Encourage all universities to *engage in education, research*, policy formation, and information exchange on population, environment, and development to move toward global sustainability.
3) Educate for Environmentally Responsible Citizenship	Establish programs to produce expertise in *environmental management*, sustainable economic development, population, and related fields to ensure that all *university graduates are environmentally literate* and aware and understand to be ecologically responsible citizens.
4) Foster Environmental Literacy for All	Create programs to develop the capability of *university faculty to teach environmental literacy to all undergraduate*, graduate, and professional students.
5) Practice Institutional Ecology	*Set an example* of environmental responsibility by *establishing institutional ecology policies* and practices of resource conservation, recycling, waste reduction, and *environmentally sound operations*.
6) Involve All Stakeholders	Encourage *government, foundations, and industry involvement in supporting interdisciplinary research, education, policy formation, and information exchange in environmentally sustainable development. Expand work with the community and non-governmental organisations to assist in finding solutions to environmental problems.*
7) Collaborate for Interdisciplinarity Approaches	Convene university faculty and administrators with environmental practitioners to *develop curricula, research initiatives, operations systems, and outreach activities to support an environmentally sustainable future*.
8) Enhance Capacity of Primary and Secondary Schools	*Establish partnerships* with primary and secondary schools to help develop the capacity for interdisciplinary teaching about population, environment, and sustainable development.
9) Broaden Service and Outreach Nationally and Internationally	Work with *national and international organisations* to promote a worldwide university effort toward a sustainable future.
10) Maintain the Movement	Establish a Secretariat and a steering committee to continue this momentum and inform and support each other's efforts in carrying out this declaration.

Source: (ULSF, 1990)

The Talloires Declaration also considered a ground-breaking agreement to the extent that the fifth action plan requires the "Practical institutional ecology", which could be translated into a call for HEI to become an example of sustainable development by "establishing institutional ecology policies and practices of resource conservation, recycling, waste reduction, and environmentally sound operations." (Khan, 2013; Ramirez, 2015; ULSF, 1990; Zutshi & Creed, 2018). The value and timeliness of this statement are still recognised nowadays by the call to HEI to "set an example of environmental responsibility by establishing institutional ecology, policies and practices of resources conservation, recycling, waste reduction, and environmental sounds operations." (ULSF, 1990).

Finally, as stated in Table 2-4, the Talloires Declaration requires that HEI "develop interdisciplinary approach to curricula, research initiatives, operations, and outreach activities that support an environmentally sustainable future". As of June 2020, 515 HEI around the globe were signatories to the Talloires Declaration (ULSF, 2020).

Halifax Declaration was provided because of the Conference on University Action for Sustainable Development in Halifax, held in 1991. The Declaration frames the need for consensus in order to "ensure that the voice of the university is clear and uncompromising in its commitment to the principles and practice of sustainable development within the university, and at the local, national and global levels" (Clark & MacDonald, 1992; IAU, 1992; Wright, 2003).

The importance of the conference lies in the fact that it recognises that HEI "must be challenged to rethink and reconstruct their environmental policies and practices in order to contribute to environmental sustainability on local, national, and international levels."(Wright, 2003, p. 233).

The United Nations Conference on Environment and Development (UNCED), or **Earth Summit**, was held in Rio de Janeiro in June 1992, brought more heads of state and government together than any previous meetings. At this meeting, five autonomous agreements were signed: The Framework Convention on Climate Change (FCCC), Agenda 21, The Rio Declaration, and the Forest Principles (Grubb et al., 2019). Agenda 21 consisted of an action plan formed by a set of commitments grouped into 40 chapters that contribute to the operationalisation of the concept of Sustainable Development for the whole of global society (Leicht et al., 2018). Chapter 36.1 supports the development of sustainable educational institutions, encouraging the government to develop strategies and plans to support research and education for sustainability. It specifies that:

> Education, including formal education, public awareness and training, should be recognised as a process by which human beings and societies can reach their fullest potential. Education is critical for promoting sustainable

> development and improving the capacity of the people to address environmental and development issues. (UNCED, 1992, p. 320)

In 2000, the **UN Millennium Summit** put in place the eight-millennium development goals to be achieved by the end of 2015, known as the Millennium Development Goals (MDGs). The eight goals focus mainly on reducing poverty, meeting basic human wants and needs, fulfilling human rights (including primary education and gender equality) and integrating Sustainable Development into country policies and programmes.

The launch of the MDGs is seen as a milestone in the early adoption by multilateral and governance bodies of global performance indicators (GPIs), which is understood in literature as a more accurate performance assessment metric (Bisbee et al., 2020). Each goal is structured into one or more “targets”, which is divided into detailed numerical indicators that serve as a basis for assessing progress. Bisbee et al.(2020) state that these metrics facilitate performance monitoring in implementing objectives while encouraging governments to achieve the quantifiable targets set. According to Unterhalter (2014), education holds some space in constructing the Millennium Development Goals (MDGs). It is considered on two goals. MDG 2 focuses on achieving universal primary education in a formal setting, and MDG 3 includes a target on achieving gender parity in formal settings for primary, secondary, and tertiary education. The UN MDG Report considers that the MDG “provided an important framework for development and significant progress has been made in several areas. Nevertheless, the progress has been uneven, particularly in Africa, least developed countries, landlocked developing countries and small island” (United Nations, 2015, p. 9). According to the UN report, the gaps will be further fulfilled by the 17 SDG developed on the novel Agenda to 2030.

In addition to the adoption of global performance indicators, the MDG Acceleration Framework (MAF) was created to improve the implementation of the MDGs. It provides a systematic way for countries to develop and implement their own action plan based on existing plans and processes to pursue their MDG priorities. The MDG Acceleration Framework consists of four systematic steps that governments, UN Country Teams (UNCTs) and other stakeholders could apply to boost the implementation of the MDGs. One example of the application of the MAF is shown in Figure 2-5, and the four steps are briefly explained in Table 2-5.

Figure 2-5 shows an example of a country performing poorly on MDG1 to illustrate the accelerating progress toward MDG 1 (eradicate extreme poverty and hunger) through the MDG Accelerating Framework.

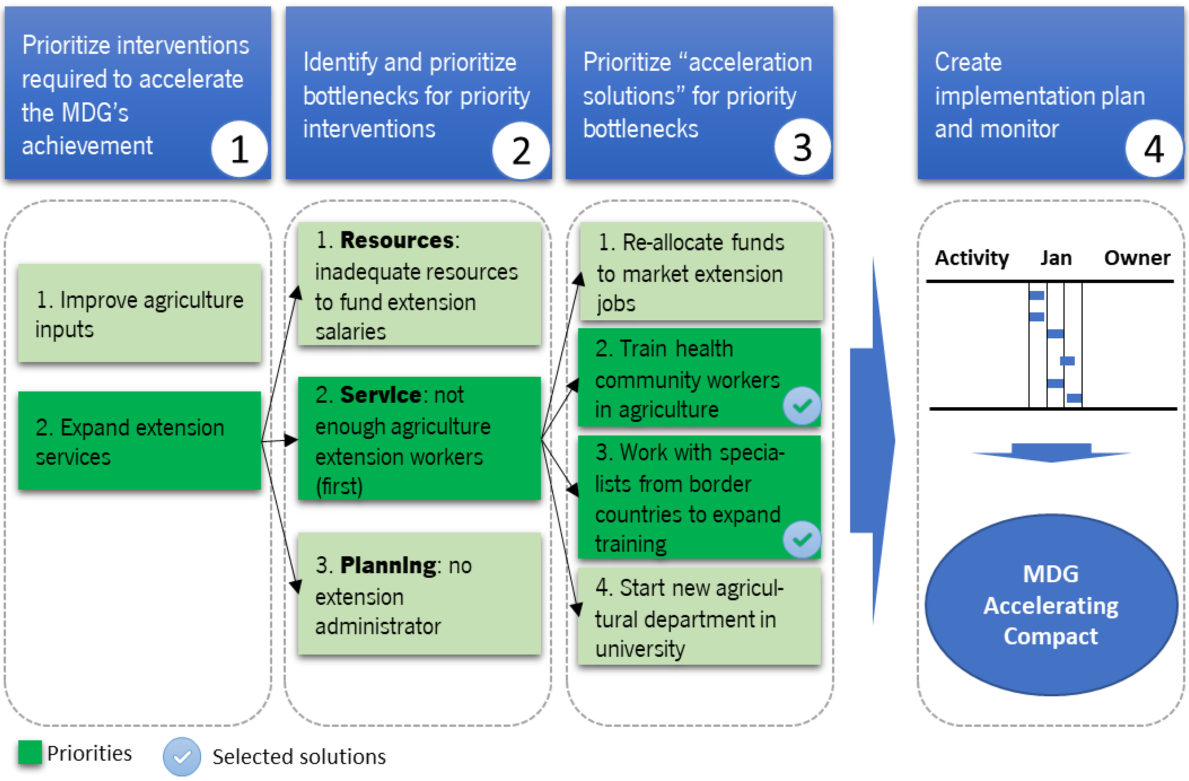

Figure 2-5 - Overview of the steps, using MDG 1 as an example.

Source: adapted from (UN, 2011, p. 16)

On the top of the columns are the four steps on the box bellow; for each step the potential interventions are listed; on the first step all interventions go through impact and feasibility analysis; on the second step it is identified and prioritised the bottlenecks that prevent implementation of the intervention; step 3 is focused on finding accelerating solutions; finally, step 4 is used to develop the implementation and monitoring plan for the solutions identified on the third step.

Table 2-5 - Steps of the MDG Acceleration Framework

Step	Description
1) Intervention identification:	Determine the strategic interventions required to achieve the MDGs by 2015 (mainly informed by country/sector plans and focused on the MDG targets that are off-track or unlikely to be met by 2015 at current rates of progress).
2) Bottleneck prioritisation	Identify and prioritise bottlenecks preventing the selected interventions from being implemented effectively and at scale.
3) 'Acceleration solutions' selection	Determine 'acceleration solutions' for these bottlenecks.
4) Implementation planning and monitoring	Create a shared implementation and monitoring plan for the 'acceleration solutions' (including an accountability matrix for the government and its partners). These actions can serve as the basis for an MDG Acceleration Compact (or MDG Acceleration Plan) for the selected off-track MDG(s) to facilitate the involvement of

	and coordination among the government, development partners (including the UNCT) and civil society. Such a compact can help ensure comprehensive support for the required actions and draw upon the strengths of each partner while streamlining efforts and reducing redundancies.

Source: (UN, 2011, p. 6)

Some of the benefits reported in adopting the MGD Accelerating Framework are: (i) identification of relevant evidence-based, cost-effective and country-specific interventions; (ii) light prioritisation of interventions based on knowledge of bottlenecks, resources needed, and funding constraints; (iii) logical approach to identify and prioritise direct-cause bottlenecks; (iv) align a network formed by agencies and development parts around the solutions; and, (v) enables systematic tracking of the progress against action plan (UN, 2011).

Ten years after Rio 92, it took place in Johannesburg the **World Summit on Sustainable Development** (WSSD). It was hardly a point of dispute acknowledging that not enough progress had been made for most global environmental issues addressed on Agenda 21, and methodological and others changes should be implemented in the framework of the formulation of commitments so as to allow for better implementation and monitoring (Kyle, 2020; UN, 2002). According to Grindsted (2011), during the Johannesburg Summit, the **Ubuntu Declaration** was embraced as an effort to make integrated solutions work for sustainable development and mobilise the education sector to contribute to sustainable development. On the Ubuntu Declaration, HEI were committed to

> work towards a new global learning space on education and sustainability that promotes cooperation and exchange between institutions at all levels and in all sectors of education around the world. This space must be developed on the basis of international networks of institutions and the creation of regional centres of excellence, which bring together universities, polytechnics, and institutions of secondary education and primary schools. We invite all other responsible stakeholders to join us in this endeavour. (UNESCO, 2002, p. 2).

Haigh (2007) states that the Ubuntu Declaration reinforces that greater emphasis must be given to education, particularly in science and technology, and that it is critical to achieving sustainable development goals and seeks a global alliance to promote these ends. The WSSD 2002 also made recommendations to the UN General Assembly to consider the adoption of the UN Decade of Education for Sustainable Development (DESD) starting in 2005.

As a result, in December 2002, United Nations General Assembly was declared 2005–2014 as a **Decade of Education for Sustainable Development** (DESD). UNESCO, the leading agency for DESD, Claims that education plays a "decisive role in providing learners across the world with the knowledge, skills and values to discover solutions to today's sustainability challenges" (UNESCO, 2014, p. 3). The Education for Sustainable Development (ESD) aimed to encourage the transformation of education so that it can contribute effectively to the reorientation of societies towards sustainable development (UNESCO, 2014). To accomplish these goals, it is necessary to reorientate the educational systems and their structures and reshape the teaching and learning processes. Following a similar approach initiated on MDG, the DESD has employed a Global Monitoring and Evaluation Framework (GMEF) that was primarily developed to set parameters for identifying how to monitor and assess progress in ESD during the Decade (Tilbury, 2009). Monitoring and evaluating the implementation of educational programmes and interventions are critical to assess progress, identify problems, and facilitate change to improve service delivery and reach the desired outcomes.

At the 70th Session of the UN General Assembly, held in September 2015, Member states set in motion the new global development agenda, entitled **Transforming our world: the 2030 Agenda for Sustainable Development**. The Agenda brings together 17 Sustainable Development Goals that have the fourth as a specific goal on education and makes explicit reference to higher education on target 4.3 of SDG 4, stating that "By 2030, ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university" (Owens, 2017). Target 4.b plea for more study abroad scholarships for students from developing countries and target 4.7 challenges schools and universities to build crucial sustainability concepts across the curriculum, such as climate change, human rights, and peace studies. After a long wait, higher education is finally formally at the development table (Owens, 2017). According to (Paletta & Bonoli, 2019), universities are gradually rethinking all their activities and processes to address **Agenda 2030**.

Many authors have been observing that the fact of becoming a signatory to some institutional commitment is not necessarily related to the embellish of effective SD initiatives to promote the needed changes in either the internal or external domains of HEI activities (Adlong, 2013; N. Alghamdi et al., 2017; Dlouhá et al., 2018; Grindsted, 2011; Lozano et al., 2013, 2015). Although it is acknowledged that there is no direct relationship, and much remains to be done, the authors describe that the statements, in some way, have contributed to driving the main changes in the educational sector towards accepting their role in shaping themselves into the existing SD policies, contributing to incorporate the SD initiatives into their managerial and formal structure (Dlouhá et al., 2018).

A detailed analysis of the original texts and comments produced from the main events, statements and commitments involving education in promoting sustainable development highlights how the issue is gradually addressed. As a summary, in Stockholm 1972, the focus was on the diagnosis of the situation of structural instability, the allocation of responsibilities between northern and southern countries, and the need to engage the entire social network to address the problem (Sohn, 1973; UNEP, 1972). The Tbilisi and Belgrade declarations focus on the environmental dimension of education, proposing a conceptual framework for promoting "environmental education" at all levels (local, regional and international) for all age groups from formal and informal education (UNESCO & UNEP, 1977). The Belgrade Declaration recognises the need to reformulate educational systems and processes to build a new ethical development and a new social-economic order (UNEP, 1975). These two statements prior to the publication of the Brundtland report set the background in which the premises of education for sustainable development (EDS) will flourish. Themes such as "continuous life-long process", "interdisciplinary approach", "active participation", "acquiring awareness, knowledge, attitudes, and skills for solving environmental problems" emerge as central to forge the critical vocabulary embraced by the education systems.

In the statements subsequent to the publication of the report "Our Common Future", an effort to integrate the dimensions of sustainable development in a more harmonious way is noted. There is also the detailing and deepening of the role of HEI in promoting the social transition to more sustainable patterns. HEI have been pressured to assume the role of leaders in this process through their example, i.e., there is an increasing push for HEI to take initiatives to manage the aspects and impacts arising from campus operations (Zutshi et al., 2018). For example, the Talloires Declaration (1990) requires HEI to "set an example of environmental responsibility by establishing institutional ecology policies and practices of resources conservation, recycling, waste reduction and, environmentally sound operations" (ULSF, 1990, p. 1).

Further, because of the Rio 92 Conference, Agenda 21 emerges, the first global commitment structured in 40 chapters that incorporate the main nuances of the concept of sustainable development, as published in "our common future". Despite Agenda's advance, the frame adopted to face the issues addressed in Agenda 21 has not been settled as a management plan structure, with deadlines, goals and responsibilities formally established. In spite of the progress of the Agenda concerning previous statements, it is still considered to be less than necessary, as it does not establish formal plans with assigned goals and responsibilities or instruments for monitoring performance in the implementation of commitments. For example, Alghamdi et al. (N. Alghamdi et al., 2017) state that although the declarations include important educational guidelines, many fail to offer concrete prescriptions to make the SD concept operational. The difficulties involved in implementing the declarations are reported widely, as well as the need for developing monitoring and development tools (Grindsted, 2011).

This limitation has been partially overcome since the United Nations Millennium Declaration in 2000. This Declaration committed nations to a new global partnership to reduce extreme poverty and set out a series of eight time-bound targets - with a deadline of 2015 - that have become known as the Millennium Development Goals (MDGs). A framework was designed to monitor the progress of the MDG, strengthening the use of robust and reliable data for evidence-based decision-making.

> The MDG monitoring experience has clearly demonstrated that effective use of data can help to galvanise development efforts, implement successful targeted interventions, track performance and improve accountability. Thus, sustainable development demands a data revolution to improve the availability, quality, timeliness and disaggregation of data to support the implementation of the new development agenda at all levels. The monitoring of the MDGs taught us that data are an indispensable element of the development agenda.

The MDGs provided efforts to increase the production and use of development data as well as the capacity to strengthen statistical methodologies and information systems at both national and international levels. This has made it possible to carry out a global follow-up of the established goals.

This tendency to establish commitment formats more in line with management plans and monitoring systems is being consolidated in the following commitments. For example, during the implementation of DESD, the Monitoring and Evaluation Expert Group (MEEG) was formed to develop the Global Monitoring and Evaluation Framework (GMEF) (UNESCO, 2005). Moreover, in the 2030 Agenda for Sustainable Development, 169 indicators were developed to guide the implementation of the 17 goals. Additionally, Section 47 of the Agenda refers to establishing instruments to enable follow-up and review during its implementation. The quote below describes this commitment:

> Our Governments have the primary responsibility for follow-up and review, at the national, regional and global levels, in relation to the progress made in implementing the Goals and targets over the coming fifteen years. To support accountability to our citizens, we will provide for systematic follow-up and review at the various levels, as set out in this Agenda and the Addis Abeba Action Agenda (2015, p. 14).

According to Alghamdi et al. (2020, p. 2), the wide range of non-statutory declarations signed by HEI has impacted the promotion of SD principles in HEI in the following ways: "(i) They help shape as instrumental argument of the surrounding role of a university about sustainable development. Among these, (ii) these declarations help formulate national legislations around resource utilisation and highlight goals towards reducing the adverse impacts of HEI, (iii) they pave the road towards the development of tools that help rank, assess, and communicate the progress of sustainability in HEI". While authors such as Leal Filho, Shiel, et al. (2019) and Lozano et al. (Lozano et al., 2013) have presented the benefits of adopting an integrated managerial approach that allows the unification of the main initiatives carried out by HEI, however, these institutions have experienced difficulties in integrating the initiatives. Finally, as outlined previously, the signed declarations and events have also boosted the emergence and proliferation of networks formed by universities committed to sustainable development principles (Adomßent, 2013; Blanco-Portela et al., 2018; Dlouhá et al., 2018).

2.3. **Sustainable Development Initiatives at HEI**

2.3.1. Concept and dimensions of sustainable HEI

There has been a growing consensus that universities have played a strategic role in promoting sustainability in the last two decades. Furthermore, it has been a relative broad recognition that universities have somehow converged to assume their responsibility in implementing sustainability policies under the terms established by the multilateral agreements signed at conferences such as those previously mentioned (Figure 2-4).

The acknowledgement of the convolute role of HEI to assist society in addressing more sustainable styles takes into account different aspects, such as the fact that they are institutions that promote innovation (Lozano, 2006b), and have an enormous potential to: (a) change the world preparing future leaders and citizens through training, research, practical initiatives related to sustainability and effective engagement of community participation. The purpose is to make future leaders and citizens more conscious and active in the dissemination of sustainable development principles in areas of the world where opinion leaders and media outlets have created pervasive misinformation among the public about environmental issues (Baletić et al., 2019; Etse & Ingley, 2016; Hess & Collins, 2018); (b) to take a leading role in promoting regional sustainable development (Karatzoglou, 2013); (c) to accelerate transition towards low-carbon technologies (William Horan et al., 2019; Leal Filho, Vargas, et al., 2019) and also (d) as owners of large physical structures that consume water, energy and other resources and also produce high amounts of complex and dangerous waste. Therefore, HEI have the opportunity to implement actions to monitor and decrease the impacts and costs of their own activities (Abdullah et al., 2017; Alshuwaikhat & Abubakar, 2008; Bieler & McKenzie, 2017); (e) taking into account the population density under HEI administrative infrastructure, from diverse background and economic situation, HEI must develop ways to engage them to act in their own daily routines to support needed changes for sustainable development.

By embracing those positions, HEI call for being recognised as sustainable institutions. According to Ceulemans, Molderez and Van Liedekerke (2015), university institutions should be considered differently from other public or corporate institutions due to their specificities and importance.

Anthropogenic greenhouse gas (GHG) emissions are considered the primary reason for global climate change. To address climate change and its adverse impacts, the United Nations approved in 2015 the Paris Agreement to substantially reduce global GHG emissions to hold the increase in the global average temperature to well below 2° C above pre-industrial levels, while pursuing means to limit the increase to 1.5 degrees (A. Alghamdi et al., 2020; Rogelj et al., 2016). Considering that the burning of fossil fuels is one of the main factors for raising global temperatures, actions to reduce fossil fuels are fundamental to accomplishing the goals settled in the Paris 2015 agreement and on the 2030 agenda. Many HEI have been developing aggressive energy-reduction, and climate change plans to address it. Besides the advances regarding the promotion of sustainability on HEI, through the implementation of the described sustainable initiatives, numerous self-funded HEI have also been engaged in divestment campaigns to enhance the actions to promote sustainability. Divestment in a broad sense could be understood as the “removal investments, such as stocks, bonds of funds, from certain institutions, due to prejudicial activities developed by them” (Fabbri, 2018, p. 115). The divestment trend has become increasingly global, and the pressure for social responsibility has led to several HEI committing to divest their financial holdings from fossil fuel companies.

Fabbri (2018) acknowledge fossil fuels divestment (FFD) as the action of removing investments from companies dedicated to finding and burning oil, gas and coal due to the adverse effects their activities cause to climate change. The literature reports several experiences related to fossil fuel divestment carried out on HEI from different countries and highlights the relevance of community campaigns to pressure HEI on the divestment process. Maina et al.’s (2020) study examined the extent of fossil fuel divestment campaigns at HEI across Canada. Findings suggest that out of 220 HEI, there are 38 active divestment campaigns; up to date, 6 HEI have agreed to partial or total divestment. According to the cited authors, two Canadian HEI divested from FFD apparently without external pressure.

As reported by Alshuwaikhat and Abubakar (2008), a sustainable campus or higher education institution promotes equity and social justice in its affairs and exports these values at community, national and global levels. It also should provide a healthy campus environment with a prosperous economy through energy and resource conservation, waste reduction and effective environmental management. Hence it should be stressed that in a broader perspective, the effects of HEIs' sustainability practices often extrapolate the boundaries of their geographical area, bringing benefits to their local, regional and sometimes national environment (Leal Filho, Vargas, et al., 2019).

Larrán Jorge, Herrera Madueño, Calzado Cejas, and Andrades Peña (2013) assumed that the leadership model that is expected from the higher education institutions in terms of sustainability practices is a piece of application evidence - setting the example by integrating sustainability practices into its operations and daily routines.

Several authors define sustainable HEI. For example, Cole (2003, p. 30) has defined it as

> the one that acts upon its local and global responsibilities to protect and enhance the health and well-being of humans and ecosystems. It actively engages the knowledge of the university community to address the ecological and social challenges that we face now and in the future.

Later in 2006, Velazquez (2006, p. 812) describes it as

> A higher educational institution, as a whole or as a part, that addresses, involves and promotes, on a regional or a global level, the minimisation of negative environmental, economic, societal, and health effects generated in the use of their resources in order to fulfil its functions of teaching, research, outreach and partnership, and stewardship in ways to help society make the transition to sustainable lifestyles.

The authors, acknowledging the broad scope of the term sustainability, argue that each HEI should develop its own definition of sustainable HEI (Velazquez et al., 2006). The completest definition found in the literature review was proposed by Sterling, Maxey, and Luna (2013, p. 23), according to which a sustainable university, in a holistic approach,

> 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.

Considering the magnitude and complexity of environmental challenges, coping with these problems can be a bold dare for higher education institutions and society. Due to the extent, size of the academic community and the complexity of its activities, HEI can cause high impacts on the environment, making some authors such as Alshuwaikhat and Abubakar (2008) and Zhang et al. (2011) compare them to small cities and living labs for sustainable development. Given the broadness and continuously growing of the HEI's responsibility regarding the promotion of sustainable development principles, HEI has been required to institutionalise not only their commitment but also the ways adopted to accomplish it through efforts to design formal and integrated plans (Leal Filho et al., 2016; Leal Filho, Skanavis, et al., 2019).

Literature provides several models to HEI shape themselves into the principles of SD. For instance, Velazquez et al. (2006) designed a model of a sustainable university using a benchmarking process, consisting of benchmarking the best practices embellished by HEI. The data used by the authors were collected by literature review and the administration of a survey. The model comprises four phases. The first phase consists of designing the vision of a sustainable university. According to the authors, it would guarantee that all resources are used to accomplish the university's mission in a sustainable manner. The second phase deals with creating the mission. On the third phase, the authors recommend forming a Sustainable Committee that will assist the institution in incorporating policies into its routine operation and the generations of the needed means to the achievement of the mission. The last phase comprises the sustainability strategies to infiltrate sustainable development in all aspects of the university (Velazquez et al., 2006). The central aspects of the designed model are shown in Figure 2-6.

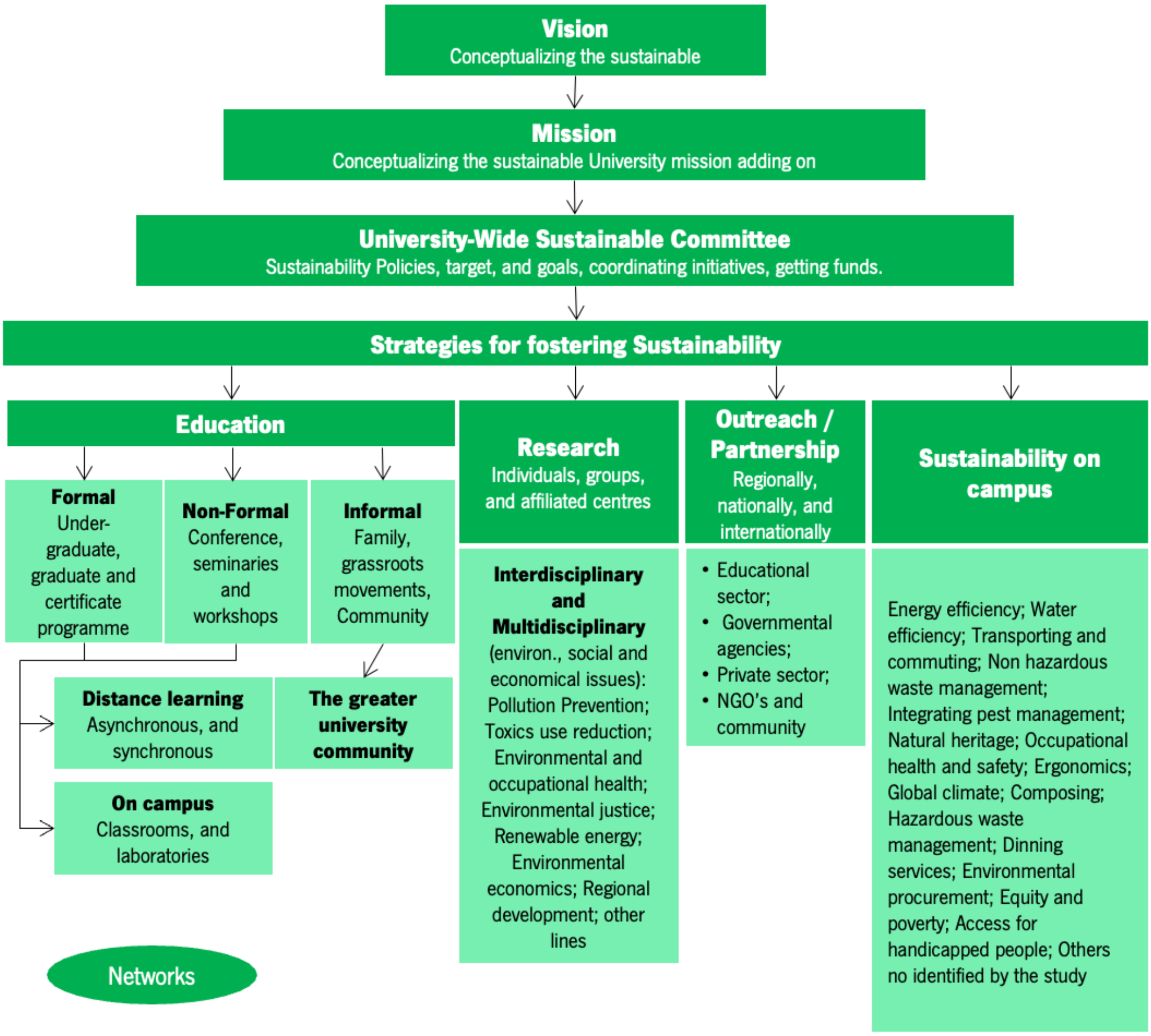

Figure 2-6 - Sustainability university model adapted from Velazquez et al. (2006)

A similar framework to achieving campus sustainability was proposed by Alshuwaikhat and Abubakar (2008). The main difference is that the former authors propose an approach to achieving campus sustainability by implementing the ISO 14001 standard. The authors recognise significant limitations of his model based on the ISO 14001 standard, such as a) the lack of coverage of the social and economic dimensions of the HEI sustainability; b) the generic policy of the standard that does not describe specific environmental performance, objectives, or targets to the main activities of an HEI. The model designed by Alshuwaikhat and Abubakar (2008) is illustrated in Figure 2-7.

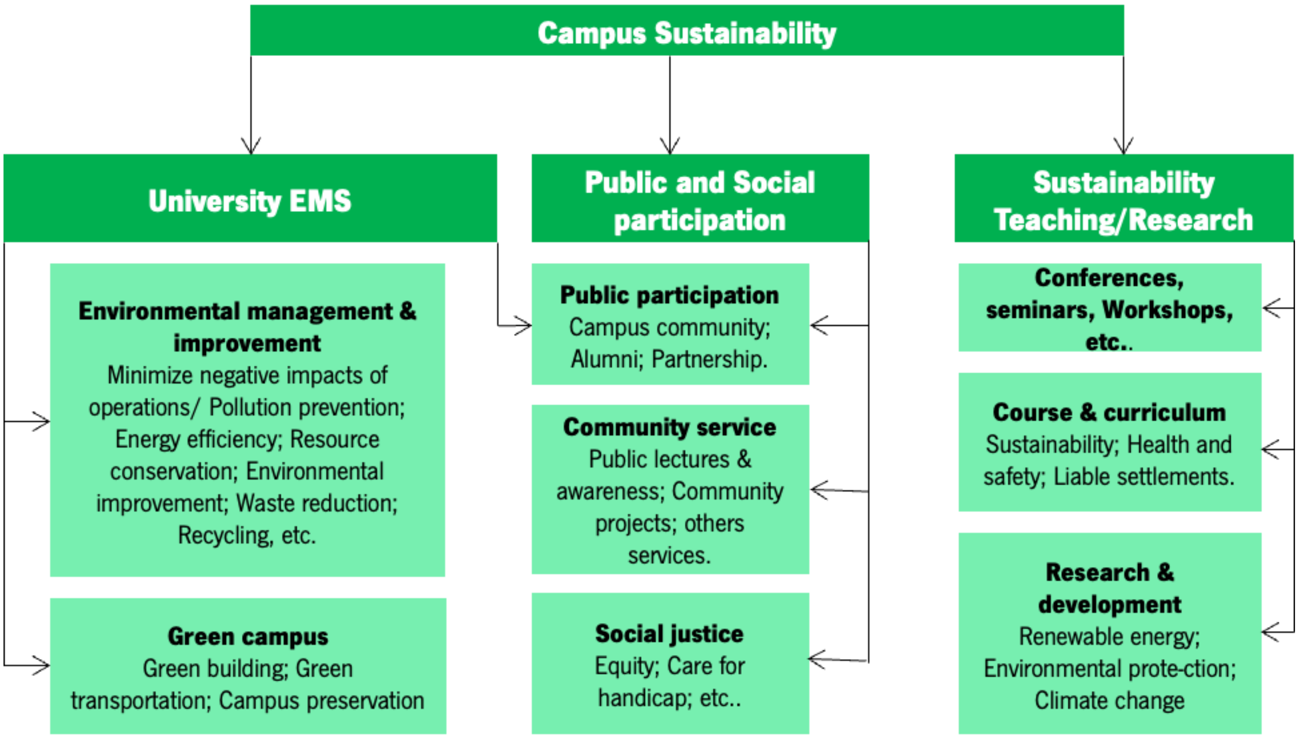

Figure 2-7 - Framework for achieving sustainability (Alshuwaikhat & Abubakar, 2008).

In recent decades, HEI sustainability has become a core issue for many university policymakers and practitioners as a result of the comprehension of its impacts arising from its activities and operations over the environment, society, and public budget. Leal Filho et al. (2019) stated that HEI must engage in internationalisation strategies in order to learn and deliver back to local level best international practices in sustainable development. HEs might also influence local stakeholders, acting as an example in implementing sustainable development principles and creating living laboratories in cooperation with the local community to provide the needed education, research, and innovation to address the sustainability issues.

The need for environmental sustainability in HEI has been stressed in many articles. To address these demands HEI are developing a variety of initiatives, among which are those aimed at: redesigning the curriculum (Gough & Longhurst, 2017; McGibbon & Belle, 2015; Tan et al., 2017; Willats et al., 2017); encouraging applied research and innovation to help society monitor and solve environmental problems (Adomßent et al., 2014; Salehi et al., 2015; See et al., 2016; Suriyankietkaew & Petison, 2019); promoting strategies to improve the wellbeing of the academic community (LeBleu-Burns, 2020; Tausen et al., 2020); haring technologies with local stakeholders to improve levels of local development (Leal Filho, Vargas, et al., 2019), and dealing with campus operation (A. Alghamdi et al., 2020; Leal Filho et al., 2017).

Shawe, Horan, Moles, and O'Regan (Shawe et al., 2019) quote a great diversity of initiatives that HEI are engaging in, namely initiatives relating to the sectors of finance, curriculum, energy, green buildings, green labs, biodiversity, research, waste, outreach and student engagement, transport, food, governance, and water, to cite a few. These can be classified under education, outreach, research, operations, and governance.

The following paragraphs will summarise literature reports on experiences of good practices in implementing SDI in the routine activities of a typical HEI: education, research, outreach, governance, and operations.

Regarding the educational and research systems, there is a broad consensus that HEI must boost their students SD competencies to fulfil their role. Hensley (2018) states that the conventional approaches to higher education are failing to equip students with the ability to respond to sustainability issues, such as climate change, the rapid loss of biodiversity, extreme poverty, and water shortages, to name a few. According to Etse and Ingley (2016), in order for education to play its role in promoting the sustainability agenda, the curriculum should be developed to shape the sustainable world.

To reassembling education to implement SD in the curriculum of HEI, Schweizer et al. (2019) suggest the following three approaches: 1) integrating it as a perspective into the existing curriculum; 2) offering specific degree programs or shorter courses on SD, and 3) providing elective study programs in which students may achieve competencies related to SD in addition to their conventional degree program.

Another recurrent topic in the literature in the area of education, is about which competencies should be developed in students to meet the knowledge and skills demands related to sustainable development, as well as the pedagogical methods that allow the acquisition of the required competencies (Faham et al., 2017; Molderez & Fonseca, 2018; Warda, 2014). Among the pedagogical approaches that have been adapted to address the learning gaps in promoting sustainability literacy are the project-based and problem-based learning approaches: two student-centred approaches based on "learning by doing," which involve students in design, problem-solving, decision making, or investigation of activities related to complex tasks (Dobson & Tomkinson, 2012; Leal Filho et al., 2016; Wals, 2014).

According to del Mar Alonso-Almeida et al. (2015), the commitment of HEI to embolden research in the SD field was established on a considerable number of agreements and declarations. For instance, in the

Rio+20 and the UN Conference, HEI are committed to "teach concepts related to SD, encourage research on development issues, support sustainability efforts and engage with and share its results through international sustainability research frameworks." (Alonso-Almeida et al., 2015, p. 145).

The research for sustainable development is also a concern to governments. The European Commission on the report 'Mission-Oriented Research and Innovation in the European Union – A problem-solving approach to fuel innovation-led growth', written by Mariana Mazzucato, provides strategic recommendations on missions and how they can be structured in the future EU Research and Innovation Programme. On the report it is stated that

> Research and innovation missions at the European level should be prioritised in those areas where the added value to the EU is greatest. A mission should have societal relevance, for example in the ability to improve health, nutrition, or the living environment for a large section of European citizens across a range of Member States. Research and innovation missions should aim to improve society's welfare (Mazzucato, 2018, p. 8).

The work of Genus and Theobald (2015) was intended to improve the understanding of the potential roles of academic researchers in facilitating the development of low carbon and generally more environmentally sustainable neighbourhoods and communities. The authors highlight the convenience of securing research funding for SD projects and assessing the quality of the research undertaken in HEI and also emphasise the benefits of integrating academic research teams and local agencies in order to promote applied and field-based research. The concern about funding in sustainable development research is also considered in the works of Aguinis, Shapiro, Antonacopoulou, and Cummings (2014) and Bozeman and Youtie (2017). The latter analysed the socio-economic impacts of government research funds.

Integrating sustainability development into the outreach system involves sharing sustainability knowledge and expertise beyond the academic sphere. Narasimharao (2013, p. 245) suggest that "the university outreach should be based more on the concepts of collaboration and cooperation with all the players as equal partners with free flow of information between all the players." For those authors, the HEI have been evolving programs/research focused on "knowledge integration and knowledge management at all levels and facilitates the use of academic capacity in practice and also in developing academic capacity based on the practice in real life situations."

The significance of campus operations systems has been highlighted in most HEIs' SD declarations, such as the Talloires Declaration, Rio + 20 and Higher Education Sustainability Initiatives (HESI) in 2012. According to Leal Filho et al. (2017), HEI have a high potential to implement SD into their operations rapidly. The implementation of campus operations initiatives is one of the sustainable development areas in HEI that has shown significant advances with many publications (Findler, Schönherr, Lozano, Reider, et al., 2019; Lozano et al., 2015). The campus operations system generally covers physical operations/facilities management and includes energy efficiency (Altan, 2010; Leal Filho, Salvia, et al., 2019; Salehi et al., 2015), transport and GHG emissions (Robinson et al., 2015; Xu et al., 2018), waste management (Merger et al., 2018), green building (Abdelalim, 2017), water management (Bhattacharyya, 2020), and ethical procurement (Leal Filho, Skouloudis, et al., 2019) or green purchasing mainly on the field of private HEI (Leal Filho, Kovaleva, et al., 2021).

In the work of Leal Filho et al. (2017), an exploratory study carried out an international study with a sample of 269 experts to identify the fundamental obstacles to implementing sustainability at universities. The outcomes showed twenty-five obstacles preventing HEI from engaging in sustainable development actions. The six more reported by the sampled specialists are lack of support from management, lack of appropriate technology, lack of awareness and concern, lack of buildings with sustainable performance and government barriers.

On the work of Leal Filho, Amaro et al. (2021) applied to mapping sustainability initiatives in higher education institutions in Latin America, in a sample of 157 participants from 13 Latin American counties were identified a set of 19 different types of initiatives undertaken to implement sustainable development in HEI. As illustrated in Figure 2-8, the implementation occurs by means of three distinctive groups: campus operations, outreach and research, and teaching.

Campus operations act within the scope of sustainability practices aimed at managing operational aspects, such as water, energy, landscaping, reduction of consumption, control of emissions, and green purchasing.

The second group - *outreach and research* - clustered initiatives are related to the interaction of the HEI with their stakeholders and SD-related research. Referring to the need for integration between theory, research and practice, Ali and Brown (2017) recognise that these three aspects have to be better integrated in order to offer practical solutions to face the challenges of the 21st century. In particular, there are some efforts to integrate the research dynamics with institutional outreach actions in applied research. For example, in work carried out by Redwood et al. (2016), the development and establishment of micro-level 'operating units' were undertaken evolved through a structural partnership between the National Health Service (NHS), local authorities, patients, the public and universities, to foster collaboration across its stakeholders and generate healthcare knowledge and foster good practice. This system, characterised by mutual engagement and collaboration, created the right conditions to produce the desired outcomes of integration and innovation. This approach also facilitated the collaboration and information flow among research and communities of practice while assuring the development and promotion of a joint research agenda on health issues.

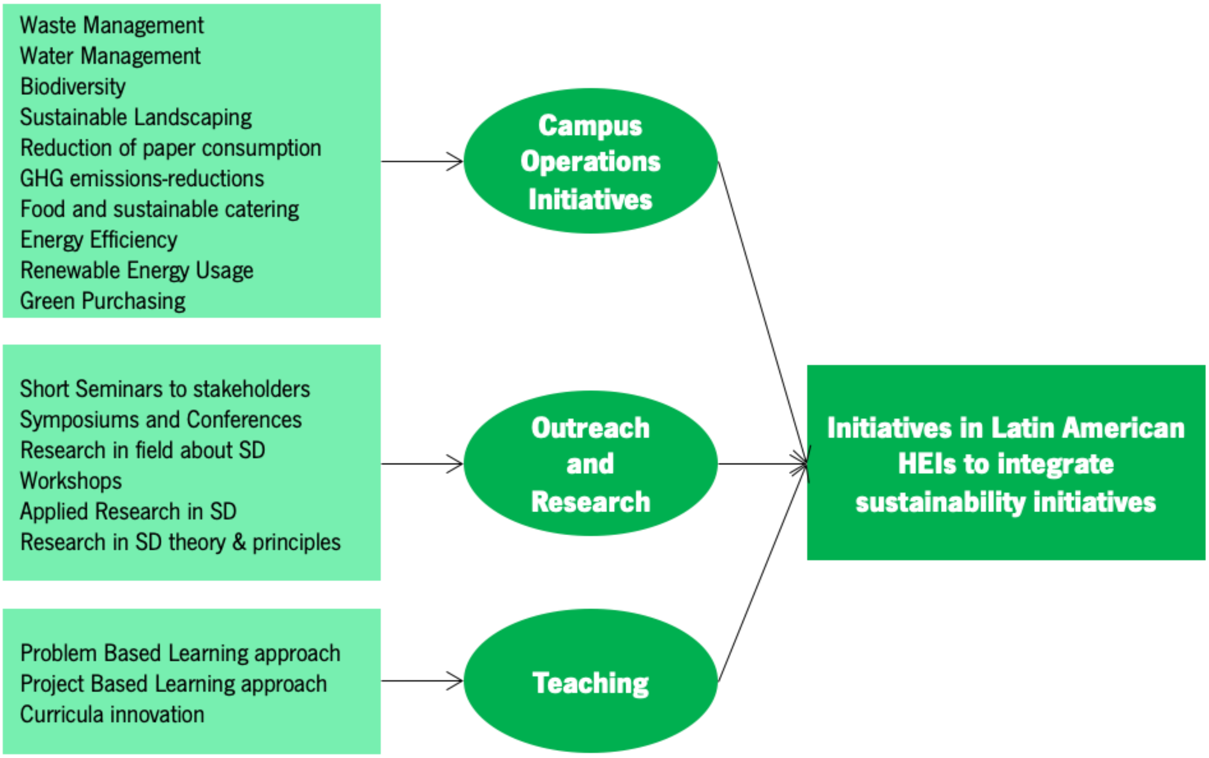

Figure 2-8 - Model for Sustainability Initiatives at Latin-American HEI

Source: (Leal Filho 2021)

Finally, the *teaching* group embraced strategies developed to provide students with the necessary skills to work in their professions considering SD aspects.

In the previously mentioned study (Leal Filho, Amaro, et al., 2021), the authors also identified the main drivers and barriers to implementing these initiatives in Latin American universities. The three drivers most mentioned by the surveyed sample were: the ethos of the organisation, the organisational image, and the possibility of cost reduction with the implementation of SDI. In contrast, the three most mentioned barriers were: the lack of funding, the lack of materials or resources, and the lack of support from the administration.

Cortese (2003) stated that HEI sustainability is achieved by considering the following four dimensions: education, research, campus operations, and reporting. Later Lozano (2006) and Lozano et al. (2015) complemented the model, including some new dimensions: institutional framework, on-campus experience, and outreach, and finally, associated the existing dimension reporting with the assessment practices. Table 2-6 presents a brief description of each dimension of HEI sustainability.

Table 2-6 - Dimensions of HEI sustainability

Dimension	Description
Education	It comprises propositions related to the presence of sustainability themes in the course curriculum, skills development, and teacher training programs. This dimension relates not only to the theme of sustainable HEI but also to a much broader scope of knowledge, including 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 to produce knowledge technology and sustainable innovations.
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 to sustainable development. It considers the presence of SD 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 academic community's daily manifestation of sustainability concerns.
Outreach	It refers to actions related to the integration of the university with society, which includes other universities, governments, companies, schools, civil society organisations and the local community.
Assessment and reporting	It involves implementing an integrated environmental management system (EMS) 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.

Source: Adapted from Cortese (2003); Lozano (2015) and Fischer et al. (2015)

Much of the attention of the sustainability research focusing on HEI, 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 (E. A. Hopkins, 2016), waste (Zen et al., 2016) and carbon emission (Altan, 2010; Larsen et al., 2013; T. B. Ramos et al., 2015).

Some of the dimensions listed in Table 2-6 have emerged as a response to the HEI 'signed' agreements at international conferences and meetings mentioned in the previous section 2.2 of this PhD thesis. More traditional assessment frameworks such as AISHE (Assessment Instrument for Sustainability in Higher Education) and SAQ (Sustainability Assessment Questionnaire) tend to focus on items related to the curriculum and more superficially through aspects related to campus operation.

Without intending to cover all the models for implementing sustainability initiatives in HEI, given the vastness of existing models, this topic is concluded with the presentation of a conceptual framework designed by Casarejos, Frota, et al. (2017) and Casarejos, Gustavson et al. (2017) that proposes a set of 40 sustainability actions, clustered into four dimensions (Administrative, Social and Cultural, Academic, and Operational) to provide a guide to support HEI in implementing SD initiatives. The dimensions and their key topic are described in Table 2-7.

Table 2-7 - Conceptual framework of Casarejos, Frota et al. (2017)

Dimensions	Key topics fostering sustainability in HEI
Administrative	Governance; Transparency; Planning; Monitoring; sustainability Reporting; Assessment; Budgeting; Investment innovation
Social and Cultural	Social equity; Gender equality; Awareness; Engagement; Altruism; Wellbeing; Outreach; Affordability; Holistic thinking
Academic	Curriculum; Research; Interdisciplinary approach; Intercultural dialog; Innovation and transferability; Collaboration
Operational	Water; Energy; Food; Materials; Waste; Grounds and biodiversity; Climate change; Resilience

Source: adapted from (Casarejos, Frota, et al., 2017; Casarejos, Gustavson, et al., 2017)

Additionally, the authors also designed an assessment scheme to measure the degree of commitment, technical and financial difficulty, and institutional performance of HEI considering the whole process of implementing the 40 sustainability actions proposed in the designed framework (Casarejos, Frota, et al., 2017)

The authors argue that the four integrated dimensions encompass the main needed aspects of fostering sustainable development at HEI, helping them surpass the challenges commonly addressed in implementing SD at HEI. It is also suggested that implementing SD initiatives in a holistic perspective requires "a multidimensional and an integrated approach accordant with the challenge itself". Therefore, it is needed to "systematically integrate sustainability actions into the routines of HEI to provide learning and career value from the process of implementation"(Casarejos, Frota, et al., 2017, p. 1000). The scheme designed by the cited authors to assess sustainability was further tested in 23 HEI of the United States of America (Casarejos, Gustavson, et al., 2017).

This subsection aimed to present concepts described in the literature that define sustainable HEI. To this end, the most referred concepts in the literature, such as those by Cole (2003), Velazquez (2006), Sterling, Maxey, and Luna (2013), were brought up. Additionally, it described the way in which HEI incorporate sustainable development initiatives into their traditional management models, by presenting management models and sustainability dimensions being adopted by HEI worldwide. The following management models that integrate sustainable development in HEI were presented: Velazquez et al. (2006), Alshuwaikhat and Abubakar (2008), Redwood et al. (2016), Leal Filho, Amaro, et al. (2021), Cortese (2003), Lozano (2006b), Lozano et al. (2015), Casarejos, Frota, et al. (2017), and Casarejos, Gustavson et al. (2017). This set of models and dimensions provides a global overview of how HEI are integrating sustainable development initiatives into their routines and management processes. In other words, as discussed in the next section, it provides insight into how the vertical integration of SDIs occurs in HEI.

2.4. Holistic approach – a proposed model of vertical and horizontal integration

There has been evidence that demonstrates the efforts undertaken by HEI to address the sustainable development challenges. HEI, over time, have been refining their perception of sustainable development in the main relevant aspects such as education, research on sustainable development areas, sustainable campus operations, and inter-university cooperation. HEI have also been engaged in regional and global networks to acquire shared regional/global technologies, goals, and priorities on education.

The holistic or integrated approach, as a theoretical proposition, is not new. For example, Lawrence and Lorsch (1967) define organisational integration as the process of achieving unity in the effort among various subsystems to attain the organisational goals. This definition is focused on only one dimension of the holistic approach, called vertical integration, i.e., integration among programs, actions, and subsystems of a single institution. Despite the focus on vertical integration, very little in the literature is referred to the combination of vertical and horizontal integration to improve the assimilation of sustainable development in HEI. In this sense, as a contribution to complete the detected gap, this PhD research assumes that the effects of vertical integration may be enhanced by adopting horizontal integration, which may be understood as achieving unity of effort among various institutions and stakeholders to accelerate the process of organisational learning, optimizing the organisational and cultural systems of member institutions.

In this research insights for understanding the extent to which HEI have obtained success in promoting vertical and horizontal integration will be pursued. Thus, both types of integration of SD into HEI will be conceptualised, and, subsequently, a matrix of integration will be outlined and the evolution of the process of maturation in incorporating SD at HEI. This matrix would be used to identify at which level of sustainability a given HEI is.

2.4.1. Vertical integration – Structuration of SD initiatives into HEI SD management system

Institutional vertical integration is considered to be achieved through top managers' efforts to employ coordinating functions, which is a core role of managers (Chiavenato, 2005). Managers have been developing integrative devices focused on increasing complexity in management systems in a comprehensive perspective. Additionally, the conventional hierarchy will try to supplement it, thus leading to the emergence of the integrated management systems, that "consists of a collection of internal policies, assessment, [action] plans and implementation actions that are oriented towards simultaneously achieving environmental, quality and social goals" (Ahsen, 2015, p. 329). Pellinen et al. (2016, p. 1185) state that the vertical "interaction between units [of an institution] is seen to facilitate the sharing of knowledge, ideas and resources". Coordinating departments, such as planning unity, cross-functional coordinating teams and task force are examples of integrative devices that emerged to improve coordination between unities and promote vertical integration.

The development of the "University-wide sustainable committee" proposed in the framework designed by Velazquez et al. (2006), in Figure 2-6, works as an integrative device, considering that it comprises a team of skilled professionals that works on various areas of the HEI and has the charge to establish collaborative policies, goals and coordinated initiatives to promote the integrative achievement of the vision of the HEI. To this end, HEI have been developing integrated strategic plans to guide sustainable development implementation.

The holistic vertical integration approach to managing improvements across an institution involves the comprehension of the interactivity between different organisational processes and the implementation of continuous improvements. BPMN (Business Process Management Notation), lean production, and total quality management are some examples of the process improvement tools that consider the interactions of the processes from across the organisation, their interdependencies, and identifies how inefficiencies or ineffectiveness might be found and eliminated (Loshin, 2011).

Some of the benefits of implementing the institutional process improvements at the vertical perspective are listed in Figure 2-9.

Aspects of Institutional Process Improvement

1. Aligning the new identified institutional objectives with existing conventional processes;
2. Mapping and documenting those end-to-end institutional processes, programs and actions;
3. Collecting data from critical junctures within those end-to end processes that reflect performance in order to gain increased visibility into the mechanics of those processes;
4. Adjusting the functional infrastructure to identify overlaps, dependencies, and functionality and integrate common services that can simplify maintenance of existing systems as well as define and implement new systems; and
5. Optimizing the organization to reduce or eliminate bottlenecks, leading to improvements in efficiency and effectiveness.

Figure 2-9 - Benefits of implementing the institutional process.

Source: adapted from (Loshin, 2011)

The mapping and integration of processes related to implementing SDI at HEI could improve programs and actions designed to address the sustainable development agenda. Besides integrating processes, HEI are encouraged to take a step forward by institutionalizing all actions devised in an integrated sustainable development plan.

According to Leal Filho, Skanavis et al. (2019), implementing a sustainable development plan could be considered a complex task requiring reengineering the strategies of conventional management systems. However, it might deliver several meaningful advantages to HEI, as condensed below (Leal Filho, Skanavis, et al., 2019, p. 680):

1. They demonstrate institutional commitment.
2. The goals and themes to be addressed are clearly set out.
3. Specific actions to address the themes and achieve outcomes are articulated.
4. Timelines and responsibilities are indicated.
5. Clear targets and success criteria may enable an assessment of progress.
6. Arrangements are specified for monitoring and reporting.
7. Estimates may also include the staff time and resources needed to implement the plan enabling gaps to be identified.

The vertical integration envisaged in the scope of this PhD thesis would be achieved through a set of complementary processes —the first consists of identifying the sustainable development programmes and actions carried out on the HEI. The second comprises the design of actions for each action plan, which includes establishing goals, responsibilities, resources, deadlines, performance indicators, baselines, and monitoring strategies.

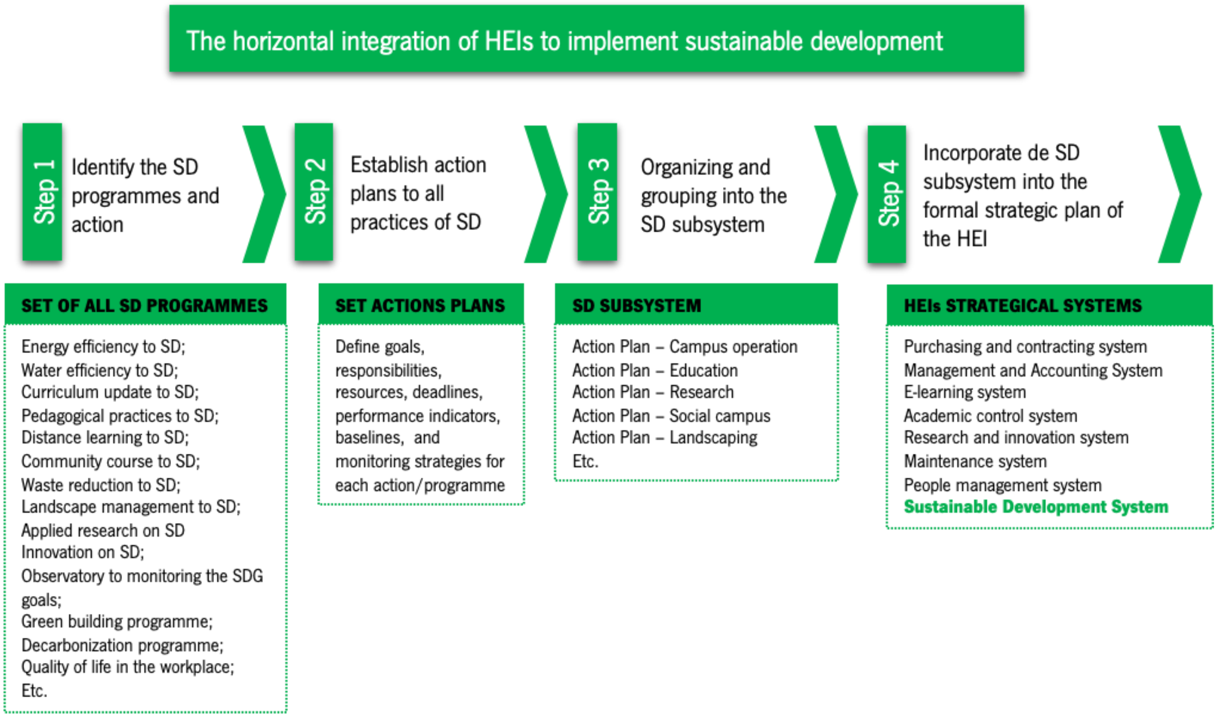

Figure 2-10 - The horizontal integration of HEI to implement sustainable development.

The third step consists in organizing and clustering all the action plans. Whether it is aimed at education, research, campus operation, outreach or another dimension, all action plans should be grouped in a sustainable development subsystem of the HEI. In the fourth step, the sustainable development subsystem is incorporated into the formal management systems, such as accounting or administration. Therefore, sustainable development actions would become part of HEI's strategic plan with formally established goals, responsibilities, resources, deadlines, and monitoring strategies. All steps are depicted in Figure 2-10.

Planning the vertical integration of sustainable development across the HEI is considered crucial for gaining advantages from the long-term perspective. The mapping of the process and initiatives using the tools listed above would simplify the implementation of sustainable development in HEI and might facilitate the elaboration of the plan, reducing the costs and the necessary work time (Loshin, 2011).

2.4.2. Horizontal integration - Networks

Economy centred literature reports mergers and acquisitions (takeovers) as the primary forms of an institution to promote horizontal integration (Kazmi, 2008). However, this is not the unique meaning of this term. Gulati, Dialdin, and Wang (2002) state that organisations can be unified with other organisations by varied arrangements of social and economic relationships, resource flows and prior strategic alliances. This approach can be transposed to define what is referred to here as the horizontal integration of HEI towards achieving the broader commitments that the world's HEI have made over the past decades, as extensively described in the previous topics. Acting harmoniously through inter-organisational networks related to SD nurture the horizontal integration strategy carried out by higher education institutions to boost the implementation of SDI. Gulati, Dialdin, and Wang (2002, p. 281) define a social network in a broad sense as a "set of nodes (e.g. persons, organisations) linked by a set of social relationships (e.g. friendship, transfer of funds, overlapping membership) of a specified type". In their most comprehensive perspective, organisational networks might be formed by non-commercial actors such as the government and their agents, non-governmental organisations and civil society organisations (Mountford & Kessie, 2017). The network is forged on the universal notion that economic activity does not occur in a barren social context but is instead embedded in a social network of relationships.

with the aim of exploring the field of sustainability-oriented higher education networks, analysing their critical areas of interest, inter-network relationships, links with the policy field, and (conditions for) cooperation in joint programs and strategy development, Dlouhá et al. (Dlouhá et al., 2018) performed desk-top research to mapping 14 higher education networks. The authors categorized, as it is shown in Table 2-8, seven areas of network activities and cooperation that describes the actions undertaken by the analysed networks to boost the achievement of the ESD agenda. The variety of areas embraced by the networks demonstrates the diversity of actions carried out and, in addition, some benefits to the HEI in becoming a member of a network.

Table 2-8 Categories of the network activities

Category	Keywords describing the network activities corresponding to the relevant category
Education	innovative education; cross-cutting themes; interdisciplinarity; curricular change; ESD transformation; professional development; degree programs; knowledge dissemination; educational technologies; online learning; Massive Open Online Course (MOOC); sourcebook for academia; Sustainability Literacy Test
Research	joint projects; interdisciplinary research; sustainability science; social relevance; values in research; sustainability theory; students; ESD; roles of HE; institutional 'greening'; internationalization; European research projects; global cooperation; innovation; hot topics; emerging issues; globalization issues; evidence-based policy; barriers and opportunities; reflection; assessment; evaluation (Regional Centres of Expertise)
Campus operations	global forum; institutional policy; exchange of information; best practices; Campus Sustainability Program; Green Guide for Universities; Campus Sustainability Toolkit; assessment tools
Outreach	partnerships; social actors; local communities; businesses and industries; governments; civil society; NGOs; open knowledge; democratic principles; equity; participation; technology transfer; global citizenship; leadership; critical issues; scientific and technical expertise; practical solutions; global strategies
HE policies (Internal and external)	access, equity, and quality; democracy; whole-institutional approach; social responsibility; awareness-raising; internalisation; HE for all; ethics; institutional collaboration; inter-university cooperation; research-intensive universities; strategic platforms; networking; global, national, and regional HE system; organisational change; sustainability science; ESD
Professional development	professional capacity; leadership; organisational change; sustainability; consultation forum; key-stakeholders; radical re-thinking on ESD; Educating Future Leaders' program

Students	institutional joint working; students' support; campus committee; students' leadership; courses, summer schools; internships; student-driven initiative; cross-disciplinary research; internal cooperation (students, faculty, administration, and staff)

Source: (Dlouhá et al., 2018)

As stated by Giesenbauer and Müller-Christ (2020, p. 14), "if higher education institutions (HEI) are willing to meet the complex challenge of sustainable development (SD), they would do well to raise their general capacity to deal with complexity". The authors argue that making part of active networks should be considered as a primary strategy of choice for implementing sustainable development at HEI. In the UNESCO's report entitled "Shaping the Future We Want - UN Decade of Education for Sustainable Development (2005-2014) - Final Report", it is recognised that

> One of the most visible developments helping to advance sustainability agendas in higher education has been the increased collaboration among institutions of higher education. The last 10 years have seen the scaling-up of university networks and consortia that are brokering dialogue and change in the sector. (UNESCO, 2014, p. 122).

Several advantages of HEI engaging in a network are reported in the literature. It is considered that the participation of HEI in networks can accelerate the process of placing sustainability as a capital concern of HEI initiatives, bringing the sustainable development implementation to a mainstream position of HEI strategies. It would also facilitate the standardization of processes and routines to promote and integrate sustainability into the core areas of HEI activities, such as education, campus operation, research, outreach, disclosure, and governance. It is of utmost benefit to the vertical integration (considering the scope described previously), that they provide educators with a platform (Blanco-Portela et al., 2018; Blewitt & Tilbury, 2013; Dlouhá et al., 2018; Giesenbauer & Müller-Christ, 2020; UNESCO, 2014).

Over the last decades, several expressive networks have emerged to support HEI in achieving their complex challenges regarding sustainable development. In Table 2-9, a list of networks placed globally or in a specific part of the world is presented, summarising when the networks were created and their coverage. As will be detailed in the next chapter, the emergence of the networks was fundamental for developing sustainability assessment tools (SAT).

Finally, it should be clarified that what is conceptually called a sustainable university network actually encompasses a myriad of institutions with multiple purposes and structures, composed of various types of accepted members, such as HEI, NGOs, businesses, research institutions, local and regional government or individuals, which may be either free or fee based. They can also vary in the number and variety of dimensions considered (education, professional development, student initiatives, research, campus operation, international policy, outreach, etc.), as well as in relation to the exchange supporting activities (Organisational conference, workshops, research communication, publication activities, policy advocacy, project funding, distribution of awards, newsletter, e-mail exchange, etc.) (Dlouhá et al., 2018).

Table 2-9 - Compiling list of networks committed to promoting SD at HEI

Acronym	Network name	Year of creation	Coverage
AASHE	Association for the Advancement of Sustainability in Higher Education	2005	Global
GUNi	Global University Network for Innovation	1999	Global (250 members from 80 countries)
ARIUSA	Alianza de Redes Iberoamericanas de Universidades por la Sustentabilidad y el Ambiente	2007	Latin America, Caribbean and Iberia
BUP	Baltic University Programme	1991	Regional (Baltic Sea Region – 90 members)
CA	COPERNICUS Alliance	1993	Europe – 326 members)
ASCN	Asian Sustainable Campus Network		Asian
ASCN	Asian Sustainable Campus Network	2006	Asian
	Environmental Association for Universities and Colleges	1996	UK/Ireland
CGUN	China's Green University Network		China
CAS-NET Japan	Campus Sustainability Network in Japan	2014	Japan
IUSDRP	Inter-University Sustainable Development Research Programme	2015	Global
ESSSSR	European School of Sustainability Science and Research	2018	Europe
GUPES	Global Universities Partnership on Environment and Sustainability	2012	Global
MSA	Mainstreaming Environment and Sustainability in African Universities network	2004	Africa
ProSPER.Net	Promotion of Sustainability in Postgraduate Education and Research	2008	Asia Pacific
PNIUS	Pacific Network of Island Universities for Sustainability		South Pacific
MUNSD	Mediterranean Universities Network for Education for Sustainable Development	2002	Europe
TRUFTS	Talloires Network of Engaged Universities	2005	Global
IARU	International Alliance of Research Universities	2006	Global

Source: adapted from: (A. Alghamdi et al., 2020; N. Alghamdi et al., 2017; Berzosa, Bernaldo, & Fernández-Sánchez, 2017; Dlouhá et al., 2018; UN, 2015; UNESCO, 2002)

As will be seen in the next topic, the level of maturity of a given HEI with regard to the integration of sustainable development will be impacted, not only by the level of internal integration between its processes and sectors (horizontal integration), but also by the level of integration in network of sustainable HEI (vertical integration).

2.4.3. HEI maturity in incorporating SD.

Since HEI had received the claim to support and sometimes lead society towards the required transformation to more sustainable lifestyles, these institutions have been gradually shaping themselves to accomplish such complex and challenging tasks. As it was shown earlier in this chapter, HEI have signed up formal commitments and declarations (Aleixo et al., 2018; Lozano et al., 2015; Savelyeva & Douglas, 2017), updated their curricula to offer courses aligned with the demands of sustainable development (Aleixo et al., 2018; Gough & Longhurst, 2017; Wang et al., 2020), implemented programmes to improve the governance and management of campus operations (Bieler & McKenzie, 2017; Lidstone et al., 2015; Lozano et al., 2015; T. B. Ramos et al., 2015), developed management models and assessment tools (Alshuwaikhat & Abubakar, 2008; Giesenbauer & Müller-Christ, 2020; Velazquez et al., 2006), and sought to be part of networks to accelerate the path towards sustainable development (Adomßent, 2013; Dlouhá et al., 2018; Hancock & Nuttman, 2014). They have also invested in applying research and created strategies to internalize the concern with sustainable development in the institutional culture (Casarejos, Frota, et al., 2017; Casarejos, Gustavson, et al., 2017).

There are a growing number of authors, e.g. Disterheft et al. (2016), Findler et al. (2019), Blanco-Portela et al. (2017), and Dlouhá et al. (Dlouhá et al., 2018), who recognise that the most appropriate way for HEI to be shaped towards assuming their role with regard to sustainability is to engage themselves in a holistic approach to implementing the principles of sustainable development through combined vertical integration and horizontal integration strategies. HEI that manages to provide a suitable balance on these systematic integration processes might reach the stage of maturity more promptly and efficiently.

In this path, HEI has become a living lab, to the extent to which they are creating opportunities for students to engage with hands-on experience and solution-oriented approaches to global challenges both on campus and more broadly to learn and solve critical issues of our society. It has also been progressively and steadily integrating the principles of sustainable development into campus infrastructure and operations (Alexa et al., 2020; William Horan et al., 2019; ISCN, 2018; Willats et al., 2017).

Considering the arguments detailed in the previous topic concerning the holistic approach to implementing sustainable development in HEI, there is a synergistic imbrication between vertical and horizontal integration that is still rarely studied in the literature. This relationship is referred to in Giesenbauer and Müller-Christ (2020), but the authors do not succeed in structuring the connection between inter-organisational integration and intra-organisational integration aspects and present the two aspects in isolation.

As a contribution to filling the identified gap concerning synergies between vertical and horizontal integration, this PhD research assumes that the level of maturity of the internalisation od SDI in HEI should be understood as a relationship between the level of vertical and horizontal integration. In other words, it is reasonable to assume that: (a) an HEI that has a high number of SDI, systematically implemented and managed; and (b) is part of networks that effectively and systematically promote cooperation and dissemination of best practices aimed at the commitment to SD by HEI, has a high level of maturity in terms of HEI sustainability. This conceptual relation is depicted in Figure 2-11.

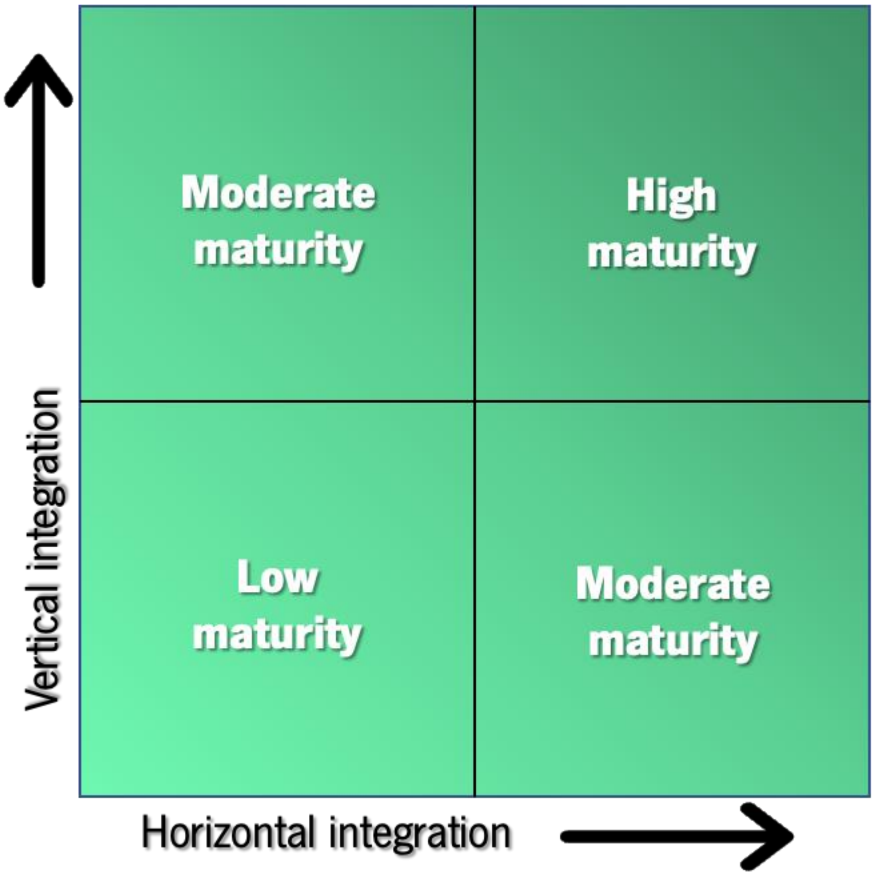

Figure 2-11 – Conceptual matrix of maturation of incorporating SD at HEIs.

The vertical axis assesses the level of inter-organisational integration, i.e., the extent to which the internal initiatives to promote sustainable development, developed by a given organisation in the most varied areas of activity, are integrated into an interdisciplinary and complex system. It comprises the three levels: low maturity, moderate maturity, and high maturity, as illustrated in Figure 2-11.

Therefore, on the first quadrant of the vertical axis (Figure 2-11, bottom left position), should be allocated all programs or initiatives aimed at improving aspects of sustainability implemented by HEI. For example, the (a) adaptation of curricula or creation of new curricula in courses to address sustainability issues, as well as (b) energy efficiency and energy generation actions, management of available water resources, waste management programmes, (c) actions to improve the quality of life of the academic community on campus, as well as actions intended to introducing the concern regarding sustainability in the university culture, and (d) incentives for research and development of innovations related to SD, to cite a few.

In the second quadrant of this axis (top-left position), those initiatives regarding SD that are internally integrated and those used in the management decisions will be allocated. To cite an example, it should be positioned on this quadrant a systematic set of actions related to managing, in an integrated manner, the use and generation of energy in the campus, which leverage Industry 4.0 strategies such as IoT and databases to monitor and control real-time energy consumption on campus and generating periodic scores on consumption performance. Furthermore, finally, to be included in the second upper quadrant of the vertical integration axis, the scores and information generated should be considered in the institutional decision-making processes.

In parallel, the horizontal axis of Figure 2-11 assesses the level of inter-organisational integration that a given HEI has. The first quadrant allocates the policies aimed at strengthening SDI, the outreach actions developed within the scope of sustainable development, the institutional commitments signed, such as the Talloires Declaration, and the inclusion of a given HEI in networks that provide implementation guidelines for SDI considering isolated aspects of the HEI and not requiring periodic and systematic evaluations of the sustainable performance of the HEI. Alternatively, even HEI networks with a focused approach to specific dimensions of HEI sustainability, such as research or campus operations, disregard others such as curriculum or outreach activities. All those initiatives might be representative of a premature horizontal integration, therefore a stage of low maturity of the HEI in internalizing the SD principles.

In the second quadrant of horizontal integration (bottom right) are the initiatives considered to be at a more mature stage. HEI at this stage is geared towards engaging with networks that consider the implementation of sustainable development in HEI through a holistic approach that includes the main dimensions of sustainable development. They are usually connected to more than one network of sustainable universities and use sustainable assessment tools to identify their position in the clusters they belong to, as well as participate in meetings to exchange experiences about best practices in each dimension of sustainability of HEI. The HEI or initiatives allocated in this quadrant can be considered as having a moderate stage of maturity.

The quadrant named "high maturity" (top-right) brings together all the previous initiatives, with the difference that they need to be interconnected. A strong interconnection is encouraged between the integrated actions developed by the HEI and the networks, insofar as the broadening of the geographic limits of the HEI is stimulated to intensify the beneficial effects of the networks within the HEI. In this way, synergies are promoted on both sides, strengthening the sustainability of both the networks and the HEI.

The search for systemic and innovative solutions is stimulated by encouraging the creation of physical spaces and interdisciplinary virtual environments for the co-creation and digitalisation of scientific knowledge that can be used to solve everyday problems. It is also fostered the creation of collaborative hubs, offices, labs and classrooms to boost the applied research, educational processes, campus operations strategies and outreach actions among the member institutions of the networks (N. Alghamdi et al., 2017; Brandli et al., 2019; Dlouhá et al., 2018; Giesenbauer & Müller-Christ, 2020; Leal Filho et al., 2016; Rampasso et al., 2019; Shiel et al., 2020).

The set of these initiatives is expected to denote a high stage of maturity of HEI, providing the necessary armour for institutions to fully fulfil their role in promoting education for sustainable development (ESD).

Chapter 3. Sustainability Assessment Tools for HEI

As detailed in the previous chapter of this report, HEI were initially engaged in meeting the various commitments made and assumed roles toward sustainable development. At that time, the efforts of HEI were directed to both, on one hand, at putting in place multiple programmes related to SDI and on the other at being part of a list of several sustainable university networks. The latter were being created to assist HEI in operationalising SDI in the dimensions inherent to higher education institutions (Gough & Longhurst, 2017; Hancock & Nuttman, 2014; ISCN, 2018; Leal Filho, Amaro, et al., 2021; Lozano et al., 2013; Shiel et al., 2020).

Lozano et al. (2015), who analysed the promotion of sustainability practices and methodologies in seventeen HEI, concluded that there needed to be more integration between sustainability efforts, its metrics, and HEI strategies. The authors underlined the need to perform a HEI integrated sustainability assessment and publish sustainability reports that decision-makers could use to define strategies that consider sustainable practices as an essential component. The literature considers the integration of sustainable development in HEI an arduous task to be reached in so far as it usually demands substantial changes in plans and daily routines (Leal Filho et al., 2016; Sammalisto et al., 2015).

The integration between the sustainable development management system and the assessment system, including its actions, goals, risks, performance indicators and reference levels, improve the effectiveness of the performance evaluation process. In the design phase of the integrated system, the creators should consider that the monitoring and control actions, data collection and systematisation procedures can be designed simultaneously for use later in the assessment phase. Integrating these two systems from the outset will ensure the system's robustness as a whole. It may stimulate their adoption by other institutions, allowing for comparative analyses of performance based on the principles of benchmarking.

According to Shriberg (Shriberg, 2002a), cross-institutional sustainability assessment in HEI is desirable to advance strong initiatives and assist lagging institutions in achieving acceptable standards of compliance and performance in the sustainable development sphere. For the author, "campuses require methods of comparison to each other as well as to a vision of a 'sustainable college or university'" to ensure that they are moving in the right direction (Shriberg, 2002a, p. 154).

Singh, Murty, Gupta, and Dikshit (2009), stated that in view of the challenge faced in implementing the principles of sustainable development, there is a widespread need for metrics and tools for assessing the extent to which and how current activities are sustainable. Ajayi (2018) defines assessment as gathering valuable data that could be interpreted to support the decision-making. It comprises collecting data to judge the quality of a person, object, group or event.

Casarejos and Gustavson (2017, p. 998) point out that "given the enormity of issues and attention required to align HEI with sustainable development practices and goals, there is a strong need for mechanisms to assist with this task". Subsequently, it was necessary to design monitoring mechanisms based on plausible indicators and metrics to disclose the achievements systematically and consistently towards the commitments related to sustainable development and compare the performance among HEI. Thus, several sustainability assessments tools (SAT) have been developed. Alghamdi et al.(N. Alghamdi et al., 2017), in their literature review about 12 sustainability assessment tools, have reported that SAT can assist in the mapping of best practices, as well as allow HEI to promote continuous improvement in the implementation of SDI. According to Findler et al. (Findler, Schönherr, Lozano, & Stacherl, 2019a), SAT can be understood as instruments that assist in adopting a diversified approach and aim to provide universities with a systematic set of procedures and methods to measure, audit, benchmark and communicate their efforts towards achieving commitments related to sustainable development.

Although they aim to evaluate performance, the tools might differ in classifying the analysed institutions. Some of the tools intended to compare HEI to one another and place them in an order based on their performance in a range of indicators. An example of this type of SAT is UI-GreenMetric, which establishes an order position for each of its 912 HEI that made up its portfolio of analysed institutions in 2020. Wageningen University and Research, located in the Netherlands, attaining 9150 points, were ranked first while Basrah University College, an Iraq HEI, with 175 points, was ranked last (912th). On the other hand, another set of SAT aims to rating the HEI into a specific scale. For instance, the Sustainability Tracking, Assessment and Rating System™ (STARS) assess HEI based on similar indicators but judge how they perform against a predefined standard rather than comparing them against one another. The analysed HEI are clustered in one of its five positions (Platinum, Gold, Silver, Bronze and Reporter) (AASHE, 2019a).

Besides ranking and rating approaches, Du et al. (Du et al., 2020) found that SAT are also designed with the purpose of "raising conscientiousness", "identifying the overall sustainability picture", as well as "strategic tools" to guide the policy-making or strategic management processes. According to the authors (Du et al., 2020), the SAT, mainly for HEI in the mature stage of implementing SDI, have also the purpose to use the SAT as a "benchmarking tool". So far, many of the SAT developed only serve as a platform for institutions to showcase their experiences in implementing SDIs.

Thus, this chapter has twofold aimed to list SAT found in the literature and detail the most prominent ones in order to accomplish tasks 1, 2 and 3, related to the secondary objective of this PhD research (see Figure 1-1). Initially a bibliometric analysis was performed intended at identifying the most relevant references and authors on the subject, as well as the main keywords used to index studies that describe worldwide experiences in SAT application. Then a literature review was performed to summarise the state of the art on the tools, procedures, and specificities of SAT.

3.1. Bibliometric Analysis Sustainable Assessment in HEI

Considering that the steps followed in carrying out a bibliometric analysis were extensively defined and described in chapter 1, this chapter will focus on the bibliometric results. At this aim, it will summarise, to the basic, the definitions related to the method of analysis chosen. Like chapter 1, the bibliometric analysis will cover the study of (a) co-occurrences in keywords and (b) the most active authors that study sustainability assessment tools applied to higher education institutions.

3.1.1. The Co-Occurrence of Keywords

The co-occurrence of author keywords highlights the most common keywords used to characterise a set of references (Cancino et al., 2017).

Figure 3-1 shows the results of this analysis. It was performed considering five as the minimum number keywords occurrences. In a total of 2,586 documents, 784 were compiled, in which were found 63 that meet the established threshold. Those 63 items were grouped into the five clusters of co-occurrences of author keywords, with a total of 667 links among the selected keywords and a total link strength of 1,134. The five clusters are described below:

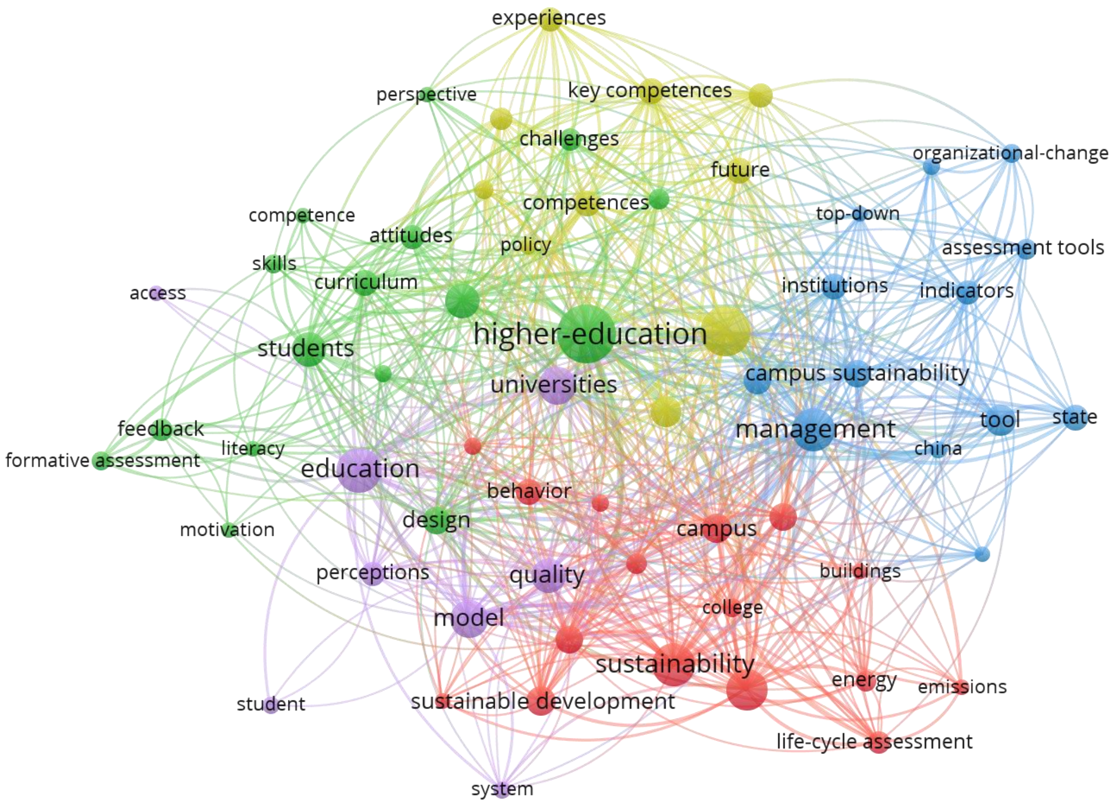

Figure 3-1 - Co-occurrence of author keywords of documents published regarding SAT in HEI

- Cluster 1, in red, has 16 items, grouping mainly for keywords regarding sustainability performance at HEI.
- Cluster 2, in green, has 16 items, and it is composed of keywords related to higher-education curriculum and student perspective on implementing initiatives towards sustainable development.
- Cluster 3, in blue, is composed of 13 keywords, and it is related to management campus sustainability and assessment tools and indicators.
- Cluster 4, with ten items, appears in yellow. It is related to improving sustainable campus governance by developing policies, programs, and competencies to face the challenges of implementing SD initiatives.
- Cluster 5, in purple, is the smallest one, with eight items. It is composed of keywords related to modelling and systematising education toward SD to better demonstrate the perception of quality.

In addition to the five clusters previously commented, Table 3-1 presents the keywords with occurrence equal to or higher than 11 in all clusters that have been formed, highlighting the total link strength of each co-occurrence keyword, and informing which cluster each keyword belongs to.

Table 3-1 List of the most occurrent keywords

Cl.	Keyword	Occ.	TLS	Cl.	keyword	Occ.	TLS
2	higher-education	65	150	**1**	impact	15	46
4	university	47	114	**2**	design	14	51
5	education	36	72	**3**	implementation	14	48
1	sustainability	35	81	**1**	systems	14	40
3	management	34	97	**1**	behaviour	13	22
1	performance	31	86	**2**	competences	13	40
5	model	26	71	**2**	curriculum	13	42
5	universities	26	44	**4**	key competences	13	45
2	students	23	62	**3**	state	13	32
5	quality	22	45	**4**	future	12	36
2	science	22	53	**3**	institutions	12	40
4	framework	19	52	**2**	attitudes	11	32
3	tool	18	41	**4**	experiences	11	33
1	campus	17	52	**3**	indicators	11	38
1	sustainable development	17	43	**4**	integration	11	39
3	campus sustainability	15	50	**5**	perceptions	11	27

Cl.= Cluster; Occ.= occurrences; TLS = total link strength

Although the first clusters are the most expressive, in terms of the number of items, it is noticed in Table 3-1 that the keywords are well balanced among the clusters. There are seven keywords for each of the first three clusters (1, 2 and 3) and six and five keywords related to clusters four and five, respectively.

3.1.2. Analysis of influential authors publishing in SD in HEI

Table 3-2 shows the most prominent authors compiled in the sampled references extracted through the bibliometric analysis. The table is ordered considering the number of citations. The most quoted author is Rodrigo Lozano, a lecturer at the University of Gävle, located in the city of Gävle, Sweden. The author is highly scored in Google Scholar with an h-index equal to 46, having 13,005 citations (accessed on September 12, 2021), being "Declarations for sustainability in higher education: becoming better leaders, through addressing the university system" the most cited article with 890 citations. The author has developed a sustainability assessment tool named Graphical Assessment of Sustainability in Universities (GASU) (Lozano, 2006a) and has many co-authored references with other authors listed in Table 3-2, for example, Donald Huisingh, Win Lambrechts (h-index 18), Kim Ceulemans (h-index 18) and Sandra Caeiro (h-index 37). Donald Huisingh, according to data available in his profile in ResearchGate, is a retired professor at Tennessee University. He was the founder and Editor-in-Chief (EIC) of the Journal of Cleaner Production (JCLP), and nowadays, he is the Editor-in-Chief, Emeritus of the JCLP. In 2021 Donald

Huisingh was co-author of the paper published at JCP entitled “Co-creating a sustainability performance assessment tool for public sector organisations” (T. B. Ramos et al., 2021). This work develops a conceptual framework, named “Formal and Informal Sustainability Performance Assessment”, designed to support and assess public sector organisations in their sustainability performance.

The author Walter Leal Filho is a Professor at Manchester Metropolitan University, UK and HAW Hamburg, Germany. He has an active volume of publication (h-index equal to 61) and 17,484 citations in Google Scholar (accessed on September 12, 2021) with a vibrant network. He also contributes with several authors listed in Table 3-2, such as Win Lambrechts, Kim Celeumans, Sandra Caeiro. His work is mainly related to the field of sustainable development at higher education institutions in a broad perspective. Together with other authors, he recently published the article "Sustainable development goals: a framework for deploying indicators for higher education institutions”, which analyses the adherence of sustainability indicators used by HEI with the Sustainable Development Goals (Griebeler et al., 2021). Besides this, he has collaborated with the "Mapping sustainability initiatives in higher education institutions in Latin America", which analyses the current status of sustainability initiatives among Latin American HEI (Leal Filho, Amaro, et al., 2021).

All the authors listed in Table 3-2 have relevant contributions related to the development or review of the literature concerning the sustainability assessment of university campuses. For example, Yusuf Adenle, Professor at Hong Kong Polytechnic University, has published papers in campus sustainability assessment. He recently published the paper " Exploring the usage of social media in extant campus sustainability assessment frameworks for sustainable campus development". The paper explores the existing campus sustainability assessment tools to identify the length of use of social media, especially in environmental sustainability indicators’ selection and empirical verification (Adenle et al., 2021).

Table 3-2 - Most prominent authors in the field of SAT to HEI

id	author	documents	citations	TLS
5990	Lozano, Rodrigo	12	1280	10
4371	Huisingh, Donald	6	925	9
5452	Lambrechts, Wim	6	897	6
1688	Ceulemans, Kim	6	596	8
5568	Leal Filho, Walter	8	316	2
1514	Caeiro, Sandra	6	304	5
4213	Holdsworth, Sarah	7	62	13
9701	Thomas, Ian	7	62	13
8635	Sandri, Orana	6	36	12

112	Adenle, Yusuf a.	5	14	0
1368	Broglio, Steven p.	7	0	5
6440	Mcallister, Thomas W.	5	0	5

3.1.3. Review of the pertinent references in the field of SAT at HEI

Table 3-3 lists the leading references used to identify and review sustainability assessment tools, structure, indicators, and metrics.

Table 3-3 - Synthesis of the most relevant references reviewed in the literature.

Main Topics	Reference	N. of citations*
Comparative analysis	(Shriberg, 2002a)	601
	(L. P. Amaral et al., 2015)	188
	(Lauder et al., 2015)	106
	(Fischer et al., 2015)	88
	(Asmuss & Kamal, 2013)	81
	(N. Alghamdi et al., 2017)	81
	(Findler, Schönherr, Lozano, & Stacherl, 2019a)	68
	(Saadatian et al., 2011)	51
	(Bullock & Wilder, 2016)	49
	(Casarejos, Frota, et al., 2017)	23
	(Alba-Hidalgo et al., 2018)	21
	(Du et al., 2020)	3
	(Adenle et al., 2020b)	1
	(Galleli et al., 2021)	1
Proposal of a SAT Framework	(Velazquez et al., 2006)	823
	(Lozano, 2006a)	388
	(Sonetti et al., 2016)	107
	(Saadatian et al., 2013)	81
	(H. Shi & Lai, 2013)	78
	(Alshuwaikhat et al., 2017)	30
	(Casarejos, Frota, et al., 2017)	23
	(Silva & Almeida, 2019)	9
	(Adenle et al., 2020b)	1
Analysis of sustainability reports related to SAT	(Kapitulčinová et al., 2018)	49
	(Sepasi et al., 2018)	20
	(Son-Turan & Lambrechts, 2019)	11
Mathematical model to integrate SAT	(Saadatian et al., 2011)	51
	(Casarejos, Frota, et al., 2017)	23
	(Lauder et al., 2015)	106
	(Adenle et al., 2020b)	1
	(Waheed, Khan, & Veitch, 2011)	71

*Number of citations on 12/09/21 in Google Scholar

The table is organised into four main topics. The first topic lists the references regarding comparative analysis, whereas the second outlines the references that propose a novel SAT design. The third topic points out some of the references focused on reporting the performance in terms of sustainability development at HEI. The last topic highlights mathematical models designed to integrate and assess sustainability in HEI.

3.1.3.1. Review of comparative analysis on SAT

Almost two decades ago Shriberg (2002b, p. 255) was, to the best of our knowledge, the pioneering author in comparing tools for evaluating the sustainability of HEI. His work aimed to analyse eleven cross-institutional SAT to "assist colleagues, universities, non-profit organisations and others meet this goal by identifying attributes of ideal assessment tools and evaluating current efforts". Of the eleven tools analysed by the author, only the Sustainability Assessment Questionnaire (SAQ) and Auditing Instrument for Sustainability in Higher Education (AISHE) have been frequently analysed by the authors who followed him. In fact, many of the extensively mentioned tools were created after 2002 (year of publication of the article), such as Graphical Assessment of Sustainability in University (GASU), created in 2006 or Sustainability Tracking, Assessment and Rating System (STARS) and UI-Green Metric, both created in 2014.

The second most-cited authors are Amaral et al. (2015). They intended to provide a general review of the methods used to conceptualise "sustainable university". Thus, the authors analysed web references available to identify university sustainability implementation and assessment methods and reporting tools. The authors list the three main approaches to developing SAT (accounts, narrative assessment, and indicator-based); their work also outlines the call for specific tools to assess the sustainability of HEI. It must be considered that these institutions differ in their process and routines and their core competencies from other corporations. According to the authors (L. P. Amaral et al., 2015, p. 157), "university infrastructures [...] are significantly large systems containing lecture classes, restaurants, sports hall, student residences, laundry, library, laboratories, etc. The activities taking place on the campus use large amounts of energy and resources and generate wastes", and it has been committed to *lead by example,* a term often referred to since it came to view in Talloires Declaration (ULSF, 1990). Among the best practices undertaken by HEI to promote SD, Amaral et al. (2015) highlight the green building initiatives, the implementation of ISO 14001 standard and Leadership in Energy and Environmental Design (LEED) certification. The SAT analysed by the authors cited above are Auditing Instrument for Sustainability in Higher Education (AISHE), Sustainability Tracking, Assessment & Rating System (STARS), Sustainability Tool for Auditing curricula in Higher Education (STAUNCH), and National Wildlife Federation's State of the Campus Environment.

The work conceived by Lauder et al. (2015) aimed at presenting a critical review of GreenMetric, a world university ranking system (UI-GM), by comparing it with other assessment methods, among which the STARs, a rating system. By doing so, the authors revise a set of SAT. Some of them are peripherally focused on sustainable development dimensions, like QS World University Rankings and Webometrics Ranking of World Universities (Webometrics), centralising their focus on the overall performance comparison of HEI. However, others such as UI-GM, STARS, AISHE, GASU, STAUNCH were SD centred. The authors (Lauder et al., 2015, p. 857), reviewing the ranking design, notice the risk of bias that occurs "when the indicators and their weightings that make up the ranking give a systemic, unfair advantage to certain types of universities". In his work, the authors refer that "English-speaking", "research-intensive HEI", "large" and "older" HEI, and also HEI located in "developed counties" could have some unfair advantages, causing biases in the assessment method designed by some ranking SAT.

Fischer et al. (2015) performed a comparative analysis of twelve sustainability assessment tools. The authors associate the SATs' emergence because of the growth of sustainability declarations of HEI in the past decade. They also noticed that the expansion in the number of SAT enlarged the diversity of methods used to assess SD at HEI. Some tools have been created to evaluate individual institutions, whereas others to evaluate HEI alliances. To perform the comparative analysis the authors divided the indicators into the four following distinct domains: Operations, Research, Education and Community. Although it differs among tools, the study reveals an extensive concentration of indicators into the operations domain (67%). For instance, the tool Alternative Universal Appraisal (AUA) has a greater focus on the education domain. Contrary to the average trend considering the twelve tools, the operations domain is the one with the smallest number of indicators.

Asmuss and Kamal (2013) compare four SAT, two academic-focused and two with a broader scope. The authors aim to identify practical sustainability-benchmarking tools to assist the University of Saskatchewan (UofS) in promoting the improvement of sustainability performance in education, research, campus operation, governance, and community engagement. The four Tools analysed were the Sustainability Assessment Questionnaire (SAQ), Campus Sustainability Assessment Framework (CSAF), College of Sustainability Report Card, and STARS. The comparative study examines each tool's strengths and weaknesses and the ability to assess performance concerning the five areas presented above. The authors developed a checklist composed of 27 variables to assess the efficiency of each SAT in measuring the attributes related to the five areas (governance, education, research, operation, and community engagement). STARS has obtained the highest score, and therefore it was identified as the most suitable benchmarking tool for assessing and tracking sustainability performance at HEI.

N. Alghamdi et al. (2017, p. 85) expressed that “measuring sustainability remains a complex and challenging process for higher education institutions, especially institutions that are at the early stage of their sustainable development system”. In their study, the authors acknowledge the efforts made by their predecessors to review a variety of tools. They recognise that despite this effort, “very little is known about the indicators through which sustainability in university can be assessed. Neither the structure of the assessment tools nor the type and number of indicators are shown” (N. Alghamdi et al., 2017, p. 86). To fill this gap, the authors have committed themselves to going beyond the analysis of the tools, revealing the structure and content indicators intelligibly. Therefore, the authors bring to light a synthetic description summarising the background, purpose, criteria, indicators, and design approach of each of the twelve analysed tools. Additionally, they designed a diagram that depicts the architectural structure of the tools, outlining their dimensions and subdimensions, as well as the indicators selected and the main strengths and weaknesses of each tool. The tools analysed in the mentioned reference are Sustainability Assessment Questionnaire (SAQ), Graphical Assessment of Sustainability in University (GASU), Sustainable University Model (SUM), University Environmental Management System (UEMS), Assessment Instrument for Sustainability in Higher Education (AISHE), Benchmarking Indicators Questions – Alternative University Appraisal (BIQ-AUA), Unit-based Sustainability Assessment Tool (USAT), The Green Plan (Green Plan), Sustainable Campus Assessment System (SCAS), Adaptable Model for Assessing Sustainability in Higher Education (AMAS), Sustainability Tracking, Assessment and Rating System (STARS), and, Green Matric – UI’s GreenMetric University Sustainability Ranking (UI-GM) (N. Alghamdi et al., 2017).

Findler et al. (Findler, Schönherr, Lozano, & Stacherl, 2019a), in their work, reviewed nineteen tools, being so far the most extensive review, in terms of the number of analysed tools. The study aimed to analyse how SAT can measure the direct and indirect impacts that HEI have related to Sustainable Development. The authors summarised the following previous studies: Shriberg (2002b), Yarime and Tanaka (2012), Sayed and Asmuss (2013), Fischer et al. (2015), Bullock and Wilder (2016), N. Alghamdi et al. (2017), and (Berzosa, Bernaldo, Fernández-Sánchez, et al., 2017). By doing so, the authors summarise, describing the tools analysed, the chosen methodology and major findings. To analyse the 1,134 compiled indicators the authors clustered them into the six key-dimensions found in the model designed by Lozano et al. (Lozano et al., 2013) education, research, campus operations, institutional framework, on-campus experience and outreach. The main lessons learned reported in the work of Findler et al. (Findler, Schönherr, Lozano, & Stacherl, 2019a) are the following two. The research confirms previous studies in that most SAT have their indicators strongly concentrated in the dimension of campus operations. To a large extent, SAT are designed to provide information regarding internal engagement on sustainable development, tending to pay not enough attention to the impacts that HEI compel outside their institutional boundaries.

The review conducted by Bullock and Wilder (2016) pursues the following purposes: (a) exploring the relevant literature identifying its key discourses and insights regarding HEI sustainability assessment and (b) analysing the comprehensiveness and validity of nine competing SAT, using as comparing parameter the GASU, designed by Lozano (2006a), which, according to the authors, is based on Global Reporting Initiative (GRI) and the Association of University Leaders for Sustainable Future (ULSF). The authors consider this tool "the most comprehensive sustainability framework because it was developed through a broad-based and rigorous process" (Bullock & Wilder, 2016, p. 283). The paper concludes that some tools may be biased in some way, advantaging the emergence of greenwashing strategies undertaken by HEI on assessing and disclosing their SDI. It is also concluded that, in general, the analysed SAT are not comprehensive. There is a lack of coverage of the social and economic dimensions of sustainability. The work considers STARS and Pacific Sustainability Index as the most comprehensive SAT in the sector of HEI.

In the work of Alba-Hidalgo et al. (Alba-Hidalgo et al., 2018, p. 447) the authors intend to highlight the different evaluation approaches and their incorporation into the main assessment tools. Thus, the authors performed an integrative meta-analysis on articles and book chapters related to the sustainability assessment in HEI. The references compiled were classified according to the article's type and the main evaluation approach. Of the sixteen references analysed, 17% are tool reviews, 43% aim at proposing new tools, 21% are case studies, and 20% are classified as sample studies. Considering the references studied, the tools that appeared the most were STAR, SAQ and AISHE, which appeared in eleven studies, followed by GASU, reported by eight studies, Green Report Cart, analysed in six, CSAF, AUA and STAUNCH studied in five references. In contrast, USAT was the least reported, appearing in only two studies.

Concerning the approaches to evaluation of HEI SDI, the authors (Alba-Hidalgo et al., 2018, pp. 461–462) recognise three predominant patterns of evaluations (assessment, evaluation, and appraisal). The three types are defined as follows:

> The first level, assessment, implies a basic evaluative system at an internal level to identify key issues to act upon. In the second level, evaluation, an external focus emerges, and internal assessment is compared with the assessment in other educational institutions: good practices (benchmarking), ratings and rankings are therefore contrasted among several universities. Besides, the need of reporting is acknowledged, i.e., dissemination of results and accountability on actions through public reports. Finally, a third level, known as appraisal, is described. This is an advanced-level assessment, which

> seeks a global transformation of the educational institution towards sustainability. Its goals and organisation go beyond the classic aspects of both university life (teaching, research, and extension) and environmental, economic and social sustainability. Moreover, links between universities and society are highly considered in this level.

Fifty-three articles of the analysed sample were classified as assessment types. Twenty-nine were grouped into the second type, named assessment, among which fourteen were classified as benchmarking, seven as ranking/rating and eight as reporting. Finally, ten articles were classified as having an appraisal evaluative approach. Three benefits envisioned by the authors as motivating force to make HEI engage themselves in the field of sustainability assessment are:

1. to become acquainted with their strengths and weaknesses.
2. to amplify reputational value to their activities in the eyes of the university community, government, institutions, and society at large.
3. to establish indicators and metrics that assist in identifying and comparing the advances made to ensure internal and external sustainability.

Intending to formulate guidelines as input to develop a SAT for China that fits in the current SD stage of Chinese HEI, an article was written by Du et al. (Du et al., 2020). It considered 24 references along with 15 SAT and more than 1000 indicators were selected and analysed through a mixed-method approach that included desk research and further discussions using an online workshop that engaged participants of a Chinese research team. The 15 tools were grouped according to their coverage (regional or global), stage of maturation (early or mature), purpose (ranking tools, raising consciousness, identifying the overall sustainability picture, strategic tools, benchmarking tools, and transmission tools), and emphasis attributed to SD dimensions (governance, operations, education, research, engagement, and others). An in-depth analysis in each dimension emphasised was performed to raise the leading indicators, descriptions, questions, examples, rationally and sub-criteria (if provided) were then highlighted and 148 items considered vital topics and issues for the dimensions of SD in HEI were then analysed. The analysis mapped the position of SAT in reference to a set of critical criteria that supported the discussion in the online workshop to define the best profile for a proposed Chinese SAT.

Adenle et al. (2020b) developed a modifiable campus-wide appraisal model (MOCAM) for a comprehensive spatial-based information and appraisal framework for policymakers to conduct in Nigerian HEI and HEI allocated in Sub-Saharan African Countries. The study's novelty rises in the intention to include indicators related to social media, and the authors are concerned about the weighting method carried out to integrate and evaluate the existing SAT.

The last work of the sample presented in Table 3-3 that compares SAT was carried out by Galleli et al. (2021) and intended to assess the adherence of UI Green Metric and Times Higher Education World University Rankings (THE-WUR) to the Berlin Principles Framework. The authors considered that the main lesson learned in their work could be related to the complexity involved in assessing sustainability in HEI employing evaluating systems. Because of the difference between HEI, the authors declared that developing a unique and more suitable ranking might not be possible. This argument is in line with Shriberg's (Shriberg, 2002a) work, which considers it undesirable to create a single “ideal tool” that would be able to evaluate all HEI throughout the world. The researcher believes that the specificities of each region and even the particularities of the HEI themselves should have the opportunity to select the adequate tool to evaluate their specific structure. The literature even warns about the risk of bias in the choice (Bullock & Wilder, 2016; Lauder et al., 2015); however, it is necessary to recognise that the HEI are not similar. There are many forms and structures of HEI, and depending on the HEI, one tool may be better than another.

Table 3-4 lists the SAT that were compared in each reference described below. Analysing Table 3-4, it is possible to realise that the tools that are most influential in the selected literature are Sustainability Tracking, Assessment & Rating System (STARS), which is referenced in 10 articles, UI Green Metrics (UIGM), and Graphic Assessment of Sustainability in Universities (GASU), both cited nine times. Those tools are followed by Sustainability Assessment Questionnaire (SAQ) and Auditing Instrument for Sustainability in Higher Education (AISHE), both referenced in eight articles.

Table 3-4 - SAT analysed by each reference.

Tools reported	Reference													
	(Shriberg, 2002a)	(Amaral et al., 2015)	(Lauder et al., 2015)	(Fischer et al., 2015)	(Kamal & Asmuss, 2013)	(N. Alghamdi et al., 2017)	(Findler et al., 2018a)	(Bullock & Wilder, 2016)	(Casarejos, Frota, et al., 2017)	(Alba-Hidalgo et al., 2018)	(Du et al., 2020)	(Adenle et al., 2020)	(Galleli et al., 2021)	Total
Sustainability Tracking, Assessment & Rating System (STARS)		X	X	X	X	X	X	X		X	X	X		10
UI Green Metrics (UIGM)			X	X		X	X	X		X	X	X	X	9
Graphic Assessment of Sustainability in Universities (GASU)	X	X	X			X	X	X		X	X	X		9
Sustainability Assessment Questionnaire (SAQ)	X			X	X	X	X			X	X	X		8
Auditing Instrument for Sustainability in Higher Education (AISHE-01)	X	X		X		X	X			X	X	X		8
Campus Sustainability Assessment Framework (CSAF)				X	X		X			X	X			5
Unit-based Sustainability Assessment Tool (USAT)						X	X			X	X	X		5

Adaptable Model for Assessing Sustainability in Higher Education (AMAS)						X	X				X	X		4
Sustainability Tool for Auditing Curricula in Higher Education (STAUNCH)		X	X				X			X				4
The National Wildlife Federation's State of the Campus Environment (NWFCE)	X	X					X							3
Benchmarking Indicators Questions – Alternative University Appraisal (BIQ-AUA)				X		X				X				3
Graz Model for Integrative Development (GMID)				X			X					X		3
Green League (People & Planet)				X			X				X			3
College Sustainability Report Card					X			X		X				3
Princeton Review's Guide to Green Colleges (PRGGC)		X						X						2
German Commission for UNESCO (DUK)				X			X							2
University Environmental Management System (UEMS)						X						X		2
Sustainability Campus Assessment Systems (SCAS)						X						X		2
Green Plan (GP) FRANCE				X		X								2
Sustainability Assessment Model (SUM)						X					X			2
DPSEEA-Sustainability Index Model (D-SiM)							X					X		2
Three-dimensional University Ranking (TUR)							X					X		2
Pacific Sustainability Index (PSI)								X			X			2
Sustainable University Model (SUM)												X		1
Campus Ecology (CE)	X													1
Environmental Workbook and Report (EWR)	X													1
Greening Campuses (GC)	X													1
Red de Ciencia, Tecnologia, Innovación y Educación Ambiental (CITEAMB)				X										1
Conference of Rectors of Spanish Universities (CRUE)				X										1
Business School Impact System (BSIS)							X							1
CSF (CSF-Michigan)							X							1
Penn State Indicators Report (PENN)							X							1
Good Company's Sustainable Pathways Toolkit (SPT)							X							1
Beyond Grey Pinstripes (BGP)								X						1
Sierra Club's Cool Schools (SCCS)								X						1
American College and University Presidents' Climate Commitment (ACUPCC)								X						1
Guardian's Green Leagues (GGL)								X						1
Assessment System for Sustainable Campus (ASSC)											X			1
Sustainability in Higher Education Institutions (SusHEI)											X			1
Greening Universities Toolkit (Toolkit)											X			1
Times Higher Education													X	1
Environmental Performance Survey (EPS)	X													1
Indicators Snapshot/Guide (ISG)	X													1
Grey Pinstripes with Green Ties (GPGT)	X													1
EMS Self-Assessment (EMSSA)	X													1
Higher Education 21's Sustainability Indicators (HE21SI)	X													1

The list of studies that conduct a comparative analysis of SAT does not intend to cover all existing references on the topic since this strategy would be beyond the objectives of this PhD thesis. In this sense, the list of references in Table 3-3 is only made up of well-structured examples of comparisons that, as a whole, offer a general overview of the most relevant existing tools, highlighting their main characteristics. Authors such as Berzosa, Bernaldo, and Fernández-Sánchez (2017), Masaru Yarime and Tanaka (Masaru

Yarime & Tanaka, 2012), H. Shi and Lai (2013), Sepasi et al. (Sepasi et al., 2018), Silva and Almeida (2019), Zainordin and Ismail (2017), Drahein et al (2020), and (Adenle et al., 2020a) among others, also contribute to the literature by comparing SAT, however they are not listed in the mentioned table. By examining the literature review that comprises articles on SAT, it is possible to perceive an evolutionary thread in the analyses performed, evidenced by the effort to summarise the studies previously carried out that became visible in the studies performed by Findler et al. (2018) and Du et al. (Du et al., 2020). It also draws attention to the concern in promoting the gradual evolutionary consensus by including SAT more recurrently referred to in the literature as, for example, STARS, UI-GM, AISHE, SAQ, and GASU.

3.1.3.2. New proposed SAT

Throughout the reading of the comparative tools reviews articles, one notices a recurrent concern of the authors in critically analysing the compared tools, pointing out the limitations and aspects of improvement of each tool analysed. It is expected that some of those authors, having identified the misfit in some of the analysed tools, propose new ones with characteristics that offer a possibility of overcoming the ascertained aspects of improvement. Therefore, new tools propositions arise, such as the nine listed in Table 3-3.

Four propositions of new or newish sustainability assessment tools were selected to represent the set of SAT proposed in the literature related to the reviews of SAT. The first, proposed by Lozano (2006), is not a new proposition considering it was proposed a decade and a half ago. It is now placed as an influential tool well acknowledged in the literature. It is acknowledged in Table 3-4 that the Graphical Assessment of Sustainability in Universities (GASU) was reported in 2006 in the paper "A tool for a Graphical Assessment of Sustainability in Universities (GASU)", published in the Journal of Cleaner Production. In this work, the author Lozano (2006a) presents a comparison between different tools that have been designed to evaluate and report HEI' sustainability efforts, resulting in an adaptation of the GRI Sustainability Guidelines for use in universities; finally, the developed tool offers a summarised graphical overview of a set of indicators from the GRI adapted. According to the author, the GASU was developed to simplify the analysis, longitudinal comparison and benchmarking of universities' sustainability initiatives and achievements. The GASU comprises 59 indicators clustered into five components and eight subcomponents, as shown in Table 3-5.

Table 3-5 - Basic structure of Graphical Assessment of Sustainability in Universities - GASU - (Lozano, 2006a)

Graphical Assessment of Sustainability in Universities - GASU - (Lozano, 2006)			
(Lozano, 2006a) GASU	Economic	Direct Economic Impact	01. Customers, 02. Suppliers, 03. Employees, 04. Providers of capital, 05. Public sector.
	Environmental	Environmental	06. Materials, 07. Energy, 08. Water, 09. Biodiversity, 10. Emissions, effluents & waste, 11. Suppliers, 12. Products and services, 13. Compliance, 14. Transport, 15. Overall.
	Social	Labour Practices and Decent work	16. Employment, 17. Labour management relations, 18. Health and safety, 19. Training and education, 20. Diversity opportunity.
		Human Rights	21. Strategy and management, 22. Non-discrimination, 23. Freedom of association and collective bargaining, 24. Child labour, 25. Forced and compulsory labour, 26. Disciplinary practices, 27. Security practices, 28. Indigenous rights.
		Society	29. Community, 30. Bribery and corruption, 31. Political contributions, 32. Competition and price.
		Product responsibility	33. Customer health and safety, 34. Products and services, 35. Advertising, 36. Respect for privacy.
	Educational	Curriculum	Core indicators: 37. number and percentage of courses related to sustainability concepts, 38. The number of students enrolled in sustainable related courses, 39. The number of the courses with content on sustainable development themes, 40. Courses to educate the educators in SD, 41. Management procedures to monitor incorporation of SD themes into curricula.
			Additional indicators: 42. list with the courses title and SD theme continued, 43, Course structure, goals and duration, 44. Management structure and incorporation follow up procedures, continuous improvement methods, etc. 45. Administrative support, 46. Number and percentage of departments and colleges, including sustainability courses and curricula.
		Research	Core indicators: 47. Research in sustainability, 48. Percentage of graduate students doing research in sustainability, 49. Percentage of faculty doing research in sustainability issues, 50. Institutional support and management procedures for multidisciplinary and interdisciplinary research in sustainability, 51. The number of research projects that are multidisciplinary and interdisciplinary in sustainability.
			Additional indicators: 52. list issues addressed: Renewable energies, ecological economics, urban planning, etc. 53. List of knowledge fields involved, 54. List of faculty members and Departments or centres to which they belong. 55. Type of support provided: budget allocation, office and personnel especially dedicated, etc. 56. List of Departments and Centres involved. 57. Total revenues from grants and contracts specifying sustainability-related research, 58. Publication research with a focus on sustainability-related issues. 59. Number and faction of centres on campus providing sustainability-related research services.

The following tool is proposed by H. Shi and Lai (2013) in a work entitled “An alternative university sustainability rating framework with a structured criteria tree”, published in the Journal of Cleaner Production. The author analysed a set of SAT (STARS, ACUPCC and the Green Report Card) and developed a “practical university sustainability ranking framework that includes the core themes of sustainability and is based chiefly on objectively quantifiable criteria for broad applicability to different universities worldwide" (H. Shi & Lai, 2013, p. 59). The tool comprises six components and 24 indicators, as detailed in Table 3-6. The tool is satisfactorily balanced in most components, although the indicators are climate change centred in the component "Campus sustainability".

Table 3-6 - Alternative university sustainability rating framework (H. Shi & Lai, 2013)

Alternative university sustainability rating framework (H. Shi & Lai, 2013)		
(H. Shi & Lai, 2013)	Formal statement	1. Sustainability is a core value 1 of the university, 2. Stated vision in SR or management plan, 3. Stated mission in SR or management plan, 4. Drivers: Legislative or financial.
	Governance	5. The establishment of a sustainability office, 6. The establishment of a carbon management task force team or committee, 7. Involvement of key players in the university,
	Education	8. Formal course: A specific degree in sustainability or environmental management, 9. Formal course: PhD or master research degree in sustainability, 10. Student grants, 11. Student champions, 12. Informal education courses.
	Research	13. Sustainability research institution or centre, 14. Sustainability research programs/project
	Outreach	15. Joined any voluntary offset program Participate in any forum or network to support carbon management/sustainable development, 16. Participate in any inter-university carbon reduction commitment, 17. Awards
	Campus sustainability	18. Policies (general and detailed policies), 19. The carbon management plan, 20. Reduction target, 21. Access to funding, 22. Greenhouse gas inventory (direct and indirect emissions), 23. Demonstration (Green buildings and technology), 24. Implementation

The model proposed by N. Alghamdi et al. (2017) in the article "Assessment tools' indicators for sustainability in universities: an analytical overview" results from their analysis of 12 assessment tools of sustainability. The authors identify five representative components present in most tools and their key indicators. The proposed model has characteristics more aligned to a conceptual model than a tool itself. It has no proposed metrics for the designed indicators and, according to the authors' suggestion, acts as a guide to support the development of unique tools that meet the specific needs of each HEI while being aligned with the most highly regarded international tools. The proposed model is summarised in Table 3-7.

Table 3-7 - Conceptual model (N. Alghamdi et al. 2017)

Conceptual model designed by N. Alghamdi et al. 2017		
(N. Alghamdi et al., 2017)	Management	Including, but not limited to: 1. Commitment, 2. Vision, 3. Mission, 4. Statement, 5. Strategies, 6. Policies, 7. Leadership, 8. Planning, 9. Administration, 10. Governance, 11. Investment, 12. Wellbeing, 13. Special team, 14. Webpage.
	Academia	Including, but not limited to: 15. Formal and informal education, 16. Curriculum, 17. Research, 18. Scholarship.
	Environment	Including, but not limited to: 19. Infrastructure, 20. Land use, 21. Transportation, 22. Planning, 23. Design and Build, 24. Energy, 25. Waste, 26. Water, 27. Materials.
	Engagement	Including, but not limited to: 28. Engagement with the public, 29. Social Responsibility, 30. Engagement with the campus community, 31. Outreach
	Innovation	Including, but not limited to: 32. Any innovative solutions (sustainability challenges, leadership)

The model proposed by Adenle et al. (2020b), outlined in Table 3-8, is focused on aspects of campus operation to the detriment of other general aspects related to sustainable development such as governance and administrative structure, or even aspects specific to HEI, for example, teaching and research.

Table 3-8 - Model proposed by Adenle et al. (2020b)

Model proposed by Adenle et al. (2020b)		
(Adenle et al., 2020b)	Environment	1. Land, 2. Public Space, 3. Landscape, 4. Greenspace and Forest land.
	Infrastructure	5. Building, 6. Green Buildings.
	Energy	7. Greenhouse gas, 8. Energy consumption.
	Waste	9. Sewage disposal, 10. Waste reduction,
	Water	11. Water efficiency, 12. Water consumption
	Transportation	13. Campus fleet, 15. Pedestrian and Cycling

3.1.3.3. Analysis of sustainability reports related to SAT.

Torelli et al. (2020) acknowledge the incremental adoption of social and sustainability reporting by organisations on a global scale, recognising its pivotal role in creating a constructive conduit for conveying their corporate social responsibility endeavours to their various stakeholders.

Sustainability reporting (SR) has been defined as “the practice of measuring, disclosing, and being accountable to internal and external stakeholders for organisational performance towards the goal of sustainable development” (Global Reporting Initiative, 2011, p. 3). According to Morioka et al.(2018) and Kim Ceulemans et al.(2015), SR serves as a crucial mechanism for disseminating information about an organisation's sustainable performance regarding its integration of sustainable development initiatives.

Despite HEIs having the potential to influence a significant proportion of future leaders and exert a substantial impact on short, medium, and long-term value creation, they often struggle to effectively convey their contributions and value-added initiatives to society, the environment, and governance(Adhikariparajuli et al., 2021). In this context, sustainability reporting can play a vital role in enhancing communication. The authors argue that SR facilitates such information's communication to internal and external stakeholders.

Moggy (2019, 2023) acknowledges that HEIs have been subject to significant institutional pressure from key stakeholders to actualise their environmental commitments and disclose social and environmental information as responsible entities. In order to meet the expectations of their stakeholders and fulfil institutional demands, HEIs have undertaken the development of sustainability reports and other disclosure mechanisms. Furthermore, Caputo et al. (2021) suggested that government decisions and their call for greater transparency have also exerted an influence on HEI to publicise their SR.

GRI is one of the most commonly used tools for reporting the sustainability of HEIs. The Global Reporting Initiative was established in 1979 by the Coalition for Environmentally Responsible Economies - CERES and UNEP, aiming to develops guidelines for reporting the economic results of an organisation and also on the social and environmental impact of its activities (Lozano, 2006a; Yáñez et al., 2019). Examples of applying the GRI framework to report on the performance of universities in promoting sustainable development are illustrated by the studies conducted by Monteiro et al. (2022) and Ramísio et al. (Ramísio et al., 2019b), which detail aspects of the implementation of a GRI-based framework for sustainability disclosure at the University of Minho in Portugal.

However, many authors have criticised its adoption as the tool includes a set of global indicator systems that were not designed to assess the sustainability of specific aspects of HEI, such as education, research, and campus operations (Amiano Bonatxea et al., 2022; Kim Ceulemans et al., 2015; Son-Turan & Lambrechts, 2019).

In addition to GRI, academics have been developing specialised tools for HEI to create their sustainability reports. As an Illustration, Sepasi et al. (2018) devised an assessment tool tailored explicitly for evaluating sustainability reporting within HEIs. They applied their study at the University of California, revealing commendable environmental and educational performance while highlighting social and governance/economic deficiencies.

There needs to be more literature that considers SR as an outcome of the planning, execution, and evaluation processes within HEI sustainability. Adhikariparajuli et al. (2021) examined the integration of sustainability reporting, albeit from the perspective of incorporating sustainability reports into conventional institutional reports. According to these authors, integrated reporting can be designed to provide a consolidated disclosure of financial and non-financial information by publishing a single, concise, and comprehensive report that caters to the demands of various stakeholders. While this approach represents a step forward in integration, it still maintains a gap between reporting and the preceding phases, specifically, the planning, execution, and evaluation of sustainability within HEIs.

3.1.3.4. Mathematical models to integrate indicators into SAT.

Gan et al. (2017) state that sustainability assessment is usually intricate and multifaceted and involves making trade-offs between various sustainability dimensions. This process necessitates the attainment of dynamic and concurrent harmony among ecological subsystems (environmental sustainability), social subsystems (social sustainability), and economic subsystems (economic sustainability). Therefore, this task often requires the integration of multiple indicators to form a composite index. Composite indices (CI) are valuable because they simplify complex measurement constructs (Booysen, 2002). According to Nardo et al. (2005, p. 7)

> A composite indicator is the mathematical combination of individual indicators that represent different dimensions of a concept whose description is the objective of the analysis (...) The construction of composite indicators involves stages where subjective judgement has to be made: the selection of indicators, the treatment of missing values, the choice of aggregation model, the weights of the indicators, etc.

OECD (2008) discussed that a composite indicator emerges by amalgamating individual indicators into a unified index, grounded in an underlying model. Ideally, this composite index should gauge multifaceted concepts that cannot be adequately represented by a solitary indicator. Schlossarek et al. (2019) assume that setting weights might be the most frequently challenged issue in building CI. Gan et al. (2017), Nardo et al. (2005) and OECD (2008) provide an extensive set of methodologies to assist researches and practitioners in setting up a mathematical model based in CI to integrate dimensions of sustainability.

Since their inception, these methodologies have been extensively employed to measure and assess a wide range of phenomena, including human development, well-being, quality of life, and sustainable development. For instance, Alaimo (2018) utilised CI to analyse the performance of European countries in their pursuit of SDG. Through a systematic review, Brousmiche et al.(2020) compiled over 1,500 studies that employed spatialised CI to evaluate environmental health inequalities. Engida et al. (2018) and Dobrovolskienė et al. (2019) employed CI to assess the sustainability of business projects.

Complex systems can be effectively measured by creating indicator systems that generate CI. When organised within a system, these indicators are not merely isolated measurements but interconnected. Such an indicator system enables the measurement of complex concepts that would otherwise be challenging to gauge if considered in isolation.

OECD (2008, pp. 19–21) designed a ten steps "ideal sequence" to develop a theoretical framework based on composite indicator. By ideal sequence the OCDE highlight the need to evaluate what is possible to achieve in a real context and the purpose of the proposed theoretical framework. Table 3-9 shows the ten steps procedure proposed by OECD for building a composite indicator.

Table 3-9 - Ten steps procedure for building a composite indicator (OECD Guidelines)

Step	Description	Why it is needed
1 Theoretical framework	Provides the basis for the selection and combination of variables into a meaningful composite indicator under a fitness-for-purpose principle (involvement of experts and stakeholders is envisaged at this step).	- To get a clear understanding and definition of the multidimensional phenomenon to be measured. - To structure the various sub-groups of the phenomenon (if needed). -To compile a list of selection criteria for the underlying variables, e.g., input, output, process.
2 Data selection	Should be based on the analytical soundness, measurability, country coverage, and relevance of the indicators to the phenomenon being measured and relationship to each other. The use of proxy variables should be considered when data are scarce (involvement of experts and stakeholders is envisaged at this step).	- To check the quality of the available indicators. - To discuss the strengths and weaknesses of each selected indicator. - To create a summary table on data characteristics, e.g., availability (across country, time), source, type (hard, soft or input, output, process).
3 Imputation of missing data	Is needed in order to provide a complete dataset (e.g., by means of single or multiple imputation).	- To estimate missing values. - To provide a measure of the reliability of each imputed value, so as to assess the impact of the imputation on the composite indicator results. - To discuss the presence of outliers in the dataset.
4 Multivariate analyses	Should be used to study the overall structure of the dataset, assess its suitability, and guide subsequent methodological choices (e.g., weighting, aggregation).	- To check the underlying structure of the data along the two main dimensions, namely individual indicators and countries (by means of suitable multivariate methods, e.g., principal components analysis, cluster analysis). - To identify groups of indicators or groups of countries that are statistically "similar" and provide an interpretation of the results. - To compare the statistically- determined structure of the data set to the theoretical framework and discuss possible differences.
5 Normalisation	Should be carried out to render the variables comparable.	- To select suitable normalisation procedure(s) that respect both the

		theoretical framework and the data properties. - To discuss the presence of outliers in the dataset as they may become unintended benchmarks. - To make scale adjustments, if necessary. - To transform highly skewed indicators, if necessary.
6 Weighting and aggregation	Should be done along the lines of the underlying theoretical framework.	- To select appropriate weighting and aggregation procedure(s) that respect both the theoretical framework and the data properties. - To discuss whether correlation issues among indicators should be accounted for. - To discuss whether compensability among indicators should be allowed.
7 Uncertainty and sensitivity analysis	Should be undertaken to assess the robustness of the composite indicator in terms of e.g., the mechanism for including or excluding an indicator, the normalisation scheme, the imputation of missing data, the choice of weights, the aggregation method.	- To consider a multi-modelling approach to build the composite indicator, and if available, alternative conceptual scenarios for the selection of the underlying indicators. - To identify all possible sources of uncertainty in the development of the composite indicator and accompany the composite scores and ranks with uncertainty bounds. - To conduct sensitivity analysis of the inference (assumptions) and determine what sources of uncertainty are more influential in the scores and/or ranks.
8 Back to the data	Is needed to reveal the main drivers for an overall good or bad performance. Transparency is primordial to good analysis and policymaking.	- To profile country performance at the indicator level so as to reveal what is driving the composite indicator results. - To check for correlation and causality (if possible). - To identify if the composite indicator results are overly dominated by few indicators and to explain the relative importance of the sub-components of the composite indicator.
9 Links to other indicators	Should be made to correlate the composite indicator (or its dimensions) with existing (simple or composite) indicators as well as to identify linkages through regressions.	- To correlate the composite indicator with other relevant measures, taking into consideration the results of sensitivity analysis. - To develop data-driven narratives based on the results.
10 Visualisation of the results	Should receive proper attention, given that the visualisation can influence (or help to enhance) interpretability	- To identify a coherent set of presentational tools for the targeted audience. - To select the visualisation technique which communicates the most information. - To present the composite indicator results in a clear and accurate manner.

Adapted from (OECD, 2008)

Saadatian and Salleh (2011) emphasise that models must be able to adapt to local application conditions. The most popular campus sustainability assessment tools use benchmarking techniques, applying weights and averages to evaluate the overall performance of an individual HEI, or relatively, in a ranking or a rating. The assessment is usually based on the analysis of self-assessment reports or structured questionnaires, creating assessment ranges and performance scores. Two important examples of this type of tool are STARS, which organises the performance of HEI into ratings, and UIGM, which sorts HEI using the ranking approach.

STARS (Sustainability, Tracking, Assessment and Rating System) is divided into three main categories plus a bonus category. Each indicator within these categories has a factor defined in the tool, weighted by the number of aspects that meet the indicator's parameter divided by the total number of parameters in the HEI, up to the maximum points obtained. Thus, the tool establishes a minimum value of compliance with the indicator that guarantees the HEI the maximum score for a given aspect, according to the specifications of the tool's filling manual. For example, in indicator, AC 1 - Academic Courses, the maximum score of 14 points is obtained if 20% or more of the courses offered by the institution are sustainability-focused or sustainability-inclusive. Suppose at least 90% of the institution's departments offer such courses. This weighting logic applies to all categories and indicators, considering the number of points available in each indicator and its particular aspects. In total, there are four categories, 63 indicators in the tool's main catalogue (excluding the extra innovation indicators) and 104 available points (PSTARS). The result of the arithmetic mean of the score in the four major categories (Academics - AC; Engagement - EN; Operations - OP and Planning & Administration - PA), adding four extra points for the innovation category (IN), is detailed in the following equation (Lauder et al., 2015). Equation 1 shows the STARS Mathematical model to assess the HEIs' Sustainability.

$$P_{STARS} = \left(\sum_{i=1}^{11} AC_i + \sum_{j=1}^{15} EN_j + \sum_{k=1}^{22} OP_k + \sum_{l=1}^{15} PA_l \Big/ 4 \right) + \sum_{m=1}^{46} IN_m \quad (1)$$

The indicators related to innovation are optional, and HEI must meet specific criteria to include them calculating their scores. There are 46 other suggested indicators (the HEI can also add others), which award 0.5 points each. However, the maximum score that can be incorporated into the final score of the tool is four points.

According to the score, the HEI is classified in one of the five existing levels: reporter designation (no score required); Bronze (from 25 points); Silver (from 45 points); Gold (from 65 points) and Platinum rating (from 85 points) (AASHE, 2019b).

Following a different logic, in the GreenMetrics UI tool, participating HEI are ranked based on the score obtained in a questionnaire with six categories. The questionnaire presents objective answers employing compliance intervals for each indicator, assigning a score for each interval.

The tool distributes 10,000 points in 6 categories and 51 indicators. The score obtained in each category by the HEI is weighted according to the weight of the category, according to the following values: Setting and Infrastructure-SI (11 indicators, 1500 points and weight 0.15); Energy and Climate Change-EC (10 indicators, 2100 points and weight 0.21); Waste-WS (6 indicators, 1800 points and weight 0.18); Water-WR (5 indicators, 1000 points and weight 0.1); Transportation-TR (8 indicators, 1800 points and weight 0.18) and Education and Research-ER (11 indicators, 1800 points and weight 0.18). In the GreenMetrics UI tool, each variable has a score. When the variables are joined, it will compose a category that is weighted in the final calculation of the score (P_{UIGM}) of the HEI, according to the Equation 2, that presents the UI GreenMetrics Mathematical Model to Assess HEIs' sustainability (UIGM, 2021).

$$P_{UIGM} = 0{,}15\sum_{i=1}^{11} SI_i + 0{,}21\sum_{j=1}^{10} EC_j + 0{,}18\sum_{k=1}^{6} WS_k$$
$$+0{,}10\sum_{l=1}^{5} WR_l + 0{,}18\sum_{m=1}^{8} WR_m + 0{,}18\sum_{n=1}^{11} ER_n \quad (2)$$

Several mathematical models of SAT are derived from the most prominent global models in the literature. Manyl authors seek to adjust such models to local realities or correct any gaps found in the benchmarking done by the model. The Framework proposed by Casarejos, Frota and Gustavson (2017) comprises four dimensions: management, society and culture, academia, and operation. For each dimension, the model proposes the adoption of strategic actions driving HEIs' initiatives towards sustainability, whose number determines the overall weight of the dimension. Thereafter, the assessment model has four indices to measure the degree of commitment, parity, difficulty, and institutional performance of the HEI during the implementation of the proposed actions. This model's main objective is to position the HEI at a development level in relation to sustainability actions. It can be applied to several HEI simultaneously. The proposed tool does not limit the number of strategic actions inserted into the model by HEI, conditioning them to the weight of each dimension. This modularity gives the tool a higher level of adaptability in relation to others, which do not admit such a resource.

Shi and Lai (2013) propose a model based on a tree of criteria in 4 levels that decrease from strategic to operational. They are 1 - Vision and conceptualizing sustainability; 2 - Mission and how to become a sustainable university; 3 - University-wide sustainability committee and the vehicle to drive a sustainable university; 4 - Strategies for fostering sustainability: Education, Research, Outreach and Partnership and

Sustainability on Campus. When met by the HEI, each level has criteria that generate a score point for the criterion, with some exceptions, which generate two points. The four criteria are added up in order to generate an overall score for the HEI studied. The maximum score obtained in the tool is 28 points. The advantages of this modelling are the elimination of double counting within the tool and the possibility of comparing strategic and operational criteria separately.

Most of the known sustainability assessment tools follow a weighted based mathematical modelling using data collected from HEI. This data, however, may suffer excessive variation according to the collection principle and importance given to the dimension considered within the tool.

3.2. Sustainability Assessment tools for HEI

In order to track the implementation of the commitments made by HEI in various international meetings, such as those mentioned in chapter 1, environmental management and performance assessment systems and reporting procedures were created and have been used by several universities worldwide (L. P. Amaral et al., 2015).

Berzosa et al. (2017) considered sustainability assessment tools pivotal to enabling institutional sustainability achievement. However, despite its benefits, the authors state that researchers have not paid much attention to what these tools conclude about HEI sustainability.

Lambrechts and Ceulemans (2013) found three reasons to carry out a sustainable development assessment in HEI:

1. promoting policy development.
2. Turning SD initiatives as the mainstreaming in HEI.
3. Supporting actions devoted to improving transparency and communication at HEI.

To accomplish the first reason, several HEI worldwide have signed many charters and declarations committed to boosting the integration of SD into HEI. According to the authors, the use of SAT might support the translation of theoretical concepts commonly embodied in the declaration and charts into a practical approach. In addition, it could help to identify the strengths and weaknesses and provide decision-makers with information regarding the current situation of the integration of SD into HEI and might ameliorate the communication, governance, and transparency.

As claimed by Disterheft et al. (2013), not many HEI had so far properly integrated SD initiatives through a holistic implementation process. Such implementation in an HEI requires adopting an integrated management approach to modelling a system that allows the institution to plan, implement, assess, and report the SD initiatives into the conventional management system to integrate the main processes of a given HEI (Sroufe, 2018). The unified assessment of sustainable development at HEI requires aggregating measures based on integrating various thematic dimensions of SD. Ramos and Pires (2013) stated that there is an agreement in the literature that currently, sustainability indicators are not only necessary but imperative instruments to simplify the collection of information for planning, decision making, implementation, and assessment of SD policies.

In the opinion of Franceschini et al. (2019, p. 7), "measuring is essential for the process performance control and improvement. However, constructing and starting-up a measurement system is easier said than done". The most critical aspect is not identifying the indicators but identifying those that "properly" represent the process: the so-called Key Performance Indicators (KPI). The meaning of quality indicators are expressed in the UNI 11097:2003, the Italian Agency of Standardization, as "the qualitative and/or quantitative information on an examined phenomenon (or a process, or a result), which makes it possible to analyse its evolution and to check whether quality targets are met, driving actions and decisions" (cited by Brambilla et al., 2020, p. 437)

The relevance of the assessment of the initiatives related to the implementation of sustainable development in higher education institutions lies in the ability to improve the deployment of SD programmes, helping meet the goals established and the possibility to compare sustainable performance among HEI. According to Vasconcelos et al. (Vasconcelos et al., 2021), in the existing literature, more attention has been given to the development of objective assessment tools rather than human-centred ones, which allow the generation of knowledge about the perception of individuals that make up an HEI, such as students, teachers, or staff. With the maturation of sustainability assessment systems in HEI, it is expected that the emergence of tools that use both objective and subjective performance indicators will improve the effectiveness of the measurement procedure.

In the field of HEI, a review of sustainability assessment tools was performed by Fischer et al. (2015). The authors comparatively analysed twelve sustainability assessment tools (SAT), more than 600 indicators and criteria, and introductory passages in supporting documents to identify their domain and points of convergence and divergence. The authors defined the four fields of action mainly covered by the analysed SAT: operations, research, education, and community. The overall distributions of indicators and criteria reveal an extensive concentration of the field "operation", which comprises 67% of all analysed indicators and criteria. This result highlights the prominence of operational aspects as a determinant factor of university campus sustainability.

However, concentration in one field or another will depend on the assessment tool adopted. Berzosa et al. (2017) analysed four sustainability assessment tools: AISHE, SAQ USAT and Sustaintool. The study demonstrated that the AISHE and SAQ tools place greater emphasis on the "curriculum" dimension, which is similar to the coined "education" field of action of Fisher et al. (2015) model at the expense of the "environment" dimension that is also close to the "operations" field of action of Fisher et al. (2015).

Table 3-10 catalogue 73 sustainable assessment tools compiled through several reviews papers, among which the works of Alba-Hidalgo et al. (2018), Alghamdi et al. (2017), Asmuss and Kamal (2013), Du et al. (Du et al., 2020), Findler et al. (2018), Fischer et al. (Fischer et al., 2015), Lauder et al. (2015), Shriberg (Shriberg, 2002a) are highlighted.

In terms of design, the list ranges from conceptual or theoretical models proposed in the literature (Sustainability Assessment Framework - SAF; and Sustainability Indicators for Higher Education Institutions - SIHEI) to practical ones already implemented in HEI and consolidated through reports of application experiences reported in scientific journals (An indicator-based model to assist in assessing participatory processes - INDICARE; and Benchmarking Indicators Questions – Alternative University Appraisal - BIC-AUA).

Considering the geographical coverage area, the compiled list of SAT addresses tools developed in all continents, from Latin America (Adaptable Model for Assessing Sustainability in Higher Education - AMAS; and Sustainability Assessment for Higher Technological Education - SAHTE), North America (Sustainability Assessment Framework - SAF; and Maclean's Magazine Annual Guide to Canadian Universities - MMAGCU), Europe (Green League (People & Planet) - P&P; and Sustainability Campus Assessment Systems - EUAC), Asia (Assessment System for Sustainable Campus ASSC; and Benchmarking Indicators Questions - Alternative University Appraisal - BIQ-AUA) and Australia (Learning in Future Environments Index - LiFE).

Some tools are implemented in regional contexts (Sustainable Assessment Framework for Waterloo University - SAFWU), while others are adopted in broader contexts (Global), such as the Global Reporting Initiative - GRI.

Table 3-10 - Compiled list of Sustainability Assessment Tools for Educational Institutions

Num.	Acronym	Assessment Tool	Origin	Context (R/G)*	Source
1	**Accelerator**	A set of change agentry tools and method based on sustainable development principles and theories	International	G	(Kapitulčinová et al., 2018)
2	**ACUPCC**	American Colleges and Universities Presidents' Climate Commitment	USA	R	(Dyer & Dyer, 2017) (Sassen & Azizi, 2018) (Sepasi et al., 2019)
3	**AISHE**	Auditing Instrument for Sustainability in Higher Education	Netherlands	G	(Lambrechts & Ceulemans, 2013) (Caeiro, Sandoval Hamon, et al., 2020) (Clarke & Kouri, 2009)
4	**AMAS**	Adaptable Model for Assessing Sustainability in Higher Education	Chile	R	(Gómez et al., 2015) (Zainordin & Ismail, 2018) (N. Alghamdi et al., 2017)
5	**ASSC**	Assessment System for Sustainable Campus	Japan	R	(Ikegami & Neuts, 2020)
6	**AUSP**	Assessment of University Sustainability Policies and their relation to the International Campus of Excellence program	Spain	R	(Urquiza Gómez et al., 2015)
7	**BGP**	Beyond Grey Pinstripes	USA	R	(Weber, 2013)
8	**BIQ-AUA**	Benchmarking Indicators Questions – Alternative University Appraisal	Asia– Pacific	G	(Fischer et al., 2015)
9	**BSIS**	Business School Impact System	Brussels	G	(Findler, Schönherr, Lozano, & Stacherl, 2019a)
10	**CE**	Campus Ecology	USA	R	(Drahein et al., 2019)
11	**CITE AMB**	Red de Ciencia, Tecnología, Innovación y Educación Ambiental en Iberoamérica	Colombia	R	(Fischer et al., 2015)(Sáenz, 2018)
12	**CITEAMB**	Red de Ciencia, Tecnología, Innovación y Educación Ambiental en Iberoamérica	Colombia	R	(Fischer et al., 2015) (Sáenz, 2018) (Calitz et al., 2018)
13	**CRC**	Campus Report Card	USA	R	(Parvez & Agrawal, 2018)
14	**CRUE**	Conference of Rectors of Spanish Universities	Spanish	R	(Jorge et al., 2015) (Larrán Jorge et al., 2015)
15	**CS**	Cool Schools	USA	R	(Cai, 2017)
16	**CSAF**	Campus Sustainability Assessment Framework	Canada	R	(Beringer, 2006) (Asmuss & Kamal, 2013)
17	**CSAF- MALAY**	The refined Campus Sustainability Assessment Framework	Malaysia	R	(Du et al., 2020; Parvez & Agrawal, 2019)
18	**CSAF Core**	Campus Sustainability Assessment Framework Core	Canada	R	(Cronemberger de Araújo Góes & Magrini, 2016; Du et al., 2020; Sepasi et al., 2018)
19	**CSAR Framework**	Campus Sustainability Assessment Framework (Campus Sustainability Assessment Review Project)	USA	R	(Nixon & Glasser, 2002)
20	**CSRC**	College Sustainability Report Card	USA	G	(Lopez & Martin, 2018) (Asmuss & Kamal, 2013)
21	**CSRP**	College Sustainability Report Card	Canada	R	(N. Alghamdi et al., 2017)

22	**CSSISG**	Campus Sustainability Selected Indicators Snapshot and Guide	USA	R	(Shriberg, 2002b; Shuqin et al., 2019)
23	**DLEPIA**	Draft List of Environmental Performance Indicators Approach	_	R	(Tumbas et al., 2015)
24	**DUK**	German Commission for UNESCO	German	R	(de Haan et al., 2010)(Leal Filho, 2009) (Singer-Brodowski et al., 2019)
25	**EAMC**	An Environmental Assessment Method for Community	Singapore	R	(Maletič et al., 2018)
26	**E-MAS**	Eco-management and audit scheme	European	G	(Martins & Fonseca, 2018) (Tourais & Videira, 2016)
27	**EMS Self-Assessment**	Environmental Management System Self-Assessment Checklist	USA	R	(Clarke & Kouri, 2009)
28	**EMS Self-Assessment**	Environmental Management System Self-Assessment Checklist	USA	R	(Clarke & Kouri, 2009)
29	**EPS**	Environmental Performance Survey	Canada and the USA	R	(Marrone et al., 2018)
30	**ERW**	Environmental Report and Workbook	England	R	(Zhao & Zou, 2018)
31	**ESD toolkit**	Education for Sustainable Development Toolkit	Canada	R	(McKeown et al., 2002)
32	**ESDGC**	Education for Sustainable Development and Global Citizenship	UK	R	(Edwards et al., 2020)(Glover et al., 2013) (Glover et al., 2011)
33	**ESETSU**	Environmental sustainability evaluation tool for Spanish universities	Spain	R	(Xiong & Mok, 2020)(Mader et al., 2013)
34	**EUAC**	Sustainability Campus Assessment Systems	Europe	G	(N. Alghamdi et al., 2017)
35	**FLA**	Framework, Level, Actors	International	G	(Alba-Hidalgo et al., 2018)
36	**GASU**	Graphical Assessment of Sustainability in University	UK	G	(Lozano, 2006a) (Kurniawan, 2020)
37	**GC**	Greening Campuses	Canada	R	(Shriberg, 2002a)
38	**GCSP**	Good Company's Sustainable Pathways Toolkit	USA	G	(Findler, Schönherr, Lozano, & Stacherl, 2019a)
39	**GCUR**	Greenopia College and University Rankings	USA	R	(Du et al., 2020; Parvez & Agrawal, 2019)
40	**GM**	Green Metric	Indonesia	R	(Drahein et al., 2019) (Lauder et al., 2015)
41	**GMID**	Graz Model for Integrative Development	Austria	R	(Mader, 2013) (Alba-Hidalgo et al., 2018)
42	**GP**	Green Plan	France	R	(Cronemberger de Araújo Góes & Magrini, 2016)
43	**GREENSHIP**	GREENSHIP	Indonesia	R	(Ahmed & Sugini, 2020)
44	**GRI**	Global Reporting Initiative	International organisation	G	(Lozano, 2006a) (Drahein et al., 2019) (Caputo et al., 2021)
45	**GUT**	Greening Universities Toolkit	International organisation	G	(Sisriany & Fatimah, 2017)
46	**HE 21**	Higher Education 21's Sustainability Indicators	UK	R	(Martín & M Moneva, 2018)
47	**HEPS RT**	Higher education Partnership for Sustainability Reporting Tool	UK	R	(Sepasi et al., 2018) (Du et al., 2020)

48	**INDICARE**	An indicator-based model to assist in assessing participatory processes	International	G	(Disterheft et al., 2016) (Alba-Hidalgo et al., 2018)
49	**KSDAMCG**	Knowledge for Sustainable Development Assessment in MC Gill	Canada	R	(Saadatian et al., 2013)
50	**KSGSE**	Knight School Guide to Sustainable Education	Canada	R	(Saadatian et al., 2013)
51	**LiFE**	Learning in Future Environments Index	UK and Australasia	G	(Macgregor et al., 2019)
52	**MCA**	Multi-Criteria Analysis: A Tool for Sustainability approach	-	R	(Tumbas et al., 2015)
53	**MMAGCU**	Maclean's Magazine Annual Guide to Canadian Universities	Canada	R	(Amey et al., 2020)
54	**P&P**	Green League (People & Planet)	UK	G	(Jones, 2017) (Jones, 2012)
55	**PENN**	Penn State Indicators Report	USA	R	(Findler, Schönherr, Lozano, & Stacherl, 2019b)
56	**PSI**	The Pacific Sustainability Index	USA	G	(Okanovic et al., 2021) (Bullock & Wilder, 2016)
57	**SAF**	Sustainability Assessment Framework	USA	R	(Koehn & Uitto, 2014)
58	**SAFWU**	Sustainable Assessment Framework for Waterloo University	Canada	R	(Saadatian & Salleh, 2011) (Du et al., 2020)
59	**SAHTE**	Sustainability Assessment for Higher Technological Education	Brazil	R	(Drahein et al., 2019)
60	**SAQ**	Sustainability Assessment Questionnaire	International institution	G	(Drahein et al., 2019) (Asmuss & Kamal, 2013)
61	**SCE**	State of the Campus Environment	USA	G	(Bardati, 2006) (Putri et al., 2020) (Savely et al., 2007)
62	**SIHEI**	Sustainability Indicators for Higher Education Institutions	Brazil	R	(Silva & Almeida, 2019)
63	**STARS**	Sustainability Tracking, Assessment and Rating System for Colleges and Universities	Northern America	G	(Okanovic et al., 2021) (Kurniawan, 2020) (Sepasi et al., 2019) (Caeiro, Sandoval Hamón, et al., 2020) (Parvez & Agrawal, 2019)
64	**STAUNCH**	Sustainability Tool for Auditing Curricula in Higher Education	UK	G	(Glover et al., 2011)
65	**SUM**	Sustainable University Model	Mexico	R	(Velazquez et al., 2006) (Grecu & Ipiña, 2014)
66	**SusHEI**	the model Sustainability in Higher Education Institutions	Portugal	R	(Leal Filho et al., 2018) (Madeira et al., 2011)
67	**TUR**	Three Dimensional University Ranking	Slovenia	R	(Lukman et al., 2010)
68	**UCLA**	An environmental audit in university California Los Angeles Approach	North America	R	(Saadatian & Salleh, 2011)
69	**uD-SiM**	uncertainty-based DPSEEA-Sustainability index Model	Canada	R	(Waheed, Khan, Veitch, et al., 2011)
70	**UEMS**	University Environmental Management System	Saudi Arabia	R	(N. Alghamdi et al., 2017)
71	**UNI-Metrics**	Value Metrics and Policies for Sustainable University Campus		R	(Sonetti et al., 2016)
72	**USAT**	Unit-based Sustainability Assessment Tool	Swedish/Africa	G	(N. Alghamdi et al., 2017; Du et al., 2020; Tamrat, 2021);

* R/G = Regional or Global

The vastness of SAT listed, as well as the geographical areas covered worldwide, indicate the importance that HEI and society as a whole have placed on the implementation of SDI in HEI, as well as for the need to assess and report on institutional performance in implementing actions and programmes related to the promotion of sustainable development over time.

As a conclusion of Fischer et al. (2015, p. 796), the authors mentioned that "Assessment and evaluation tools for higher education institutions constitute a vibrant and growing field, with new sustainability assessment tools emerging in different parts of the world." The authors reflect on the need to systematise these tools and their metrics to allow comparative performance studies. In this sense, the aforementioned authors consider it valuable and "fruitful not only to have more comparative research in the dynamic field of sustainability assessment tools but to work towards setting standards for the analysis collaboratively".

Chapter 4. Method

4.1. Methodological Characterisation

In the research manual developed by Saunders, Lewis, and Thornhill, (2009, 2019) the methodological decisions are grouped into a diagram entitled The Research Onion, which comprises six dimensional characterisation layers as indicated in Figure 4-1.

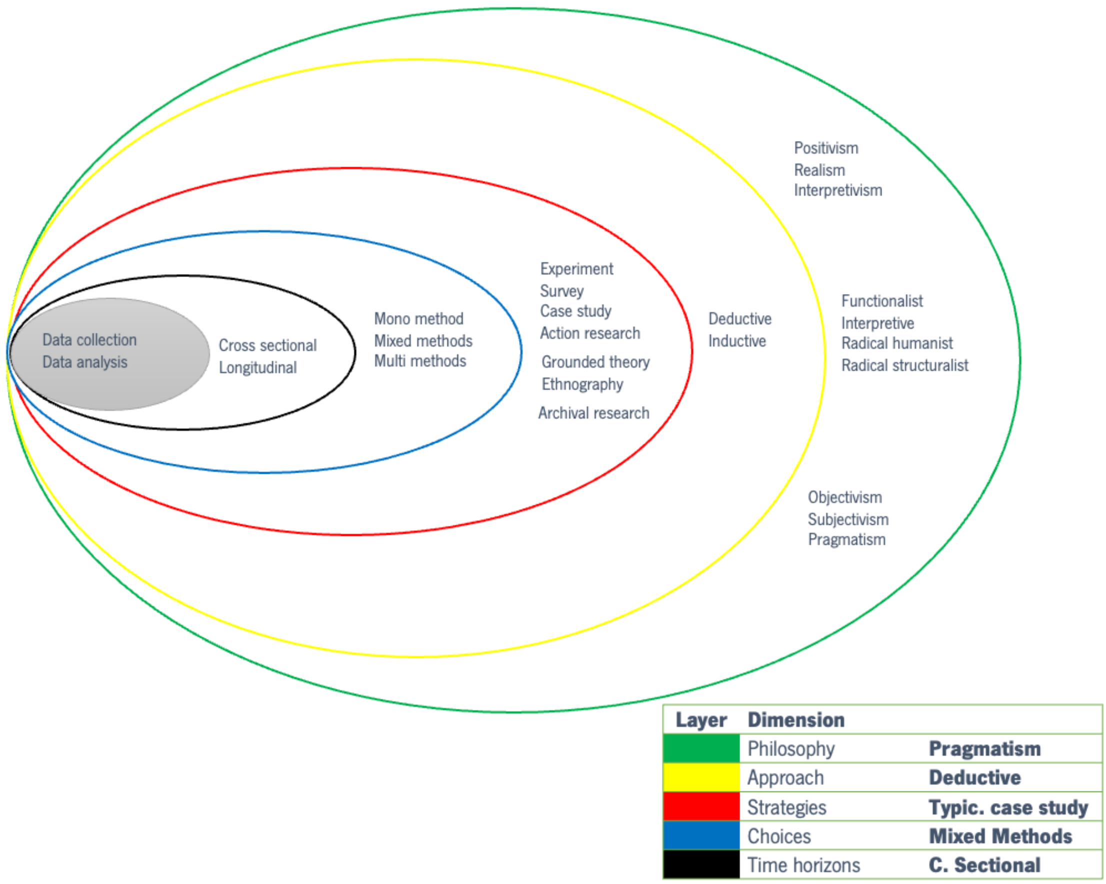

Figure 4-1 - The research onion.

Source: Adapted from Saunders et al (2009, 2019)

Departing from this Figure 4-1, the research component chosen for each research dimension for this PhD thesis is presented in Table 4-1. In particular, the last line of the table summarises the data collection and analysis conducted which include three stages of data collection (DC) and its respective data analysis (DA) procedure. Each one of these dimensions will be detailed in the next sub-sections.

Table 4-1 - Dimensional characterizations of the research

Layer	Dimension	Components
1	Research Philosophy	Pragmatism
2	Research Approach	Deductive
3	Research Strategies	Case study; Action research;
4	Research Choices	Mixed methods;
5	Time Horizons	Cross-sectional;
6	Data Collection and Data Analysis	1) DC: Critical review of the literature, DA: Systematic literature review; 2) DC: Interview, Diary; and Direct Observation DA: Content analysis; Process Design by BPMN;

Source: Adapted from (Saunders et al., 2009);

4.2. Research Philosophy

Research philosophy is the first and the broadest layer and refers to the researcher values and perspectives adopted to interpret the world and its impact in the way the research is carried out. These assumptions will underpin the research strategy and the chosen methods as part of that strategy (Saunders et al., 2009). To carry out this research the pragmatism philosophical approach was chosen because it "rejects binary (either-or) choices suggested in traditional dualisms and considers the knowledge as being both constructed and based on the reality of the world one experiences and lives in"(Teddlie & Tashakkori, 2009, p. 74) and is also considered suitable in the case of the use of mixed-method research (Tashakkori & Teddlie, 2010) and to carryout research on complex adaptative systems (Baldwin et al., 2011). Hesse-Biber (2018), also states that philosophical pragmatism focuses on the research question and builds the scientific arguments using a range of methods that best fit its needs and research purpose.

4.3. Research Approach

The second layer comprises the research approach which could be deductive (moving from theory to data) or inductive (from data to theory) or even Abductive, which according to the authors "moves back and forth, in effect combining deduction and induction (Saunders et al., 2019, p. 155). Considering that the hypotheses are based on the sustainable assessment frameworks theories, the research approach adopted to conduct this work was the deductive one. Saunders, Lewis, and Thornhill (2009) explain that by using this approach, a theory and hypothesis are developed and a research strategy is planned to test the hypothesis. A deductive approach is suitable to describe a method of reasoning where findings are deduced logically from theories that are already known (Jonker & Pennink, 2009).

4.4. Research Strategies

In this section the research strategies that will be employed in the research project are briefly presented. Those strategies are related with the research purpose. Regarding to the characterisation of the research nature according to Saunders, Lewis, and Thornhill (2009, p. 139) "most often used in the research methods' literature is the threefold one of exploratory, descriptive and explanatory" and those are not mutually exclusive, which means that one research may have more than one purpose. The same occurs on the selected research strategies. In the specific case of this work, one research strategy was chosen: modelling supported by a typical case study strategy. In synthesis, a framework was modelled to integrate, monitor, and report the adoption of sustainable development initiatives in HEI, using as typical case the UFPB. To this end, research techniques in complex adaptive systems were employed, as well as the System Approach Framework (SAF) proposed by Lucia (T. S. Hopkins et al., 2011; Støttrup et al., 2019) which is composed of five stages.

Biswas and Kabir (Biswas & Kabir, 2022, p. vii) defines mathematical modelling research as the process of attempting to accurately explain a "nonmathematical situation, real-life phenomena of changing world and the relationships between the situations in the language of mathematics". In model-based research, driven by empirical findings and measurements, the attention of the researcher should be devoted to "ensure that there is a fit between observations and actions in reality and the model made of that reality" (Bertrand & Fransoo, 2016, p. 298). Thus, modelling research is a form of research that uses a mathematical model to simulate the behaviour of a system. It is used to study and predict the behaviour of a system in various scenarios, often with the goal of improving its performance or finding solutions to problems.

A complex adaptive system is a type of system composed of multiple interconnected components that interact with one another to produce emergent behaviour (Siegenfeld & Bar-Yam, 2020; Støttrup et al., 2019). Mathematical modelling is a powerful tool for understanding complex adaptive systems. It can be used to identify the dynamics of such systems and the emergent behaviour that arises from the interactions of their components (Ehresmann & Vanbremeersch, 1987). By combining mathematical modelling with complex adaptive systems research, we can gain insights into the system's functioning, identify critical components and their interactions, and develop strategies for managing the system to achieve desired outcomes.

Yin (2013) defined case study as an empirical inquiry that investigates a phenomenon within its real-world context, when the boundaries between phenomena and context are not clearly evident, in which multiple data sources are used. In this specific research at least one higher education institution will be used as a case study and data from at least two of its campuses will be analysed. Saunders, Lewis, and Thornhill (2009) suggested a set of data collection techniques that could be used in conducting a case study: interviews, observation, documentary analysis and questionnaires. For this work the Federal University of Paraíba was used as a typical case study, according to the qualitative sampling techniques (Saunders et al., 2009, 2019), since it has potential of embedding the target sustainability indicators.

4.4.1. *HEI Used as a case study.*

For more than a decade, the Brazilian government has been adopting a fiscal agenda that seeks to apply the principles of rationalisation and control of public spending, together with the promotion of transparency, data integration and accountability. This policy, together with environmental responsibility, have generated a set of pressure policies for the adoption of governance and sustainability practices in federal public institutions. Among them are the 63 federal public universities that, according to data from the 2017 Census, offer a total of 4,884 courses for 1,120,804 undergraduate students.

The Federal University of Paraíba - UFPB is located at the Northeast of Brazil, and it is the biggest HEI of the Paraíba State. It has 127 undergraduate and 111 postgraduate courses that enrol 38,880 students in its 16 academic centres (UFPB, 2020). UFPB was used as the pilot case in which it was developed and tested the proposed framework designed to build and analyse indicators that enable the integration, monitoring and measurement of HEI sustainability.

Most of the sustainability practices of UFPB are planned by the Environmental Management Committee (EMC), an organ directly linked to the Rectory, and implemented by the various sectors of the University distributed in its four university campuses. Currently, the EMC monitors the implementation of several programmes developed to operationalise sustainability practices along the Institution, among which the following could be highlighted: Conscious Consumption Program; Construction and Demolition Waste Program; Special Waste Program; Health Service Waste Program; Chemical Waste Program; Management of Green Areas Program; Water Management Program; Energy Efficiency Program; Sustainable Use and Occupancy Program; and Environmental Education Program.

The largest of the UFPB campus, located in the capital of Paraíba, was built more than 60 years ago in a dense area of Atlantic Forest. Since its inception, there has been a reduction of about 40% of the forest area and currently, the Atlantic Forest area is compressed into ten fragments. As an example of one of the programs, from 2013 onwards the EMC, through the programs of Environmental Education and

Management of Green Areas, has been promoting the planting of seedlings of native species and performing their monitoring. Since the beginning of this program, more than 10,000 seedlings have been already planted.

On November 2012, the Ministry of Planning, Budget and Management of the Brazilian Government published NI10, 12/11/12, which establishes rules for the elaboration of a Sustainable Logistics Management Plan (SLMP) in public institutions. The SLMP "are planning tools with defined objectives and responsibilities, actions, goals, execution deadlines and monitoring and evaluation mechanisms, which allows the organ or entity to establish sustainability practices and rationalization of expenditures and processes in Public Administration" (Normative Instruction No. 10, 2012, p. 1). This Normative Instruction also establishes a set of sustainability indicators grouped into seven domains: 1) material consumption; 2) electric energy, 3) water and sewage, 4) waste selective collection, 5) life quality in the work environment, 6) sustainable purchases and contracting, 7) personnel displacement.

A report published in May 2019 by the Laboratory of Sustainability Engineering and Consumption (LabESC in Portuguese) of the Federal University of Paraíba presented the results of a survey conducted to identify the number of Sustainable Logistics Management Plans which were already performed by the 68 federal public universities. According to this report a total of 55.88% of the institutions have SLMP; from those, only 47% are publishing some performance reports as requested by law (Laboratório de Engenharia de Sustentbilidade e Consumo, 2019).

The Federal University of Paraíba was chosen as pilot case because it has already developed the SLMP and presented fourteen semi-annual reports. In addition, since the beginning of the research, it was ensured facilitated access to the required databases and to staff personnel working on the laboratory responsible for collecting data, developing sustainable indicators, and systematising the reports. The preparation and monitoring of the execution of the SLMP oversaw of the EMC, became part of the Conscious Consumption Program and is being implemented in collaboration with the Laboratory of Sustainable Engineering and Consumption of the UFPB. Figure 4-2 shows the steps conducted to design the UFPB Sustainable Logistics Management Plan.

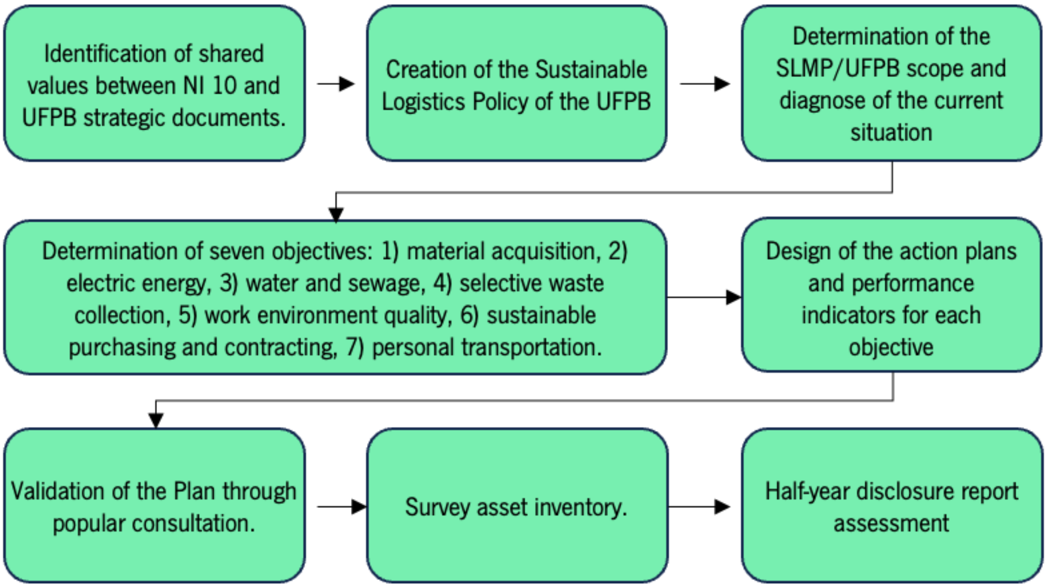

Figure 4-2 SLMP/UFPB design procedure.

Source: adapted from (Laboratório de Engenharia de Sustentbilidade e Consumo, 2019)

4.5. Research Choices

The research choices are placed in the fourth layer of the model designed by Saunders et al., 2009. In this layer the researcher is guided to decide about the qualitative, quantitative or mixed approach, concerning data collection and analysis methods (see Figure 4-1). A quantitative approach is considered mainly when data collection techniques (such as a questionnaire) or data analysis procedures (such as graphs or statistics) will generate or use numerical data. In contrast, the qualitative approach is used predominantly as a synonym for any data collection technique (such as an interview) or data analysis procedure (such as categorizing data) that generates or uses non-numerical data. Mixed methods is the general denomination when both quantitative and qualitative data collection techniques and analysis procedures are used in a research design (Saunders et al., 2009).

Thus, in developing chapters 2, "HEI commitments to Sustainable Development" and 3, "Sustainability Assessment tools for HEI", the technique of systematic literature review and mapping, through VosViwer, was adopted. Chapter 5 was based on a desk review of the SLMP reports of a representative sample of Brazilian federal HEI. The data collected were analysed by means of descriptive statistics. chapter 6 employed the systems approach to modelling the proposed framework. Therefore, the System Approach Framework, designed by Støttrup (2019), was adopted to compile the main dimensions of sustainability of HEI, with their respective indicators and calculation metrics to design the conceptual model of the framework proposed in this PhD research which complies with the system design that is the second stage in applying the SAF. Subsequently, in chapter 7, the framework was specified through the systematic integration of the indicators and metrics compiled, ordered, and modelled in the previous chapter. Finally, in chapter 8, the proposed FIMARSHEI was applied to the typical case study to measure the HEI' performance in integrating sustainable development initiatives. For this purpose, the data were collected by desk review in the database of the analysed university and the government transparency portal and analysed by means of descriptive statistics. In chapter 9, the main insights resulting from the application of the modelled framework are presented, as well as the main limitations that emerged in the process and, finally, suggestions for future work are discussed.

4.6. Time Horizons

The research was conducted in a cross-sectional perspective, meaning that a specific period was considered rather than the evolution of the phenomena studied over time.

The timeframe considered for gathering and analysing data pertaining to performance in terms of implementation of SDI at UFPB comprises 36 months from January 2017 to December 2019. The decision not to include more recent years is justified by the fact that, as a result of the pandemic with the shutdown of the Institution, gradual changes were implemented towards a remote work model, whether the work was related to administrative or teaching and research activities. This change dramatically altered the normal rates of most variables analysed, such as energy consumption, for example, or water. The effect of COVID-19 on higher education is analysed by several studies, namely Leal Filho et al. (Leal Filho, Price, et al., 2021), that analysed the extent to which COVID-19 as a whole and the lockdown it triggered in particular, which has led to the suspension of presence-based teaching in universities in 47 different countries and had influenced teaching on matters related to sustainable development, and Leal Filho, Azul, et al. (2021) that analysed the effect of Covid-19 in sustainability research, and it outlines the solutions pursued by researchers from 39 counties around the world to overcome the many challenges they have experienced.

4.7. Data Collection and data Analysis

In the sixth layer of the model designed by Saunders et al. (2009), shown in Figure 4-1, the attention is turned to the data collection and data analysis which will support the process of modelling the framework and computing the indicators. Thus, the aim of this section is to describe the adopted procedure to:

(i)collect and systematise the data, (ii)design the framework and (iii) compute their sustainability indicators. Table 4-2 summarises the procedures adopted for collecting and analysing the data in each designed task.

Table 4-2 - Data Collection and analysis procedures

Task	Data Collection	Data Analysis
(1) Assess the evolution of the integration of SD initiatives in Brazilian federal public HEI.	Desk research	Content analysis and descriptive statistics
(2) Inventory of extant literature related to frameworks of sustainable universities.	Critical review of the literature, reference mapping	Systematic literature review; science mapping approach
(3) Inventory of dimensions, indicators and metrics assessment of HEI sustainability.	Critical review of the literature, reference mapping	Systematic literature review; science mapping approach
(4) Analyse the adherence between the NI requirements and the SDI models, available in the literature to design the conceptual model to integrate, monitor, assess and report the sustainability in Brazilian HEI.	Critical review of the literature, desk research	Systematic literature review; science mapping approach; Content analysis.
(5) Validate the framework data collection and analysis process with experts (preliminary validation).	Interviewing sector key staff; Diary; Documental analysis	Content analysis; Process design by BPMN
(6) To develop the procedural structure of the framework.	Observation; Documental analysis	Process design by BPMN
(7) To formulate the mathematical model of integration.	Diary	Process design by BPMN
(8) Assessment of usability with the test of application in the typical case	Diary	Process design by BPMN, Descriptive statistic

4.7.1. Task 1 - Assess the evolution of the integration of SD initiatives in Brazilian federal public HEI.

To study the institutionalization of SDI and the level of compliance of HEI with the normative that establishes the guidelines for the formulation and monitoring of the sustainability plan in federal public HEI, a cross-sectional study was performed. At this end, 35 Brazilian HEI were aleatorialy selected and their online availabe data concerning each SD plan were analysed through desk-research. The sample encompasses 55.5% of the total of 63 Brazilian federal universities listed in the INEP´s official statistical synopsis published in 2021 (INEP, 2021). As described in Table 4-3, of the total sample, 12 universities are located in the Northeast, 5 in the North, 3 in the Midwest, 10 in the Southwest and 5 in the South region of Brazil. Minas Gerais is the federal state that has the highest number of sampled HEI, 5 as it is shown in Figure 4-3.

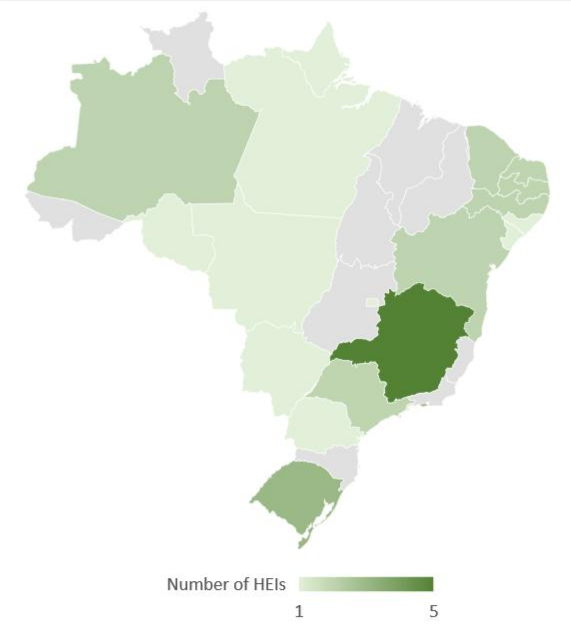

Figure 4-3 - Geographical distribution of the sampled HEI.

Table 4-3 - List of sampled HEI segmented by Region and State

Region	Stat	HEI
Norwest	Bahia	Universidade Federal do Oeste da Bahia - UFOB
Norwest	Paraíba	Universidade Federal da Paraíba - UFPB
Norwest	Ceará	Universidade Federal do Ceará - UFC
Norwest	Rio Grande do Norte	Universidade Federal do Rio Grande Do Norte - UFRN
Norwest	Sergipe	Fundação Universidade Federal de Sergipe - FUFSE
Norwest	Ceará	Universidade da Integração Internacional da Lusofonia Afro-Brasileira - UNILAB
Norwest	Paraíba	Universidade Federal de Campina Grande - UFCG
Norwest	Pernambuco	Fundação Universidade Federal do Vale do São Francisco - UNIVASF
Norwest	Alagoas	Universidade Federal de Alagoas - UFAL
Norwest	Pernambuco	Universidade Federal de Pernambuco – UFPE
Norwest		Universidade Federal Rural do Semiárido - UFIRs
Norwest	Bahia	Universidade Federal do Sul da Bahia -UFSB
North	Amazonas	Universidade Federal Rural da Amazônia - UFRA
North	Rondônia	Fundação Universidade Federal de Rondônia - UNIR
North	Pará	Universidade Federal do Para - UFPA
North	Amazonas	Fundação Universidade do Amazonas - UFAM
North	Amapá	Fundação Universidade Federal do Amapá - INIFAP
Mid-West	Mato Grosso	Universidade Federal de Mato Grosso - UFMT
Mid-West	Distrito Federal	Fundação Universidade de Brasília - FUB
Mid-West	Mato Grosso do Sul	Fundação Universidade Federal de Mato Grosso do Sul – UFMS
South-East	Rio de Janeiro	Universidade Federal do Estado do Rio de Janeiro – UNIRIO
South-East	São Paulo	Universidade Federal de São Paulo - UNIFESP
South-East	Minas Gerais	Universidade Federal de Juiz De Fora - UFJF
South-East	Rio de Janeiro	Universidade Federal Fluminense - UFF
South-East	São Paulo	Fundação Universidade Federal de São Carlos - UFSCar
South-East	Minas Gerais	Universidade Federal de Itajubá - UNIFEI
South-East	Minas Gerais	Universidade Federal de Lavras - UFLA

South-East	Minas Gerais	Universidade Federal de Minas Gerais - UFMG
South-East	Rio de Janeiro	Universidade Federal Rural do Rio de Janeiro - UFRRJ
South-East	Minas Gerais	Universidade Federal de São Joao Del-Rei - UFSJ
South	Rio Grande do Sul	Universidade Federal do Rio Grande do Sul - UFRGS
South	Rio Grande do Sul	Universidade Federal de Santa Maria - UFSM
South	Paraná	Universidade Tecnológica Federal do Paraná - UTFPR
South	Rio Grande do Sul	Universidade Federal de Pelotas - UFPel

To perform the desk research a cheklist was designed to assess the compliance of the documents reported by each analysed HEI with a set of 59 requirements of the NI10, 12/11/12 (Normative Instruction No. 10, 2012, p. 1)divided into four parts as described in Table 4-4:

Table 4-4 -Checklist of the requirements of the normative

Part	Requirements
Part 1 - General SD Commitment	1) HEI has a IDP*; 2) The IDP considers SD in the mission or vision; 3) HEI has a SD policy; 4) HEI has a formal structure to deal with SD issues;
Part 2 - Sustainable Logistic Management Plans	5) HEI has SLMP; 6) The Plan has objectives for the Action Plans; 7) The Plan has details on the implementation of the actions; 8) The Plan defines the units and areas involved in the implementation of each action and the respective responsible parties; 9) The Plan has goals to be reached for each action; 10) The Plan has a timeline for the implementation of the actions; 11) The Plan has a forecast of financial, human and instrumental resources, among others, necessary for the implementation of the actions; 12) Designation of the SLMP management commission
Part 3 - Disclosure of the Sustainability Reports	13) HEI has a report on SLMP; 14) 2014.1; 15) 2014.2; 16) 2015.1; 17) 2015.2; 18) 2016.1; 19) 2016.2; 20) 2017.1; 21) 2017.2; 22) 2018.1; 22) 2018.2; 23) 2019.1; 24) 2019.2; 25) 2020.1; 26) 2020.2; 27) 2021.1
Part 4 - Disclosure of the set the indicators regarding the objectives of the SD Plan	28) Monthly consumption of white paper (bleached); 29) Per capita consumption of white paper (bleached); 30) Expenditure with acquisition of white paper (bleached); 31) Consumption of 200 ml disposable cups; 32) Consumption of 50 ml disposable cups; 33) Per capita consumption of 200 ml disposable cups; 34) Per capita consumption of 50 ml disposable cups; 35) Expenditure with the acquisition of disposable cups; 36) Electricity consumption (kwh); 37) Electricity consumption per capita (kwh); 38) Electricity expenditure; 39) Energy expenditure per capita; 40) Adequacy of the demand contract (off-peak); 41) Demand contract adequacy (peak); 42) Energy expenditure by area; 43) Volume of water used; 44) Volume of water per capita; 45) Volume of water used per capita (m3); 46) Water expenditure per capita; 47) Destination of paper for recycling; 48) Destination of cardboard for recycling; 49) Toner for recycling; 50) Destination of plastic for recycling; 51)Total recyclable material destined for cooperatives; 52) Paper Reuse; 53) Participation of public servants in programs and/or actions regarding quality of life at work; 54) Expenses per telephonic line/extension (fixed); 55) Expenses per telephonic line (mobile); 56) Initial value of the Post; 57) Current value of the Post; 58) Cleaning expenses by area; 59) Degree of renegotiation

*IDP: Institutional Development Plan

4.7.2. Tasks 2 and 3 - Inventory of frameworks of sustainable universities, and assessment metrics of HEI sustainability.

This work concerning tasks two and three aimed to describe the evolution of university-based sustainability literature since the emergence of the environmental crisis and the commitments taken on by HEI as a way of contributing to society on tackling the crisis. Additionally, this work intends to describe the changes that have occurred in the business models of HEI to accommodate the new social requirements related to the implementation of sustainable development.

To accomplish this objective a systematic literature review was carried out to identify references published on the Web of Science through bibliometric and science mapping approaches. The chapters 2 and 3 are two theoretical chapters of this PhD research is the result of the systematic analysis carried out.

Fink (2019, p. 6) defines research literature review as a “systematic, explicit and reproducible method frequently adopted to identifying, evaluating and synthetizing the existing body of completed and recorded work produced by researches, scholars, and practitioners”. According to Linnenluecke, Marrone, and Singh (2019) among the numerous ways to present the results of a systematic literature review, bibliographic mapping approaches are suggested for visualising the intellectual origins of that topic and the structure of the literature over time. Those approaches support a temporal analysis to identify the nature of phenomena represented by a sequence of observations such as patterns, trends, seasonality, and outliers, which is the basic “to analyse the evolution of the research field across different periods of time” (Cobo et al., 2011, p. 1385).

The process model proposed by Cobo, López-Herrera, Herrera-Viedma, and Herrera (2011), has been chosen for this work as it provides a clear structure for conducting a systematic literature review through science mapping approach on a detailed basis. The process model followed comprises three steps: a) data retrieval and pre-processing; b) network extraction, normalization, and mapping; and c) analysis and visualisation, as shown on Table 4-5.

Table 4-5 - Methodological procedure followed to collect, analyse and ma data.

Steps	Description
Step 1 data retrieval and pre-processing	Retrieving data from bibliometric source (Web of Science); Applying pre-processing methods to delete duplicated or unrelated references as well as misspelled elements.
Step 2: network extraction, normalization, and mapping	Defining and applying the network extraction approach (unit of analysis; co-word analysis; co-author analysis, etc.); to normalise the text to set a weight to each term according to its importance in the corpus; applying a mapping algorithm to the whole network formed using the relationship among the selected units of analysis
Step 3: analysis and visualisation	Applying a set of analysis to extract useful knowledge (network analysis; temporal analysis to analyse the evolution of the research field across different period of time; and geospatial analysis); define the proper visualisation technique to a good understanding and good interpretation of the output.

While contributing to the knowledge on the evolution of university-based sustainability research over time, the study presented in this PhD thesis nonetheless is subject to the following limitations: first, although adopting a set of strategies on the pre-processing phase to guarantee the quality of the selection procedure, it may not be enough to rule out all selection bias; secondly, the choice of Web of Science as a boundary of the analysis, even considering its wide scope, disregards the others and could lead to some misstep in identifying relevant nodes for the analysis of the evolution of university-based sustainability research literature.

Thus, to accomplish step 1, as shown in Table 4-5, two systematic literature reviews were performed. The first (Part 1, Table 4-6), intended to compile the extant literature related to integrating sustainable development into HEI by the means of commitments, tools, business model and frameworks. The second (Part 2, Table 4-6), aimed to build the inventory of the dimensions, indicators and assessment' metrics used to integrate SD into HEI. Table 4-6 summarises the criteria adopted in conducting the two systematic literature reviews.

Table 4-6 - Data synthesis of the systematic reviews conducted.

Cod.	Date	Database	String words	Tracked reference fields	Type of doc.	Results
Part 1	20/01/2021	WOS core collection (SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI)	" Sustainab*" AND "higher education" AND LANGUAGE: (English), IC Timespan = 2010 - 2021	Topic (Searches title, abstract, author keywords, and Keywords Plus).	Articles	2,853 references
Part 2	28/06/2021	WOS core collection (SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI, CCR-EXPANDED)	(TS= (Higher Education OR Campus OR University)) AND (Ts=(Sustain*)) AND (TS=(Assessment)) AND LANGUAGE: (English), Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI, CCR-EXPANDED, IC Timespan=2010-2021	Topic (Searches title, abstract, author keywords, and Keywords Plus).	Articles	2,586 references

Steps 1 and 2, as shown in Table 4-5, were achieved through an analysis carried out on VOSviewer software and comprised the investigation of: (a) co-occurrences in keywords, (b) the most prominent journals; and (c) the most active authors as shown on the section 2.1. “Bibliometric analysis on SD in HEI” in chapter 2, section 3.1 “Bibliometric Analysis Sustainable Assessment in HEI” in chapter 3. As the main output of tasks two and three, a comprehensive theoretical and conceptual perspective of the integration of SD into HEI was forged and used as a basis to design the conceptual model of the proposed framework illustrated in Figure 6-4.

4.7.3. Task 4 - Analyse the adherence between the NI requirements and the SDI models in HEI to model the proposed FIMARSHEI.

The task four intend to evaluate the connexion between the NI10, 12/11/12 and the sustainable development initiatives carried out by HEI with the proposed framework.

In executing the previous tasks, two and three, several business models designed to integrate sustainable development into HEI have been surveyed and described in the literature review presented in chapter 2, as those illustrated in Figure 2-6, Figure 2-7, and Figure 2-8. Additionally, in chapter 3 a literature review was performed to identify references regarding sustainability assessment tools used to evaluate higher education institutions' sustainability. Those two chapters worked as a pilar in developing the general conceptual model of the proposed FIMARSHEI presented in Figure 6-4. Therefore, the outcome from task four is the conceptual model and later the complete FIMARSHEI ready to be preliminarily validated.

4.7.4. Task 5 - Validate the framework data collection and analysis process with experts (preliminary validation).

The fifth task planned for execution of this PhD thesis encompasses the following four actions devoted to developing and implementing the data collection procedures: (i) Identification of the sector responsible for the generation of data; (ii) Interviewing the critical staff of the sector to understand the processes related to the generation and storage of the data of each indicator; (iii) Design and map the process of collecting and systematising the data for each indicator by using the principles of BPMN. Implementing the actions set out in Task four will assist in achieving the secondary objective (C), which is "To test the effectiveness of the framework by evaluating the sustainability performance of a typical Brazilian federal public HEI.".

The sectors responsible for generating the data necessary for the preparation of the reports of the Sustainable Logistics Management Plan at the Federal University of Paraíba were selected based on the data needed to fill the report required by the SLMP. The list of the eight sectors and their ten sub-sectors is presented in Table 4-7, below.

Table 4-7 - List of sectors interviewed.

Sector (number of interviews)	Sub-sector
Superintendence of Infrastructure (3)	Environment Division
	The office of Management of projects and buildings
	The office of Management of Electricity
Superintendence of Logistics and Transportation (1)	Management of Planning and Transportation
Institutional Security Superintendence (1)	Cabinet coordination office
Dean of Administration (1)	Office of Materials Acquisition
Dean of Personnel Management (1)	Division of Quality of Life and Health
Environmental Management Committee (1)	Member of the Waste Selective Collection Program
Superintendence of General Services (1)	Green Areas Management Office
Superintendence of Budget and Finance (1)	Coordination

After the selection of sectors and sub-sectors, the distribution of the indicators compiled for the previously selected sectors was performed. An interview script was prepared to guide the interviews with representatives from each of the selected sectors. The interviews aimed to:

(a) identify the main actions carried out in each sector and its relationship with the integration of SD initiatives.

(b) list barriers and drives identified by each sector in integrating sustainable development.

(c) present to the interviewed both, the indicators required in the Normative Instruction and additional indicators selected through a literature review (tasks 2, and, 3 summarised in Figure 1-1), in order to collect information on the availability of the data required to fill out the indicators and the best manner to collect them.

(d) verify whether the sector compiles additional indicators related to the integration of sustainable development that could be added to the proposed FIMARSHEI.

(e) and finally assess the pre-validation of the indicators in terms of (i) replicability – indicators and metrics that can be replicated in other HEI; (ii) integration – indicators and metrics that can be incorporated to others, forming an index; (iii) – feasibility - indicators and metrics possible to be collected in HEI.

The interviews took place during the second semester of 2020 using videoconference held through Skype and Google Meet. Before starting the interview, a brief explanation was made about the context of the integration of sustainable development initiatives at UFPB and the purpose of the interview, and, subsequently, was requested authorization for the collection, analysis, and dissemination of data relevant to the theme. After this initial phase, the audio of the interviews was recorded. The interviews lasted an average of 50 minutes.

After each interview, the audio was played back at least twice to compile the relevant information to meet the above objectives. The compilation of information immediately after the interview was essential to avoid the need for a complete transcription of the content.

PART 2

Part Two of this study represents a critical component of the research project, which seeks to shed light on the state of SD integration in Brazilian federal public universities. The second part of this PhD research is organized into three distinct divisions, each aimed at achieving a particular research objective.

Chapter 5 results from desk research to analyse the implementation of the SLMP in a sample of Brazilian federal public HEI and provides a comprehensive overview of the current state of SD integration. This chapter offers an in-depth analysis of the Brazilian NI10, 12/11/12 as a tool for driving SD integration in universities (Normative Instruction No. 10, 2012). The chapter further examines the processes and routines involved in SD integration, and the challenges faced by Brazilian federal public universities in their pursuit of sustainable development.

Chapter 6 presents a conceptual framework to address the gaps identified in chapter 5. The framework is designed to guide universities in their efforts to integrate sustainable development into their operations and decision-making processes. The framework draws from relevant literature and best practices and offers a practical approach to address the challenges of SD integration.

Finally, Chapter 7 offers a procedural and mathematical modelling of the previously designed framework. This chapter provides a detailed description of the development and implementation of the framework and offers a solution to the theoretical and practical challenges presented in previous chapters. The chapter also highlights the importance of a systematic and structured approach to SD integration.

Overall, Part Two of this study offers a comprehensive analysis of the current state of SD integration in Brazilian federal public universities and proposes a framework to address the identified gaps. The procedural and mathematical modelling of the proposed FIMARSHEI offers a practical solution to the challenges faced by universities in their efforts to integrate sustainable development into their operations and decision-making processes.

Chapter 5. Evolution of the integration of SD initiatives in Brazilian federal public HEI

This chapter reports the results of the study that analyses the evolution of the integration of sustainable development in HEI, through the implementation of NI10, 12/11/12, issued at that time by the Brazilian Ministry of Planning, Budget, and Management - MPOG (Acronym in Portuguese).

The Normative Instruction establishes rules for elaborating a Sustainable Logistics Management Plan – SLMP. The SLMP "are planning tools with defined objectives and responsibilities, actions, goals, execution deadlines and monitoring and evaluation mechanisms, which allows the organ or entity to establish sustainability practices and rationalisation of expenditures and processes in Public Administration" (Normative Instruction No. 10, 2012, p. 1).

Before presenting the empirical study, a brief presentation of statistical data highlighting the importance of the Brazilian federal public higher education system is shown.

5.1. The prominence of the public Brazilian Higher education system

The Brazilian university system emerged late compared to other international education systems and even those in Latin America. It was only in 1920 that the Federal University of Rio de Janeiro was created, the first formal Brazilian university. It was built from the agglutination of some existing faculties in the region (Sguissardi, 2009; Silva & Almeida, 2019; Sonia Simões Colombo, 2011).

Currently, the Brazilian higher education system has become vast and complex. According to the last census of Brazilian higher education, published in 2021 with data from 2019, Brazil has a total of 2,574 HEI, being 204 universities, 350 teaching centres, 1,979 colleges and 41 federal education institutes, which mainly offer technical courses. Of the 204 universities, 113 are public (68 federal, 40 state and 5 municipal), and 91 are private (INEP, 2021).

The difference in the number of public and private universities is not enough to properly indicate the soft power of public higher education institutions for the national education system. The substantial difference between the number of public and private institutions is diluted when a closer look is given at more specific indicators, for instance, observing the number of undergraduate courses offered by the public sector is 10,860 (4,977 in federal universities) and 9,132 in private universities. Another element that denotes the importance of public higher education in the country is the qualification of the lecturing staff. According to official data published by the National Institute of Educational Studies and Research Anísio Teixeira (INEP, acronym in Portuguese), Brazil has a total of 160,414 lecturers holding a doctoral degree working in the whole higher education system. Of this total, 105,796 work in public universities, and, only 20,671 professionals work at private universities, i.e. less than 12% compared to the total number of PhD holders in public HEI (INEP, 2021). The significantly higher number of PhDs in the lecturer staff of public HEI has relevant consequences in postgraduate education. According to data from the Coordination for the Improvement of Higher Level Personnel (CAPES, Acronym in Portuguese), the agency responsible for quality assurance in graduate and postgraduate institutions, in Brazil has 2,459 doctoral courses evaluated and accredited in the quadrennium from 2017 to 2020. Of these, 403 are from private institutions and 2,056 from public institutions, primarily universities. Also, according to the report's data, 185 doctoral courses were evaluated, with seven, the highest possible grade. Of these doctoral courses, 171 are offered by public HEI and 14 by private ones. Finally, federal public universities have maintained leadership in filing patents with the national control agency (CAPES, 2021).

5.2. Integration of sustainability at Brazilian HEI

The stage of maturation of the Brazilian federal HEI in implementing the SD initiatives was measured as its ability to accomplish NI10, 12/11/12, which establishes the requirements of the sustainability plan of these institutions (Normative Instruction No. 10, 2012). Hence, this section details the state of play in implementing the SLMP and its disclosure practices. Henceforth, within this section, the level of accomplishment presented in the subsequent tables pertains to the numerical and/or percentage representation of the HEI that constituted the sample. Within the "requirement" column, the alphanumeric code corresponding to each standard's requirement under analysis is enclosed within parentheses. The compendium of standards' requirements and their corresponding cataloguing codes can be accessed in Table 6-3. In the final row of the tables within this section, the average percentage of accomplishment for all requirements within each table is delineated. This is computed by calculating the mean of the percentages achieved by HEI for each requirement in the table.

As described in chapter 4, the documents available on the web pages of a sample consisting of 55.5% of federal public universities were analysed, through desk-research. The sample of universities was analysed employing a checklist, divided into four parts and composed of 59 variables that analises the accomplishment with the requirements of the Normative Instruction (Normative Instruction No. 10, 2012), and ultimately assessed the level of maturity of Brazilian federal public universities in implementing the SLMP.

The first part, entitled "General SD Commitment", comprising four variables, was sought to analyse the SDI integration into institutional documents, such as strategic plans and policies, and, additionally, verified if the universities had a specific sector to deal with the SDI integration.

The second part, composed of eight variables, was named "Development of Sustainable Logistics Management Plans" (SLMP) and evaluated whether the structure of the universities' SLMPs was adherent to the requirements of the Normative Instruction, which gave rise to the plans.

The third part of the checklist, entitled "Disclosure of the Sustainability Reports", employing 16 indicators, verified the quantity of SLMP reports published on the respective websites of the studied universities.

Finally, the fourth and last part of the checklist assessed whether the available reports adequately reported the universities' performance, following the requirements established in the normative. This part was entitled "disclosure of the set of indicators" and analysed a set of compulsory indicators. For this purpose, it evaluates the performance of each of the seven sustainable development objectives defined in the IN10, 12/11/12, which are purchasing of materials, energy consumption, water consumption, waste, Quality of life at work, services and contracts and displacement. Each of those mentioned parts are detailed in the following topics.

5.2.1. General SD Commitment

Sroufe (2018, p. xxi) advocates that sustainability must be integrated into business strategy and management practices because "sustainability is not something that is to be done in addition to strategy, it is part of strategy and leads to dynamic permanent improvement". This argument demonstrates the importance of integrating sustainability initiatives into institutional strategic documents.

The General SD Commitment was measured through four variables: (a) whether the HEI has Institutional Development Plan (IDP); (b) if the IDP of each HEI considers sustainable development in their mission or vision; (c) whether the HEI has a specific policy directed to SD; and finally (d) whether the HEI has a formal structure to cope with SD issues.

Planning tools can improve public management in the provision of quality services through the rational use of available resources while providing a sense of direction to managers and improving transparency and governance (L. Ávila et al., 2016; Sant'Ana et al., 2017). In the context of HEI, considered complex organisations with significant social, political, economic, artistic, and cultural responsibility, planning is crucial to meet the social demands that justify their existence. Strategic planning at HEI is carried out through the Institutional Development Plan (IDP), which allows for the preparation of a diagnosis and the bases for a systematic reflection, design, implementation, and management of action plans for all central processes inherent to an HEI. The plan makes it possible to improve control over the use of the human, economic, environmental and immaterial resources available (Sant'Ana et al., 2017).

The strategic plan of the public federal Brazilian universities is entitled the Institutional Development Plan (IDP). The IDP is a legal obligation based mainly on the following presidential decrees: n°. 3,860 of 9 July 2001 (2001); n°. 9,235 of 15 December 2017 (2017). According to Dal Magro and Rausch (2012), the IDP is conceived as an institution´s commitment to the Ministry of Education to plan and report the main aspects of the institution, such as its work philosophy, the mission it proposes, the pedagogical guidelines that guide its actions, its organisational structure and the academic activities it develops or intends to develop. Because of that, the IDP can be characterised as the institutional document that works as strategic planning for the HEI. The document is a requirement for the accreditation and re-accreditation processes and for the periodic evaluation of the institution performed by external control bodies (Law No. 10861 of 14 April 2004, 2004).

Although the relationship between the Institutional Development Plan and SDI is not directly highlighted in the legislation, several authors have analysed IDPs' contribution to consolidating actions aimed at promoting sustainable development within higher education institutions. For instance, Santos (2019) intended, in her thesis, identified how the strategic planning of the *Universidade Federal do Ceará* could contribute to the achievement of Sustainable Development Goals.

Ávila (2014) studied the IDP of 28 HEI, aiming to analyse how Sustainable People Management is addressed in the IDPs of Brazilian federal universities. His work found that SDI is still embryonically established in most studied IDPs. Garlet et al. (2018) concluded that the focus of the IDPs is more on aspects related to the service to the external public and the improvement in administrative routines and processes, leading to the management of people to be treated as a peripheral theme. In contrast, as shown in Figure 5-1 (a) and (b), progress has been made since the studies previously presented were published. For instance, all sampled HEI have IDP, and most (74%) included a commitment to sustainable development in the mission or vision of their strategic plan.

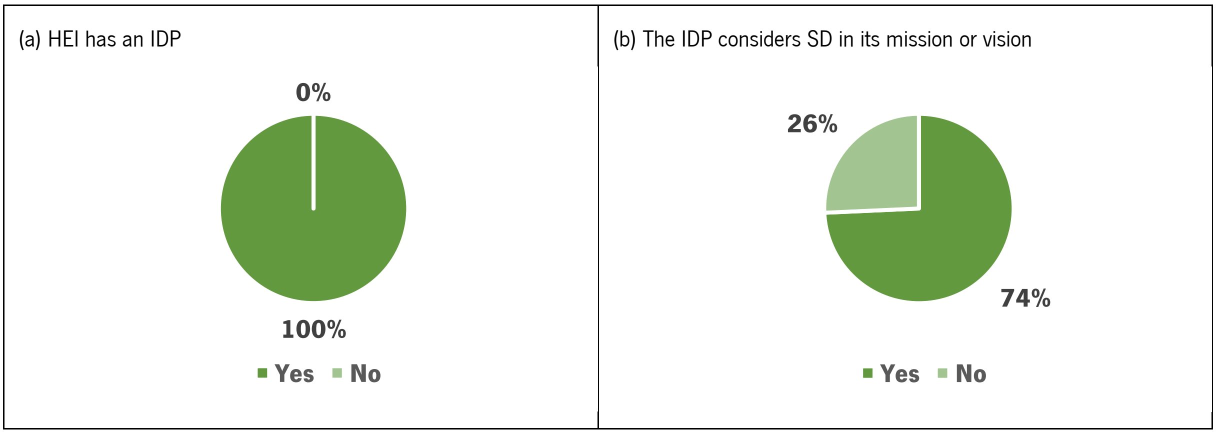

Figure 5-1- Inclusion of SD within the IDP of the sampled HEI.

Besides the inclusion of the sustainable development theme in the strategic plan, for the majority of the studied HEI (Figure 5-1(b)), as it was highlighted on chapter 2, Figure 2-4, many HEI have embarked in assuming their commitment towards sustainable development since Stockholm 1972. Fifty years on, there have been some gradual advancements in the literature pertaining to the integration of sustainability into strategic documents - namely, mission, vision, and policy - of Higher Education Institutions (HEI). Nonetheless, a discernible geographical divide appears to exist between countries situated in the Northern and Southern hemispheres. For instance, while in 2013 all universities in UK had sustainability policies, only 8% of Australian universities had a vision and mission committed to sustainable development (Kosta, 2017; Lee et al., 2013).

According to Kosta (2017, p. 266) "sustainability policies are a significant integrative tool for the institutionalization of sustainability as they have normative and coercive powers (…) it seems that the existence of a sustainability policy is aligned with more coordinated sustainability efforts". Velazquez et al. (2006) argues that sustainable university policies must be incorporated into their daily operations. According to the mentioned authors (Velazquez et al., 2006), the development of sustainable policies should be considered a capital task to build a sustainable university. This is consistent with this research findings. Considering the sampled HEI analysed, a substantial part, 49%, has approved a specific policy to guide the efforts in implementing the initiatives towards SD (Figure 5-2(a)).

Concerning the creation of a formal structure Kosta (2017) recognises the relevance in working through formal committees that guide the implementation of the sustainable agenda. Velazquez et al. (2006) states that the creation of a sustainable committee, at a main decision-making level, facilitates the tasks of developing and implementing comprehensive campus-wide policies, goals and targets. In their study 55% of the people surveyed informed that there is a department to coordinate efforts across distinct SD initiatives undertaken in their campus. This result is consistent with what was observed on the analysed sample, as depicted in Figure 5-2(b), according to which 71% of the HEI have a formal structure to cope with SD issues. If the analysis of the integration of SD in Brazilian federal public universities was composed only of this first part, one could say that both policy and formal structure to deal with SD issues, evidencing the maturation of HEI, in as much as HEI are successfully coping the basic aspects of SD implementation. Nevertheless, premature deduction from the existing dataset would be unwise, as elucidated in subsequent sections.

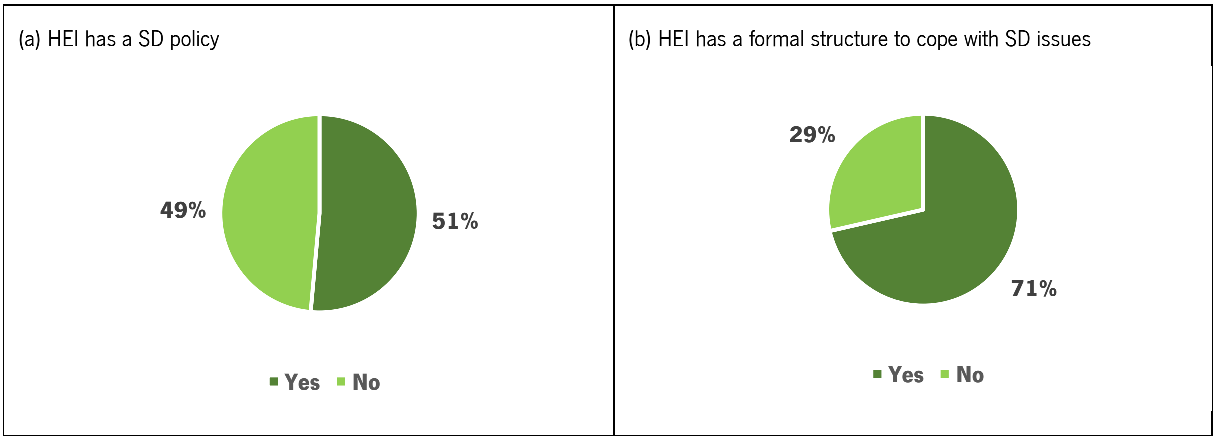

Figure 5-2 - Policy and formal structure in dealing with sustainability.

Shiel and Smith (2017) had performed a case-study in a UK university to describe how this institution has sought to maintain an integrative approach to SD. The authors concluded that a formal plan and integrative approach to SD is important and requires considerable effort and on-going actions that must be addressed across multiple fronts and with holistic ways of working by combining the available efforts of a whole institution.

5.2.2. Development of Sustainable Logistic Management Plans

The need for the elaboration of formal action plans to support the implementation of the SDI is outlined in the literature. Leal Filho, Skanavis, et al. (2019) considers that planning is seen as one of the keys for the successful implementation of SD initiatives. Mulà et al. (2017) states that the guide of global dialogues and plans, for the education for sustainable development and professional development, is a relevant and strategic theme for higher education worldwide. As reported by Vaughter et al. (2016) sustainability planning from the perspective of long-term plans can improve the governance of HEI insofar as it highlights an overarching purpose, the role that the institution should occupy in society, and can even contribute to consolidating its identity and culture.

In Table 5-1 is shown the result of the analysis of compliance regarding eight requirements related to the planing phase. The requirements were formalized mainly in the 3rd, 8th and 9th articles of the Normative Instruction N° 10, from 12 November 2012, (Normative Instruction No. 10, 2012).

In chapter 6, section 6.1.3, Table 6-3 summarizes all the requirements of IN10, 12/11/12. The empirical analysis performed in this chapter verifies the degree of compliance with the requirements of the mentioned standard in absolute numbers and percentages. In other words, the degree of compliance of the Brazilian federal public HEI industry with IN10, 12/11/12, which establishes requirements for integrating sustainable development initiatives in federal public agencies, has decreased.

Thus, the tables in this section present the degree of compliance, in absolute value and percentage, of analysed HEI that meet the requirements of IN10, 12/11/12. In the column entitled "requirement", the code of each requirement listed in Table 6-3 is presented in parentheses. The next column lists the number of HEI that meet the requirement, followed by the percentage.

As shown in Table 5-1 the highest percentage of compliance among HEI in the sample was achieved by the requirement of existence of a sustainable development management comitee, since 74% of the HEI have this committee. It is also outlined that the majority of the sampled HEI has a plan available on its website, to implement SDI (71%). 63% have objectives for the action plans, 66% detail the implementation of the actions comprised in the plan. 69% point out the units and areas covered in the implementation of the actions. 63% establish goals and 66% present the timelines to guide the actions implementation. On the contrary, the inclusion of a definition of a forecast of financial, human and instrumental resources necessary for the implementation of the actions is the requirement less acquired by the sampled HEI. Only 34% of the sample has reached this achievement.

Table 5-1 - The analysis of sampled HEI compliance with SD planning requirements at sampled HEI

Requirement	Degree of accomplishment	
	n	%
(R02 – R13) HEI has SLMP (SD planning)	25	71%
(R14) The Plan has objectives for the Action Plans	22	63%
(R15) The Plan has details on the implementation of the actions	23	66%
(R16) The Plan defines the units and areas involved in the implementation of each action and the respective responsible parties	24	69%
(R17) The Plan has goals to be reached for each action	22	63%
(R18) The Plan has a timeline for the implementation of the actions	23	66%
(R19) The Plan has a forecast of financial, human, and instrumental resources, among others, necessary for the implementation of the actions.	12	34%
(R20) Designation of the SLMP management committee	26	74%
Average accomplishment of the set of planning requirements	-	*63%*

In the analysis of the Sustainable Logistics Management Plans it was possible to verify a great diversity in the conception of the Plans. For instance, some universities, such as UNIFESP prepared a single plan with specific targets, indicators and, sometimes, metrics for each of its university campuses (UNIFESP, 2021). As a consequence, reports presented particularized results per campus, making it impossible, for some of the indicators, to analyse the institution's overall performance.

Another variation found is related to the implementation period of each plan. UFSM planned the actions of the SLMP to be executed over three years. Thus, UFSM has three SLMP available on its website, the first for the 3 year period 2013 till 2015, the second for 2016 until 2018 and the third for 2019 until 2021 (Munaretto, 2015; UFSM, 2013, 2016, 2019, 2021). On the other hand, UNIFESP carried out annual planning for the following years 2015, 2017, 2018, 2019, 2020 and 2021 leaving available the plans on its webpage (UNIFESP, 2021). Finally, some institutions, such as the UFF, prepared a single static plan (2017), without establishing the implementation periodicity (UFF, 2017).

Most of the plans analysed do not present clear methodologies for monitoring the minimum performance indicators established by the NI10, 12/11/12. One institution uploaded on its official website a preliminary draft of the SLMP, based on the normative instruction, with tables that were not filled in with data from the institution.

The UFPB Sustainable Development Plan was created in the second half of 2013 by a multidisciplinary team coordinated by members of the Environment Management Committee, EMC. The creation process involved the five steps depicted in Figure 5-3.

Step 1

To create Sustainable Logistic Policy of UFPB, based on the Institutional values, mission and vision and Normative Instruction Nº 10.

Step 2

To carry out the diagnosis for each of the seven dimensions established in the Plan.

Step 3

To define the strategic objectives:
- To Develop a programme to rationalise the use of consumables.
- To develop a programme to rationalise the use of electricity
- To develop a programme to rationalise the use of water and the generation of sewage.
- To develop a programme for selective collection
- To develop a programme for quality of life in the working environment.
- To develop a programme to rationalise purchasing and contracting.
- To develop a programme for the displacement of staff.

Step 4

To develop action plans for each strategic objective.

Step 5

To carry out an inventory of patrimonial goods and indicate more sustainable substitutes.

Figure 5-3 - Steps followed to design the SD Plan of the UFPB

In the first step the UFPB Sustainable Logistics Policy was elaborated, in the second step a general diagnosis of the sustainability conditions in the four campus of the Institution was carried out. Based on the diagnosis and the requirements of the Standard, as a third step, seven strategic objectives were established, one for each dimension considered in the NI10, 12/11/12. In the fourth step, action plans were developed for each of the objectives. The action plans were structured in a spreadsheet, consisting of: strategic objective, goal, responsible sectors, actions, timeline, performance indicators and necessary resources. The actions were grouped into the following three dimensions: (i) quantify and monitor consumption; (ii) promote reduction; and (iii) develop environmental education campaigns. In the fifth and last step the asset inventory of the Institution was added.

After the elaboration, the Plan was publicized? and uploaded in a web page of the Institution, where it stayed for a month, so that the university community could read the draft of the document and make suggestions for improvement. After this period the suggestions were partially incorporated and the Plan went into effect.

The existence of a sustainability plan, consisting of a set of articulated documents, such as objectives, goals, indicators, schedule and responsibilities is considered as a requirement for sustainable development performance by various HEI assessment tools, such as Conférence des Présidents d'Université (CPU), Conférence des Grandes Ecoles (CGE) Green Plan Framework, Sustainability assessment questionnaire (SAQ), Sustainability tracking assessment and rating system (STARS), Graphical Assessment of Sustainability in University (GASU), and Sustainability University Model (SUM) (N. Alghamdi et al., 2017; Casarejos, Frota, et al., 2017; Du et al., 2020; Gamage & Sciulli, 2017; Ricard & Dussaux, 2015; Velazquez et al., 2006). The requirements regarding the sustainable development plan is the part that obtain the highest average score (63%) among the three analysed parts.

5.2.3. Disclosure of the Sustainability Reports

Information corresponds to the basis of activities regardless of the type of organisation. It is a crucial asset for daily process execution, decision-making, assess compliance with regulations, quality assurance, behaviour management, marketing performance, etc. Thus, Tirnitz (2017) argues that, in the organisational context, information should be transferred from its source to the recipient in a suitable manner and this is performed by a report. Considering that a sustainability report is an outcome to the main stakeholders, it should be a disciplined corporate document that enables any recipient to know what its content will be, therefore it must be concise, accurate and a quality document (Gbangbola & Lawler, 2020).

In a general perspective firms have been under pressure to provide a sustainability report as a way to attend stakeholders' demand for greater transparency which improves the firm reputation (Bini & Bellucci, 2019; Lee Brown et al., 2009).

Son-Turan and Lambrechts (2019) describe that in literature the topic of sustainability reporting in higher education, in general, might be considered at an early stage. The production and disclosure of sustainability reports has growing in recent decades as a mean of accounting to society the commitment made by HEI regarding the inclusion of sustainability-related initiatives into HEI.

According to An et al. (2019), the number of HEI around the world that has been paying attention to report their sustainability related efforts has been growing in the recent decade. The reporting of sustainability related initiatives might be considered as a consequence of the assessment process (Son-Turan & Lambrechts, 2019). Authors have complained about the wide variety of reporting published by HEI, as this variation has made comparative analysis of performance across institutions difficult. Even though, there is no standardization in the structure or metrics used. The reports usually describe the performance of the dimensions considered basic in the sustainability analysis of HEI, that is, they commonly report the performance related to teaching activities, research outreach and campus operation.

Regarding the Brazilian framework considered – the SLMP, it must be emphasised that it was developed in a generic way to assess the performance, in terms of SDI, for federal public institutions, in an indiscriminate way. Hence it does not assess dimensions that are exclusive to a specific type of institution, such as the teaching, research and extension dimensions, which are specific to higher education institutions. Thus, the focus of the framework is generic and, therefore, is directed to managerial aspects, such as contracts and procurement of materials, social issues such as the quality of life of public servants, and campus operational aspects, such as water and energy consumption, fossil fuel consumption and emissions. This is the main limitation of this framework in analysing the sustainability of HEI, which, as will be seen below, can be overcome with the inclusion of specific *ad-hoc* modules. On the other hand, the framework determines the mandatory disclosure of semi-annual reports to describe the performance of HEI. Thus, considering this time interval, to meet this requirement the HEI should have 15 reports published on their web pages, that is, from the first semester of 2014 (2014.1) to the first semester of 2021 (2021.1). However, the sample studied, illustrated in Figure 5-4, shows another reality. On average, only 18% of the reports were made available throughout the period considered. It was found that this result is in line with the study performed by Sassen et al. (2018), according to which, on their sampled HEI in UK only 17% disclosed their sustainability reports.

In a more detailed examination of the data, it becomes evident that out of the 35 Brazilian HEI analysed, only 15 had published at least one report. Figure 5-5 acknowledges the percentage of HEI that made reports accessible on their respective web pages.

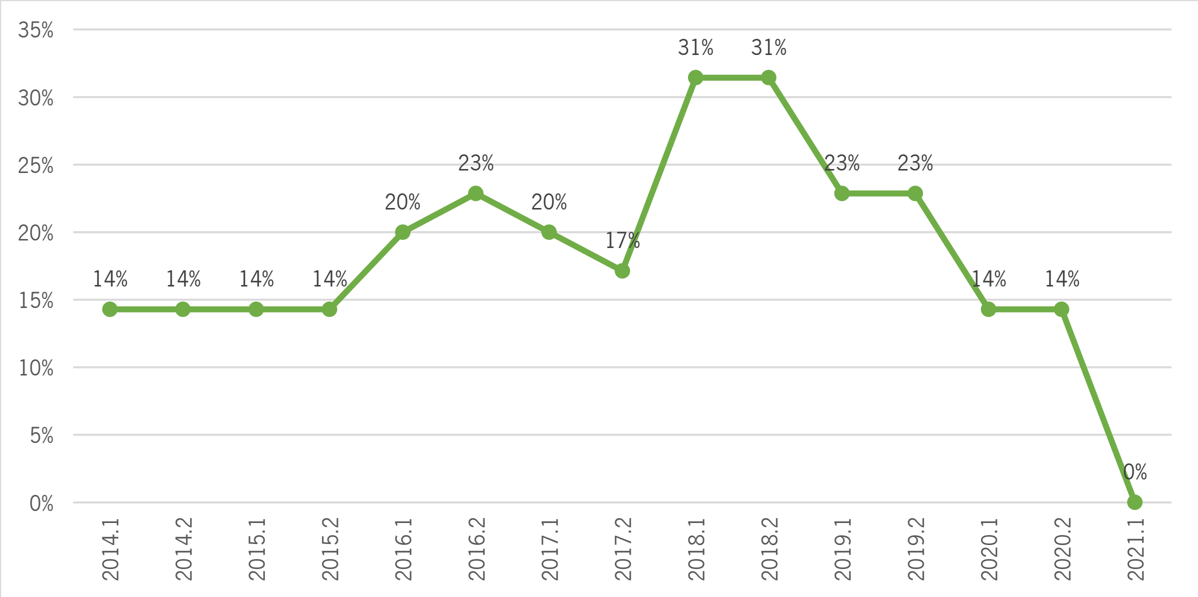

Figure 5-4 - Percentage of accomplishment in SD reports published each semester.

Figure 5-4 demonstrates that Universidade Federal da Paraíba, Universidade Federal do Mato Grosso and Universidade Federal de São Paulo have the highest number of published reports (14) and, conversely, Universidade Federal do Semi-Árido e Universidade Federal Fluminense, have the fewest (2). Figure 5-5 groups the HEI that made the most SLMP reports available.

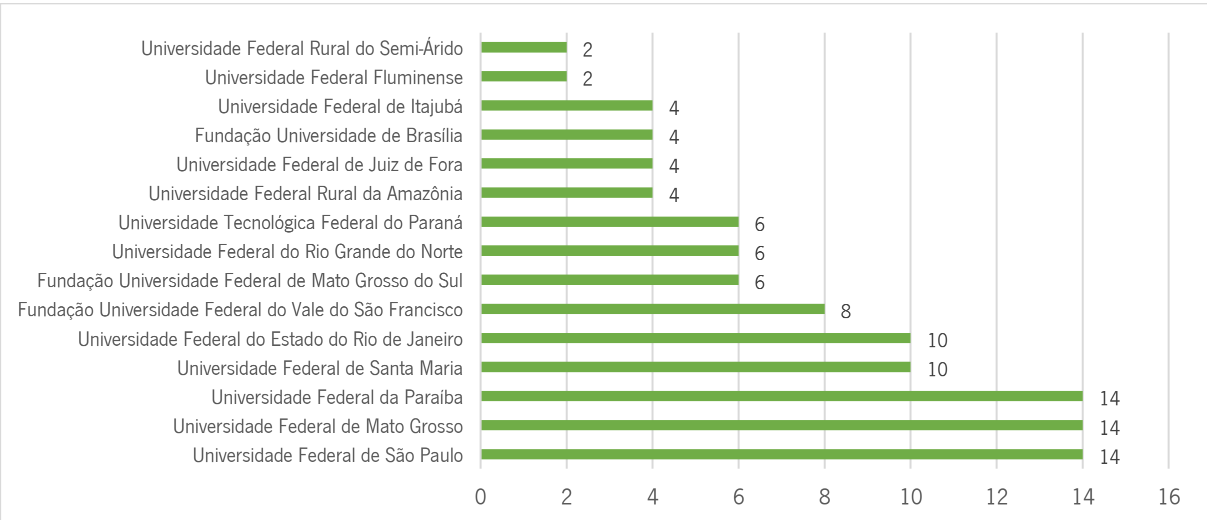

Figure 5-5 - Number of published SD reports for each HEI.

5.2.4. Disclosure of the Set of Indicators

This session examined how the HEI, that make up the sample, report on the SLMP objectives, namely, consumables material, electric power consumption, water consumption and sewage generation, waste selective collection program, quality of life in the work environment, and purchasing and contracting processes.

Fuentes-Bargues et al. (2018) state that considering the volume of the purchasing and contracting activities, public universities might play an important role in promoting sustainable development, since the public procurement-related activities accounts around 10% to 15% of the GDP. Leire and Dalhammar (2019) explain that governments are influential actors in the market, not only because of their role in create laws, but also as buyers, thus, they have the power to turn sustainable procurement into an extremely potent policy. The power of governmental players is considerable also as, unlike other market players, public organisations at various levels that might manage their buying strategies to achieve policy goals (Czech & Panasiuk, 2020; Lindström et al., 2020; Ssennyonjo et al., 2022).

The High Level Committee on Management Procurement Network (HLCMPN) has defined Sustainable Procurement Practices (SPP) as the one that

> integrate requirements, specifications and criteria that are compatible and in favour of the protection of the environment, of social progress and in support of economic development, namely by seeking resource efficiency, improving the quality of products and services and ultimately optimizing costs (HLCM-PN, 2009, p. 1)

The sustainable public procurement in Europe is also called as Green Public Procurement (GPP) and it is designed as

> process whereby public authorities seek to produce goods, services, and works with a reduced environmental impact through their life cycle when compared to goods, services, and works with the primary function that would otherwise be procured (EU, 2008, p. 4).

According to the UNEP et al. (2011) Sustainable Procurement Practices (SPP) has been employed by relevant international organisations including the Asian Development Bank, the Inter-American Development Bank, and the World Bank, to cite a few. The latter has made efforts to include environmental specifications, when possible, to assure that a growing number of procurement processes is environmentally sound and cost effective. In this line, the organisation requires, for instance, "environmentally-friendlier produced paper, soy-based inks, carpet and ceiling tile recycling in renovation projects, inclusion of pallet recycling in loading dock contracts, and specification of minimal packaging and take-back programmes for electronic equipment." (UNEP et al., 2011, p. 21).

The incentives and control tools for contracting and acquiring sustainable Brazilian goods and services are supported by a set of laws and normative instructions, such as those presented in Table 5-2.

Table 5-2 - Legal regulation integrating of sustainable development in Brazilian public institutions.

Legal Regulation	Description
Normative Instruction No. 01, of 19 January 2010	Establishes criteria for environmental sustainability in the acquisition of goods, contracting of services or works by the direct, autarchic, and foundational Federal Public Administration and makes other arrangements.
Law No. 8666 of 21 June 1993	Regulates art. 37, section XXI of the Federal Constitution, establishes rules for tendering and contracts of the Public Administration and makes other provisions. Article 3 defines that the bid is intended to guarantee the observance of the constitutional principle of equality, the selection of the proposal that is most advantageous to the administration and the promotion of sustainable national development and shall be processed and judged in strict conformity with the basic principles of legality, impersonality, morality, equality, publicity, administrative probity, binding to the call for bid, objective awarding, and their correlative principles.
Decree no 2.783 of September 17, 1998	Deals with the prohibition of acquisition of products or equipment that contain or make use of Substances that Destroy the Ozone Layer - SDO, by the organs and entities of the direct, indirect, and foundational Federal Public Administration, and makes other provisions.
Decree No. 7.746 of June 5, 2012	Regulates article 3 of Law No. 8.666 of June 21, 1993, to establish criteria and practices for the promotion of sustainable national development in contracts undertaken by the direct federal public administration, independent agencies and foundations and dependent state companies, and establishes the Interministerial Commission for Sustainability in Public Administration - CISAP.
Ordinance No. 23 of February 12, 2015, MPOG	Establishes good management practices and use of electricity and water in organs and entities of the direct, autonomous, and foundational Federal Public Administration and provides for the monitoring of consumption of these goods and services.
Normative Instruction No. 2 of June 4, 2014	Establishes rules for the acquisition or leasing of energy-consuming machines and devices by the direct, autonomous, and foundational Federal Public Administration, and the use of the National Energy Conservation Label (ENCE) in projects and respective new or retrofitted federal public buildings.

Table 5-2 doesn't intend to list the entire legal framework created by the Brazilian government to integrate sustainable development into public institutions, but only provides an idea of the Brazilian State's effort to develop regulations to accelerate the public sector's transition towards integrated and more sustainable management models.

The following paragraphs describe the performance of federal public HEI regarding the integration and reporting of practices of material's acquisitions by the sampled HEI.

There are three items that the SLMP NI10, 12/11/12 defines for basic mandatory monitoring, paper, disposable cups and printer ink cartridges and toners. Table 30 presents the indicators related to the acquisition of paper and disposable cups. Paper is the item that is most reported in the reports, since almost 30% of the HEI report the number of sheets of paper purchased. The table also shows a trend that persists in the following tables (Table 5-4, Table 5-5, and Table 5-8) that highlights the HEI' apparent difficulty in providing data regarding the amount spent and, consequently, the amount spent per capita. For both items, only 11% of HEI were able to report the expenditure with paper and disposable cups as shown in Table 5-3.

Table 5-3 - Report on Material Acquisition Indicators

Requirement	Degree of accomplishment	
	n	**%**
(24;1) Monthly consumption of white paper (bleached)	10	29%
(24;2) Per capita consumption of white paper (bleached)	4	11%
(24;3) Expenditure with acquisition of white paper (bleached)	4	11%
(24;4) Consumption of 200 ml disposable cups	9	26%
(24;5) Consumption of 50 ml disposable cups	9	26%
(24;6) Per capita consumption of 200 ml disposable cups	4	11%
(24;7) Per capita consumption of 50 ml disposable cups	3	9%
(24;8) Expenditure with the acquisition of disposable cups	4	11%
Average accomplishment of the set of purchasing requirements	-	*17%*

It is assumed that the difficulty in reporting the monetary value spent on the acquisition of materials occurs due to the fact that, in HEI, purchases are usually carried out by various purchasing sectors within the organisations. In the case of UFPB, there are six sectors that can carry out purchases. This diversity of sectors may be hindering the unification of the consolidated monetary expenditure data of the university.

The following indicators required by the SLMP deals with electricity and water consumption, as illustrated in Table 5-4 and Table 5-5. Due to the volume and complexity of resources required to maintain a university campus, many authors compare these institutions to small cities (Bahçelioğlu et al., 2020; Im et al., 2020; Kolokotsa et al., 2016; Zhang et al., 2011). In this sense, the efficient use of energy and water in HEI is crucial both because of the need to reduce ozone-damaging fossil fuel emissions and to mitigate the use of limited resources, such as water and those resources needed to produce electricity. Thus, understanding the energy consumption of HEI could drive successful sustainable management strategies (Alla et al., 2019; Kolokotsa et al., 2016; Ocampo Batlle et al., 2020; Pepplow et al., 2019).

Comprehension of water and energy consumption, and waste generation dynamics is pivotal for acknowledge their drivers and assessing the performance of potential measures to improve efficiency and/or reliability on actions to cope with those issues. These patterns can differ considerably depending on the HEI building attributes, the manner the building is used and even cultural, social, and economic context in which the building is located, that could affect the user's pattern (Almeida et al., 2021; Eteng et al., 2022; Wichowski et al., 2019).

Adequate monitoring of the use of electric energy, water and waste generation is a basic action and precedes the adoption of strategies to promote energy and water efficiency and to reduce and properly manage the waste generated (Im et al., 2020; Wichowski et al., 2019; Zhang et al., 2011).

If there is no information available on energy use by a given HEI, it is unlikely that this institution will be able to measure the performance improvement achieved with the energy efficiency strategies undertaken.

Table 5-4 - Report on Electric Power Consumption

Requirement	Degree of accomplishment	
	n	%
(24;11) Electricity consumption (kWh)	9	26%
(24;12) Electricity consumption per capita (kWh)	4	11%
(24;9) Expenditure with electric energy	6	17%
(24;10) Electric energy expenditure per capita	3	9%
(24;13) Adequacy of the demand contract (off-peak)	1	3%
(24;14) Adequacy of the demand contract (peak)	1	3%
(24;15) Energy expenditure by area	2	6%
Average accomplishment of the set of Energy requirements	-	11%

Table 5-4 indicates that, on average, only 11% of the indicators related to the use of electricity are reported in the reports published by the HEI that are part of the analysed sample. The most reported indicator is consumption in kWh (26%) and the least reported are adequacy of the demand contract on peak and off-peak (3%).

The indicators related to water consumption are the ones that obtained the second highest percentage of adequacy to the SLMP NI10, 12/11/12, with 18% of compliance, which indicates the size of the difficulty of HEI in reporting their environmental performance in the way that is required by the normative Instruction. The most reported indicator is volume of water used, which is available in 31% of the surveyed HEI.

Table 5-5 - Report on water consumption

Requirement	**Degree of accomplishment**	
	n	**%**
(24;16) Volume of water used	11	31%
(24;17) Volume of water per capita	6	17%
(24;18) Water expenditure	7	20%
(24;19) Water expenditure per capita	9	3%
Average accomplishment of the set of water and sewage generation requirements	-	*18%*

Zhang et al. (2011), which describe the waste management experiences at the University of Southhampton (U.K.), state that "Integrated waste management systems in particular, are one of the greatest challenges for HEI' sustainable development". Since the management of waste means more than just a proper destination or treatment of residues, it involves rethinking production processes, minimizing waste generation, reusing and recycling (Fagnani & Guimarães, 2017; R. Moreira et al., 2018; Tangwanichagapong et al., 2017). The residue management should also be considered from a non-linear perspective and in a broader context, considering economic, social and environmental issues (Bahçelioğlu et al., 2020; Tangwanichagapong et al., 2017). Additionally, the educational value as a pedagogy to raise awareness of the university community toward sustainable development should be taken into account (Michael & Elser, 2019).

To surpass the challenges, Zhang et al. (2011) suggest adopting a plan based on a holistic approach, such as that which employs PESTLE factors (Political, Economic, Social, Technological, Legal and Environmental). This integrative perspective is in line with the circular economy approach, in which the residue of a production process can be the input of another.

The European Environment Agency (EEA, 2016) states that the circular economy represents a natural alternative to the linear take-make-consume-dispose economic model that currently predominates. The circular economy proposes a scheme in which waste is replaced by subproducts that can be used in other industrial processes. According to Salguero-Puerta et al. (2019), the circular economy aims at removing or reducing wastes and subproducts in several production processes. When it is not feasible, the authors advocate that wastes and subproducts must be integrated into the same production processes or others of similar or different nature to avoid negative externalities. The authors studied the adoption of circular economy principles to boost the sustainability of a waste management system of a Spain university.

As a way of strengthening the solid waste collection network, through Decree number 5,940, of October 25, 2006, the Brazilian state determines the separation of recyclable waste discarded by bodies and entities of the direct and indirect federal public administration and its subsequent donation to associations and cooperatives of pickers of recyclable materials that are formally constituted (Decree No. 5940, of October 25, 2006).

This initiative prohibits federal public bodies from selling recyclable waste, forcing them to donate to waste picker networks as a way of stimulating the popular waste market, generating income for vulnerable citizens. To operationalise this initiative, the SLMP requires the systematic monitoring of at least the following waste: paper, cardboard, toner and plastic. Additionally, it determines that the total in kilograms of recycled material donated to associations and cooperatives, as well as the total amount of paper reused by the university, be computed (Normative Instruction No. 10, 2012). Table 5-6 presents the results of the analysis of the waste management initiatives undertaken by the samples HEI. It shows that the indicator more reported is "Total recyclable material destined for cooperatives" which is monitored and reported by 26% of the analysed HEI. None of the HEI reported the number of paper's reuse. In total, the average accomplishment is 14%.

Table 5-6 - Report on waste management

Requirement	**Degree of accomplishment**	
	n	**%**
(24;20) Destination of paper for recycling	7	20%
(24;21) Destination of cardboard for recycling	6	17%
(24;22) Toner for recycling	2	6%
(24;23) Destination of plastic for recycling	6	17%
(24;24) Total recyclable material destined for cooperatives	9	26%
(24;25) Paper Reuse	0	0%
Average accomplishment of the set of selective collection requirements	-	*14%*

The low percentage of disclosure of the number of toner donated to pickers may be due to the Brazilian legislation that establishes the correct destination of toner for the reverse logistics program, according to which producers are responsible for collecting their waste.

For the quality of life at work objective, SLMP establishes the following indicator "Participation of public servants in programs and/or actions regarding quality of life at work".

Brazilian universities create an annual training plan for their public servants, whether they are professors or staff. The plan usually includes courses on specific skills, such as the "Planning and Instruction for Hiring Works and Outsourced Services Processe"s, which were offered to public servants who work in the Planning for Hiring Works and Outsourced Services teams, emphasizing good practices and jurisprudential guidelines relating to the internal phase of public procurement.

They also offer courses aimed at caring for and improving the quality of life in the work environment, such as the course entitled "physical, nutritional and emotional health care", offered as a means of promoting a healthy lifestyle, aimed at integrating between emotional, nutritional and physical education. Both courses were offered by UFPB and are included in the annual training plan (UFPB, 2020).

Table 5-7 Report on Quality of life in the work environment

Requirement	**Degree of accomplishment**	
	n	**%**
(24;26) Participation of public servants in programs and/or actions regarding quality of life at work	8	23%
Average accomplishment of the set of quality of live in the work environment requirements	-	*23%*

As can be seen in Table 5-7, 23% of the universities analysed reported activities aimed at promoting quality of life in the work environment.

Table 5-8 points out that "Reporting on purchasing and contracting processes" is the objective that obtained the lowest percentage of average compliance (4%). The table shows that most of the indicators deal with expenditure on cleaning, security and telephone services. Data relating to public gestures are usually managed by different business units, which have their own computerized systems, which can make it difficult to integrate these data to fill in the indicators. This is an obstacle that universities need to overcome in order to satisfactorily report their performance with regard to the integration of sustainable development.

Table 5-8 - Reporting on purchasing and contracting processes

Requirement	Degree of accomplishment	
	n	%
(24;27) Expenses per telephonic line/extension (fixed)	2	6%
(24;28) Expenses per telephonic line (mobile)	1	3%
(24;29) Surveillance - Initial value of the Post	2	6%
(24;30) Surveillance - Current value of the Post	1	3%
(24;31) Cleaning service - Cleaning expenses by area	2	6%
(24;32) Cleaning service - Degree of renegotiation	0	0%
Average accomplishment of the set of purchasing and contracting processes requirements	-	4%

As places where society is formed, where knowledge is presumed to be produced, and societal development is critically reflected upon, higher education institutions are failing to fully deliver what is expected of them by society and multilateral bodies (Leal Filho et al., 2022; Leal Filho, Shiel, et al., 2019; Moyer & Hedden, 2020).

The results show that, in general, HEI have developed sustainability policies (49% - Figure 5-2) and plans (71% - Table 5-1) and created committees to manage the SLMP (74% - Table 28). However, the study demonstrates the inability to implement and report the results of the plans prepared consistently. Although the publication of sustainability reports is a legal obligation for HEI, in the second half of 2020, only 14% of the reports of the analysed sample were located on their webpage (Figure 5-5).

The non-compliance with the normative is even more remarkable when observing the methodologies for calculating and reporting performance indicators for each of the seven objectives that should be reported. For instance, regarding establishing sustainability practices and rational use of electric power, the norm requires the publication of seven performance indicators. Analysing all universities that report results at some point, only 17% (n=6) reported such an elementary indicator as "Expenditure with Electric Energy". When analysing more specific indicators, such as adequacy of demand on peak and off-peak, only 3%, one HEI, reported data on these two indicators.

Experiences of tackling difficulties in operationalising plans are reported in the literature in various fields of action. For example, Di Marino et al. (2019) explore the obstacles in incorporating green infrastructure and ecosystem services concepts into planning practices in the Helsinki-Uusimaa Region and the City of Järvenpää in Finland, Fassbender et al. (2022) outline the obstacles faced by the province of Alberta, Canada in operationalising a province-wide policy and procedures for advance care planning (ACP) and goals of care designation (GCD) across its complex, integrated public healthcare system. Finally, Iyamu and Batyashe's (2020) work highlights the barriers commonly alluded to in the operationalisation of strategies in the field of information technology in organisations. For the authors, many organisations have encountered barriers that prevent the operationalisation of strategies and plans for information technology. Those barriers have generated negative implications in internalising sustainability, managing the investments and, ultimately, for the organisational objectives and goals.

The results presented in this chapter point to the barriers and difficulties encountered at the federal public universities analysed concerning the consistent implementation of the NI10, 12/11/12 that aims to formulate, implement, monitor and report sustainability plans in the terms required by the norm. It is crucial to reflect that the normative Instruction was launched in November 2012, so it has completed a decade and, so far, has yet to generate the expected effects of systematising and unifying the procedures for integrating sustainability initiatives in Brazilian federal public HEI.

In brief, these institutions fail to adequately fulfil their role of leading society, by example, in the transition to models more aligned with the assumptions of sustainable development.

On the other hand, it must be stressed that integrating sustainable development initiatives in a holistic manner that encompasses the main dimensions of HEI, as NI10, 12/11/12 requires, takes work. In order to achieve this goal, HEI need technological support from a framework that allows for the integrated execution of the planning, exception, monitoring and reporting phases. In this sense, this PhD thesis intends to provide a systematic solution to the bold problem described through the data analysis of this chapter.

Chapter 6. Integration, monitoring and assessment: frameworks' conceptual model.

As it was shown in the past chapters, the most current way in the literature of dealing with university sustainability, consists in the isolated analysis that focuses on some of the components related to the integration of SDI into HEI, namely, (a) engaging in formal commitments towards SD into HEI, (b) mapping sustainability dimensions of HEI, (c) designing planning strategies, (d) modelling sustainability performance assessment tools, and (d) deploying sustainability reporting models. The line of action to study single components related to the integration of sustainable development into HEI that was broadly carried out in the academic literature may have emerged as a way of reducing the complexity inherent to the analysis of these components in a unified structure. That is, a single, internalised and interdependent structure or system, in which each component acts as a subsystem of the bigger system that integrates all dimensions related to sustainability in education. Figure 6-1 shows a diagram that summarises this reductionist approach widely adopted in the literature, while citing examples of references that focus their efforts on understanding specific aspects (components) for integrating sustainable development in education.

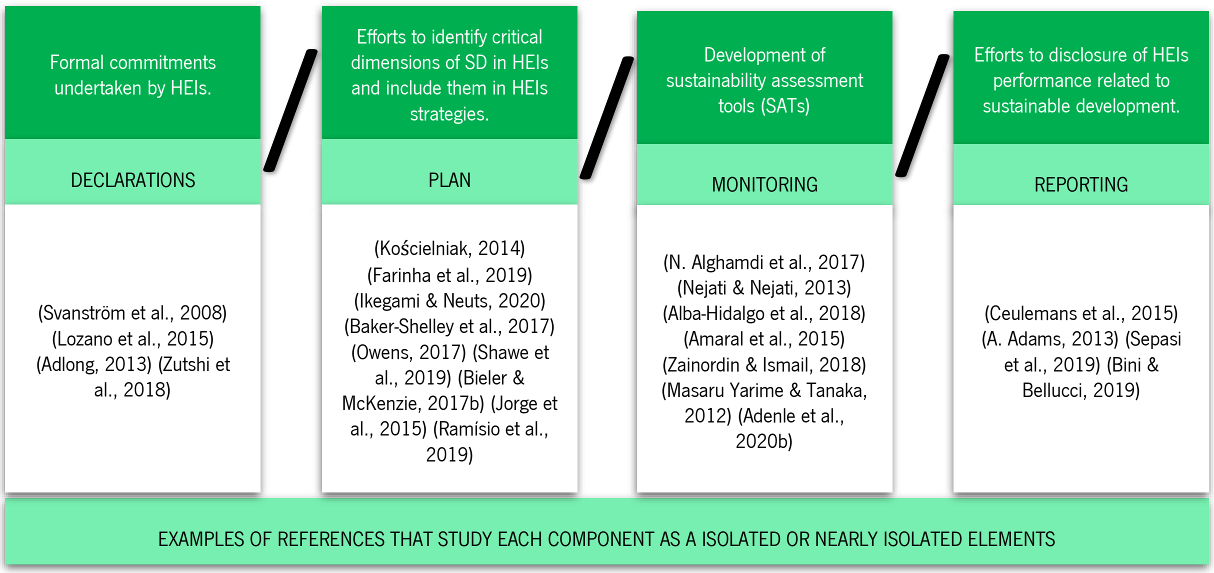

Figure 6-1 - Main components considering in studies related to SD at HEIs

Source: (Svanström et al., 2008)(Lozano et al., 2015) (Adlong, 2013) (Zutshi et al., 2018) (Kościelniak, 2014) (Farinha et al., 2019) (Ikegami & Neuts, 2020) (Baker-Shelley et al., 2017) (Owens, 2017) (Shawe et al., 2019) (Bieler & McKenzie, 2017) (Jorge et al., 2015) (Ramísio et al., 2019a) (N. Alghamdi et al., 2017) (Nejati & Nejati, 2013) (Alba-Hidalgo et al., 2018) (L. P. Amaral et al., 2015) (Zainordin & Ismail, 2018) (Masaru Yarime & Tanaka, 2012) (Adenle et al., 2020b) (K. Ceulemans et al., 2015) (A. Adams, 2013) (Sepasi et al., 2019) (Bini & Bellucci, 2019)

This divide and conquer approach, or more precisely the adoption of the Newtonian-Cartesian paradigm (Rausand & Haugen, 2020) of reducing the complex to smaller and simpler structures, may have been considered the most reasonable solution, given that the theoretical framework on university campus sustainability was in its formative stages. However, taking into account the maturation of Education for Sustainable Development theory, it is time to overcome this major gap of knowledge by offering scholars and practitioners integrated solutions that allow the better understanding of the complex problems that come from integrating SD into HEI.

A manner to overcome the limitation of the Newtonian-Cartesian method mostly used to study SDI integration into HEI was proposed in the 1960s by von Bertalanffy through his General Systems Theory (von Bertalanffy, 1968). Since von Bertalanffy's contributions, systems science emerges as an alternative to the reductionist approach based on fractionating complex phenomena into smaller and more intelligible parts, which is still widely adopted in science. The system sciences boosters invoke the need to develop scientific methods that consider the holistic, integral, and systematic perspective of complex phenomena or object (Barin Cruz et al., 2006; Morin, 1992; Szekely & Mason, 2019).

A system is commonly described as a set of objects tied together by some form of interaction of interdependence. Therefore, the system science approach draw attention to holism and insists that it is arduous to exhaustively comprehend a phenomena or object simply by splitting it into its component parts and then rebuilding it. The supporters of the systems theory claim that to fully understand the analysed object one needs to scrutinize it from a higher level of organisation (Link, 2018). Coupled social-ecological systems, such as management of climate-change and their component as energy matrix and emissions control continue to defy reductionism. The vastness of components that make up such system exceed the usual capacity of treatment and representation, which tends to make the proper analysis of the system unfeasible with the conventional scientific procedure. Systems of this nature, such as those that determine climate change, could be better understood through a complex adaptive systems approach.

In literature the complex adaptive system is defined as a “system composed of interacting adaptive elements and possessing four properties and three mechanisms. The properties are aggregation, non-linearity, flows and diversity, while the mechanisms are tagging, internal models and building blocks” (Baldwin et al., 2011, p. 303). Those properties and mechanisms are condensed in Table 6-1.

Table 6-1 - Properties and mechanisms of Complex adaptive systems

	Type	Description
Properties	Aggregation	Contains elements of autonomy in a way that component system are individual systems
	Non-linearity	often behaving in non-linear fashion
	Flows	This property deals with throughput and connectivity
	Diversity	Since multiple autonomous systems imply heterogeneity, diversity is related to differences and variety between systems.
Mechanisms	Tagging	Works as a mechanism for selectively interacting
	Internal models	Provide the mechanisms to anticipate consequences, which is analogous to adaptability
	Building blocks	It equates to self-organisation which is a combination of autonomy and increase in order or structure. Adding the characteristic of connectivity elevates self- organisation as a stand-alone attribute

Adapted from (Baldwin et al., 2011; Felder & Collopy, 2012; Støttrup et al., 2019)

According to Rausand and Haugen (2020, p. 96) the behaviour of at least some components or interactions among them are not completely acknowledged, even employing all available knowledge. Its performance cannot be predicted accurately through linear relationships (Fieguth, 2021). Consequently, those kinds of systems cannot be assessed and analysed via traditional approaches such as Newtonian-Cartesian paradigm because the system is somehow more than the sum of its components. In other words, it cannot be decomposed without losing its characteristics and because of that it is not recommended to use the Newtonian-Cartesian paradigm to analyse complex systems (Rausand & Haugen, 2020).

Støttrup et al., (2019) set out an example of a designed Complex adaptive system. To this end, the author updated an existing integrated management system devoted to providing an integrated coastal management in a set of six Baltic Sea case studies. The proposition allowed the improvement of the system performance by adding new variables and interconnections to the existing System Approach Framework (SAF). Systems-level thinking' value lays on the potentiality to investigates processes in a more integrated, comprehensive matter. For that reason, this line of action delivers a plethora of emergent characteristics, connexions, and related information used in a wide range of applications.

By adopting this perspective research often faces the challenger of interpreting the vastness of information that might emerge from such perspective of analysing a system. In that sense Link (2018, p. 2), state that "a [complex] systems approach acknowledges that there are myriad processes, connections, and ´components´ in any given system and that combined these are both highly complex and interactive. Yet a system approach also emphasises the collective whole and emergent features therefrom by examining the system at a higher hierarchical level of organisation".

In view of the above, it is evident the potential of the systemic approach to contribute, through its consolidated theoretical framework, to overcome the gap related to the lack of integration in studies on the different components of education for sustainable development. The proposed holistic analysis may reveal new nuances and interconnections between sustainable development and HEI and will certainly contribute to accelerate the required integration of SDI in higher education institutions, as well as facilitate the compliance with existing legal requirements.

6.1. Employing the SAF approach to develop the proposed FIMARSHEI.

The SAF approach is considered consistent to be used as a guide in developing complex systems in which they often behave in a non-linear fashion and cannot be understood in their entirety by breaking them down into compartments and examining each individually (Støttrup et al., 2019), such as the framework proposed in this work.

In brief, what is proposed here is to use SAF to build the framework envisaged in this doctoral work that will allow to integrate, monitor, and assess the sustainability of Brazilian federal public HEI. To this end, a hybrid SAF model, consisting of six stages, was constituted from the model of Støttrup et al. (2019), T. S. Hopkins et al. (2011) and Reis (2014) to assist in designing an integrated framework to integrate, monitor and assess the incorporation of SDI in HEI.

As shown in Figure 6-2, the first stage, named *issue identification*, starts from the perception of the scenario changes, commonly related to the emergence of a political, social, or legal change that requires a shift in the *status quo* adopted by a given institution or sector. The case studied in this research focuses on the launching of a Presidential Decree (n° 7,746 of June, 05/2012, (Decree n 7,746, 2012)) and a Normative Instruction (n° 10 of November 12, 2012, (Normative Instruction No. 10, 2012)) that determines and regulates the insertion of sustainability practices in a coherently planned manner in all federal public agencies in Brazil. This external pressure (Scenario Change) forces a structural change in the way HEI operate, bringing new complex issues that HEI have been faced in complying with the legal requirements previously described. To cope with this new scenario, a set of procedures is required in the first stage, entitled *Issue Identification*, among which, (a) identifying potential issues, (b) mapping the sectors, processes and activities and stakeholder groups that will be impacted by the changes, (c) prioritising the most relevant environmental, social, and economic elements.

The second stage, *System Design*, comprises the development of a conceptual model of the framework that links the real with the virtual world. The conceptual model needs to be build taking into account the holistic approach with a view to integrating as many system components as possible. In this stage, beyond the conceptual model, the scope and system boundaries are defined, as well as success criteria and indicators. A set of action plans is the main outcome of this phase.

The third stage, *System Formulation*, involves the development of procedures and rationality for data collection, forms and metrics and data analysis methods. In other words, the mathematical modelling of the calculation and integration of the indicators of each component, as well as the junction of the components for the consolidation of the overall system (framework proposed).

The fourth stage, *System Assessment*, is focused on the process of evaluation of the framework usability through application in a representative case of the population. In this phase the framework performance was tested with the application at the Federal University of Paraíba, which can be considered as a typical case of implementation of SDI to meet the legal requirements related to the Brazilian regulation.

The last, but not least stage, entitled *System Output*, discusses the consequences of the implementation of the framework, pointing out the ways to overcome the conflicts and difficulties identified during the application test phase in the pilot case (Federal University of Paraíba), as well as the potential of the framework for future uses.

Figure 6-2 depicted the five stages undertaken to develop the proposed FIMARSHEI of integration, monitoring and assessment of SDI in higher education institutions. Subsequently, the procedures adopted in the implementation of the stages 1 and 2 described above will be detailed for the for the intended application, that is, to develop an integrated framework, aligned to national regulations and to international assessment systems, to plan, monitor and report the sustainability of Brazilian HEI.

Considering that stages 3 System Formulation, 4 System Assessment and 5 System Output are results of this PhD thesis, they will be detailed in chapters 7, 8 and 9 respectively.

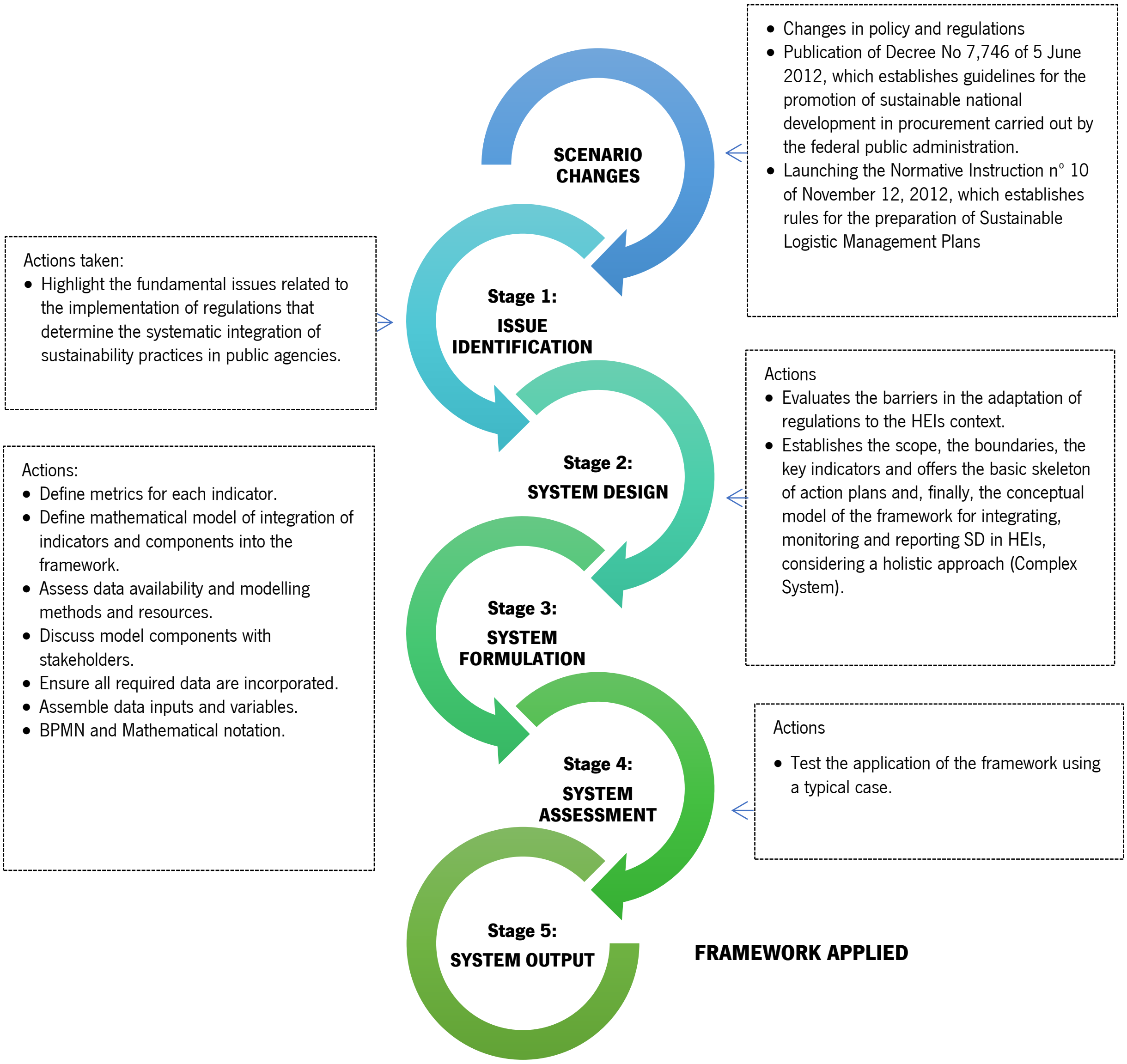

Figure 6-2 - The five stages of the System Approach Framework

6.1.1. Scenarios Changes

Universities in general have started to formally assume their commitments to sustainable development since 1972, as presented earlier in chapter 2 of this work which describes the core commitments and statements related to the mainstreaming of sustainable development in HEI.

Pereira and Barbosa (2018), argue that the holding of Rio+20 in Brazil somehow pushed the Brazilian State to create laws to reorient public agencies towards sustainable development. The authors state that the National Organizing Committee of Rio+20 prioritised the procurement of sustainable materials. To this end, Presidential Decree no. 7,746, of 5 June 2012, was enacted, addressing sustainable public procurement. The Decree reoriented public procurement procedures by giving precedence to the acquisition of sustainable products and services for the Rio+20 Conference. The same Decree determined, that organs of the federal public administration should prepare and implement the Sustainable Logistics Management Plan with the aim of inducing public organs to establish sustainable development practices and to streamline the State's costs and improve the quality of public expenditure on the activities developed (Luiz et al., 2015).

Subsequently, the Brazilian government ratified the NI10, 12/11/12 that established rules to regulate the sustainable logistics management plans to be implemented in all federal public agencies. This includes federal agencies of the Ministry of Health, such as public hospitals, as well as service stations of the Ministry of Social Security, which is responsible for assisting the elderly in the retirement process, and also all bodies that comprise the Ministry of Education, among which the 66 Brazilian federal public universities (Franco et al., 2017; Luiz et al., 2015; Silva & Almeida, 2019).

The instrument to guide the drawn of the Sustainable Logistics Management Plan (SLMP) is established in the Normative Instruction N° 10, from November 12, 2012 (Normative Instruction No. 10, 2012).

The Normative Instruction is composed of fifteen articles and three annexes. In the following paragraphs, the parts of the NI10, 12/11/12 considered essential for understanding the underlying philosophy, as well as its basic structure, will be presented. As will be detailed later, the third article of the normative defines the plan and points out its main elements. The fifth article establishes the framework structure of the plan. The eighth article of the Normative indicates the minimum scope that the plan must meet. The ninth article establishes the methodological requirements related to the implementation, monitoring and periodicity rules in the reporting of the Plan. Additionally, the NI10, 12/11/12 includes in the third annex a list of indicators and minimum metrics to be included in the plans of each public institution that adheres to the normative. Below, we comment in more detail on each of the referred chapters.

The 3° Article of the mentioned Normative Instruction stablishes that SLMP "are planning tools with defined objectives and responsibilities, actions, goals, execution deadlines and monitoring and evaluation mechanisms, which allows the agency or entity to establish sustainability practices and rationalisation of expenses and processes in public administration".

It is beneficial that this Resolution, besides making the Sustainable Logistics Plan mandatory, has brought uniformity in the application of SDI, determining standard indicators, which make it possible to assess the results acquired by means of the descriptions of the objectives, actions, goals, deadlines and the monitoring itself (Leão & Melo, 2018). It is noteworthy that the standardisation of the requirements, indicators and metrics are advantageous to creating interactivity between the different sectors and institutions involved in a complex and extremely heterogeneous field like integration of SD into public HEI.

The structure of the plan is determined in Article 5, in which it is defined that the action plans shall contain, as a minimal: (a) the inventory of goods and materials of the institution and identification of similar ones with lower environmental impact for replacement; (b) sustainability initiatives and actions to guarantee the rationalization of the use of materials and services; (c) definition of responsibilities, methodology of implementation and evaluation of the plan; and (d) description of the dissemination, awareness and training actions (Normative Instruction No. 10, 2012).

In its eighth article it is defined the areas of sustainable development that should be covered in the design and implementation of the Sustainable Logistics Management Plan. The following seven areas are considered as the basic scope of the plan. I - consumer material comprising at least printing paper, disposable cups and cartridges for printing; II - electricity; III - water and sewage; IV - selective collection; V - quality of life in the work environment; VI - sustainable procurement and contracting, comprising at least works, equipment, surveillance services, cleaning, telephony, data processing, administrative support and building maintenance; and VII - displacement of personnel, considering all means of transport, focusing on reducing expenditures and emissions of polluting substances (Luiz et al., 2015; Normative Instruction No. 10, 2012).

The Article 9 ° provides de methodological guidelines to build the action plans of the SLMP, according to which it

> should be formalized in processes and, for each theme cited in Art. 8, Action Plans should be created with the following topics:
>
> I - objective of the Action Plan.
>
> II - detailing the implementation of the actions.
>
> III - units and areas involved in the implementation of each action and their respective responsible.
>
> IV - goals to be achieved for each action.
>
> V - schedule of implementation of actions; and
>
> VI - forecast of financial, human, instrumental resources, among others, necessary for the implementation of actions (Normative Instruction No. 10, 2012).

This Article also states that the results should be evaluated every six months by the management committee, considering at least the indicators provided in the third annex of the norm. In the Article 14 the reporting theme is complemented as follow:

> Art. 14. At the end of each year, a follow-up report of the PLS should be prepared in order to show the performance of each body or entity, containing:
>
> I - consolidation of the results achieved; and
>
> II - identification of the actions to be developed or modified for the following year.
>
> Single paragraph. The reports should be published on the website of the respective bodies or entities and forwarded electronically to the Executive Secretariat of CISAP (Normative Instruction No. 10, 2012).

Looking closely at the set of chapters that make up the NI10, 12/11/12, previously presented, and considering their specifications and requirements, it is possible to figure out a vigorous adherence of the their guidelines to the principles of integrated planning management and project management, in the sense that it is oriented towards management by objectives and processes (Hitchcock & Willard, 2008; Kerzner, 2019; Rieder & Lawson, 2020). This structure facilitates its execution through conventional planning or project management tools.

6.1.2. Stage 1 – Issue identification

In the context of complex adaptive systems, "issue identification" refers to the process of detecting and diagnosing potential problems or challenges within the system analysed. The ability to identify and address issues is crucial for proper design of health and stable system, as well as for achieving optimal performance. Once the issues have been identified they should be addressed in the following steps (B. Cleveland, 2018; Norman & Yip, 2013).

Regarding the application of complex adaptive systems (CAS) in health systems, Van Beurden et al. (2013, pp. 75–76) acknowledge that CAS

> provides a lens through which we can better understand multi-causal dynamics within our contexts, issues, organisations and communities. It can guide us to appropriate ways to manage, plan, design, implement and evaluate with respect to the degree of complexity of the issue in question.

As it is shown previously, the creation of the normative is considered to be an innovative step for at least two reasons. Firstly, by including public services in the sustainable development agenda. Secondly, the law stands out for its structure in the form of requirements for a modern management action plan. Leão and Melo (2018) recognise the need for all public authorities to be involved in the elaboration and implementation of an active and solid social and environmental management in their structure.

However, it is important to stress that, unlike the management models for SDI presented in chapter 2, or the sustainability assessment tools, described in the chapter 3, this normative has a complex issue that should be addressed. That is, it was not instituted with the specificities of HEI in mind. It is worth bearing in mind that the services provided by a public service office consisting of 20 or 50 employees in a single building differ drastically from those provided by a federal public HEI, not only in terms of the number of employees or buildings involved in providing services, but also in the volume of resources employed in terms of energy, water, and materials, to cite a few, as well as the variety, volume and complexity of the waste generated with regard to solid waste, sewage, or chemical, radioactive and biological residues.

To unify the recommended steps by Støttrup et al. (2019) for developing a framework based on complex adaptive systems theory with the methodology adopted in this PhD research, we reviewed the research questions from chapter 1. With minor adjustments, we then identified connexion between these questions and the emerged following eight issues to be addressed in designing the proposed FIMARSHEI. Therefore, the following issues were addresses in the process of designing the proposed framework:

(a) To what extent do organisational strategic documents support the development of a SLMP in HEI?

(b) What is the current status of SLMP implementation in Brazilian federal public universities?

(c) What are the key dimensions, actions, and indicators required to effectively operationalise the NI10, 12/11/12 and develop a coherent and feasible structure for planning, assessing, and reporting the sustainability of HEI in an integrated manner that aligns with international literature on planning and SAT for promoting SDI in HEI?

(d) What are the incongruencies and conflicts of the NI10, 12/11/12, which was created with a general spectrum, when applied to HEI?

(e) What is the most effective and credible methodology for data collection?

(f) How can multiple sectors within each university be integrated into the process of developing the plan, monitoring indicators, and preparing semi-annual and annual reports?

(g) How can different dimensions be mathematically integrated to formulate a single system?

(h) Can a benchmarking approach be utilised to develop a system for comparing the progress of every Brazilian federal public HEI??

The set of eight issues related to the publication, in 2012, of regulations governing the integration of SDI in public institutions, presented above, can be condensed into the four themes presented in Table 6-2:

Table 6-2 - Set of themes related to the issues of implementing SD into HEI

Themes	Issues	To be addressed in
1- Adherence between normative and HEI model	(d) What are the incongruencies and conflicts of the NI10, 12/11/12, which was created with a general spectrum, in application to HEI?	Stage 2
2- Implementation issues	(c) What are the key dimensions, actions, and indicators required to effectively operationalise the NI10, 12/11/12 and develop a coherent and feasible structure for planning, assessing, and reporting the sustainability of HEI in an integrated manner that aligns with international literature on planning and SAT for promoting SDI in HEI? (f) How can multiple sectors within each university be integrated into the process of developing the plan, monitoring indicators, and preparing semi-annual and annual reports?	Stage 2
3 - Methodological issues	(e) What is the most effective and credible methodology for data collection? (g) How can different dimensions be mathematically integrated to formulate a single system? (h) Can a benchmarking approach be utilised to develop a system for comparing the progress of every Brazilian federal public HEI?	Stage 3
4 -Structural and cultural issues	(a) To what extent do organisational strategic documents support the development of a SLMP in HEI? (b) What is the current status of SLMP implementation in Brazilian federal public universities?	Stage 4

6.1.3. Stage 2 – System Design

This stage comprises the development of a conceptual model of the framework proposed, considering the core components SD-related as well as identify the main interactions between the components, assess data availability and modelling methods and resources, define the indicators of each component and the scope of application (Støttrup et al., 2019). A conceptual model is defined by Meleis (2007, p. 571) as a set of abstract concepts and the assumptions that combine them into a meaningful structure.

In this regard, to provide as output the conceptual model, the system design stage must come up with answers to the following questions, some of them raised in the previous stage (issues identification).

Namely, it identifies the normative requirements and discusses preliminarily the incongruities and conflicts between the normative and its application to HEI; It establishes the scope, boundaries, dimensions, and key indicators of the framework based both on the requirements established by Law and taking into account the literature review presented in chapters 2 and 3 of this work; it provides the basic skeleton of the action plans.

6.1.3.1. Theme 1: Adherence between normative and Brazilian HEI SDI model

This subsection will focus on answering research question two, issue d, which asks "What are the incongruencies and conflicts of the NI10, 12/11/12, which was created with a general spectrum, when applied to HEI?". This research question is addressed as a way to overcome the stage 2 of the SAF, namely System Design.

Despite a consolidated theoretical framework that deals with the integration of sustainable development in education and, more specifically, in institutions of higher education, as extensively described in chapters 2 and 3 of this PhD thesis, the legislation in question (Decree No. 7,746, of 5 June 2012 and Normative Instruction N° 10, from November 12, 2012) was designed as a general guideline for all public institutions that make up the federal government, regardless of the service provided. In this sense, although in general terms the normative regulates most of the aspects of sustainable development of an HEI, it does not cover the specificities of the activities performed there, namely teaching, research and extension.

Most models of education for sustainable development or campus operations incorporate these components in their modelling. For example, Velazquez's model identifies four components related to strengthening sustainable development within HEI, namely, Education, research, outreach and partnership and campus sustainability (Velazquez et al., 2006). The model designed by Alshuwaikhat and Abubakar (2008) also include education and research as one of the components of the model. Likewise, the model of incorporation of sustainability initiatives in Latin American HEI proposed by Leal Filho, Amaro (2021) is another example of the inclusion of the components “teaching” and “outreach & research” as determinants of the inclusion of SD into HEI. All these examples were presented in chapter 2 of this work. Additionally, when we take into consideration the sustainability assessment tools described in chapter 3 of this work, we notice that SAQ (curriculum / research & scholarship / outreach & services), GASU (curriculum / research), SUM (education / research / outreach & partnership), AISHE (education / research / Society), STARS 2.0 (Academic / engagement) and UIGM (Education) all these tools include the education, research and outreach components in their sustainability assessment models (Alba-Hidalgo et al., 2018; N. Alghamdi et al., 2017; Du et al., 2020; Fischer et al., 2015; Lauder et al., 2015; Shriberg, 2002b).

To examine the adherence between the NI10, 12/11/12 and the dimensions commonly referred in the literature as the best descriptors of HEI sustainability, Figure 6-3 presents a comparison of the original dimensions of the SLMP and the dimensions recurrently adopted in management models for sustainable development in HEI, studied in chapter 2, as well as in HEI sustainability assessment tools, described in chapter 3.

According to Findler et al. (Findler, Schönherr, Lozano, & Stacherl, 2019a)on a broad perspective the component governance covers indicators such as: "policies and the administrative structure of the HEI, including, e.g., governance body structure, vision and mission statements, policies for staff and faculty hiring, budget issues, student associations, and development programs for staff and faculty". Governance is one of the dimensions of the GASU tool, presented in chapter 3, and Procurement/Purchase is referenced in at least seven SAT (GASU, CSAF, PSI, ASSC, STARS, USAT and SUM) (N. Alghamdi et al., 2017; Du et al., 2020; Kurniawan, 2020; Lozano, 2006a). The components "acquisition of materials" and "sustainable procurement" from SLMP are related with the proposed component "Governance/procurement".

The component "Campus operation" is reported in several conceptual models like those reported by Velazquez et al. (2006) in Figure 2-4, that uses the term "sustainability on campus", by Filho et al. (2021) in Figure 2-8, and Lozano et al.(2015), depicted in Table 2-6. It is also considered comprehensively in the SAT, such as: STARS that deal with campus operation through the dimension "operations"; UIGM, which even though not having a dimension called campus operation, has four of its six dimensions being related to this theme (energy and climate change, waste, water, transportation); and USAT, concerned with campus operation through the dimension "operations and management". The SAT UEMS cope with this component through the one called "university environmental management system". As shown in Figure 6-3, the campus operation component is the one that groups the majority of components of the SLMP regulations, since it groups Electricity, Water and Sewage, Waste selective collection, and displacement.

The outreach and on campus experience component deals with two aspects. The outreach concerns collaboration efforts undertaken by HEI towards external stakeholders on regional, national, and international level while, on campus experience is related to indicators that account for experiences for students and staff on campus. Only the component “Quality of life in the work environment” from SLMP is related to the dimension Outreach and on campus experience.

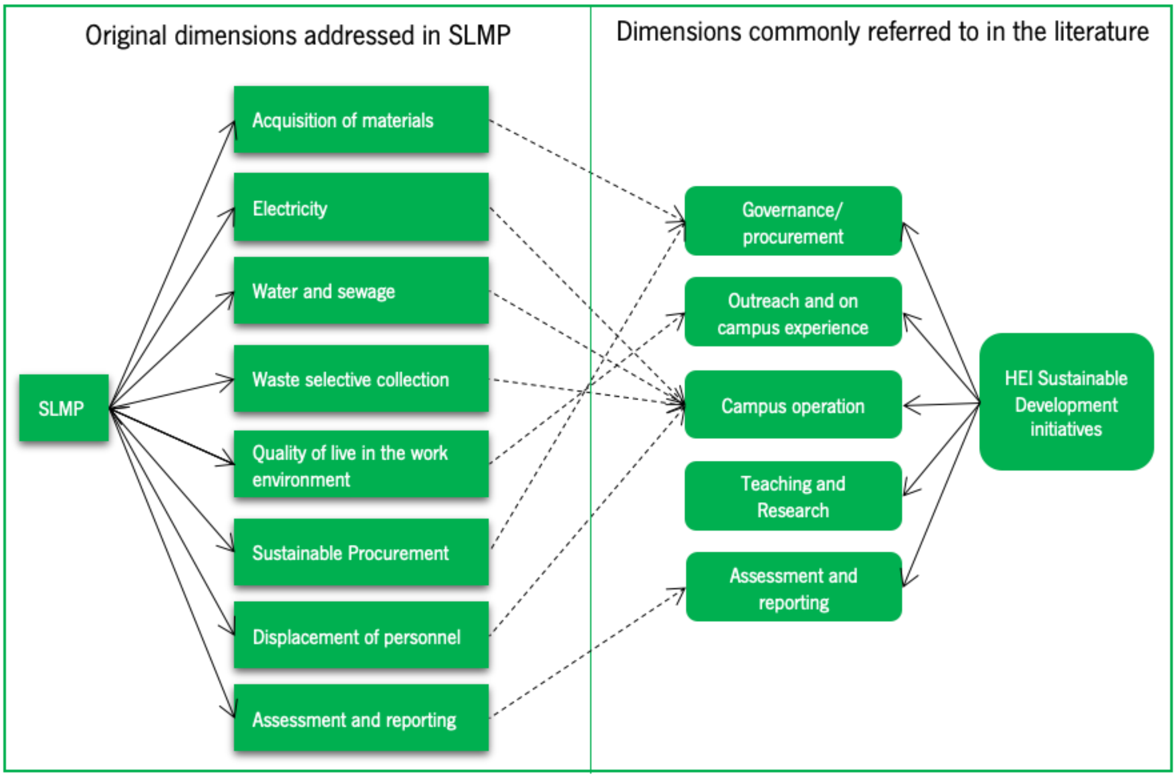

Figure 6-3 - Connexions between SLMP dimensions and those reported in literature.

The teaching dimension includes propositions related to the presence of sustainability themes in the course curriculum, the development of skills and teacher training programs (Findler, Schönherr, Lozano, Reider, et al., 2019; Leal Filho, Amaro, et al., 2021). In a broader perspective it concerns the central role that education plays in the science of sustainability and the promotion of SD. The research dimension is related to the existence of structures and financial support to produce knowledge and technology and innovations in sustainability (Lozano et al., 2017). Regardless of whether they are configured in SAT as two separate components, as is the case of SAQ, GASU, SUM, UEMAS, AISHE, BIC-AUA, The Green Plan, AMAS and STARS, or whether they are combined into a single component as for instance in the case of the tools USAT, SCAS and UI-GM, "Teaching and Research" is included in the vast majority of tools for assessing the sustainability of HEI. This dimension is considered capital if HEI are to fully assume their role in promoting sustainable development (N. Alghamdi et al., 2017; Du et al., 2020). The component Teaching and research has no connection with the normative enacted by Brazilian government to boost SD at public agencies.

The component Assessment and reporting concerns the implementation of an integrated Environmental Management System (EMS) to monitoring and control the SD-related impacts caused by HEI, as well as the internal and external disclosure of the results of this monitoring and the adoption of continuous improvement principles (Findler, Schönherr, Lozano, Reider, et al., 2019). The fourteenth article of the SLMP regulations determines the periodic monitoring of a set of performance indicators, as well as the publication of the results (Normative Instruction No. 10, 2012, sec. 14).

Defining the scope comprises, on the one hand, determining the structural and procedural limits of the framework, but also, specifying the limits of the framework in terms of real-world application. Thus, the proposed FIMARSHEI, while maintaining a structure that suits most of the actions normally developed in educational institutions, has a design specifically thought out for application in Brazilian federal public institutions of higher education. These institutions became the target of a set of Laws and Standards that aim at the implementation of sustainability practices, as it was described previously. As a typical case, the Federal University of Paraíba was chosen to test the applicability of the framework.

Taking into account the discussion presented in the previous topic, in terms of scope or comprehensiveness of the proposed FIMARSHEI, it was decided to design a modular framework that incorporates both the minimum and the extended scope. This approach based in a modular and expansible set of indicators is in line with the perspective defended in the work of Lauder et al. (2015). The minimum comprises all the requirements determined in the normative and the extended version would comprise all adjustments needed to make the framework functional for Brazilian federal public universities (Table 6-3).

Analysing the NI10, 12/11/12 in detail, it is possible to distinguish the requirements of the regulation into five distinct groups. The first comprises the content requirements, the second the scope requirements, the third group brings together the requirements related to the procedural structure, the fourth group of requirements consists of those related to disclosure and, finally, the fifth group includes the requirements related to the minimal indicators. Table 6-3 below details each of these requirements.

Table 6-3 - List of requirements of the SLMP from NI10, 12/11/12

Requirement group	Req. cod	Requirement description	Section
Content	R01	Inventory of heritage assets with a list of more sustainable substitutes	Article 5, I
	R02	Inclusion of sustainability practices and rationalisation of the use of materials and services	Article 5, II
	R03	Definition of responsibilities	Article 5, III

	R04	Description of implementation method	Article 5, III
	R05	Description of assessment method	Article 5, III
	R06	Inclusion of dissemination, awareness, and training actions.	Article 5, IV
Scope	R07	Consumables comprising at least printing paper, disposable cups, and printer cartridges	Article 8, I
	R08	Electricity	Article 8, II
	R09	Water and sewerage	Article 8, III
	R10	Selective waste collection	Article 8, IV
	R11	Quality of life in the work environment	Article 8, V
	R12	Purchasing and contracting, including construction works, equipment, security services, cleaning services, telephone services, data processing services, administrative support services, and building maintenance.	Article 8, VI
	R13	Displacement (transportation, considering all modes) - costs and emissions	Article 8, VII
procedural structure	R14	The Plan must contain the objective of the action plans	Article 9, I
	R15	The Plan must contain details of implementation	Article 9, II
	R16	The Plan must contain the units involved	Article 9, III
	R17	The Plan must contain goals to be reached for each action	Article 9, IV
	R18	The Plan must contain timeline for each action	Article 9, V
	R19	The Plan must contain a forecast of financial, human, and instrumental resources, among others, necessary for the implementation of the actions.	Article 9, VI
	R20	The Plan must contain biannual evaluation	Article 9, VII
Disclosure	R21	The Plan should be prepared and published on the website	Article 12
	R22	The results achieved will be evaluated every six months by the management committee, using at least the indicators listed in Annex III.	Article 13
	R23	Publication on the website and sending a copy to CISAP (governmental control agency) of the follow-up report with the consolidation of results and the identification of actions to be developed in the following year	Article 14
Indicators	R24	**Consumable materials**: *Paper:* (1) Monthly consumption of white paper (bleached); (2) Per capita consumption of white paper (bleached); (3) Expenditure with the acquisition of white paper (bleached); *Disposable cups*: (4)Consumption of 200 ml disposable cups; (5) Consumption of 50 ml disposable cups; (6) Per capita consumption of 200 ml disposable cups; (7) Per capita consumption of 50 ml disposable cups; (8) Expenditure with the acquisition of disposable cups; **Electricity**: (9) Consumption of electrical energy (R$); (10) Electricity consumption per capita; (11) Energy consumption (kWh); (12) Energy consumption per capita; (13) Adequacy of the demand contract (off peak); (14) Adequacy of the demand contract (peak); (15) Energy expenditure by area; **Water and sewage**: (16) Volume of water used; (17) Volume of water per capita; (18) Water consumption; (19) Water consumption per capita; **Waste selective collection**: (20) Disposal of paper for recycling; (21) Disposal of cardboard for recycling; (22) Toner for recycling; (23) Destination of plastic for recycling; (24) Total recyclable material destined for cooperatives; (25) Paper Reuse; **Quality of life in the work environment**: (26) Participation of employees in programs and/or actions focused on quality of life at work; **Procurement and contracting**: Fixed telephony: (27) Expenditure per extension/line; Mobile telephony: (28) Expenditure per line; Surveillance: (29) Initial value of post; (30) Current value of Post; Cleaning: (31) Cleaning Expenditure by area; (32)Degree of repactuation; **Displacement**:	Annex III

After identifying and grouping all the requirements of the NI10, 12/11/12, the moment in which the main requirements were addressed during the implementation of the System Approach Framework was analysed.

To meet *content requirement* R01 a form was elaborated in "stage 3: system formulation "to list more sustainable substitutes to materials purchased by HEI. The content requirements R02, R03, R04, R05, and R06, were also addressed in stage 3, through the development of action plans for the components of the framework (See Appendix B).

The *scope requirements* comprising R07, R08, R09, R10, R11, R12, and R13 were addressed in two stages, stages 2 and 3: in stage 2 - system design, to define the conceptual model, scope, and boundaries; in stage 3- system formulation, for the detailed formulation of all action plans.

Most of the procedural structure requirements were addressed in stage 3, as shown in more detail in Chapter 7, where objectives for action plans were defined through R14, implementation details are highlighted in R15, units involved is required in R16, targets for each action is an obligation indicated in R17, timetable for implementation, required in R18, and resources needed is expressed in R19. The bi-annual evaluation was carried out at the next stage, stage 4: system assessment which is detailed in Chapter 8.

The *disclosure requirements* were addressed during stage 3, which is the system formulation phase. To achieve this, the SLMP template was translated into an easy-to-read structure that can be published on the institution's website (R21), and a copy could be send to CISAP to achieve the requirement 23 (R23). Finally, protocols for evaluating the results were established (R22).

The sustainability *indicators requirements* are the central and most important part of the design of the integrated framework. Consequently, special attention was paid to these elements which were addressed in stage 3: "system design", detailed in Chapter 6, used to define the general structure of the indicators that composed the action plans. In stage 3: system formulation the metrics for measuring the indicators were designed and validated in the subsequent stage 4: system assessment is addressed in chapter 8.

To answer the issue (c) Which are the key dimensions, actions, and indicators to properly operationalise the requirements of the NI10, 12/11/12 into a coherent and feasible structure that allows planning, assessment and reporting of the sustainability of HEI in an integrated way and at the same time, is aligned with the international literature on planning and SAT to promote SDI at HEI?" it is necessary to undertake several tasks: in Table 6-2, for the accomplishment of the *requirements of scope*, the conceptual model shall include all components listed in Figure 6-3 (a). However, it is attainable that the components may be rearranged in a structure that is more aligned with the campus sustainability assessment tools as it is depicted in Figure 6-3 (b). Therefore, the components of the proposed framework, as shown in Figure 26, comprise the following components: (1) "governance/procurement" component that incorporates in its set of indicators those related to "acquisition of materials" and "sustainable procurement" components established in the SLMP, and additionally the dimension “institutional framework”; (2) "outreach and on-campus experience" embracing the indicators related to the component “quality of life in the work environment”, as a compulsory dimension, and the “extension programme” and “networking” were added to this component; (3) "Campus operation" is the proposed component which best combines the components required by the SLMP. To this end, the indicators relating to the following components originally established in the NI10, 12/11/12 were incorporated: "energy", "water", "waste", and "displacement".

The design of the framework to integrate, monitor and report on the sustainability of federal public higher education institutions, should consider all the basic indicators (Table 6-3 – R024). In addition to the above, other indicators have been included in the proposed FIMARSHEI. Therefore, components and dimensions were included, with their respective action plans, indicators, metrics and methodologies for all dimensions. The components added were Teaching and Research, in which the dimensions “teaching” and “research and innovation” are grouped. Finally, the component "assessment and reporting" was included due to both the emphasis in the literature and because it is a set of SLMP requirements (Table 6-3 – R20, R21 and R22).

Thereby, Figure 6-4 epitomizes the main aspects of the proposed conceptual model. The second column shows the five components that comprise the conceptual model. The third column illustrates 14 dimensions that were grouped into the components. The action plans in green represent those required by the NI10, 12/11/12, while the ones in white represent those added based on the literature review and which were deemed necessary to accomplish the purpose of developing an integrated model for HEI, therefore also considering its specificities. The fourth column shows the number of basic (compulsory) and extended (not required by the Normative) indicators followed by the scores assigned to each of the dimensions. The fifth column shows the type of the designed assessment protocols (BPMN and/or SOP) assigned for each action plan and. The fifth column of the diagram also points out the dimensions that do or do not have qualitative (dark green dot) and qualitative (white dot) variables. The sixth column represents the execution phase of the performance evaluation, which occurs by applying the protocols developed in the previous step (planning). Finally, the sixth and last column represents the dashboard template that can be used as a guide for sustainability reporting. The assignment of scores will be discussed in detail in the next chapter, at which point the mathematical modelling of the framework will be developed.

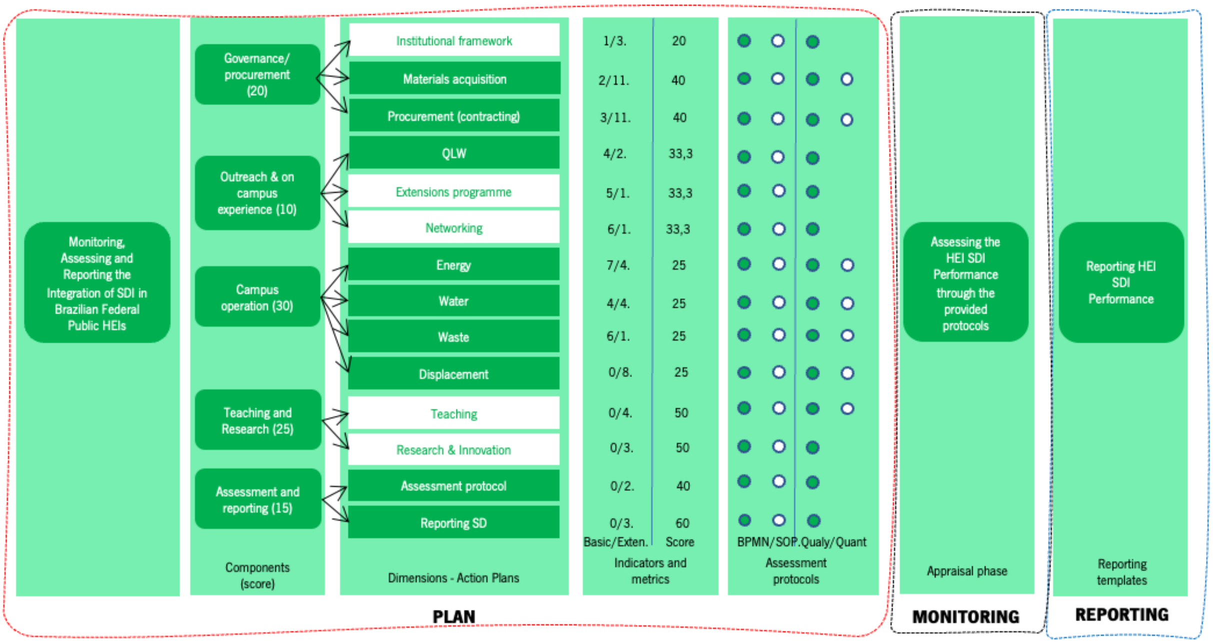

Figure 6-4 - General conceptual model of the proposed FIMARSHEI.

Figure 6-4 presents the conceptual model of a proposed framework for monitoring, assessing, and reporting the integration of sustainable development initiatives (SDI) in Brazilian Federal Public Higher Education Institutions (HEI). The framework is composed of five interrelated components that comprise a total of fourteen dimensions. In Figure 6-4, the dimensions illustrated in dark green correspond to those directly related to the NI10, 12/11/12. Those displayed in white represent the dimensions added to the model based on the systematic literature review on campus sustainability and assessment tools carried out in chapters 2 and 3.

The first component, "Governance/Procurement", is concerned with the integration of SDI in institutional documents such as strategic plans and policies. It includes the dimensions of "Institutional Framework", "Materials Acquisition", and "Procurement (Contracting)".

The second component, "Outreach & On-Campus Experience", aims to integrate SDI in university extension activities and enhance the quality of life of the university work environment. It also encourages cooperation among HEI to improve the integration of SDI. This component comprises the dimensions of "Quality Life in the Workplace (QLW)", "Extensions Programme", and "Networking".

The third component, "Campus Operation", focuses on initiatives to integrate SDI into routine campus operations. It is the most extensive component, encompassing the dimensions of "Energy", "Water", "Waste", and "Displacement".

The fourth component, "Teaching and Research", concerns the integration of SDI into the curriculum of the courses offered and research and innovation actions. This component includes the following two dimensions, "Teaching" and "Research and Innovation".

Finally, the fifth component of the proposed model is "Assessment and Reporting", which aims to assist in developing procedures to periodically evaluate and report the performance of HEI in integrating sustainable development initiatives. This component comprises the dimensions of "Assessment Protocol" and "Reporting SD".

For each dimension, an action plan is developed, which includes actions, indicators, metrics, a timeline, and the designation of sectors responsible for implementation. Additionally, the model includes performance assessment protocols and templates to aid in the development of reports.

In summary, the proposed model presents a comprehensive framework to monitor, assess, and report the integration of sustainable development initiatives in Brazilian Federal Public HEI. The tool provides a structured approach that can help institutions to enhance their sustainability performance and contribute to the achievement of sustainable development goals.

6.1.3.2. List of indicators resulting from the systematic literature review.

The systematic literature reviews presented in chapters 2 and 3 explore the international commitments and agreements made by HEI to integrate sustainable development initiatives into their processes and examines the prominent management models adopted by HEI in response to these commitments, while chapter 3 highlights the key tools used to evaluate HEI' performance in implementing SDI. The systematic review of the existing literature also resulted in the compilation of sustainability indicators for HEI, serving as the foundation for the development of the proposed framework FIMARSHEI and offering a valuable theoretical contribution.

In chapter 3 more than twenty review articles were thoroughly analysed, from which 14 provided a comparative analysis of a set of SAT (Adenle et al., 2020b; Alba-Hidalgo et al., 2018; N. Alghamdi et al., 2017; L. P. Amaral et al., 2015; Asmuss & Kamal, 2013; Bullock & Wilder, 2016; Casarejos, Frota, et al., 2017; Du et al., 2020; Findler et al., 2018; Fischer et al., 2015; Galleli et al., 2021; Lauder et al., 2015; Saadatian & Salleh, 2011; Shriberg, 2002a). Nine proposed new tools to assess and integrate sustainable development into HEI (Adenle et al., 2020b; Alshuwaikhat et al., 2017; Lozano, 2006a; Saadatian et al., 2013; H. Shi & Lai, 2013; Silva & Almeida, 2019; Sonetti et al., 2016; Velazquez et al., 2006); and 3 described the methodologies adopted by HEI to elaborate sustainability reports (Kapitulčinová et al., 2018; Sepasi et al., 2018; Son-Turan & Lambrechts, 2019). Those authors also outlined the main drivers and barriers faced by HEI in reporting their sustainability. Finally, five references described mathematical modelling procedures to compute and integrate sustainability in the proposed tools (Adenle et al., 2020b; Casarejos, Frota, et al., 2017; Lauder et al., 2015; Saadatian et al., 2013; Waheed, Khan, Veitch, et al., 2011). In total, 46 sustainability assessment tools were deeply analysed. In this process, it was possible to compile more than 600 indicators of sustainability applied to higher education institutions. Table 3-3 summarizes the most relevant references reviewed regarding SAT. Besides the 46 SAT extensively analysed, 72 SAT cited in the literature were compiled in Table 3-10.

The Brazilian regulations aimed at integrating sustainable development into HEIs were analysed to identify the requisites and indicators. As shown in Table 6-3, 24 requisites and 32 indicators were catalogued. These indicators were then grouped into the proposed framework, with 32 selected based on the requirements of the NI10, 12/11/12. These were labelled as "basic" (Bas) due to their legal obligation to be reported to Brazilian control agencies. The second group, consisting of 57 indicators, was identified through a literature review, and labelled as "extended" (Ext) due to their recurring presence as key descriptors of the level of sustainable development integration in HEI.

Table 6-4 presents a comprehensive collection of sustainability indicators relevant to HEI that were sourced from two systematic literature reviews.

Table 6-4 - The compiled list of indicators to be considered in the proposed FIMARSHEI.

NI	C	D.	B/E	Indicator	Source
1	G&P	IF	Ext	Strategic commitment to integrate SD initiatives	(Alshuwaikhat et al., 2016) (Hutchinson et al., 2009) (N. Alghamdi et al., 2017) (Zahid et al., 2021)(Findler, Schönherr, Lozano, & Stacherl, 2019b)(Mendoza et al., 2019)
2	G&P	IF	Ext	Institutional SD policy	
3	G&P	IF	Ext	Campaigns to raise awareness of the institutional commitment to the SD	
4	G&P	MA	Bas	Total quantity of sheets of white paper used	(Lozano, 2006a) (Drahein et al., 2019) (Du et al., 2020) (Lozano et al., 2013) (N. Alghamdi et al., 2017) (Young et al., 2016)(Chen et al., 2018)(Findler, Schönherr, Lozano, & Stacherl, 2019b)(Mendoza et al., 2019)
5	G&P	MA	Bas	Number of sheets of white paper per capita used by public servants	
6	G&P	MA	Bas	Total expenditure with the acquisition of white paper	
7	G&P	MA	Ext	Number of sheets of white paper per capita used by the community	
8	G&P	MA	Ext	Expenditure per capita of servant on white paper	
9	G&P	MA	Ext	Expenditure per capita of the academic community on white paper	
10	G&P	MA	Bas	Consumption of 180 ml disposable cups	
11	G&P	MA	Bas	Consumption of 50 ml disposable cups	
12	G&P	MA	Bas	Per capita consumption of disposable 180ml cups per servant	
13	G&P	MA	Bas	Per capita consumption of 50 ml disposable cups per public servant	
14	G&P	MA	Ext	Per capita consumption of disposable 180ml cups by the community	
15	G&P	MA	Ext	Per capita consumption of 50 ml disposable cups by the community	
16	G&P	MA	Bas	Spending on the purchase of disposable cups	
17	G&P	MA	Ext	Monthly consumption of printing cartridges and toner	
18	G&P	MA	Ext	Spending on the purchase of cartridges and toners	
19	G&P	MA	Ext	Regulation of the digitalisation of processes	
20	G&P	MA	Ext	Campaigns to raise awareness to reduce the use of paper	

21	G&P	MA	Ext	Campaign to raise awareness to reduce the use of disposable cups	
22	G&P	MA	Ext	Campaign to raise awareness to reduce the use of cartridges and toners	
23	G&P	P	Bas	Expenditure per extension and fixed telephone line	(Zaidi et al., 2019)(Walker & Brammer, 2009)(Goldschmidt et al., 2013)(Barth et al., 2014)(Mohanty et al., 2018)(Mário Henrique Trentim, 2013)(Mohanty et al., 2018)(Palsson et al., 2013), (Veerkamp et al., 2020)(Fuentes-Bargues et al., 2018)(Hafsa et al., 2021)(Price et al., 2020)(Trevisan et al., 2020)(R. M. Perlingeiro et al., 2021)(Li et al., 2018)(Chen et al., 2018)(Freidenfelds et al., 2018)(Findler, Schönherr, Lozano, & Stacherl, 2019b)(Mendoza et al., 2019)
24	G&P	P	Bas	Expenditure per mobile line	
25	G&P	P	Bas	Average value of the surveillance post	
26	G&P	P	Bas	Repactuation' estimate	
27	G&P	P	Ext	Total expenditure on hiring surveillance service	
28	G&P	P	Ext	Expenditure per capita of servant on security service contract	
29	G&P	P	Ext	Expenditure per capita of community on security service contract	
30	G&P	P	Bas	Total expenditure paid per m^2 with the cleaning contract	
31	G&P	P	Bas	Repactuation of the cleaning contract	
32	G&P	P	Ext	Total monthly expenditure on contracting cleaning service	
33	G&P	P	Ext	Expenditure per capita of servant on cleaning service contract	
34	G&P	P	Ext	Expenditure per capita of community on cleaning service contract	
35	G&P	P	Ext	Sum of the expenditure for construction contracts	
36	G&P	P	Ext	Sum of the expenditure on maintenance contracts	
37	G&P	P	Ext	Area covered by the camera's surveillance system	
38	G&P	P	Ext	SD education campaigns for rational use of the telephone system	

39	G&P	P	Ext	SD education campaigns for maintain the cleanliness of campus areas	
40	O/ CE	QLW	Bas	Participation of public servants in programmes and/or actions focused on the quality of life at workplace	(Vaatstra & Vries, 2007),(Alrashed, 2020) (Radinger-Peer & Pflitsch, 2017)(Rabe et al., 2018) (Chen et al., 2018), (Freidenfelds et al., 2018), (Findler, Schönherr, Lozano, & Stacherl, 2019b)
41	O/ CE	QLW	Ext	Campaigns to promote quality of life at workplace	
42	O/ CE	QLW	Ext	Assessment of employee and student satisfaction	
43	EP	EP	Ext	Screening of the adherence of the extension actions to the SDGs	
44	EP	Network.	Ext	Network of sustainable universities.	(Suwartha & Berawi, 2019), (Zhou et al., 2020)
45	CO	Energy	Bas	Expenditure with energy	(A. R. Amaral et al., 2020)(Li et al., 2018)(Chen et al., 2018)(Shuqin et al., 2019)(Freidenfelds et al., 2018)(Findler, Schönherr, Lozano, & Stacherl, 2019b)(Mendoza et al., 2019)(Bautista-Puig & Sanz-Casado, 2021)
46	CO	Energy	Bas	Electric energy consumption, in BRL R$, per capita of public servers	
47	CO	Energy	Ext	Per capita electricity expenditure by the community (public servants, students, and outsourced employees)	
48	CO	Energy	Bas	Electric energy consumption energy in kWh	
49	CO	Energy	Bas	Electric power consumption per capita of public servers	
50	CO	Energy	Ext	Per capita consumption of electric energy by the community (public servants, students, and outsourced employees)	
51	CO	Energy	Bas	Adequacy of demand contract (off-peak)	
52	CO	Energy	Bas	Demand Contract Adequacy (Peak)	
53	CO	Energy	Bas	Energy Expenditure by area	
54	CO	Energy	Ext	Analysis of the viability of alternative energy sources (solar, thermoelectric and wind)	
55	CO	Energy	Ext	Environmental education campaigns for electricity consumption	
56	CO	Water	Bas	Volume of water used	

57	CO	Water	Bas	Per capita volume of water of public servants
58	CO	Water	Ext	Per capita volume of water by the community (employees, students, and outsourced workers)
59	CO	Water	Bas	Expenditure with water
60	CO	Water	Bas	Servers' per capita spending on water
61	CO	Water	Ext	Per capita spending on water by the community (employees, students, and outsourced workers)
62	CO	Water	Ext	Communication channel on water leaks
63	CO	Water	Ext	Campaigns to promote sustainable development for water consumption
64	CO	Waste	Bas	Destination of paper for recycling
65	CO	Waste	Bas	Destination of cardboard for recycling
66	CO	Waste	Bas	Destination of toner for recycling
67	CO	Waste	Bas	Destination of plastic for recycling
68	CO	Waste	Bas	Total recyclable material destined to cooperatives
69	CO	Waste	Bas	Volume, of reused paper
70	CO	Waste	Ext	Environmental education campaigns to promote selective collection
71	CO	Displace.	Ext	Operational costs with the HEI fleet
72	CO	Displace.	Ext	CO_2 emissions by UFPB's vehicle fleet, total and by fuel type
73	CO	Displace.	Ext	Monitoring of fuel volume consumption
74	CO	Displace.	Ext	Monitoring of fuel cost consumption

75	CO	Displace.	Ext	CO2 emissions after compensation by planting seedlings	
76	CO	Displace.	Ext	Environmental education campaigns to promote awareness in the use of institutional transport	
77	CO	Displace.	Ext	Seedlings planted	
78	T&R	Teaching	Ext	Courses committed intensively of peripherally to the SD	(Shuqin et al., 2019)(Freidenfelds et al., 2018) (Findler, Schönherr, Lozano, & Stacherl, 2019b)(Bautista-Puig & Sanz-Casado, 2021)
79	T&R	Teaching	Ext	Institutionalised programmes to promote campus as a living laboratory	
80	T&R	Teaching	Ext	Sustainability of HEIs' curricula	
81	T&R	Teaching	Ext	Campaigns to raise awareness of the integration of the SD into the curricula	
82	T&R	R&I	Ext	Funding for research and innovation into areas of SD	
83	T&R	R&I	Ext	Sustainability of HEI's research and innovation	
84	T&R	R&I	Ext	Campaigns to raise awareness of the research and innovation commitment to the SD	
85	A&R	AP	Ext	Existence of a formal structure for monitoring the environmental performance of HEI.	(Shuqin et al., 2019)(Bautista-Puig & Sanz-Casado, 2021)
86	A&R	AP	Ext	Comprehensive system of formally established indicators for key sustainability aspects of HEI (including at least energy, water, curriculum, research, waste)	
87	A&R	Rep. SD	Ext	Comprehensiveness of data coverage of sustainability assessment reports (whether sectoral or HEI as a whole)	
88	A&R	Rep. SD	Ext	Availability of reports on institutional website	
89	A&R	Rep. SD	Ext	Campaigns to publicise HEI environmental performance	

NI.: Number of indicator; C.: Component; D.: Dimension; B/E.: Basic/ Extended; G&P: Governance & procurement; O / CE: Outreach / on campus experience; EP: Extension Program; Network.: Networking; CO: Campus operation; Displace.: Displacement; T&R: Teaching & research; A&R: Assessment & reporting; IF: Institutional framework; MA: Material acquisition; P: Procurement (contracting); QLW: Quality of life at work; R&I: AP: Assessment Protocol; Rep. SD: reporting on S

Subsequently, the indicators, previously selected via the extensive literature review, were validated through expert interviews. To this end ten interviews were conducted with personnel from the sectors responsible for the integration of sustainable development in all five dimensions of the proposed model at Federal University of Paraíba (Figure 6-3). At this point it is worth stressing that the NI10, 12/11/12 developed by the Brazilian Government was designed to be applied in all federal public bodies and not specifically in a higher education institution, which has its own specificities that differ greatly from regular public bodies.

Therefore, it was necessary to include such an expressive number of supplementary indicators classified as Ext in Table 6-4. These additional indicators were included either to measure specific aspects of a dimension already included in the NI10, 12/11/12 or to include new dimensions such as "teaching & research" or "outreach/ on campus experience" which are both specific to an HEI. In other words, public offices generally do not have the function of training individuals or producing scientific knowledge and innovations for society. In the context presented, this is the specific objective of public educational institutions.

6.1.3.3. Summary of the interviews conducted.

The interviews were organized in two parts. In the first phase, a brief presentation was made focused on the presentation of the actions implemented to promote the integration of SD carried out at the University and implemented by means of the Sustainable Logistic Management Plan. In the second phase, shaped as a dialogue between the interviewer and the interviewee, information was collected about the sector in which the respondent works, the main barriers and drivers for SDI integration, pre-validation of the suggested indicators and data collection form. The interviews were pivotal to validate the indicators, especially regarding the aspects related to integration and feasibility. Finally, it was verified whether the sector compiled additional data that could be used in the construction of the proposed FIMARSHEI. A brief report of the interviews is presented in Table 6-5

Table 6-5 - Brief reporting of the interviews

Sector (*)	Sub-sector	Main Findings
Superintendence of Infrastructure (3)	Environment Division	The interviewee briefly described the work that is developed in his sector emphasizing those related to the integration of SD at the university; Among the main challenges for the integration of SD were cited: (a) the lack of digital meters in all buildings of the institution to compute, in real time, the consumption of electricity; (b) the lack of government grant that authorizes the use of water from artesian wells installed on campus for use in gardening activities, cleaning and human consumption. The interviewee validated all the sustainability indicators presented, acknowledging their importance and the feasibility of periodic data collection. No additional indicators were suggested by the interviewee.
	The office of Management of projects and buildings	The interviewee briefly described the work that is developed in the office of Management of Projects and Buildings, emphasizing those related to the integration of SD at the university; The main challenge reported was the lack of a specific budget to face the additional costs of sustainable projects, such as sustainable building, construction of renewable energy's power plants. The office has helped in the implementation of several projects to integrate sustainable development at the university, among which are (a) the program to replace internal and external lighting with led lamps; and (b) the installation of solar panels to increase the amount of renewable power in the energy matrix of the university. The interviewee validated all the sustainability indicators presented, acknowledging their importance and the feasibility of periodic data collection. Additionally, the relevance of promoting educational campaigns for sustainable development to raise awareness and engagement of the academic community was stressed by the interviewee.
	The office of Management of Electricity	The interviewee briefly described the work that is developed in his sector emphasising those related to the integration of SD in the university. Basically, the sector is responsible for managing the electricity supply contract for the Institution's campuses. The main challenge reported by the interviewee is the assignment of optimized values for energy consumption in the contract, in view of the following three limitations: (a) lack of a real-time reading system for electricity consumption; (b) variation in energy demand on campuses; and, (c) contractual time limitations for changing peak and off-peak demand, since changes in the contracted value can only be changed twice a year and not according to monthly demand, for example. Regarding the integration of the SD in the institution, the main actions developed by the sector that were reported by the interviewee were: (a) implementation of the structured maintenance plan of the power grid that provides for the gradual replacement of external lighting by LED lamps, and that the new bidding processes for the acquisition of lamps for internal lighting are aimed at the acquisition of led lamps; (b)The sector has planned the individualization of the power grid by the centres (which is equivalent to colleges or schools in international universities). This action will enable the identification of critical areas and the quicker proposition of solutions to emerging problems, as well as the attribution of consumption targets by centre with a view to reducing consumption. Especially at peak hours (17h30min to 20h30min), when electricity is three times more expensive. The interviewee considered the indicators presented to be adequate and recognized the importance of indicators related to controlling the adequacy of contracts in peak and off-peak periods, in view of the economic impacts.
Superintendence of Logistics and Transportation (1)	Management of Planning and Transportation	The interviewee briefly described the work that is developed in his sector emphasising those related to the integration of SD in the university. In broad terms, the sector manages the fuel and maintenance contracts for the fleet of institutional vehicles, as well as the contract of drivers to drive the fleet and, finally, the authorization to make vehicles available for the displacements required by the various sectors of the institution. At the time of the interview, the main challenge that the sector was facing was the under-dimensioned values of the contracts that limited the possibility of properly carrying out fleet maintenance. This problem caused impacts on the environment such as the increase in fuel consumption per vehicle, which increased the cost per km of transport while increasing emissions and the risk of accidents in the displacements performed. Regarding the implementation of actions related to the DS, (a) it was reported that the sector has been digitizing the process of requesting displacements with the enabling of this functionality in the Institution's integrated system; The importance of this action is based on the fact that it allows for a reduction in

		the use of paper and printing, while improving control and transparency in the management of the use of the vehicle fleet; (b) With the objective of adapting to the legislation, the sector partnered with the environmental engineering department to redesign the process of washing cars and sanitation of effluents so as not to allow contamination of soil or water resources with the expelled oils and chemicals. in car washing. The interviewee validated all the sustainability indicators presented, acknowledging their importance and the feasibility of periodic data collection.
Institutional Security Superintendence (1)	Cabinet coordination office	The interviewee briefly described the work that is developed in his sector emphasising those related to the integration of SD in the university; The main activity developed by the sector is the management of institutional surveillance contracts. Property surveillance contracts are onerous, affecting an important part of the institution's budget. The challenge that the sector has faced to reduce costs is related to the installation of cameras with sensors and automated facial recognition barriers. The installation of this equipment could reduce the need for personnel in surveillance contracts, reducing the total expenditure on campus security. The interviewee validated all the sustainability indicators presented, acknowledging their importance and the feasibility of periodic data collection.
Dean of Administration (1)	Office of Materials Acquisition	The interviewee briefly described the work that is developed in his sector emphasising those related to the integration of SD in the university; The sector is responsible for acquiring materials and equipment for the Institution through a bidding process; The main barrier faced by the sector is to include sustainability criteria in bids, considering the wide variety of items that are bid annually by the University. Among the efforts reported to integrate the SD in the acquisition of materials, the following stand out: (a) 30% of the paper purchased by the institution is recycled; (b) encouraging the use of ceramic mugs instead of disposable cups; (c) replacement of the material of the cups, which were previously made of polystyrene and are now made of polypropylene, which is less expensive; (d) decrease in the purchase of cartridges and toners with the parallel contracting of printing services; (e) acquisition of printers with a native bulk system that reduces the printing cost per sheet; (f) shared acquisition of materials with other sectors, which reduces the costs of bidding processes and the time for holding the auction; and (g) prioritization of energy efficiency in the acquisition of electronic equipment, such as multimedia projectors, refrigeration devices, etc. Finally, the interviewee evaluating the suggested indicators indicated that the federal government's transparency portal provides the necessary data for the computation of the indicators and, in addition, offered search tips on the portal.
Dean of Personnel Management (1)	Division of Quality of Life and Health	The interviewee briefly described the work that is developed in his sector emphasising those related to the integration of SD in the university; According to the interviewee, the sector implements actions to promote the employee's quality of life, following two distinct strands that complement each other. The first, hegemonic, is characterized by conventional actions, such as the course to combat smoking, course to prepare for retirement, program to combat suicide and the actions linked to the agenda of the Brazilian Unified Health System (SUS, acronym in Portuguese). The second aspect, called "counter-hegemonic" by the interviewee, encompasses the actions aimed at the daily improvement of quality of life at work and, therefore, requires the commitment of senior management, as well as financial investments. Therefore, it is deemed as a barrier to the integration of sustainable development as far as the social aspect of the triple bottom line is concerned. In the interviewee's opinion, the indicators and metrics suggested during the interview were considered adequate. Additionally, he informed that the Dean of Personnel Management and the Division of Quality of Life and Health have the necessary data for the calculation of the suggested indicators.
Environmental Management Committee (1)	Member of the Waste Selective Collection Program	The interviewee briefly described the work that is developed in his sector emphasising those related to the integration of SD in the university; The respondent explained that the EMC coordinates the implementation of several initiatives to promote sustainable development at the institution's four campuses and that he acts exclusively in the management of the campus waste selective collection program, responsible for the collection of recyclable waste and the donation of this waste to cooperatives and associations around the university. Brazilian legislation prohibits public institutions from commercializing recyclable waste and determines that this waste should be donated to cooperatives of waste pickers associations as a way to empower the most vulnerable links of the waste market. According to the interviewee, the major barriers faced in the integration of sustainable development in the institution are related to the lack of investment for the programs and the academic community's lack of commitment

		to environmental issues. To increase engagement the Committee has developed awareness campaigns on the institution's social media as well as environmental education programs. Also, according to the interviewee, the programme monitors the recyclable waste donated to the cooperative so that it has records that ensure the supply of the necessary data to fill in the indicators suggested for the area.
Superintendence of General Services (1)	Green Areas Management Office	The interviewee briefly described the work that is developed in his sector emphasising those related to the integration of SD in the university; The respondent explained how cleaning areas are divided in the university campuses and how this division impacts on the amount paid monthly for the cleaning contract. He also informed that the contract determines the use of biodegradable cleaning material and that this brings benefits to the environment. There were no identified barriers to the integration of SD related to the area of cleaning and general services. Finally, the interviewee considered that the indicators presented during the interview incorporated the main elements related to the contract execution and stated that the sector had all the data required to measure the indicators, but also informed that most data is on the governmental transparency web portal.
Superintendence of Budget and Finance (1)	Coordination	The interviewee briefly described the work that is developed in his sector emphasising those related to the integration of SD in the university. The interviewee clarified issues related to the execution of fixed and mobile phone contracts; he explained the rationality of the construction contracts, exalting that the university maintains basically two contracts, one for general maintenance and another for exclusive labour (to hire bricklayers, electricians, glaziers, etc.). Regarding the existing discrepancies between the amounts invoiced and paid, the interviewee justified that sometimes, especially when there is interest charged for delay, the sector negotiates directly with the service providers to reduce the amounts of interest charged and the discount assigned and the final amount with the discount is paid, without the issuance of a new invoice. A discount is given on the original invoice. The most significant barriers identified by the interviewee that limit the integration of sustainable development in the sector in which he works are related to (i) cuts in the execution of expenses made by the government, i.e., cuts in the previously approved budget and (ii) reduction in the budget allocated to education. By verifying the indicators proposed for the framework, the interviewee found that with the advanced process of digitalisation of public finances, much of the necessary data is available on the transparency portal website managed by the federal government.

(*) Number of interviews performed

After the interviews and detailed analysis of the portal, it was decided to prioritize, when available, the data collection on the portal, to the detriment of the collection in the various sectors of the institution. This decision is justified by the accuracy of the data provided by an official web page of the federal government, as well as, to make the proposed FIMARSHEI replicable for other Brazilian public federal universities, as well as, and finally, to make the collection process feasible. This is in line with the criteria established in Task 5, which aimed at validating the frameworks' data collection and analysis process with experts (preliminary validation).

Chapter 7. System formulation

Chapter 6 of this work argued that developing a framework to integrate, monitor and assess the sustainability of HEI was a complex activity and that it could be better carried out by adopting a systems approach.

To this end, the System Approach Framework (Figure 6-2), a scheme composed of the analysis of scenario changes and five stages, was employed to guide the implementation of the proposed FIMARSHEI. The analysis comprises the survey of the main, issues, barriers and motivators that lead to the development of a framework to integrate the planning, implementation, evaluation and reporting of the sustainability system's performance in HEI.

Thus, chapter 6 started the adoption of the SAF by implementing the following stages: (a) the presentation of the changes in the scenario of insertion of SDI in Brazilian federal public HEI, with the launching of a set of norms directed to the public sector; fulfilling the requirements of the first stage, concerning the (b) *issue identification*, arising from the emergence of the new scenario that was set in motion, with the identification of eight issues considered vital to better understand the context and to design a framework to overcome the conflicts that emerged from the integration of SD initiatives into HEI (see Table 6-2); in sequence, there was the implementation of the second stage, dealing with (c) *system design*, in which the adherence between normative and HEI model was analysed, highlighting the point of convergence and divergence between the normative and literature regarding the integration of SD into HEI (Figure 6-3). This stage also discusses the scope, boundaries, and critical indicators to be adopted by the proposed FIMARSHEI. It culminates in the presentation of the general conceptual model of the proposed framework (Figure 6-4).

This chapter will describe the activities undertaken to accomplish stage three of the SAF, which deals with *system formulation*. In this stage, the indicators and scope defined in the previous stages will be taken into account, and the objectives and action plans will be defined (Table 6-3, R14). It is composed of actions, implementation details (R04 and R15), designation of the units involved (R16), indicators, metrics, targets (R17), timeline (R18), resources (R19), responsibilities (R13), and metrics for each indicator. This stage will also design the mathematical model for integrating the framework components, the data collection strategies, the indicator evaluation protocols, and the structure for reporting results. In a nutshell, this chapter intends to give some insights to answer the research question three, issue f, "How can multiple sectors within each university be integrated into the process of developing the plan, monitoring indicators, and preparing semi-annual and annual reports?" presented in Table 6-2.

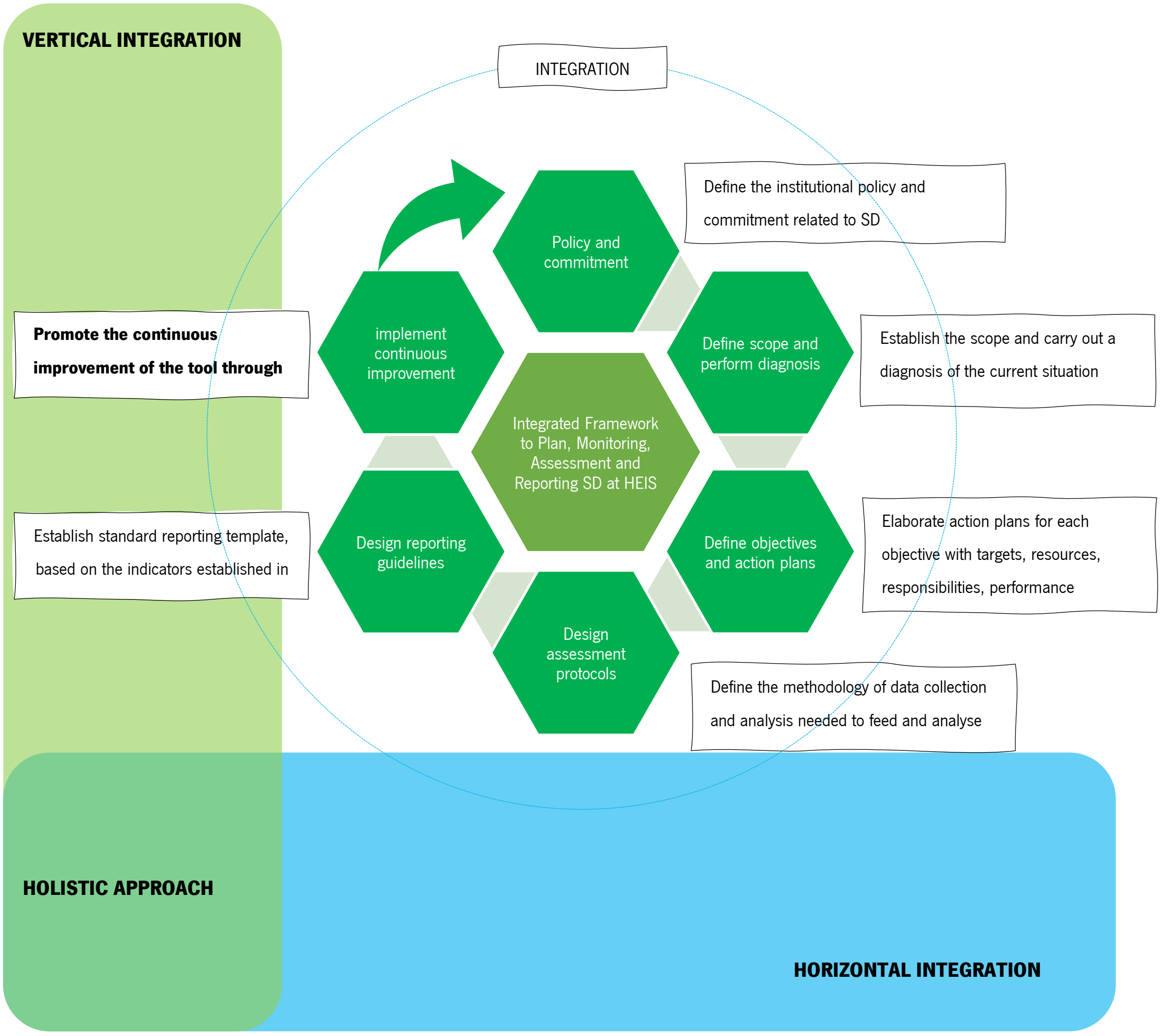

Figure 7-1 - Procedural structure of the proposed framework.

7.1. Procedural structure

Figure 7-1 presents the procedural structure of the proposed FIMARSHEI to integrate, monitor and evaluate the sustainability of Brazilian public federal HEI. It comprises the following procedures that will be addressed in the framework development: design the policy and commitment, define scope and perform the diagnosis, define objectives and actions plan, design assessment protocols, design report guidelines, implement continuous improvement, and assure vertical and horizontal integration.

7.1.1. Policy and Commitment

The proposed FIMARSHEI is expected to meet most of the HEI integration principles described in chapter 2 of this work, that is, its implementation must meet the sustainable development commitments made. To this end, SDI must be supported by specific policies as well as by the HEI's strategic documents (Abdullah et al., 2017; Aleixo et al., 2016; Bullock & Wilder, 2016; Dlouhá et al., 2018; Hancock & Nuttman, 2014). It is also desirable that the framework allows for the systemic integration of existing SDI with those that will be planned to meet emerging legal requirements (Leal Filho et al., 2017).

7.1.2. Define scope and perform the diagnosis.

The scope, in terms of components was previously defined in Figure 6-4. The proposed framework will comprise five components through which all the requirements of the NI10, 12/11/12 will be fulfilled. The scope, in terms of application covered, is designed to be applicable in Brazilian federal public HEI. The framework has been developed and tested using a typical case, which was the Federal University of Paraíba (UFPB). UFPB has been compiling data on sustainability indicators since 2014, which will facilitate the preparation of a diagnosis of the current situation. In the general case of other Brazilian federal public HEI, a study was carried out in a sample of 50% of these HEI to assess the current status of implementation of the Sustainable Logistics Management. The results of this study were presented in chapter 5 of this PhD thesis.

As previously mentioned, UFPB was chosen as a typical case study for its volume and ease of access to information. This institution has implemented a Sustainable Logistic Management Plan, with fourteen follow-up reports published. Hereinafter, the University is briefly presented.

According to the last management report (UFPB, 2020), the Federal University of Paraiba (UFPB), located in the Northeast of Brazil, is the largest HEI in its state, with 2,831 lecturers, 4,368 technical-administrative and outsourced professionals, and 37,752 students allocated in four campuses. The campus I is located in João Pessoa, capital city as presented in Figure 7-2, the Campus II is located in the city of Areia, the campus III is located in Bananeiras, and the campus IV is located in the cities of Rio Tinto e Mamaguape. The University has been a national leader in the submission of patents in various areas of knowledge.

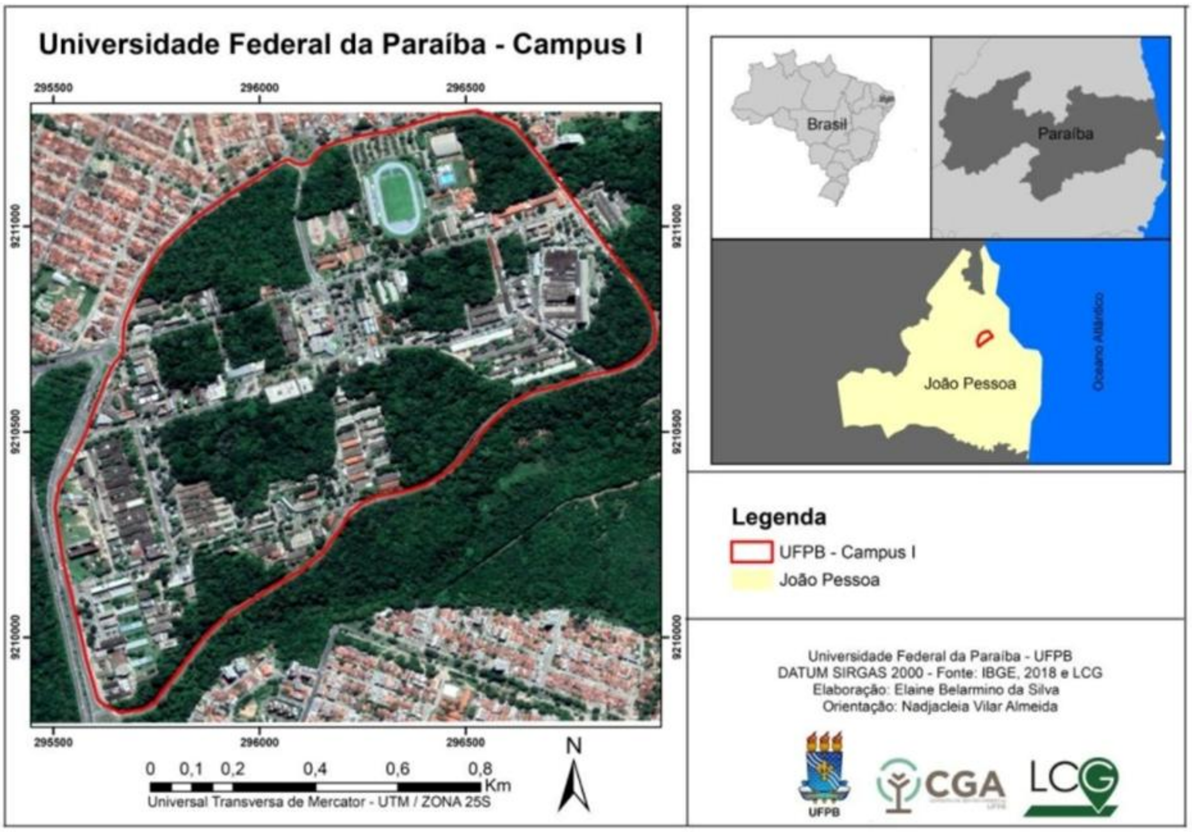

Figure 7-2 - Map of Campus I of the Universidade Federal da Paraíba.

Since 2013, the institution's Environmental Management Commission, linked directly to the Rector's Office, addresses the strategic issues related to the implementation of SDI at UFPB.

As shown in Table 7-1, the Annual Report of the Environmental Commission (UFPB, 2000) highlights 23 action plans/programs that are related to the most commonly adopted dimensions of sustainable development in Higher Education Institutions. Their implementation follows the living-lab approach, where teams consisting of professors, staff, and students have the opportunity to put sustainability initiatives into practice on campus (Brandli et al., 2019).

Table 7-1 - List the main actions, programmes and initiatives implemented at the UFPB.

Dimension	Actions	Description
1. Waste	Chemical Waste Programme	Designing of a Chemical Waste Disposal Plan; implements an action plan to reduce chemical risks; and suggests solutions for cases of incorrect disposal of chemical waste.
	Selective Collection Programme	Perform the quantification and classification of solid waste, the displacement of containers and waste collectors on the campus; promotion of campaigns of selective collection and awareness-raising to the academic community; identification of points of inadequate disposal of solid waste to be cleaned by the specific

		personnel; coordination of the safe disposal of special waste, such as needles from laboratories, cooking oil and organic waste from the university canteens.
	Composting Programme	Storage and reuse of the large volume of organic waste, like leaves and branches, which are collected from pruning and sweeping on campus
	Electro-electronic Waste Programme	Proposal of the quantification, proper storage and disposal of toners, printer cartridges and computer components
	Civil Construction Waste Programme	Promote the identification and monitoring of construction sites and pruning activities, designing an action plan for the management of civil construction waste, until destination
	Fluorescent Lamps Programme	Support the quantification of the evolution of the level of disposal of fluorescent lamps; as well as the collection, storage and proper disposal of it
	SLMP* – Waste	Promote the monitoring and overview of selective collection actions and the donation of recyclable waste to an association of waste collectors; quantification of the amount of waste produced; and suggested action plans for the reuse and recycling of different types of wastes
2. Emissions/ Procurement	SLMP* – Displacement	Monitoring compliance with the principles of public administration in the procurement of office materials; monitoring the evolution of the number, average age and distance travelled of the institution's vehicles, and the costs of fuel, drivers' contracts, and maintenance; monitoring of overall fossil fuel consumption and estimation of CO2 emissions from vehicles in the official vehicle fleet; monitoring the carbon offset strategies implemented by the University.
	Rational use and maintenance of vehicles	Conducting meetings with drivers to raise awareness of more economical driving techniques and greater participation in preventive maintenance and conservation processes, carrying out preventive maintenance and periodic inspections of the vehicles
	SLMP* - Procurement	Monitoring of expenditure on contracting cleaning and conservation, surveillance and telephone services
3. Energy	SLMP* – Energy	Evaluation and monitoring of the performance of the electrical power contract with the supplier; support the action plan for replacing incandescent lamps with led ones.
	Consumer Quality Management System	Controlling the performance of the electrical power distribution system; promoting the automation of real-time measurement procedures for energy consumption to keep a balance between estimation and consumption.
4. Quality life in the Workplace	Lectures and Campaigns	Offer lectures and workshops about professional career and interpersonal relationships and campaigns for the prevention of work-related diseases
	Health Care Reference Centre	Providing of medical care in various specialty distribution of medicines and promotion of health information campaigns to the academic community.
	SLMP* - QLWE	Monitoring the application and offer of different actions to booster quality of life in the working environment
5. Fauna and Flora	Green Areas Management Programme	Restoration of forested areas, considering principles of dendrometry and geoprocessing; identification of the biodiversity of the green areas and protection of local species of fauna and flora
	“Green prank”	It is a ceremony in which the new students along with the Rector and authorities’ plant native seedlings in one of the forest fragments in the campus as a demonstration of institutional commitment to the SDI; and presentation of the overview of main campus sustainability projects and actions; promoting the restoration of the degraded forest area within the campus (https://www.youtube.com/watch?v=g1WGeQFN7As&t=13s)

6. Institutional framework	Sustainable Use and Occupation Programme	Spatial mapping and technical documentation of the artificial spaces of the campus; Optimising of maintenance requests for electronic devices, physical structures and water and sanitary appliances, among others
	Institutional environmental policy	A set of principles and guidelines that aim to implement or adapt institutional actions to promote the sustainable development of UFPB and society, compatible with a healthy and ecologically balanced environment
7. Education/ Research	Updating the Curricula and fostering the creation of SD courses	Updating the curricula of existing courses to include contents and methodologies related to sustainable development; creation of specific teaching to train engineers in the field of renewable energies, creation of new undergraduate and postgraduate courses, such as Environmental Engineering, Renewable Energy Engineering, Environment Development Programme, etc.
	Mapping research focused on SD	Mapping of research focused on sustainable development objectives and stimulation of research in the area of sustainable development.
8. Water	Water Management Plan	Mapping of water supply and consumption points, monitoring of water consumption; correction of wasteful points and in the quantification, location and physical conditions of the campus water and sanitation facilities.
	Distribution and Maintenance of the water supply network	Modelling water distribution by supply and wells; periodic cleaning and disinfection of the wells by a specialised team; field team fully available for distribution faults and leaks
	SLMP* - Water	Monitoring of water consumption and maintenance of distribution networks and analysis of consumption indicators

(*) SLMP = Sustainable Logistics Management Plan

As can be seen in Table 7-1, the HEI has developed initiatives to promote sustainable development in the main dimensions of campus sustainability. A large number of the actions have been implemented for a long period, which positions them in a suitable stage of maturity. The current major challenge faced by the Institution has been the integration of the SDI into an integrated holistic system. There are two main difficulties in achieving this goal. The first lies in the fact that the initiatives are quite distinct from each other, and the second is the lack of integration between the databases generated on the performance of each of the initiatives, which makes it difficult to establish integrated performance indicators. The need for integration in the implementation of sustainability development at HEI is broadly referred to in the literature (N. Alghamdi et al., 2017; Leal Filho, Skanavis, et al., 2019), and therefore it is a gap being addressed in this PhD work.

7.1.3. Define objectives and actions plan.

To solve research question two, regarding issue c, related to the implementation, which intends to discover "What are the key dimensions, actions, and indicators required to effectively operationalise the NI10, 12/11/12 and develop a coherent and feasible structure for planning, assessing, and reporting the sustainability of HEI in an integrated manner that aligns with international literature on planning and

SAT for promoting SDI in HEI?". The compiled list of indicators (table 24) was used as a starting point for the definition of action plans, actions, indicators, and metrics of the proposed FIMARSHEI. Table 24 is formed from the compilation of data from the systematic reviews described in chapters 2 and 3.

Fourteen objectives were developed and grouped into five components. To accomplish the designed objectives a set of 89 actions were created and, for each action, one indicator was attributed along with a specific metric to assess the performance, as it is shown in Table 7-2.

Table 7-2 presents in its first column the five components of the proposed FIMARSHEI, namely, "Government & Procurement", "Outreach/ on Campus Experience", "Campus Operation", "Teaching & Research", and "Assessment & Reporting".

The second column indicates the continuous numbering of each indicator in the framework (1 to 89). The third column presents the ID, a code for each indicator and is formed by three sequences separated by underlines. The first sequence, "EXT or BAS", classifies whether the indicators are basic, i.e., compulsory, according to the NI10, 12/11/12, or whether they are extended, i.e., added, based on the literature review. The second sequence "Obj1 until Obj14" indicates to which of the 14 objectives each indicator corresponds. Finally, the last sequence "Act1 until Act**N**", shows the position of each indicator within the objective it corresponds to. The next three columns list the actions, indicators, and metrics, respectively. Note that each action has a corresponding indicator and metric, so the code was adopted to mark the set composed of action, indicator and metric.

Table 7-2 - Objectives and actions plan

SET OF ACTION PLANS OF THE PROPOSED FIMARSHEI					
Governance & procurement		**ACTION PLAN - Institutional framework** Objective 1 – To establish sustainable practices for Institutional framework.			
	N	ID	Action	indicator	metric
	1	EXT_Obj1_Act1	To revise strategic plan to include commitment to SD initiatives	Strategic commitment to integrate SD initiatives	Is SD commitment included in the Strategic Plan? (Y/N)
	2	EXT_Obj1_Act2	To create institutional SD policy	Institutional SD policy	Has the institution SD policy? (Y/N)
	3	EXT_Obj1_Act3	To develop a campaign to disseminate the institutional commitment to the SD	Campaigns to raise awareness of the institutional commitment to the SD	Number of campaigns about institutional commitment to the SD created per semester
		ACTION PLAN – Material acquisition Objective 2 – To establish sustainable practices for material acquisition.			
	N	ID	Action	indicator	metric
	4	BAS_Obj2_Act1	To quantify the overall monthly consumption of white paper (bleached) in sheets	Total quantity of sheets of white paper used	Quantity (units) of sheets of white paper used
	5	BAS_Obj2_ Act2	To quantify the monthly per capita consumption of white paper (bleached) in sheets consumed by public servants in the Institution	Number of sheets of white paper per capita used by public servants	N° of white sheets/ N° of servers

6	BAS_Obj2_ Act3	To quantify the monthly expenditure, in R$, on the purchase of white paper (bleached)	Total expenditure with the acquisition of white paper	Expenditure in R$ with the acquisition of white paper
7	EXT_Obj2_ Act4	To quantify the monthly per capita consumption of white paper (bleached) consumed by the community (public servants, students, and outsourced workers) in the Institution	Number of sheets of white paper per capita used by the community	N° of white sheets/ N° of public servants + students + outsourced workers
8	EXT_Obj2_Act5	To quantify the monthly per capita spending, in BRL, of public servants on the purchase of white paper (bleached)	Expenditure per capita of servant on white paper	Expenditure, in BRL, with the acquisition of white paper /No. of public servants
9	EXT_Obj2_Act6	To quantify the monthly per capita spending, in R$, of the community (public servants, students and outsourced workers) on the purchase of white paper (bleached)	Expenditure per capita of the academic community on white paper	Expenditure in R$/ N° of employees + students + outsourced staff
10	BAS_Obj2_Act7	To quantify the overall monthly consumption of 180 ml disposable cups	Consumption of 180 ml disposable cups	Quantity (units) of 180 ml disposable cups used
11	BAS_Obj2_Act8	To quantify the overall monthly consumption of 50 ml disposable cups	Consumption of 50 ml disposable cups	Quantity (units) of 50 ml disposable cups used
12	BAS_Obj2_Act9	To quantify the monthly per capita consumption of disposable 180ml cups by public servants	Per capita consumption of disposable 180ml cups per servant	Quantity (units) of 180 ml cups / total number of servers
13	BAS_Obj2_Act10	To quantify the monthly per capita consumption of 50 ml disposable cups per public servant	Per capita consumption of 50 ml disposable cups per public servant	Quantity (units) of 50 ml cups / total number of servers
14	EXT_Obj2_Act11	To quantify the monthly per capita consumption of disposable 180ml cups by the community (employees, students, and outsourced workers)	Per capita consumption of disposable 180ml cups by the community	Quantity (units) of 180 ml cups / total community (employees, students, and outsourced workers)
15	EXT_Obj2_Act12	To quantify the monthly per capita consumption of 50 ml disposable cups by the community (employees, students and outsourced workers)	Per capita consumption of 50 ml disposable cups by the community	Quantity (units) of 50 ml cups / total community (employees, students and outsourced workers)
16	BAS_Obj2_Act13	To quantify the monthly expenditure, in BRL, on the purchase of 180ml and 50ml disposable cups	Spending on the purchase of disposable cups	Amount (R$) spent to purchase disposable cups (180ml + 50ml)
17	EXT_Obj2_Act14	To quantify the global monthly consumption of cartridges and toner	Monthly consumption of printing cartridges and toner	Quantity (units) of cartridges and toners used
18	EXT_Obj2_Act15	To quantify the monthly expenses, in BRL, with the purchase of printer cartridges and toners	Spending on the purchase of cartridges and toners	Amount (R$) spent to purchase cartridges and toners
19	EXT_Obj2_Act16	To promote the reduction of paper use by regulating the digitalisation of processes	Regulation of the digitalisation of processes	Does the institution have resolutions and/or ordinances on the subject? (y/n)
20	EXT_Obj2_Act17	To develop campaign to disseminate awareness to reduce the use of paper	Campaigns to raise awareness to reduce the use of paper	Number of campaigns to raise awareness to reduce the use of paper
21	EXT_Obj2_Act18	To develop campaign to disseminate awareness to reduce the use of disposable cups	Campaign to raise awareness to reduce the use of disposable cups	Number of campaigns to raise awareness to reduce the use of disposable cups
22	EXT_Obj2_Act19	To develop campaign to disseminate awareness to reduce the use of cartridges and toners	Campaign to raise awareness to reduce the use of cartridges and toners	Number of campaigns to raise awareness to reduce the use of cartridges and toners
	ACTION PLAN – Procurement (contracting)			
	Objective 3 – To establish sustainable practices for procurement & contracting.			
N	ID	Action	indicator	metric
23	BAS_Obj3_Act1	To quantify the monthly expenditure per extension or conventional telephone line use	Expenditure per extension and fixed telephone line	Amount in R$ / n° of landline
24	BAS_Obj3_Act2	To quantify the monthly expenditure per mobile telephone line	Expenditure per mobile line	Amount in R$ / n° of mobile lines
25	BAS_Obj3_Act3	To quantify the monthly average initial value of the surveillance post	Average value of the surveillance post	Total annual value of the contract/ number of posts
26	BAS_Obj3_Act4	To quantify the average current value of the surveillance post (repactuation)	Repactuation' estimate	Total annual renegotiation value ÷ total annual subscription amount
27	EXT_Obj3_Act5	To quantify the total expenditure in R$ on the surveillance contract	Total expenditure on hiring surveillance service	Sum of the expenditure in R$ of all the posts on the campuses

28	EXT_Obj3_Act6	To quantify the monthly expenditure per capita on security service per servant	Expenditure per capita of servant on security service contract	Expenditure, in Real R$, with hiring security service / n° of servant
29	EXT_Obj3_Act7	To quantify the monthly expenditure per capita on security service per community	Expenditure per capita of community on security service contract	Expenditure, in Real R$, with hiring security service / n° of community
30	BAS_Obj3_Act8	To quantify the average amount paid per square meter for cleaning all areas of the institution	Total expenditure paid per m^2 with the cleaning contract	Total amount spent with the contract/ m^2
31	BAS_Obj3_Act9	To quantify the repactuation of the cleaning contract	Repactuation of the cleaning contract	Total value of the repac-tuated contract / annual value of the initial contract
32	EXT_Obj3_Act10	To quantify the total monthly expenditure in R$ on the cleaning service	Total monthly expenditure on contracting cleaning service	Sum of the monthly expenditure in R$
33	EXT_Obj3_Act11	To quantify the monthly expenditure per capita on cleaning service per servant	Expenditure per capita of servant on cleaning service contract	Expenditure, in Real R$, with hiring cleaning service / n° of servant
34	EXT_Obj3_Act12	To quantify the monthly expenditure per capita on cleaning service per community	Expenditure per capita of community on cleaning service contract	Expenditure, in Real R$, with hiring cleaning service / n° of community
35	BAS_Obj3_Act13	To quantify the expenditure on construction contracts	Sum of the expenditure for construction contracts	Sum of the expenditure on works contracts
36	BAS_Obj3_Act14	To quantify the expenditure on maintenance contracts	Sum of the expenditure on maintenance contracts	Sum of the expenditure with maintenance contracts
37	EXT_Obj3_Ac15	To extend the installation of remote monitoring (cameras and emergency alarms) on campuses to reduce spending on the surveillance contract	Area covered by the camera's surveillance system	Sum of the area covered by the camera system
38	EXT_Obj3_Ac16	To develop campaign for rational use of telephone system	SD education campaigns for rational use of the telephone system	No. of SD education campaigns for rational use of telephony created
39	EXT_Obj3_Ac17	To develop a campaign to maintain the cleanliness of campus areas	SD education campaigns for maintain the cleanliness of campus areas	No. of SD education campaigns for maintain the cleanliness of campus areas

Outreach / on campus experience

	ACTION PLAN – Quality of life at work			
	Objective 4 – To establish sustainable practices for quality of life in the workplace			
N	ID	Action	indicator	metric
40	BAS_Obj4_Act1	To quantify the number of public servants that attended the programmes and/or actions focused on the quality of life at workplace each year	Participation of public servants in programmes and/or actions focused on the quality of life at workplace	Total servers trained / Total number of servers * 100
41	EXT_Obj4_Act2	To develop a campaign to promote quality of life at workplace	Campaigns to promote quality of life at workplace	Number of campaigns about quality of life at workplace created per semester
42	**ACTION PLAN – Extension programmes**			
43	Objective 5 – To establish sustainable practices for extension programme.			
N	ID	Action	indicator	metric
44	EXT_Obj5_Act1	To assess whether the institution has mechanisms to measure the sustainability of university extension activities	Sustainability of university extension activities	Does the institution have mechanisms to measure the sustainability of university extension activities? (y/n)
	ACTION PLAN – Networking			
	Objective 6 – To establish sustainable practices to improving networking.			
N	ID	Action	indicator	metric
45	EXT_Obj6_Act1	To assess whether the institution is part of a network of sustainable universities.	Network of sustainable universities.	Is the institution part of a network of sustainable universities? (y/n)

Campus operation

	ACTION PLAN - Energy			
	Objective 7 – To establish sustainable practices for energy.			
N	ID	Action	indicator	metric
46	BAS_Obj7_Act1	To quantify the monthly expenditure, in BRL, on electrical energy	Expenditure with energy	Invoice value in BRL (R$)
47	BAS_Obj7_Act2	To quantify the monthly electricity expenditure, in BRL R$, per capita of public servers	Electric energy consumption, in BRL R$, per capita of public servers	Quantity the expenditure in R$ / total number of servers
48	EXT_Obj7_Act3	To quantify the monthly electricity expenditure, in BRL R$, per capita of the community (public servants, students and outsourced workers)	Per capita electricity expenditure by the community (public servants,	Quantity the expenditure in R$ / total of the community (employees, students, and outsourced workers)

N	ID	Action	indicator	metric
			students, and outsourced employees)	
49	BAS_Obj7_Act4	To quantify the monthly consumption of electric energy in kWh	Electric energy consumption energy in kWh	Amount of kWh consumed
50	BAS_Obj7_Act5	To quantify the monthly electricity consumption, in kWh, per capita of public servers	Electric power consumption per capita of public servers	Quantity of kWh consumed / total number of servers
51	EXT_Obj7_Act6	To quantify the monthly electricity consumption per capita of the community (public servants, students, and outsourced workers)	Per capita consumption of electric energy by the community (public servants, students, and outsourced employees)	Quantity of kWh consumed / total of the community (employees, students, and outsourced workers)
52	BAS_Obj7_Act7	To monitor and manage the demand contract (off-peak)	Adequacy of demand contract (off-peak)	Registered off-peak demand / Contracted off-peak demand
53	BAS_Obj7_Act8	To monitor and Manage Demand Contract (Peak Load)	Demand Contract Adequacy (Peak)	Peak registered demand / Peak contracted demand
54	BAS_Obj7_Act9	To quantify the Expenditure with energy by total area	Energy Expenditure by area	Expenditure in BRL / total area
55	EXT_Obj7_Act10	To encourage studies that analyse the viability of alternative energy sources (solar, thermoelectric and wind)	Analysis of the viability of alternative energy sources (solar, thermoelectric and wind)	Development of at least one study on alternative energy sources at HEI
56	EXT_Obj7_Act11	To develop campaign for rational use of electricity	Environmental education campaigns for electricity consumption	To have at least 4 campaigns created per semester (continuous)
	ACTION PLAN - Water			
	Objective 8 – To establish sustainable practices for water			
N	ID	Action	indicator	metric
57	BAS_Obj8_Act1	To quantify the volume of water consumed monthly	Volume of water used	Quantity of m³ of water
58	BAS_Obj8_Act2	To quantify the per capita volume of water consumed monthly by public servants	Per capita volume of water of public servants	Quantity of m³ of water/ total number of servers
59	EXT_Obj8_Act3	To quantify the per capita volume of water consumed monthly by the community (employees, students, and outsourced workers)	Per capita volume of water by the community (employees, students, and outsourced workers)	Quantity of m³ of water/ total of community members
60	BAS_Obj8_Act4	To quantify monthly expenditure, in BRL, with water supply	Expenditure with water	Invoice value in BRL (R$)
61	BAS_Obj8_Act5	To quantify the monthly per capita spending on water supply, in BRL, of public servants	Servers' per capita spending on water	Invoice value in BRL (R$) / public servants
62	EXT_Obj8_Act6	To quantify the monthly per capita water supply expense, in BRL, of the community (employees, students, and outsourced workers)	Per capita spending on water by the community (employees, students, and outsourced workers)	Invoice value in BRL (R$) / community (employees, students, and outsourced workers)
63	EXT_Obj8_Act7	To develop a communication channel for the community to inform about water leakages	Communication channel on water leaks	Identify the existence of a communication channel on water leakages
	EXT_Obj8_Act8	Develop a campaign for rational water use	Campaigns to promote sustainable development for water consumption	Number of sustainable development campaigns created for rational water use
	ACTION PLAN - Waste			
	Objective 9 – To establish sustainable practices for waste			
N	ID	Action	indicator	metric
64	BAS_Obj9_Act1	To quantify the monthly volume, in kilos, of paper destined for recycling	Destination of paper for recycling	Quantity (Kg) of paper destined for recycling
65	BAS_Obj9_Act2	To quantify the monthly volume, in kilos, of cardboard destined to recycling	Destination of cardboard for recycling	Quantity (Kg) of cardboard destined to recycling
66	BAS_Obj9_Act3	To quantify the monthly number of toners destined for recycling	Destination of toner for recycling	Quantity (units) of toner destined for recycling
67	BAS_Obj9_Act4	To quantify the monthly volume, in kilos, of plastics intended for recycling	Destination of plastic for recycling	Quantity (Kg) of plastic intended for recycling
68	BAS_Obj9_Act5	To quantify the monthly total volume, in kilograms, of material destined to cooperatives	Total recyclable material destined to cooperatives	Kg of paper + Kg of cardboard + Kg of plastic+ Kg of plastic destined to recycling
69	BAS_Obj9_Act6	To quantify the total monthly volume, in kilos, of reused paper	Volume, of reused paper	Kg of paper reused monthly
70	EXT_Obj9_Act7	To develop a campaign to promote the correct disposal of waste	Environmental education campaigns to promote selective collection	Number of environmental education campaigns created to promote selective collection
	ACTION PLAN - Displacement			

N	ID	Action	indicator	metric
	Objective 10 – To establish sustainable practices for displacement			
N	ID	Action	indicator	metric
71	EXT_Obj10_Act1	To quantify the operational costs with the use of the HEI's vehicle fleet	Operational costs with the HEI fleet	Sum of expenses with: Fuel + lubricant + material for maintenance + maintenance services
72	EXT_Obj10_Act2	To measure the CO_2 emission index of UFPB's vehicle fleet	CO_2 emissions by UFPB's vehicle fleet, total and by fuel type	Carbon dioxide emissions in ton - $tECO_2$
73	EXT_Obj10_Act3	To quantify the monthly fuel volume	Monitoring of fuel volume consumption	Total volume of litres consumed
74	EXT_Obj10_Act4	To quantify the monthly fuel expenses	Monitoring of fuel expense consumption	Total cost in R$
75	EXT_Obj10_Act5	To estimate the compensation of CO_2 emissions	CO_2 emissions after compensation by planting seedlings	Carbon dioxide emissions in ton - $tECO_2$ after compensation
76	EXT_Obj10_Act6	To develop campaign to rationalize the use of the HEI fleet	Environmental education campaigns to promote awareness in the use of institutional transport	Number of environmental education campaigns to promote awareness in the use of institutional transport
77	EXT_Obj10_Act7	To stimulate the planting of native seedlings at HEI	Seedlings planted	Number of seedlings planted
Teaching & research	**ACTION PLAN - Teaching**			
	Objective 11 – To establish sustainable practices for teaching			
N	ID	Action	indicator	metric
78	EXT_Obj11_Act1	To Integrate sustainable development into course curricula	Courses committed intensively of peripherical to the SD	Percentage of courses intensively or peripherally dedicated to the development of DS-related skills.
79	EXT_Obj11_Act2	To turn the university into an institutional living lab for the promotion of sustainable development initiatives	Institutionalised programmes to promote campus as a living laboratory	Number of institutionalised programmes devoted to promoting campus as a living lab
80	EXT_Obj11_Act3	To assess whether the institution has mechanisms to measure the sustainability of the university curricula	Sustainability of HEIs' curricula	Does the HEI have mechanisms to measure the sustainability of the curricula? (y/n)
81	EXT_Obj11_Act4	To develop a campaign to raise awareness regarding the integration of SD into the curricula	Campaigns to raise awareness regarding the integration of SD into the curricula	Number of campaigns about the integration of SD into the curricula
	ACTION PLAN - Research & Innovation			
	Objective 12 – To establish sustainable practices for research & innovation			
N	ID	Action	indicator	metric
82	EXT_Obj12_Act1	To assess whether the institution has funding policy to boost SD research and innovation	Funding for research and innovation into areas of SD	Have some funding policy to boost SD research and innovation
83	EXT_Obj12_Act2	To assess whether the institution has mechanisms to measure the sustainability of the actions devoted to research and innovation	Sustainability of HEIs' research and innovation	Have some mechanism to monitor the integration of sustainability in research and innovation
84	EXT_Obj12_Act3	To develop a campaign to disseminate the commitment of the research and innovation to the SD	Campaigns to raise awareness of the research and innovation commitment to the SD	Number of campaigns about the commitment of research and innovation to the SD created per semester
Assessment & reporting	**ACTION PLAN - Assessment Protocol**			
	Objective 13 – To establish sustainable practices for assessment			
N	ID	Action	indicator	metric
85	EXT_Obj13_Act1	To assess whether the HEI has formal structure form monitoring the environmental performance	Existence of formal structure for monitoring the environmental performance of HEI	Has the HEI formal structure to monitor environmental performance? (y/n)
86	EXT_Obj13_Act2	To assess whether the HEI has comprehensive system of formally stablished indicators for key sustainability aspects of HEI	Comprehensive system of formally stablished indicators for key sustainability aspects of HEI (including at least energy, water, curriculum, research and waste)	Has the Hei comprehensive system of formally stablished indicators for key sustainability aspects of HEI? (y/n)
	ACTION PLAN - Reporting SD			
	Objective 14 – To establish sustainable practices for reporting SD			
N	ID	Action	indicator	metric

87	EXT_Obj14_Act1	To assess whether the HEI has a comprehensive data coverage on the sustainability assessment reports	Comprehensive of data coverage of sustainability assessment reports (whether sectorial of HEI as a whole)	Has the HEI comprehensive data coverage of sustainability assessment reports? (y/n)
88	EXT_Obj14_Act2	To assess whether the HEI publish reports on institutional website	Availability of reports on institutional website	Do Hei publish sustainability reports on institutional? (y/n)
89	EXT_Obj14_Act3	To develop a campaign to disseminate the institutional commitment to the SD	Campaigns to publicise HEI environmental performance	Number of campaigns to publicise HEI environmental performance created per semester

The development of action plans should be considered as a key step in the building of the framework, not only because the planning phase is a critical success factor, but also because the action plans are the elements of the framework with the most requirements associated with them. In the development of the action plans the nineteen following requisites should be accomplished: R02, the action plans need to include practices related to sustainability and rational use of resources; R03, it should define the responsibilities for the implementation of the actions; R04, it should describe the methods of implementation; R05, it should include the methods of performance evaluation in the implementation of the actions; R06, it should include actions related to the dissemination, awareness, and training actions; R07 to R13 should address all scope requirements (material acquisition, energy, water, waste, quality of life in the work environment, contracting, and displacement); its structure should include: R14 the objectives for the action plans; R15, implementation details; R16, units involved; R17, targets for each action; R18, chronogram, R19, a forecast of financial, human and instrumental resources, as well as, R24, the respective performance indicators for each implemented action. The requisites are expressed in Table 6-3.

Figure 7-3 illustrates the proposed FIMARSHEI, indicating the five components, the fourteen dimensions and the ID of their respective indicators.

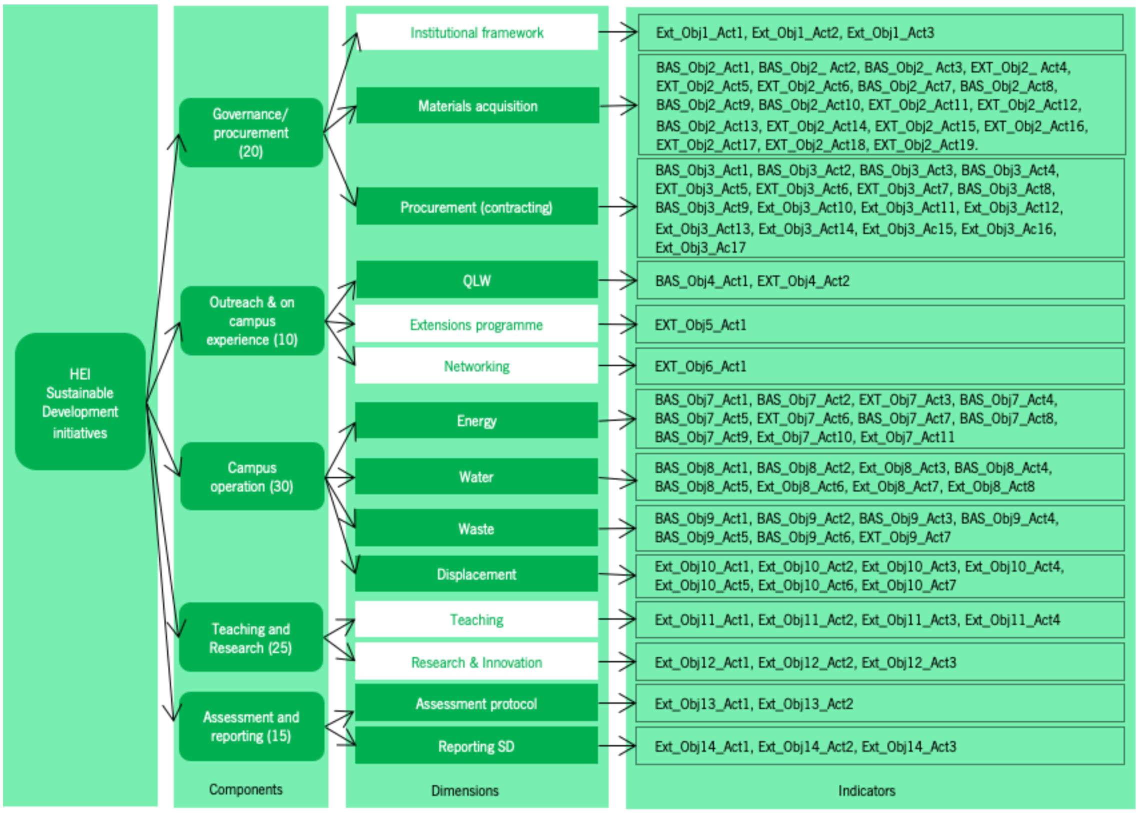

Figure 7-3 - Conceptual model of the proposed FIMARSHEI highlighting the indicators.

In order to accommodate the requirements of the NI10, 12/11/12 regarding action plans, a template was created and applied to all 14 action plans that make up the FIMARSHEI. Figure 7-4 illustrates the action plan template developed. In the first line the name of the action plan should be indicated, followed by the objective, included in the second line.

Action plans are divided into three categories of actions. The first category or dimension, groups the actions, indicators, metrics, and goals that intend to quantify and monitor consumption. While the second category, or dimension, seeks to bring together actions, indicators, metrics, and goals that aim to reduce the use of available resources to improve the sustainability of the area covered by the action plan. Finally, the third and last category of the action plan encompasses actions aimed at promoting the academic community's awareness of sustainability issues.

Not all objectives of the proposed framework have actions in all the previously described dimensions.

The actions besides having indicators, metrics and goals associated, also have a timeline that indicates the start and end period foreseen for the action, as well as a schedule of percentage of implementation during the five years foreseen for implementation of the plan. Most of the actions are related to performance tasks, such as "To quantify the monthly expenditure, in BRL (Brazilian currency), on electrical energy", therefore, they are of continuous implementation, that is, they start when the plan enters into force and will continue to be performed until the end of the plan's execution. Other actions are punctual and, therefore, have a specific period for implementation. For example, the action "To promote the reduction of paper use by regulating the digitalisation of processes" aims to create legislation that prioritizes the digitalisation of processes to reduce paper printing and is expected to be implemented only during the second year of execution of the plan (see action plan material acquisition). Finally, the action plans indicate the sector responsible for coordination (UC) and the partner sectors (UI) in the implementation of each action.

ACTION PLAN – (NAME)													
Objective (NUMBER) – (NAME)													
Dimension 1: Quantify and monitor consumption								**TIMELINE**					
ID[a]	**Action**	**Name of indicator**	**Metric**	**Goal(Period)**	**Start**	**End**	**Y1**	**Y2**	**Y3**	**Y4**	**Y5**	**UC[b]**	**UI[c]**
Dimension 2: Promote the reduction of use													
Dimension 3 – SD Campaigns													

a: identification code of each action; b: Under control. Indicates the sector that is controlling the action; c: Under influence. Indicate those sectors that act as partners in the implementation of the action.

Figure 7-4 - Action Plan template.

Figure 7-5 exemplifies the completion of the action plan template with the information referring to the energy action plan. The plan comprises a total of eleven actions, of which nine are grouped in the first dimension, one in the second and one in the third.

ACTION PLAN - Energy													
Objective 7 – To establish sustainable practices for energy.													
Dimension 1: Quantify and monitor consumption								**TIMELINE**					
ID	**Action**	**Name of indicator**	**Metric**	**Goal (Period)**	**Start**	**End**	**Y 1**	**Y 2**	**Y 3**	**Y 4**	**Y 5**	**SD**	**SI**
BAS_Obj7_Act1	To quantify the monthly expenditure, in BRL, on electrical energy	Expenditure with energy	Invoice value in BRL (R$)	Accounting for 100% of consumption (monthly and half-yearly)	Entry into force	Conti-nuous	100%	100%	100%	100%	100%	EMC	IS
BAS_Obj7_Act2	To quantify the monthly electricity expenditure, in BRL R$, per capita of public servers	Electric energy consumption, in BRL R$, per capita of public servers	Quantity the expenditure in R$ / total number of servers	Accounting for 100% of consumption (monthly and half-yearly)	Entry into force	Conti-nuous	100%	100%	100%	100%	100%	EMC	IS
EXT_Obj7_Act3	To quantify the monthly electricity expenditure, in BRL R$, per capita of the community (public servants, students and outsourced workers)	Per capita electricity expenditure by the community (public servants, students, and outsourced employees)	Quantity the expenditure in R$ / total of the community (employees, students, and outsourced workers)	Accounting for 100% of consumption (monthly and half-yearly)	Entry into force	Conti-nuous	100%	100%	100%	100%	!00%	EMC	IS

BAS_Obj7_Act4	To quantify the monthly consumption of electric energy in kWh	Electric energy consumption energy in kWh	Amount of kWh consumed	Accounting for 100% of consumption (monthly and half-yearly)	Entry into force	Conti-nuous	100%	100%	100%	100%	!00%	EMC	IS
BAS_Obj7_Act5	To quantify the monthly electricity consumption, in kWh, per capita of public servers	Electric power consumption per capita of public servers	Quantity of kWh consumed / total number of servers	Accounting for 100% of consumption (monthly and half-yearly)	Entry into force	Conti-nuous	100%	100%	100%	100%	!00%	EMC	IS
EXT_Obj7_Act6	To quantify the monthly electricity consumption per capita of the community (public servants, students, and outsourced workers)	Per capita consumption of electric energy by the community (public servants, students, and outsourced employees)	Quantity of kWh consumed / total of the community (employees, students, and outsourced workers)	Accounting for 100% of consumption (monthly and half-yearly)	Entry into force	Conti-nuous	100%	100%	100%	100%	!00%	EMC	IS
BAS_Obj7_Act7	To monitor and manage the demand contract (off-peak)	Adequacy of demand contract (off-peak)	Registered off-peak demand / Contracted off-peak demand	Accounting for 100% of contracting monitoring (monthly and half-yearly)	Entry into force	Conti-nuous	100%	100%	100%	100%	!00%	EMC	IS
BAS_Obj7_Act8	To monitor and Manage Demand Contract (Peak Load)	Demand Contract Adequacy (Peak)	Peak registered demand / Peak contracted demand	Accounting for 100% of contracting monitoring (monthly and half-yearly)	Entry into force	Conti-nuous	100%	100%	100%	100%	!00%	EMC	IS
BAS_Obj7_Act9	To quantify the Expenditure with energy by total area	Energy Expenditure by area	Expenditure in BRL / total area	Accounting for 100% of expenditure (monthly and half-yearly)	Entry into force	Conti-nuous	100%	100%	100%	100%	!00%	EMC	IS
Dimension 2: Promote the reduction of use													
EXT_OBJ7_Act10	Encourage studies that analyse the viability of alternative energy sources (solar, thermoelectric and wind)	Analysis of the viability of alternative energy sources (solar, thermoelectric and wind)	Development of at least one study on alternative energy sources at HEI	Have at least one institutional study on the feasibility of using alternative renewable sources over the 5 years. (monthly and half-yearly)	Entry into force	Conti-nuous	-	-	-	-	100%	IS	EMC
Dimension 3 – SD Campaigns													
EXT_OBJ7_Act11	Develop campaign for rational use of electricity	Environmental education campaigns for electricity consumption	To have at least 4 campaigns created per semester (continuous)	Accounting for 100% of campaigns developed. (monthly and half-yearly)	Entry into force	Conti-nuous	100%	100%	100%	100%	100%	EMC	IS

Figure 7-5 - Model of the energy action plan Defining design assessment protocols.

7.1.4. Design assessment protocols.

The performance evaluation requirements are R20, which requires the bi-annual evaluation of the Plan implementation, and R22, which determines the bi-annual evaluation of the results, as detailed in Table 6-3.

The procedures required to design the assessment protocols are related to the collection and analysis of data. These procedures are related to the collection and analysis of data for the established indicators and will be designed using the Business Process Modelling and Notation (BPMN) method, through the Bizagi software and, when necessary, standard operating procedures (SOP) were created (Banu et al., 2016).

BPMN is a graph-oriented language designed by the Object Management Group (OMG) developed with the aim of providing

> a notation that is readily understandable by all business users, from the business analysts that create the initial drafts of the processes, to the technical developers responsible for implementing the technology that will perform those processes, and finally, to the business people who will manage and monitor those processes. Thus, BPMN creates a standardised bridge for the gap between the business process design and process implementation (OMG, 2013, p. 1).

The BPMN facilitates the understanding of the process (Biermann & Ermel, 2009). Is a well-accepted standard for process modelling and can be used to describe business operations on detail, as well as on a high-level (Glissmann & Sanz, 2010). The BPMN is based on a clear syntax. Furthermore, it meets the defined purpose of building the bridge between business analysts and technical developers as also people involved in the management and operation of the process (Kirchmer, 2017). Thus, the BPMN approach was firstly chosen to support the processes design phases mainly because it will allow the standardization of the flows and algorithms. Secondly, as a web-based tool, it will reinforce the participatory perspective in which it is possible to share the draft flows with the sectors responsible for the indicators data to check the correspondence between processes and data collection and analysis.

The methodology is based on four core element types: Flow objects, connecting objects, swim-lanes and artifacts. Flow Objects are the main graphical elements to define the behaviour of a business process. There are three ways of connecting the flow objects to each other or other information, as a sequence, a message or as an association. Swim-lanes provides the ability to cluster elements into two levels of grouping: pool and lane. The fourth and last element type adopted in BPMN notation are the artifacts that can be used to provide additional information about the process as well as to associate it with a database (Fuehrer, 2018).

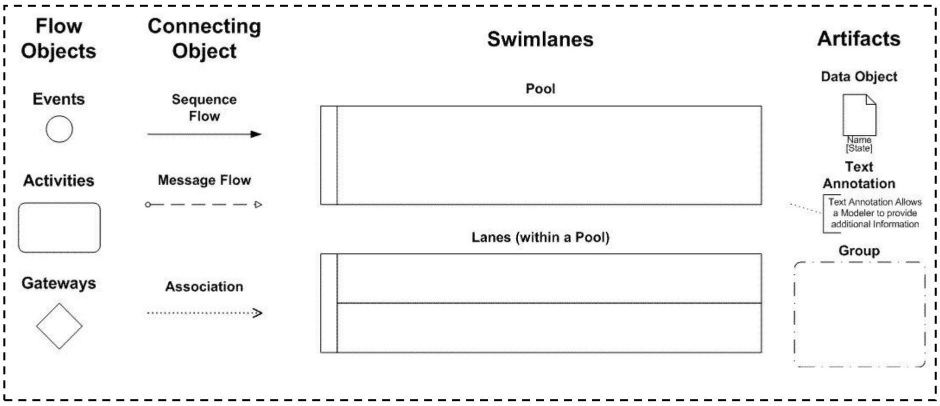

Figure 7-6 - Core set of BPMN Element types.
Adapted from (Chinosi & Trombetta, 2012)

Figure 7-6 shows the main elements used in BPMN notation. According to Martínez-Salvador et al. (2015) the BPMN provides over 50 modelling elements, but studies show that less than 25% of those elements are most frequently used to design process models.

There are several computerized tools that virtualize BPMN, some paid and others that use free software, such as BIZAGI a web-based software that was used to design processes.

The creation of flow charts, through the BMPN syntax, aimed at standardising the data collection and analysis process, as well as establishing a methodology for assigning weights to the qualitative variables included in the proposed FIMARSHEI. Thus, for each of the action plans that make up the framework, a flow chart was created. Figure 7-7 depicts the flow chart prepared for the "energy" action plan.

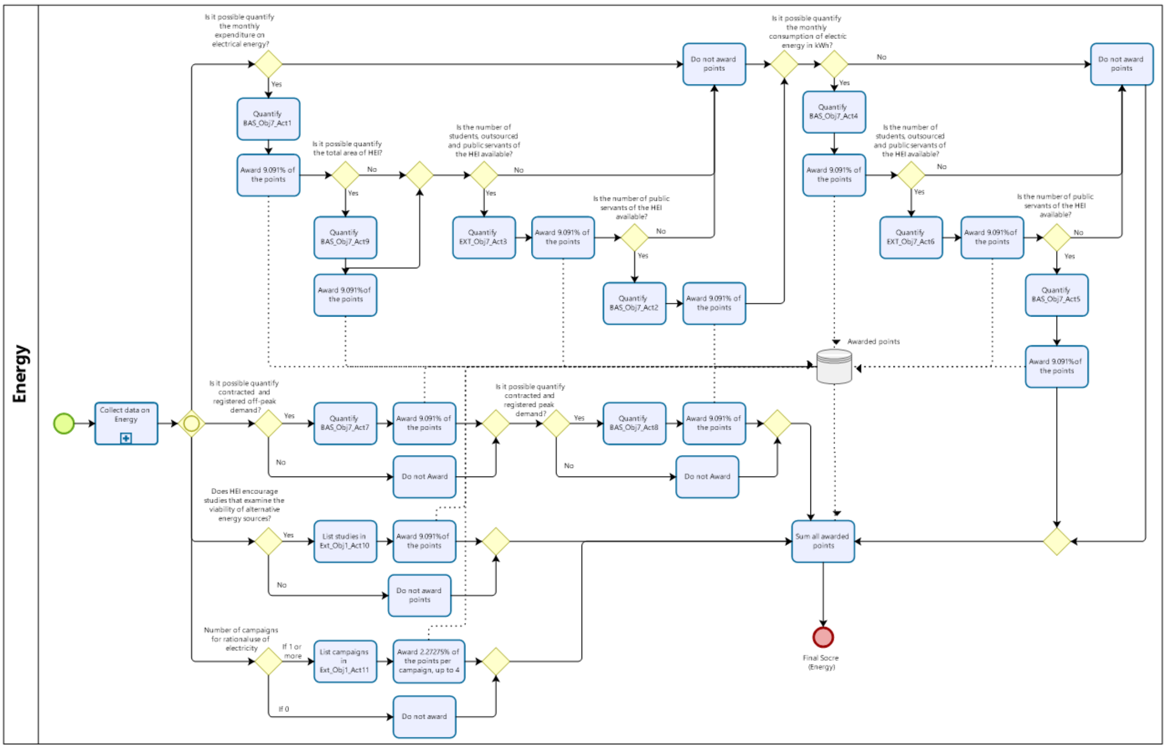

Figure 7-7 - BPMN diagram for the energy action plan.

The information contained in the flows was detailed through standard operating procedures (SOPs) designed to complement the BPMN visual information with the guidelines that feature the specificities of the processes, as well as the procedure to calculate the weight of the qualitative aspect of each variable. Table 7-3 exemplifies a standard operating procedure designed to detail the BPMN diagram designed for the energy dimension.

Table 7-3 - Standard Operating Procedure for energy

<table>
<tr><th colspan="3">STANDARD OPERATING PROCEDURE (SOP)</th></tr>
<tr><td>Action Plan: Energy</td><td>Code:</td><td>Review: 00</td></tr>
<tr><td>Date: 24/11/2021</td><td colspan="2">Page: 1 of 1</td></tr>
<tr><td colspan="3">Objective
To describe the stages of data collection and calculation of indicators related to Objective 7 – “To establish sustainable practices for Energy”. The main purpose of these indicators is to measure the degree of integration of sustainable development initiatives in Energy.

Normative Reference
Decree No. 7,746, of 5 June 2012
Normative Instruction N° 10, from November 12, 2012

Application
It covers the collection of data on Energy of a HEI, for the subsequent analyses.</td></tr>
</table>

Areas Involved
Sector responsible for collecting the SLMP data.

Documents involved in the process.

Type of Document:	None

Definitions
Peak electricity demand: Peak demand refers to the times of day when our electricity consumption is at its highest (typically from 6:00 to 9:00 p.m.).
Electricity demands off peak: Off-peak period covers the remaining 21 hours of the day or 24 hours a day for Saturdays, Sundays and national holidays.

Procedure
1) Collect energy consumption data from the government's institutional procurement portal.
2) If possible, quantify the monthly expenditure on electrical energy; 9,091% of the points attributed to the Action Plan should be attributed. (BAS_Obj7_Act1)
3) If possible, quantify the total area of HEI; 9,091% of the points attributed to the Action Plan should be attributed. (BAS_Obj7_Act9)
4) If possible, measure the number of students, outsourced and public servants of the HEI; 9,091% of the points attributed to the Action Plan should be attributed, referring to the monthly per capita expenditure of energy by community. (EXT_Obj7_Act3)
5) If possible, measure the number of public servants; 9,091% of the points attributed to the Action Plan should be attributed, referring to the monthly per capita expenditure energy by public servants. (BAS_Obj7_Act2)
6) If possible, quantify monthly consumption of electric energy in kWh; 9,091% of the points attributed to the Action Plan should be attributed. (BAS_Obj7_Act4)
7) If possible, measure the number of students, outsourced and public servants of the HEI; 9,091% of the points attributed to the Action Plan should be attributed referring to the monthly per capita consumption of energy by community. (EXT_Obj7_Act6)
8) If possible, measure the number of public servants; 9,091% of the points attributed to the Action Plan should be attributed referring to the monthly per capita consumption energy by public servants. (BAS_Obj7_Act5)
9) If possible, quantify contracted and registered off-peak demand; 9,091% of the points attributed to the Action Plan should be attributed. (BAS_Obj7_Act7)
10) If possible, quantify contracted and registered peak demand; 9,091% of the points attributed to the Action Plan should be attributed. (BAS_Obj7_Act8)
11) If there are studies that analyse the viability of alternative energy sources; 9,091% of the points attributed to the Action Plan should be attributed. (EXT_Obj7_Act10)
12) If there are campaigns for rational use of electricity; Award 2,27275% of the points per campaign, up to 4. (EXT_Obj7_Act11)
13) Sum all awarded points to obtain the final score to energy.

Responsibilities
Sector responsible for collecting the SLMP data.

Revision Control

Revision nº	**Date**	**Description**	**Person responsible to approve the SOP**
00	10/09/2021		

7.1.5. Design report guidelines.

The proposed FIMARSHEI will offer a guide for the elaboration of the Sustainable Logistics Management Plan reports in the form of a dashboard with table graphics showing the results related to the indicators previously established. This action will meet the requirements R21 that determines the publication of the plan on the university's website, and R23 that determines that the performance reports must be published on the institution's website and submitted to the responsible government agency (CISAP).

The performance reports of the action plans comprise a brief description of the analysed dimension, followed by a table with the indicators and their respective baselines. The baseline for each indicator should be the indicator's performance over the previous two years. Thus, three years of data are required to assess the performance of each quantitative indicator. In the case study of UFPB presented in this PhD thesis, we analysed the performance in 2019 based on the baseline formed by the average performance in the years 2017 and 2018.

In addition to the indicators with their respective baselines, the template includes the presentation of the most representative charts (BAS_Obj7_Act1 and baseline / BAS_Obj7_ Act4 and baseline). The template ends with a checklist that analyses the status of each of the indicators. A template of the reporting on the energy dimension is presented in Table 7-4.

Table 7-4 - Reporting template for energy

REPORTING ON THE ACTION PLAN ENERGY

Brief introduction explaining the elements that comprises the action plan and the institutional sectors involved in the implementations and most relevant achievements.

Table of indicators

ID – Indicator / Baseline	**Months**												**Des. Stat.**		**Score**
	1	2	3	4	5	6	7	8	9	10	11	12	$\bar{x}$	σ	
BAS_Obj7_Act1 - Expenditure with energy															
BAS_Obj7_Act1 – Baseline (2017)															
BAS_Obj7_Act1 – Baseline (2018)															
BAS_Obj7_ Act2 - Electric energy consumption, in BRL R$, per capita of public servers															
BAS_Obj7_ Act2 – Baseline (2017)															
BAS_Obj7_ Act2 – Baseline (2018)															
Indicator n															
Baseline n															

- Graphic of the indicator BAS_Obj7_Act1 and baseline
- Graphic of the indicator BAS_Obj7_ Act4 and baseline

ID - Action	Status
BAS_Obj7_Act1 - To quantify the monthly expenditure, in BRL, on electrical energy	Complete/ incomplete...
Action n	

7.1.6. Implement continuous improvement.

The proposed FIMARSHEI must contemplate the quality principles related to the continuous improvement of the process with periodic evaluation of the framework with a view to the constant realisation of upgrades.

As discussed in chapter 6, the proposed framework consists of an integrated solution created based on systems science principles and therefore incorporates aspects of complex adaptive systems (see Figure 6-2). As such, it was developed with the ability to adapt as it expands its database (Støttrup et al., 2019). In this first experiment, the tool was tested using data from a single HEI, the UFPB. The calculation considered, as baselines, indicators data from years 2017 and 2018, and 2019 as the term of comparison of sustainable performance of the HEI.

7.1.7. Vertical and horizontal integration.

For the purpose of this work, as detailed in chapter 2, vertical and horizontal integration seeks to bring synergy in incorporating sustainability initiatives in HEI. Vertical integration is achieved by unifying processes, routines, and dimensions of sustainable development in HEI as depicted in Figure 2-11. Horizontal integration occurs with the grouping of HEI in networks with the objective to cooperate in formalising joint sustainable development actions and embarking in benchmarking strategies to consolidate the integration of SDI.

The holistic vision employed in developing this framework contributes to filling a crucial gap in the literature, which recognizes the importance of integration strategies to include sustainable development initiatives in HEI, without adequately defining what this so-called "integration" or "holistic approach" is. In this PhD thesis, it is possible to glimpse that integration can be better achieved by crossing two axes, as initially demonstrated in figure 11. By analysing the vertical and horizontal axes. We envisage three possible paths that can lead to the desirable stage of maturity of a given HEI, as far as SDI integration is concerned, that is, to become a "Sustainable HEI": two longer ones and one shorter, efficient, and direct path.

In the first path (Alternative path attentive to SDI - Figure 7-8), the HEI leaves the initial latent stage (Stage 1 - latent phase), in which the HEI act-as-usual. Subsequently, it gradually incorporates sustainable development initiatives, at first unconnected (stage 2 - Pioneering phase); as the maturation process advances, HEI starts to group SDI in an integrated or partially integrated system (stage 3 - enhanced phase). Later on, the HEI realizes the importance of grouping with other HEI, creating a network of sustainable universities which, using a benchmarking approach, improve and accelerate the development of its SDI (stage 4 - Strategic phase). Finally, the HEI would become a sustainable HEI (stage 5 Embedded phase) due to its previous efforts.

In the second path (Alternative path attentive to networking - Figure 7-8), the HEI leaves the initial latent stage (Stage 1 - latent phase), in which the HEI acts-as-usual and reaches the second stage (stage 2 - pioneering phase) through participation in sustainable university networks. In parallel, and with the assistance of the networks, it starts to implement SDI in a still disintegrated manner (stage 3 - enhanced phase). As its efforts matured, together with the connection with the other HEI participating in the networks, the HEI started to group the initiatives in an integrated system (stage 4 - strategic phase). Finally, the HEI would become a sustainable HEI (stage 5 Embedded phase) due to its previous efforts.

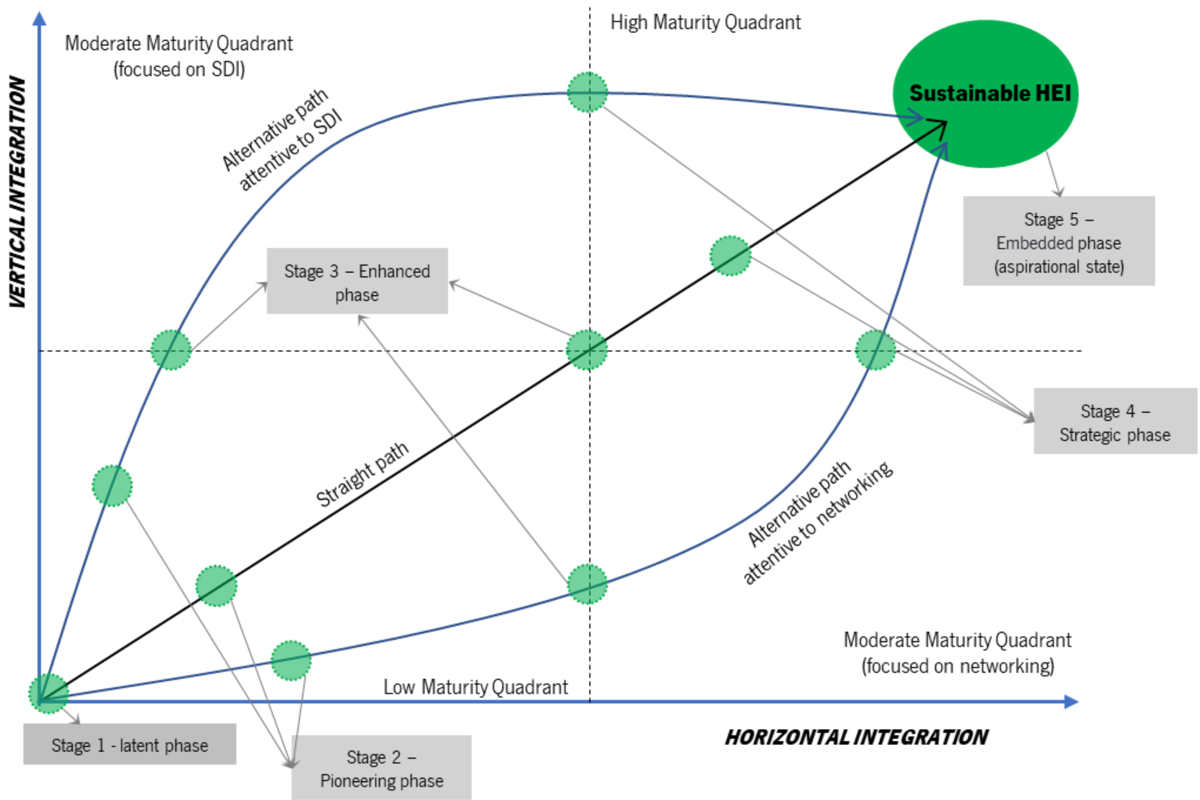

Figure 7-8 - Holistic conceptual model through vertical and horizontal integration.

In the third and more efficient (straight path - Figure 7-8), HEI leaves the initial latent stage (Stage 1 - latent phase), in which HEI acts-as-usual and reaches the second stage (stage 2 - pioneering phase). It reaches the second stage by creating a committee to promote sustainable development initiatives with defined resources and direct linkage to senior management. Early participation in networks accelerates the integration of sustainable development initiatives in all areas of HEI. It allows HEI to gain prominence in the networks as a result of the advanced process of SDI integration (Stage 3 - enhanced phase). In this stage, HEI is expected to have the main SDI processes formally documented as business processes (BPMN). As shown in the conceptual model, a shortening of the distance between stages three and four (stage 4 - strategic phase) is expected. It would enable HEI to reach stage four hastily. In this stage, HEI has the SDI integrated into a systematic, mature, and functional plan aligned with the institutional strategic plan, and also develops collaborative actions on its networks of sustainable HEI. This behaviour enables HEI to reach the desirable fifth stage (stage 5 - embedded phase) more quickly and appropriately.

7.2. System formulation

Section 7.1 detailed the entire procedural structure adopted to design and formulate the framework. It departs from the definition of policy and commitment and continues through the definition of scope and performance diagnosis, the definition of action plans with their respective schedules and responsibilities, evaluation protocols in the form of targets, indicators and metrics, the design of report templates and implementation of continuous improvement and holistic approach.

This section corresponds to the continuation of the previous section. Thus, it will focus on developing the mathematical model that connects all qualitative and quantitative indicators of the framework designed to systematically integrate, implement, monitor, and report the SDI of Brazilian HEI.

Figure 7-3 shows that the conceptual model has three layers: (1) the indicators that make up the lowest layer of the model and are directly linked to the objectives and activities analysed in the HEI; (2) the dimensions that group the indicators into themes and the (3) components that consolidate the themes. The model components together form a composite index of the framework that evaluates the HEI's overall performance. Depending on the score achieved the HEI is included in one of the rating classes further detailed.

The development of the framework partially followed the steps proposed in the *OECD Handbook on Constructing Composite Indicators: Methodology and User Guide* (OECD, 2008). The guide provides an ideal sequence of ten steps for a structured and systematic approach to constructing composite indicators.

The ten steps encompass the design of a (1) *theoretical framework* as the foundation upon which the selection and combination of model variables will occur.

(2) The *Data selection* process allows for assessing each selected indicator's strengths and weaknesses. This step helps refine the set of indicators identified during the literature review by analysing the quality of each indicator, preferably with input from experts.

(3) *Imputation of missing data* is necessary when validating the developed framework involving extensive datasets, as missing data can lead to biased results and reduced aid effectiveness (Breitwieser & Wick, 2016). Multiple imputation algorithms are commonly adopted for this purpose (Bartlett & Hughes, 2020).

After the preliminary analysis of the dataset and the imputation of missing data, (4) *Multivariate analysis* techniques can be employed for statistical grouping of the indicators into the dimensions and later to validate the framework. Several techniques are available, including principal component analysis, Cronbach's alpha analysis, confirmatory factor analysis through structural equation modelling, and partial least square, among others, which are commonly used (Field, 2018; Joe F Hair et al., 2020; Joseph F. Hair et al., 2014; Malhotra et al., 2018).

(5) The fifth step, *Normalisation*, makes the variables comparable. Various normalization techniques, such as ranking, z-scores, standardisation, distance to a reference, categorical scales, and min-max, can be employed for this purpose (Nardo et al., 2005; OECD, 2008; Schlossarek et al., 2019).

The sixth step encompasses (6) *Weighting and aggregation* procedures, which align with the theoretical framework and involve defining methods for assigning weights to the indicators and aggregating the components that make up the model (Gan et al., 2017).

The subsequent step (7) involves *Uncertainty and sensitivity analysis*. According to OECD (2008) uncertainty analysis examines how uncertainty in the input factors permeates through the composite indicator's structure and impacts the values of the composite indicator. Sensitivity analysis, on the other hand, assesses the extent to which each individual source of uncertainty influences the variance in the output (Cro et al., 2019).

(8) *Back to the data*, the eighth step discusses the possibility of decomposing the composite indicator to analyse specific characteristics of a sub-component or indicator. The decomposition of the composite indicator can provide insights into the overall performance of a phenomenon analysed through composite indicators (Brousmiche et al., 2020; OECD, 2008).

Step nine recognises that the designed composite indicator can be (9) Linked to other indicators. It is essential to seek and analyse the correlations between the developed model and well-known concepts and phenomena to assess the degree of novelty that the proposed composite index can bring to a better understanding of these well-known phenomena.

The final step deals with the importance of presenting the results appropriately, describing the proper way of (10) visualising the results.

It is critical to keep in mind that the ten steps proposed by the OECD represent a set of guidelines intended for an ideal scenario to develop a framework to be applied on a large scale, involving data collection from various cases that allows for complex statistical analysis. This approach allows for assessing the robustness and validity of the scale by employing multivariate analysis techniques such as principal component analysis, exploratory and confirmatory factor analysis, and uncertainty and sensitivity analysis, among others.

Therefore, when considering these ten steps as a whole, they extend beyond the scope of this PhD research. Regarding validating the proposed framework, in line with the secondary research objective (c), which aims to "test the effectiveness of the framework by evaluating the sustainability performance of a typical Brazilian Federal public HEI,". To achieve this goal Task 8, depicted in Figure 1-1, has been planned and intends to conduct the "assessment of usability through application in a typical case." Consequently, data from just one Brazilian university will be collected to test the framework's application or usability.

With data from only one case, it will not be feasible to perform the commonly used multivariate analyses, such as the one required in step 3, "imputation of missing data," as the anticipated database will have only one case. Similarly, step 4, which involves "multivariate analysis," step 7 regarding "Uncertainty and sensitivity analysis," step 8, which aims to "check correlation and causality," and step 9, dealing with "links to other indicators," cannot be applied for the same reason.

However, it will be possible to accomplish steps 1, 2, 5, 6 and 10. As per the OECD (2008, p. 22) commencing the construction of composite indicators hinges upon establishing a robust theoretical foundation. This foundation must distinctly delineate the specific phenomenon to be assessed, along with its constituent elements. It involves the careful selection of individual indicators and their respective weights, aligning them with their relative significance and the dimensions of the overall composite. Thus, step 1 was achieved by designing the *Theoretical framework* through a literature review performed in chapters 2 and 3 to identify the components, dimensions, and variables that will constitute the model. Consultations with experts will follow this.

Step 2, *Data selection*, was achieved by evaluating the process of collecting variables and data and assessing data type, relevance, availability, and validation through expert consultations. The strengths of composite indicators rely largely on the quality of the underlying variable. OECD (2008, p. 23) stated that "Ideally, variables should be selected on the basis of their relevance, analytical soundness, timeliness, accessibility. (...) The quality and accuracy of composite indicators should evolve in parallel with improvements in data collection and indicator development.". The list of indicators collected through a literature review was compiled in Table 6-4. Following the identification of indicators available in the literature and the subsequent construction of the conceptual model, which is illustrated in Figure 6-4. The indicators were preliminarily validated by experts' interviews. The interviews, summarised in Section 6.1.3.3, Table 6-5, were performed to assess the relevance of the indicators and the availability of the data that make them up in the various government or university system databases.

It is worth highlighting that steps 1 and 2, previously described, are related to the theoretical or conceptual definition of the proposed framework. From this point onward, attention is directed towards designing the mathematical structure based on composite indices theory. The usefulness of the theory of composite indices in this doctoral research lies in providing the theoretical and practical basis on which it will be possible to integrate, indicators into dimensions and these into components, and finally, the mathematical integration of the model to generate a performance index. This index will allow for the allocation of the studied HEI into one of the framework's ratings. And finally, to design, based on literature, a rating scale to allocate HEI into a proposed range, according to its performance. Thus, from the next paragraph onwards, steps 5, 6 and 10 are described, which are more related to the development of mathematical modelling.

Accordingly, step 5, *Normalisation*, is required prior to any data aggregation since the indicators within a dataset frequently possess diverse units of measurement. Therefore, it was performed to compare data types, such as quantitative and qualitative data, or data with distinct numeric units. The normalisation methodologies employed in the development of the framework, particularly during the "system formulation" phase, consist of following two techniques: (a) *Distance to a reference measure*, and (b) *categorical scale*. Subsequently, we will proceed to describe each of these methodologies and provide details on how they were employed to develop the proposed framework.

The rationale behind the use of the concept of distance to a reference is that this methodology allows for the calculation of the relative position of a specific indicator in relation to a reference point. This methodology was employed in designing Equation 3, which calculates the variation between the analysed year and a baseline. For the purpose of this research, the analysed year is 2019, while the baseline, i.e., the reference point, corresponds to the average performance for each indicator in the two previous years. In this case, the average is calculated considering the years 2017 and 2018. Thus, to calculate each quantitative indicator, it is necessary to collect data related to performance over three years. The first two years, 2017 and 2018, are used to construct the baseline, and the subsequent year, 2019, corresponds to the year under analysis.

The Categorical scale, which is utilised to assign a score to each indicator. These categories can be either numeric, such as one, two, or three stars, or qualitative, such as fully achieved, partly achieved, or not achieved. (Nardo et al., 2005; OECD, 2008).

Due to the impossibility of directly comparing different quantities, such as water consumption measured in m^3, energy consumption measured in kWh, or greenhouse gas emissions measured in CO_2 equivalent, it was necessary to adopt the categorical scale methodology. The idea was to integrate not the different quantities themselves into the model but rather the variations in these quantities, which were calculated previously using Equation 3, computing the variation between the baseline and the reference year.

The use of categorical scales is employed by both UI-GreenMetric and STARS. In the case of UI-GreenMetric, all indicators are constructed using either numerical or qualitative categorical scales. Table 7-5 below provides examples of two categorical scales adopted by UI-GreenMetric (UIGM, 2021). In the first instance, the indicator SI 1 within the category of Setting and Infrastructure (SI) assesses "The ratio of open space area to the total area" through a 5-point numerical scale. Depending on performance, a score between 0 and 1 can be assigned.

In the second case, the table illustrates the indicator EC 7, which forms part of the Energy and Climate Change (EC) category. It is utilised to evaluate whether the Higher Education Institution (HEI) possesses a Greenhouse Gas Emission Reduction Program. This indicator is measured using a qualitative scale that assesses both the presence of a Greenhouse Gas Emission Reduction Program at the HEI and its extent.

Table 7-5 - Examples of Categorical Scales UI GreenMetric employs to assess HEI's performance.

No	Category and indicator	Point	Score	Weighting
1	Setting and Infrastructure (SI)			15%
SI 1	The ratio of open space area to the total area	300		
	<= 1%	0		
	>1-80%	0.25×300		
	>80-90%	0.50×300		
	>90-95%	0.75×300		
	> 95%	1.00×300		
2	Energy and Climate Change (EC)			21%
EC 7	Greenhouse gas emission reduction program	200		
	None	0		
	Preparation program.	0.25×200		
	Program(s) aims to reduce one out of three scopes emissions Program(s)	0.50×200		
	aims to reduce two out of three scopes emissions Program(s) aims to	0.75×200		
	reduce all three scopes emissions	1.00×200		

Source (UIGM, 2021, pp. 34–35)

Table 7-6 of the proposed model was developed based on the categorical scale's normalisation method. The table allows for assigning scores based on the previously calculated variations (Mrzygłocka-Chojnacka & Ryńca, 2023). However, it is essential to consider that these variations sometimes bring benefits to promoting sustainable development, while other times, they bring drawbacks. Assigning scores using the categorical scale needs to consider this dichotomy in the variation.

The score assigned to the indicator's performance varies between 0.1 and 1 to address this issue. A score of 0.1 is assigned when the variation is less than or equal to -40, and 1 is assigned when the variation is greater than or equal to 40 in cases where the positive variation of the indicator reduces the pressure on sustainability, meaning it has a lesser negative impact as it increases (the lower, the worse). Conversely, for cases where the positive variation of the indicator increases the pressure on sustainability, meaning that an increase in the variation increases the impact on sustainability (the lower, the better), scores ranging from 1 to 0.1 are assigned. A score of 1 is assigned when the variation is less than or equal to -40, and 0.1 is assigned when the variation is greater than or equal to 40. The assignment of scores is detailed in Table 7-6.

The overall performance result of a HEI in a framework with the characteristics being designed in this doctoral research can be assigned as either a ranking or a rating. The two most commonly referenced sustainability assessment tools in the literature, UI-GreenMetrics and STARS, publish their results as ranking and rating, respectively (Bautista-Puig & Sanz-Casado, 2021; Bieler & McKenzie, 2017; Caeiro, Sandoval Hamon, et al., 2020; Findler, Schönherr, Lozano, & Stacherl, 2019b; Husaini et al., 2018; Kurniawan, 2020; Rivera & Savage, 2020; Stough et al., 2018). The overall score earned by a given HEI on STARS methodology allows the HEI to be allocated in one of the five ratings that comprises The Sustainability Tracking, Assessment & Rating System (STARS), as shown in Figure 7-9 (AASHE, 2019a, p. introduction p.2).

Recognition Level		Minimum Overall Score
	Reporter designation	n/a
	Bronze Rating	25
	Silver Rating	45
	Gold Rating	65
	Platinum Rating	85

Figure 7-9 STARS Rating System

Source: (AASHE, 2019b)

The categorical scale was also used to establish the rating classes in the proposed framework. The categories were constructed based on the analysis of studies on the management model for integrating sustainable development described in chapter 2 and studies on conceptual models that analyse the degree of maturity of HEI in integrating sustainable development initiatives, among which the following stand out: Baker-Shelley et al.(2017), Giesenbauer and Müller-Christ (2020), Kahle (2018), and Kapitulčinová et al. (Kapitulčinová et al., 2018).

As a result of this analysis, the following five classes emerge: Latent, Pioneer, Enhanced, Strategic and Embedded. Those ratings are presented in Table 7-9. The *Latent* class includes HEI at a very preliminary stage in integrating sustainable development initiatives, in which HEI act-as-usual. The *Pioneer* class includes HEI at an early stage with isolated actions and/or peripheral participation in sustainable university networks. The next class, called *Enhanced*, groups HEI that have managed to evolve by starting to promote at least partial integration of sustainable development initiatives. In the *Strategic* class are HEI that recognise the importance of participating in networks and adopting a benchmarking approach to improve and accelerate the promotion of sustainable development. In the last class, *Embedded*, are HEI at an advanced stage of integrating sustainable development. The mathematical model is supported by the conceptual model, developed in chapter 2, section 2.3.3, that has been evolved to the conceptual model of holistic approach through vertical and horizontal integration, illustrated in Figure 7-8.

Step 6 will be developed to define the techniques for "weighting and aggregation" of the components, dimensions, and variables in the model also will be accomplished. It is worth noting that the procedures for weighting and aggregation are considered crucial in developing composite indices. Considering the subjectivity inherent in assigning weights to variables, OECD (2008, p. 31) asserted that

> Regardless of which method is used, weights are essentially value judgements. While some analysts might choose weights based only on statistical methods, others might reward (or punish) components that are deemed more (or less) influential, depending on expert opinion, to better reflect policy priorities or theoretical factors.

In alignment with previous argumentation, Schlossarek (2019) acknowledges that when selecting a weighting method, the creator inherently reveals their preferences for certain methodological characteristics. One approach to enhance the robustness and transparency of the variable weighting process within a given framework is to anchor the chosen weight system in existing literature. This involves adapting weight systems from similar tools under development.

One of the motivations for the creation of the proposed framework is to facilitate the comprehensive compliance with NI10, 12/11/12, which regulates the development and monitoring of SLMP in Brazilian federal public universities. The Normative Instruction outlines some of the indicators but does not establish minimum or maximum performance levels for the specified indicators. Thus, it is understood that its focus is more on fostering a culture of monitoring rather than recommending acceptable performance ranges. Additionally, as detailed in Chapter 5, which assesses the status of Brazilian HEI in implementing the aforementioned Normative Instruction, Brazilian universities are encountering significant challenges in operationalising the Normative Instruction, i.e., in carrying out monitoring and disclosing reports on their sustainable performance that align with the requirements of NI10, 12/11/12.

Taking into consideration these two gaps, namely, the NI10, 12/11/12's emphasis on monitoring rather than performance and the substantial difficulties faced by universities in meeting the basic requirements of the NI. In the development of the framework proposed in this PhD research, it has been decided to assign scores both for compliance with the requirements and for the achieved performance. In this context, it has been determined that a weight of 0.3 will be assigned to the attainment of the set of qualitative indicators, which are more oriented towards monitoring aspects, and 0.7 for the set of quantitative indicators, i.e., those more closely related to the sustainable performance of the HEI.

The arguments presented in the preceding paragraphs have guided the formulation of Equation 4, which is employed to calculate the performance of quantitative indicators, and Equation 6, utilised to calculate the score for qualitative indicators.

Authors such as OECD (2008), Schlossarek (2019), and Gan (2017) collectively recognize that the most commonly employed methodology for assigning weights to variables is the "equal weighting" approach. As illustrated in Table 7-11, the equal weighting approach is employed to assign weights to indicators. In the mentioned figure, a weight of 33.333% is allocated to the indicators Ext_Obj1-Act1, Ext_Obj1-Act2, and Ext_Obj1-Act3, while a weight of 5.263% is assigned to the indicators BAS_Obj2_Act1 to BAS_Obj2_Act19.

Regarding aggregation methodologies, Gan (2019) compiles the three most recurring ones in the literature. The *additive aggregation* method, the *geometric aggregation* method, and the *non-compensatory aggregation method*, with the first being the most widely employed in the development of CI.

The theoretical basis must be thought to facilitate the collection of data and the integration of modules into the model. It should also consider integrating the sustainability tool into existing management systems so that the development of the model does not lead to errors such as the inability to differentiate events or the use of a wrong methodology (Adenle et al., 2020b).

7.2.1. Indicators

The model has 88 indicators, related to actions, and are classified as Basic and Extended. The indicators are composed based on two criteria: Qualitative (compliance) and Quantitative (variation to baseline).

7.2.1.1. Quantitative Indicator Score:

The quantitative score of the indicators for each objective (o) and activity (a) are calculated based on the percentage variation (PV_{oa}) of the Value (V_{oa}) in relation to the baseline (BL_{oa}). It is called the Percentual Variance Activity Score and is calculated according to the following equation to Equation 3.

$$PV_{oa} = \left(\frac{V_{oa}*100}{BL_{oa}}\right) - 100. \tag{3}$$

Based on the analysis of each corresponding activity, it is necessary to define whether the impact caused by the variation observed is positive or negative. In a positive case, the increase in PV_{oa} generates a lower impact, whereas in a negative case, the increase in PV_{oa} generates a higher impact. Table 7-6,

Table 7 6, drawn up using the categorical scale methodology, detailed in sections 3.1.3 and 7.2, shows the scale proposed to be considered and the corresponding score (S_{oa}) according to the relationship between the value of the activity and the impact caused by it, based on the percentage variation of the activity in relation to the baseline.

Table 7-6 – Proposed definition of score applied to the activity indicator.

Relationship between value and impact		
Positive The increase in the percentage variation causes less impact (the lower, the worse)	Relationship Value vs. Impact	**Negative** The increase in the percentage variation causes greater impact (the lower, the better)
S_{oa}		S_{oa}
0.1	if $PV_{oa} \leq -40$	1
0.2	if $-30 \leq Pv_{oa} < -40$	0.9
0.3	if $-20 \leq Pv_{oa} < -30$	0.8
0.4	if $-10 \leq Pv_{oa} < -20$	0.7
0.5	if $0 \leq Pv_{oa} < -10$	0.6
0.6	if $0 > Pv_{oa} \geq 10$	0.5
0.7	if $10 > Pv_{oa} \geq 20$	0.4
0.8	if $20 > Pv_{oa} \geq 30$	0.3
0.9	if $20 > Pv_{oa} \geq 30$	0.2
1	if $Pv_{oa} \geq 40$	0.1

The quantitative activity score (qtS_{oa}) is obtained from the S_{oa} defined in the scale in Table 7-6, applying a weight of 0.7 of the quantitative dimensions, distributed among the activities within the dimension that can be quantitatively measured (qtn_{oa}), according to Equation 4 - quantitative indicator score.

$$qtS_{oa} = \frac{(0{,}7/qtn_{oa})}{S_{oa}}. \tag{4}$$

In this way, the quantitative score for the activity is normalised and the sum of them make up the quantitative criterion of the dimension (qtS_d), contributing a maximum of 0.7 to the observed dimension as described in Equation 5 - quantitative dimension score.

$$qtS_d = \sum_{a=1}^{a} qtS_{oa} \tag{5}$$

The remaining value of 0.3 is related to the qualitative criterion of the activity (compliance). It is important to note that the measurement of the quantitative criterion of the indicators is related to the quantity of quantitatively measurable indicators. Some dimensions contemplate only the qualitative criterion in their indicators, and, in such cases, the quantitative dimension score will be defined at its maximum value (0.7).

7.2.1.2. Qualitative Indicator Score.

All activities have a qualitative criterion related to their fulfilment. Thus, within a dimension, the qualitative indicator score (qls_{oa}) is defined as the sum of the compliance of all activities, normalized by the weight of the criterion as computed in Equation 6 - qualitative indicator score. It is important to note that some activities may be partially fulfilled, such as those related to the development of awareness campaigns, for example. In such cases, the activity may be considered as partially completed, on a scale of 0 to 1, where 0 is "not completed" and 1 is "fully completed".

$$qlS_{oa} = \left(\frac{l_c}{n_{oa}}\right) * 0.3. \text{ where:} \tag{6}$$

- l_c: activity accomplishment level.
- n_{oa}: number of activities within the dimension.
- 0.3: weight of the qualitative criterion for the score of the dimension.

Finally, the sum of the qualitative scores of each activity makes up the dimension's qualitative criterion (qlS_d) and represents a maximum of 0.3 of the observed dimensions as demonstrated in Equation 7 – Qualitative dimension Score.

$$qlS_d = \sum_{a=1}^{a} qlS_{oa} \tag{7}$$

7.2.2. Dimensions

Similarly, to the calculation of the quantitative (qtS_d) and qualitative (qlS_d) criteria applied to each activity it is possible to reach the dimension score (S_d), by means of Equation 8 – Score per dimension.

$$S_d = (qtS_d + qlS_d) * W_d. \text{ Where:} \tag{8}$$

- W_d: weight given to the dimension, within the components (Table 7-7):

Table 7-7 - Weight is given to the dimension within the components.

Distribution of dimension weights	
Component 1 - Governance/ Procurement	
Dimensions	**Weight**
1.1 - Institutional Framework	20
1.2 - Material Acquisition	40
1.3 - Procurement	40
Component 2 - Outreach & on campus experience	
Dimensions	**Weight**
2.1 - QLW	33.33
2.2 - Extensions programme	33.33
2.3 - Networking	33.33
Component 3 - Campus operation	
Dimensions	**Weight**
3.1 - Energy	25
3.2 - Water	25
3.3 - Waste	25
3.4 - Displacement	25
Component 4 - Teaching and Research	
Dimensions	**Weight**
4.1 - Teaching	50
4.2 - Research & innovation	50
Component 5 - Assessment and Reporting	
Dimensions	**Weight**
5.1 - Assessment Protocol	40
5.2 - Reporting SD	60

7.2.3. Components

Finally, the score of each component of the model (C_n) is calculated as the sum of all the scores of the dimensions (d) that compose it as shown in Equation 9 – Score per component.

$$C_n = \sum_{d=1}^{d} S_d \tag{9}$$

The total score (S) of the HEI, computed through Equation (10 - Final score of HEI - is given from the sum of each component C_n, weighted by the weight of each component (W_c), according to Table 7-8:

Table 7-8 - Weight of each component

Components	**Weight**
1 - Governance/ Procurement	0.20
2 - Outreach & on campus experience	0.10
3 - Campus operation	0.30
4 - Teaching and Research	0.25
5 - Assessment and Reporting	0.15

The allocation of weights to the components adheres to a logical framework akin to the methodology employed by existing frameworks developed for assessing the scores of the dimensions comprising the UI GreenMetric (UIGM, 2021) and STARS (AASHE, 2019a). This adaptation has been applied to align with the components and dimensions delineated within the framework presented in this doctoral research study.

$$S = \sum_{n=1}^{n} (C_n * W_c) \tag{10}$$

The HEI's final score varies between 0 and 100.

Complete equation of the model proposed in Equation 11 - complete equation of the model:

$$S = \sum_{n=1}^{n}\left(\left(\sum_{d=1}^{d}\left(\left(\left(\sum_{a=1}^{a}\left(\frac{(0,7/qtn_{oa})}{S_{oa}}\right)\right) + \left(\sum_{a=1}^{a}\left(\left(\frac{l_c}{n_{oa}}\right) * 0,3\right)\right)\right) * W_d\right)\right) * W_c\right) \tag{11}$$

At the end of the evaluation process, an overall score is assigned to the institution based on the summation of the values achieved in each of the five components, which is calculated using Equations 10 and 11. The final score obtained by a given HEI ranges between 0 and 100. Depending on the score obtained, the institution is classified into one of the proposed ratings.

The literature describes the advantages and disadvantages of sustainability assessment systems that adopt either the ranking or rating approach. Several examples of sustainability assessment tools based on the ranking approach are available, including the Academic Ranking of World Class Universities (ARWU), the Quacquarelli-Symonds World University Ranking (QS), the Higher Education World University Ranking (THEs), and the UI Green Metrics. These tools allocate the evaluated HEI in an individual positions which is predetermined by order of importance based on their performance evaluation (Atici et al., 2021; Galleli et al., 2021; Liu et al., 2019).

On the other hand, sustainability assessment tools that adopt a rating approach allocate the evaluated HEI into classes, rather than unique positional orders. Examples of such rating-based tools include the American College & University Presidents' Climate Commitment (ACUPCC), the College Sustainability Report Card (the Green Report Card), and the Sustainability Tracking, Assessment & Rating System™ (STARS), among others (Dyer & Dyer, 2017; Lopez & Martin, 2018; Nejati & Nejati, 2013; Swearingen White, 2009).

The rating classification methodology adopted in this proposed framework is similar to that developed by STARS, which classifies evaluated institutions into five ratings, as detailed in Chapter 3 (AASHE, 2019a, p. 2).

The design of the class intervals that make up the rating of the proposed FIMARSHEI takes into account the concept of sustainability integration in HEI, as developed in sections 2.2.2. and 7.1.6 of this work. Therefore, this concept is based on a holistic approach achieved through vertical and horizontal integration. As a result, the following five classes of SDI integration in HEI are established. The first class, called "Latent," will group HEI that are in a very preliminary stage of integration, and their final performance score will range between 1 and 24. The second class, called "Pioneers," will include HEI that score between 25 and 39 points in their overall calculation. In the next phase, called "Enhanced," HEI that score between 40 and 59 points will be categorized. The fourth phase, called "Strategic," will classify those HEI that score between 60 and 80 points. The final class, called "Embedded," will be shared by all evaluated HEI that score above 80. Figure 7-8, shown in section 7.1.6, presents the three possible paths for HEI to reach advanced stages of sustainable development initiative integration. Table 7-9 summarises the set of classes in the proposed rating model while describing the interval values.

Regarding the aspects of mathematical modelling, it has been developed based on the Composite Indices Approach. This methodology translates into a normalization approach widely adopted in the literature, including by the UI-GreenMetric and STARS frameworks, known as the categorical scale (AASHE, 2019a; Brousmiche et al., 2020; Nardo et al., 2005; Schlossarek et al., 2019). The utilisation of both quantitative and qualitative categorical scales by UI-GreenMetric and STARS frameworks is previously illustrated in Table 7-5 and Figure 7-10.

Table 7-9 - Ratings' classes of the FIMARSHEI

Ratings' classes	
Rating	Score
Latent	Less than or equal to 24
Pioneer	Between 25 and 39
Enhanced	Between 40 and 59
Strategic	Between 60 and 79
Embedded	Greater than or equal to 80

7.2.4. Mathematical Model Integration into User-Friendly Format

The calculation of HEI's performance in integrating SDI requires the inclusion of data related to each of the indicators, whether quantitative or qualitative, and the separate measurement of the performance of each of the 14 dimensions, with their respective weights, which will later be grouped by components. The value assigned to the performance of each component is added to result in the computation of the HEI's overall performance. To streamline the calculation process, a sequence of indexed forms was developed in a spreadsheet. This procedure allows the automation of the calculation of HEI's performance in integrating SDI after the inclusion of data from each indicator. Table 7-11, and Table 7-11 illustrates the forms used to calculate the indicators of component 1.

Table 7-10 - Form for calculating the indicators from component 1, dimension 1.

Component 1 - Governance/ Procurement										
Dimension 1.1 - Institutional Framework										
			Quantitative criteria					Qualitative Criteria		
Indicator	**BL mean**	**2019 mean**	**PV_{oa} (eq. 3)**	**Rel. Value x Impact (P/N)**	**Soa (0-1)**	**qtS_{oa} (Eq. 4)**	**Ic**	**(Ic/n_{oa})**	**qlS_{oa} (Eq. 6)**	**Total**
Ext_Obj1_Act1							1			
Ext_Obj1_Act2							1			
Ext_Obj1_Act3							1			
			TOTAL		**qtS_d (Eq. 5)**			**qlS_d (Eq. 7)**		

Table 7-11 Form for calculating the indicators from component 1, dimension 2.

Dimension 1.2 - Material Acquisition										
			Quantitative criteria					Qualitative Criteria		
Indicator	**BL mean**	**2019 mean**	**PV_{oa} (eq. 3)**	**Rel. Value x Impact (P/N)**	**S_{oa} (0-1)**	**qtS_{oa} (Eq. 4)**	**Ic**	**(Ic/n_{oa})**	**qlS_{oa} (Eq. 6)**	**Total**
BAS_Obj2_Act1				Negative			1			
BAS_Obj2_Act2				Negative			1			
BAS_Obj2_Act3				Negative			1			
EXT_Obj2_ Act4				Negative			1			
EXT_Obj2_ Act5				Negative			1			
EXT_Obj2_ Act6				Negative			1			
BAS_Obj2_ Act7				Negative			1			
BAS_Obj2_ Act8				Negative			1			
BAS_Obj2_ Act9				Negative			1			
BAS_Obj2_ Act10				Negative			1			
EXT_Obj2_ Act11				Negative			1			
EXT_Obj2_ Act12				Negative			1			
BAS_Obj2_ Act13				Negative			1			
EXT_Obj2_ Act14				Negative			1			
EXT_Obj2_ Act15				Negative			1			
EXT_Obj2_ Act16							1			
EXT_Obj2_ Act17							1			
EXT_Obj2_ Act18							1			
EXT_Obj2_ Act19							1			
			TOTAL		**qtSd (Eq. 5)**			**qlSd (Eq. 7)**		

In addition to the column that allocates the indicator codes, the table comprises five columns that pertain to the quantitative criteria and four columns used to calculate the qualitative measures. The last column shows the result of the summed indicator performance.

The first column indicates the code of the indicators used. The second column shows the average baseline value for each indicator, which is computed based on the mean value of the years 2017 and 2018. The third column displays the average value of the indicators for the year 2019. The fourth column presents the difference between the baseline and the reference year values, which is calculated based on Equation 3. The fifth column is constructed based on the methodology outlined in Table 43, which analyses the relationship between value and impact and determines whether the impact is positive or negative and varies between 0.1 and 1.

Upon conducting the analysis, the sixth column attributes the value corresponding to S_{oa} in the next column, the seventh column, using Equation 4. The score for the quantitative criteria is calculated and the sum of these criteria is presented at the end of this column. This sum is made by applying Equation 5. After calculating the quantitative criteria, the qualitative criteria are then calculated (columns eight, nine and ten). Column eight presents the compliance level (lc), which in the following column is divided by the number of activities within the dimension analysed (n_{oa}) as detailed in Equation 6. Finally, the total value of the qualitative criterion is added to the total value of the qualitative criterion and the corresponding result is presented at the end of the last column. This is therefore the result of HEI's performance for the dimension analysed.

Table 7-12depicts the procedure for calculating the performance of each component. To obtain the score of a given component, the qualitative and quantitative criteria of each indicator are summed and inserted in the form (qtSd + qlSd; third column) and then multiplied by the weight of each indicator in the component (W_d; second column), as described by Equation 8. Finally, the standardised results of each indicator (S_d; last column) are summed according to Equation 9. The value in the last cell of the last column represents the performance of the HEI for the analysed component.

Table 7-12 - Form for calculating component 1 score.

Component 1 - Governance/ Procurement			
Dimensions	**Wd**	**qtSd + qlSd**	**Sd (Eq. 8)**
1.1 - Institutional Framework	20		
1.2 - Material Acquisition	40		
1.3 - Procurement	40		
Total	**100**	**Cn (Eq. 9)**	

Once the score for all indicators and their respective components is calculated, the final phase of the calculation is carried out, which consists of measuring the overall score of the analysed HEI. The calculation is performed by applying Equation 10, which basically multiplies the score achieved in each component by the weight assigned to that component. The operation is illustrated in Table 7-13. The result obtained by the HEI will be used to classify the institution into one of the classes previously designed for the framework as presented in Table 7-9.

Table 7-13 - Form for calculating the overall score of the HEI.

Total Score			
Components	**W_c**	**C_n**	**C_n * W_c**
1 - Governance/ Procurement	0,20		
2 - Outreach & on campus experience	0,10		
3 - Campus operation	0,30		
4 - Teaching and Research	0,25		
5 - Assessment and Reporting	0,15		
		S (Eq. 10)	

This chapter aimed to fulfil the procedures outlined in the third stage of the System Approach Framework application. To achieve this objective, a procedural structure was established, consisting of a set of planned steps to translate the conceptual model developed in chapter 6, section 6.1.3, entitled Stage 2 - System Design, into a mathematical modelling that integrates a comprehensive set of indicators and their respective metrics, into dimensions and components, in order to form a logical and consistent structure that allows the evaluation of the performance of higher education institutions in the integration of sustainable development initiatives.

PART 3

The third and final part of this PhD thesis represents the culmination of a comprehensive study aimed at evaluating the practical application of the proposed FIMARSHEI. Comprised of Chapters 8 and 9, this section seeks to evaluate the efficacy of the proposed framework in addressing the identified gaps in sustainable development integration in the higher education sector.

Chapter 8 presents the results of a pilot case study conducted at a typical Brazilian federal public university - the Universidade Federal da Paraíba (UFPB). The case study analyses the university's performance in integrating sustainable development practices and evaluates the effectiveness of the proposed FIMARSHEI in addressing the identified gaps. The findings of this analysis will serve to further refine the proposed FIMARSHEI and offer valuable insights into the practical implementation of sustainable development practices in Brazilian federal public universities.

Chapter 9 provides a comprehensive analysis of the research project's main findings, limitations, and future directions. This chapter presents a summary of the key outcomes of the study, highlighting the main contributions and insights gained from the research. Additionally, the chapter explores the limitations of the study, and offers suggestions for future research directions in the field of sustainable development integration in higher education institutions.

Moreover, chapter 9 presents the main outcomes in terms of publication that emerged in the period of writing this PhD research. This includes peer-reviewed articles, conference presentations, and other publications that emerged from the research findings. These publications serve to highlight the significance and impact of the research project and offer valuable contributions to the field of sustainable development integration in higher education institutions.

Overall, Part Three represents a significant contribution to the field of sustainable development integration in Brazilian federal public universities, offering practical insights and recommendations for improving sustainable development practices in the higher education sector. The findings of this section will be of interest to researchers, policy makers, and practitioners working in the field of sustainable development, and provide valuable guidance for future research and practice in the field.

Chapter 8. System assessment and output

This chapter is a continuation of the previous chapters. Chapters 2 and 3 systematically reviewed the literature on commitments made by HEI in multilateral organisations, management models for integrating sustainable development, and sustainability assessment tools for HEI. This resulted in the compilation of the main components and dimensions of HEI sustainability and a recorded list of sustainability indicators for HEI. In chapter 5 the results of a representative survey applied to assess the evolution of SDI integration in Brazilian public HEI were discussed and an overview of the main difficulties faced by HEI in meeting this demand was provided.

In light of the challenges that HEI face in integrating SDI, in chapter 6, a complex systems approach and mapped the primary descriptors of SD integration in HEI was employed, including components, dimensions, indicators, and metrics, to develop a conceptual model for the FIMARSHEI. The framework aims to facilitate the selection, collection, and analysis of indicators that enable the monitoring, assessment, and reporting of sustainability in Brazilian federal public HEI, using a holistic approach that incorporates both vertical and horizontal integration. Building on this conceptual model, chapter 7 focuses on designing a managerial structure, including management plans, process flows, and reporting models, as well as mathematical approaches, to operationalise the framework.

Thus, in the view of the context presented this chapter aims to report on the procedures adopted to test the application of the framework developed in a typical case of a Brazilian federal public HEI.

The application test was carried out at the Federal University of Paraíba, the largest university in the state of Paraíba, which, according to the 2019 Management Report, had more than 7,000 employees, including permanent and substitute faculty, staff, and outsourced workers; and around 37,000 students enrolled in technological, undergraduate, and graduate courses across its four campuses. During the analysed period, UFPB offered 124 undergraduate courses, 121 graduate courses, 15 technical courses, 17 medical residency programs, and 5 non-medical residency programs, 1,286 university extension scholarships, and 3,905 academic scholarships (UFPB, 2020, p. 17).

In 2013, the Environmental Management Committee was established as an advisory body to the Office of the Rector, and since then, it has taken on the challenge of developing and integrating SDI in various dimensions of HEI' sustainability. The Committee was created to meet the requirements of NI10, 12/11/12, as detailed in previous chapters (Normative Instruction No. 10, 2012).

The application test of the framework was performed using data from 2017 to 2019, and this period was defined as prior to the pandemic and due to the satisfactory amount of data available in the consulted databases. In summary, the consulted databases were UFPB's annual management reports, SLMP reports, reports from the Office of Personnel Management, and primarily the Federal Government Transparency Portal. The Portal, maintained by the Comptroller-General's Office, allows monitoring the use of federal resources collected. The available data is official and therefore accurate and reliable.

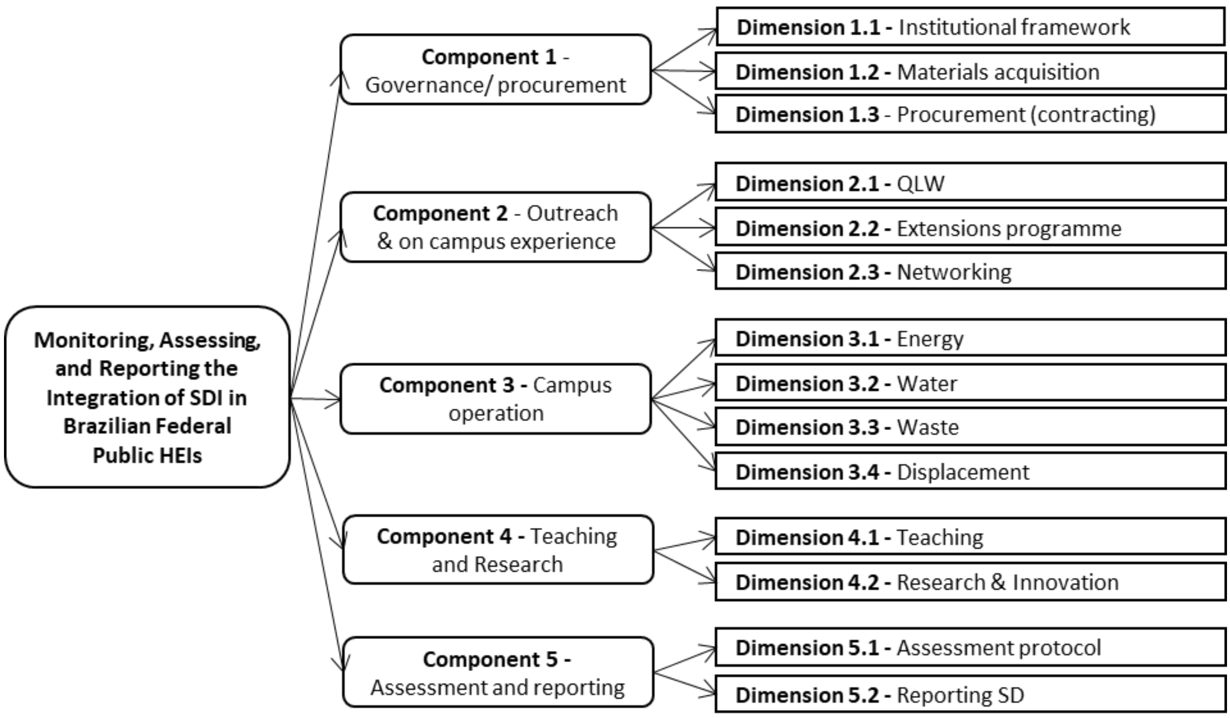

Figure 8-1 - Coding of the components and dimensions of the framework

The chapter is divided into 6 sections. The first five present the performance of the analysed HEI regarding the five components and their respective dimensions and indicators, as illustrated in Figure, which presents the coding adopted to organise the components and dimensions of the framework. In the sixth section, the overall performance achieved by institution in the framework is presented, and the results achieved and their implications are discussed.

8.1. Component 1 - Governance & Procurement

In chapter 2 of this PhD research, several models of HEI management were presented. These models incorporate sectors, departments, policies, strategies, and plans aiming at assisting HEI in fulfilling the commitments made at various multilateral meetings. Among these, we cite the models of Velazquez et al. (2006) - Figure 2-6; Alshuwaikhat and Abubakar (2008) - Figure 2-7; and Leal Filho, Amaro, et al. (2021) - Figure 2-8.

The aim of those multilateral meetings, discussed in chapter 2, was to redefine the role that HEI should assume in the transition to more sustainable social models. These changes in structure, policies, planning, and management have guided HEI in the direction that will allow them to better assume their important role in integrating sustainable development not only within the institution itself but also in society as a whole.

The first component, Governance/Procurement, encompasses the following three dimensions: 1.1. Institutional Framework; 1.2. Material Acquisition; and 1.3. Procurement (contracting).

8.1.1. Dimension 1.1. Institutional Framework

The "Institutional framework" dimension aims to evaluate this process of integrating SDIs into the organisational structure while, more pragmatically, verifying compliance with requirements R14, R15, R16, R17, R18, R19, and R20 of the NI10, 12/11/12 (available in Table 6-3). Article 9 of this instruction defines the minimum required planning structure for the implementation of sustainability practices (SLTI/MPOG/BRASIL, 2010). Additionally, requirement R22, established by the thirteenth article of the NI10, 12/11/12, requires the creation of a management committee to assess the results of the SLMP at pre-established intervals.

What is required?

The first dimension of the first component has a plan composed of three actions, as described in Table 9-1. The first one (EXT_Obj1_Act1) intends "To revise strategic plan to include commitment to SD initiatives" and has as indicator "Strategic commitment to integrating SD initiatives"; it has a dichotomous metric "Is SD commitment included in the Strategic Plan? (Y/N)", Furthermore, the goal is: "Have it or agree with including the SD commitment until the next revision (punctual)".

The second action of the first dimension (EXT_Obj1_Act2) intends "To create institutional SD policy", and the indicator name is "Institutional SD policy", which is computed through the following metric: "Has the institution SD policy? (Y/N)". The desired goal for this action is: "To have Institutional SD policy (punctual)".

The third action (EXT_Obj1_Act3) intends "To develop a campaign to disseminate the institutional commitment to the SD". The performance indicator for this action is "Campaigns to raise awareness of the institutional commitment to the SD". The metric is the "Number of campaigns about institutional commitment to the SD created per semester", and the target is "To have at least 4 campaigns created per semester (continuous)". The process' diagram of the dimension 1.1. Institutional Framework is depicted in Figure 9-2, followed by the respective Standard Operating Procedure (SOP), Table 9-2.

Analysis of the results

Table 8-1 - Performance achieved b Dimension 1.1 - Institutional Framework

Dimension 1.1 - Institutional Framework										
Quantitative criteria							Qualitative Criteria			
Indicator	BL mean	2019 mean	PV_{oa} (eq. 3)	Rel. Value x Impact (P/N)	Soa (0-1)	qtS_{oa} (Eq. 4)	Ic	(Ic/n_{oa})	qIS_{oa} (Eq. 6)	Total
EXT_Obj1_Act1							1	33.333%	0.100	0.100
EXT_Obj1_Act2							1	33.333%	0.100	0.100
Ext_Obj1_Act3							1	33.333%	0.100	0.100
			TOTAL	qtS_d (Eq. 5)		0.700	qIS_d (Eq. 7)		0.300	1.000

The UFPB has incorporated the commitment to integrate sustainable development into its official strategic planning and policy documents. The Institutional Development Plan, which serves as the institution's strategic plan, outlines its mission as "generating and disseminating knowledge and innovation through teaching, research, and extension to contribute to the development of society in a sustainable manner while ensuring public, free, inclusive, equitable, and quality education." (PDI UFPB, p 10). The Paraíba Development Institute (IDEP Acronym in Portuguese), established by CONSUNI Resolution no. 32/2011, is one of UFPB's supplementary management bodies and aims to "produce, disseminate, and promote the application of scientific, technological, artistic, and cultural knowledge integrated with the sustainable socioeconomic development of Paraíba."

In addition, UFPB has the Environmental Management Committee, an advisory body to the Rector's Office, whose responsibilities are defined in Superior University Council Resolution CONSUNI 17/2018. This resolution, approved by the University Council (CONSUNI) in 2018, establishes the Environmental Policy at UFPB as "a set of principles and guidelines aimed at implementing or adapting institutional actions to promote the sustainable development of UFPB and society in a manner compatible with a healthy and ecologically balanced environment." The resolution seeks to establish the institution's commitment to the preservation, conservation, and restoration of the environment and compliance with applicable legal requirements.

The competencies of the Environmental Management Committee are outlined in Article 12 of CONSUNI Resolution 17/2018, which states that the Committee is responsible for:

> I - Complying with and enforcing UFPB regulations and legislation.
>
> II - Proposing alterations or updates to the present Environmental Policy to the University Council.
>
> III - Articulating, guiding, prioritizing, regulating, monitoring, registering, and evaluating institutional environmental management and education programs.
>
> IV - To manifest on matters within its competence, especially in the elaboration of UFPB's Institutional Development and Expansion Plan and the Master Plan
>
> V - Providing reports and opinions on matters within its competence, either at its own discretion or upon request.
>
> VI - Proposing agreements, rules, procedures, and actions.
>
> VII - Appointing thematic sub commissions at its discretion.
>
> VIII - Ensuring access to environmental information and promoting democratic participation in all stages of environmental management and education.
>
> IX - Systematically promoting broad and democratic debate on environmental issues; and
>
> X - Carrying out any other competencies defined in its Internal Regulations.

Most of the campaigns to promote sustainable development at UFPB are disseminated through the social media channels of the Environmental Management Commission (CGA) (https://www.instagram.com/cgaufpb/) or the sub-programmes that are linked to CGA, such as "Green prank", whose campaigns can be accessed through the link (https://www.instagram.com/troteverde/), or the TV UFPB channel (https://www.instagram.com/tvufpb/) (https://www.youtube.com/user/TVUFPB). More than four campaigns were launched in the last semester.

Considering that none of the indicators in this dimension is quantitative, therefore it has no baseline, the score of 0.7 was attributed to the quantitative criteria, and the institution scored positively in all qualitative indicators, as shown in Table 8-1. Thus, the total score for dimension 1.1. Institutional Framework was 1.

8.1.2. Dimension 1.2. Material Acquisition

Lăzăroiu et al. (2020) and Novaes das Virgens et al. (2020) posit that green public procurement, eco-efficient utilisation of materials and services, adoption of biofuels, smart use of energy in public buildings, and innovative management approaches, such as remote work, should be prioritised by public agencies in order to enhance SD performance.

Communication number 400, (2008, p. 4) from the Commission to the European Parliament, The Council, The European Economic and Social Committee and the Committee of the Regions defines Green Public Procurement (GPP) as "a process whereby public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life cycle when compared to goods, services and works with the same primary function that would otherwise be procured.". The concept of green public procurement refers to the acquisition of goods and services that mitigate environmental impacts across their entire life cycle. Therefore optimal procurement decisions in the public sector carry significant ecological, economic, and social implications (Lăzăroiu et al., 2020).

The requirement regarding “material acquisition” is classified as R7 in the Table 6-3, which lists all the requirements of the Normative regarding SLMP. Thus, according to the Normative Instruction's eighth chapter, the material acquisition should be a sustainability practices that promote the rational use of materials and the action have to encompass the purchasing of consumables, including, but not limited to, (i) printing paper, (ii) disposable cups, and (iii) printing cartridges.

What is required?

Therefore, in this dimension, a comprehensive set of 19 performance indicators has been developed, comprising eight basic (BAS) and eleven extended (EXT) indicators. A detailed list of indicators that are part of this dimension is available in Table 9-4, and the distribution of the scores assigned to each of the indicators is presented in the “Diagram for Dimension 1.2. Material acquisition” (Figure 9-3), finally the “Standard Operating Procedure for Action Plan 1.2. Material acquisition” (Table 9-5), which are accessible in the appendix of this work.

The assessment of sustainable development initiatives in this dimension is focused on the acquisition of printing paper, disposable cups, and toners. The evaluation is carried out through a series of indicators. Indicators one through six, namely BAS_Objj2_Act1, BAS_Obbj2_Act2, BAS_Obj2_Act3, EXT_Obj2_Act4, EXT_Obj2_Act5, and EXT_Obj2_Act6, evaluate the performance of action plans focused on integrating sustainable development initiatives in the purchasing of printing paper. Indicators seven through thirteen, namely BAS_Obbj2_Act7, BAS_Obbj2_Act8, BAS_Obbj2_Act9, BAS_Obbj2_Act10, EXT_Obj2_Act11, EXT_Obj2_Act12, and BAS_Obj2_Act13, assess the performance of action plans aimed at promoting sustainable development initiatives in the purchase of disposable cups. Additionally, indicators fourteen and fifteen, namely EXT_Obbj2_Act14 and EXT_Obj2_Act15, are designed to evaluate the performance of action plans related to the acquisition of toners.

The sixteenth indicator, EXT_Objj2_Act16, is dedicated to assessing the effectiveness of digitalisation strategies in reducing the use of printing paper. Finally, indicators seventeen through nineteen, namely EXT_Obj2_Act17, EXT_Obbj2_Act18, and EXT_Obj2_Act19, are employed to evaluate the performance of campaigns aimed at raising awareness to reduce the use of paper, disposable cups, and toner, respectively.

Analysis of the results

The fifth column of table 47 informs that for all quantitative indicators related to the "Material acquisition" dimension, the greater the positive variation between the baseline (column two) and the reference year (column three), the more important is the negative environmental impact. And on the contrary, the greater the negative variation between the baseline and the reference year, the better the environmental performance for the indicator analysed. Thus, among the fifteen indicators, seven have positive and eight negative variations. Following the same reasoning, the indicator that presents the best environmental performance in the dimension analysed is the indicator "Per capita consumption of 50 ml disposable cups per public servant" (BAS_Obj2_Act10), since there was a meaningful reduction in the consumption of disposable cups in the reference year in comparison to the baseline. In the baseline year, an average of 0.092 cups per servant were consumed, while in the baseline period, there was an average consumption of 1.923 cups per month.

On the contrary, in parallel to the reduction of 50ml glasses, there was a significant increase in the consumption of 180 ml disposable cups in 2019 (87,667) compared to the baseline (19,895.83). These two indicators show the interdependent relationships between the various indicators in the model and their complexity. As the acquisition of 50ml cups decreases, there is a parallel increase in the consumption of 180ml cups, possibly motivated by economic and not environmental reasons. Note that although the consumption of 180ml cups has increased, the total expenditure in BRL (Brazilian currency) for purchasing these cups decreased compared to the baseline (BAS_Obj2_ Act13). The average monthly spending on 180ml cups in 2017 and 2018 was R$ 666.39 BRL; in 2019, it was lower (R$ 652.42 BRL), with a negative variation of -2.096.

Regarding the consumption of cartridges and toners, there was a significant reduction in the number of cartridges and toners purchased in 2019 compared to the baseline (EXT_Obj2_Act14). In 2019, a monthly average of 43 cartridges/toners was acquired, and in the baseline period, the average monthly number of acquisitions was 119.04 cartridges/toners. This reduction was reflected in the average expenditure for the acquisition of this material (EXT_Obj2_Act15). In 2019, an average of R$ 6,303.39 BRL per month was spent on the investment of cartridges and toners, while the average monthly expenditure in 2017 and 2018 was R$ 18,511.74 BRL.

The paper was the material with the slightest variation between the baseline and the reference year (2019). The indicators BAS_Obj2_Act1 and BAS_Obj2_Act3 deal, respectively, with the average number of sheets purchased and the amount spent on this acquisition. Both show minor, negative variations of -1.443 and -2.861.

Concerning indicator EXT_Obj2_Act16, which intends "to promote the reduction of paper use by regulating the digitalisation of processes", HEI has driven the digitalisation of administrative and academic processes through the acquisition of automated process management systems (Integrated System of Assets, Administration and Contracts - SIPAC) that allows the registration and digitalisation of all data related to the administrative processes of the institution, including those related to their movement and filing (UFPB, 2019b).

The report (UFPB, 2020, p. 100) stated that

> 2019 was a milestone at the university concerning changing behaviour regarding administrative processes. Joint work between the Central Archive and the Superintendence of Information Technology was responsible for implementing the electronic process. The CONSUNI Resolution no. 10/2019 formalised the transformation work that UFPB agencies had carried out regarding implementing electronic processes within the UFPB, establishing its implementation, operation and use parameters.

Figure 40, reported in the UFPB's 2019 Management Report, illustrates the transformation of replacing physical processes (red line) with electronic processes (blue line).

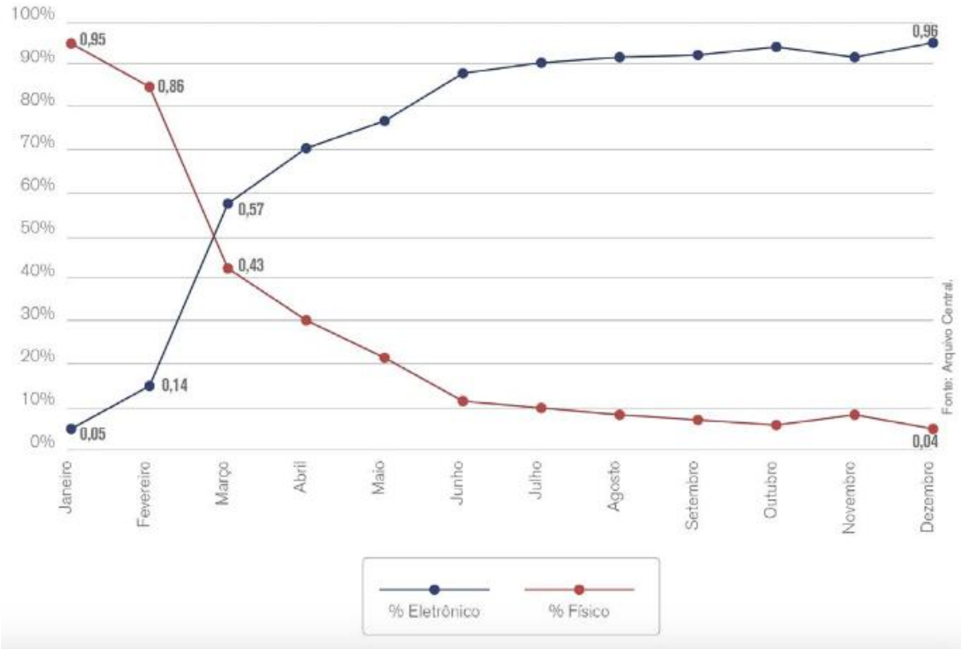

Figure 8-2 -Comparative evolution of physical and electronic process creation in 2019

Source: (UFPB, 2020, p. 100)

The campaigns required in indicators EXT_Obj2_ Act17, EXT_Obj2_ Act18, and EXT_Obj2_ Act19 were carried out on the Institution's social media. Figure 8-3shows an example of a campaign run on Instagram by the UFPB Environmental Management Committee on sustainable paper procurement.

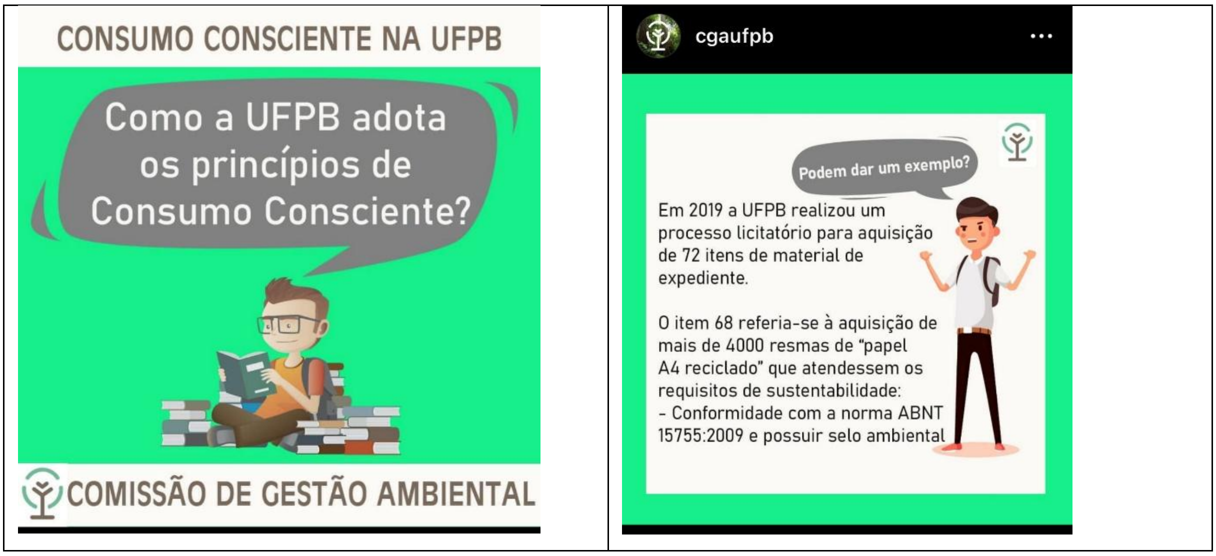

Figure 8-3 - Conscious Consumption Campaign at UFPB

(Source: https://www.instagram.com/cgaufpb/.Text of the image: How does UFPB adopt the principles of Conscious Consumption? In 2019, UFPB carried out a bidding process for the acquisition of 72 items of office supplies. Item 68 refers to acquiring over 400 reams of recycled a4 paper that meet the sustainability requirements - Compliance with the ABNT 15755:2009 standard and has an environmental seal.)

Table 8-2 - Performance achieved b Dimension 1.2 - Material Acquisition

Dimension 1.2 - Material Acquisition										
	Quantitative criteria						Qualitative Criteria			
Indicator	**BL mean**	**2019 mean**	**PV_{oa} (eq. 3)**	**Rel. Value x Impact (P/N)**	**Soa (0-1)**	**qtS_{oa} (Eq. 4)**	**Ic**	**(Ic/n_{oa})**	**qIS_{oa} (Eq. 6)**	**Total**
BAS_Obj2_Act1	441666,667	435291,667	-1,443	Negative	0,6	0,028	1	5,263%	0,016	0,044
BAS_Obj2_Act2	68,673	73,044	6,365	Negative	0,5	0,023	1	5,263%	0,016	0,039
BAS_Obj2_Act3	12941,054	12570,763	-2,861	Negative	0,6	0,028	1	5,263%	0,016	0,044
EXT_Obj2_ Act4	379,292	1153,083	204,010	Negative	0,1	0,005	1	5,263%	0,016	0,020
EXT_Obj2_ Act5	482,579	1106,250	129,237	Negative	0,1	0,005	1	5,263%	0,016	0,020
EXT_Obj2_ Act6	42,583	554,750	1202,740	Negative	0,1	0,005	1	5,263%	0,016	0,020
BAS_Obj2_ Act7	19895,833	87667,000	340,630	Negative	0,1	0,005	1	5,263%	0,016	0,020
BAS_Obj2_ Act8	12220,833	583,333	-95,227	Negative	1	0,047	1	5,263%	0,016	0,062
BAS_Obj2_ Act9	3,130	14,666	368,562	Negative	0,1	0,005	1	5,263%	0,016	0,020
BAS_Obj2_ Act10	1,923	0,092	-95,216	Negative	1	0,047	1	5,263%	0,016	0,062
EXT_Obj2_ Act11	0,504	2,310	358,333	Negative	0,1	0,005	1	5,263%	0,016	0,020
EXT_Obj2_ Act12	0,307	0,014	-95,440	Negative	1	0,047	1	5,263%	0,016	0,062
BAS_Obj2_ Act13	666,390	652,420	-2,096	Negative	0,6	0,028	1	5,263%	0,016	0,044
EXT_Obj2_ Act14	119,000	49,000	-58,824	Negative	1	0,047	1	5,263%	0,016	0,062
EXT_Obj2_ Act15	18511,740	6303,390	-65,949	Negative	1	0,047	1	5,263%	0,016	0,062
EXT_Obj2_ Act16							1	5.263%	0.016	0.016
EXT_Obj2_ Act17							1	5.263%	0.016	0.016
EXT_Obj2_ Act18							1	5.263%	0.016	0.016
EXT_Obj2_ Act19							1	5.263%	0.016	0.016
			Total	**qtS_d (Eq. 5)**		0.369	**qIS_d (Eq. 7)**		0.300	0.669

In view of the above, it is verified in Table 8-2 that the performance achieved by the analysed HEI in quantitative indicators, which have a total weight equal to 0.7, was 0.369. The qualitative indicators obtained 100% of performance, with a score equal to 0.3, making up a total score of 0.669 in this dimension.

8.1.3. Dimension 1.3. Procurement (contracting)

In part of the literature on public procurement, the terms "material acquisition" and "procurement" are treated indistinctly (Lloyd & McCue, 2001; Prier & McCue, 2009). In a sense given by Brazilian normative instruction (SLTI/MPOG/BRASIL, 2010), the first term deals with purchasing goods such as paper, computers, and printers. The second, procurement, is focused on contracting services such as cleaning, food, security, telephony, and construction services, among others.

Incorporating the liberal trend of outsourcing non-core activities in public institutions, Brazilian federal public HEI have outsourced all services that are unrelated to the main areas of action, namely management, teaching, research, and extension. Such services including security, cleaning, construction and building maintenance, as well as food-related services. Notably, sustainable development initiatives are closely monitored in the execution of services falling under this purview.

What is required?

Thus, the indicators BAS_Obj3_Act1 and BAS_Obj3_Act2 monitor fixed and mobile telephony services. Indicators BAS_Obj3_Act3, BAS_Obj3_Act4, EXT_Obj3_Act5, EXT_Obj3_Act6, EXT_Obj3_Act7 are used to analyse data on the surveillance service's execution. Indicators BAS_Obj3_Act8, BAS_Obj3_Act9, EXT_Obj3_Act10, EXT_Obj3_Act11, EXT_Obj3_Act12 are employed to assess the cleaning service carried out on the analysed HEI campuses. Indicators BAS_Obj3_Act13 and BAS_Obj3_Act14 track the execution of construction and maintenance contracts, while indicator EXT_Obj3_Act15 monitor the remote security contract performed through cameras and emergency alarms. Finally, indicators EXT_Obj3_Act16 and EXT_Obj3_Act17 are used to examine campaigns promoting the rational use of telephony services and maintenance of cleanliness in campus areas, respectively. The details of the actions, indicators, metrics, and goals related to the procurement dimension are outlined in Table 9-7 and Table 9-8 and Figure 9-4 located in the appendix.

Analysis of the results

The contract numbers for mobile and fixed telephony services (BAS_Obj3_Act1 and BAS_Obj3_Act2), as well as for building construction and maintenance contracts (BAS_Obj3_Act13 and BAS_Obj3_Act14) were not provided. Additionally, information regarding the coverage area of the remote surveillance contract (EXT_Obj3_Ac15) was also not provided. This lack of information impeded the data collection process required for the calculation of their respective indicators.

The process of repactuation, which is based on article 37, XXI of the Brazilian Federal Constitution of 1988, constitutes one of the legal means for the recompositing of the economic-financial balance aimed at maintaining the effective conditions of the proposal. Its normative origin can be found in Decree 2,271/97, which describes it as the analytical verification of the variation of input costs, occurring in adjustments where the price formation takes into account, mainly, labour costs (Lobo, 2022; Pércio, 2018).

Indicators BAS_Obj3_Act4 and BAS_Obj3_Act4 address the repactuation of surveillance and cleaning contracts, respectively. According to Wellington and Almeida (2009), price repactuation involves a mutually agreed (pact) alteration of the value with a previously fixed periodicity, not less than twelve months, and which is not linked to previous official indices. After a year of execution, the current variation of costs and charges in execution of the contract should be taken into account. In practical terms, repactuation consists of a variation in the current value paid for the contracted service in relation to the value charged in the previous year. The repactuation is more appropriate when it is closer to official price variation indices. The indicators regarding the repactuation of the contracts of surveillance and cleaning were not calculated because, there was no repactuation of those contracts in 2019, as a result of non-renewal of existing contracts and the subsequent hiring of new service providers.

In this context, the number of dimensions that can be quantitatively measured (qt_{noa} - see Equation 4) will be 13. This means that, although the dimension comprises 15 quantitative indicators two indicators (BAS_Obj3_Act4 and BAS_Obj3_Act4) have not been considered for the purposes of calculating the performance of the dimension, due to the fact that these indicators do not apply to the current context of the HEI analysed.

As described above, the mathematical modelling developed within a complex adaptive systems approach enables the inclusion or exclusion of indicators in the framework without hindering its usability. This is a differential of this tool in relation to the existing ones.

Table 8-3 shows a positive variation in practically all indicators in 2019 if compared to the baseline. The exception occurs with the indicator BAS_Obj3_Act8, which has zero variation for the years analysed. The indicator with the most significant variation was the total amount paid monthly for the cleaning service, which obtained an average monthly increase of R$ 94,699.14 BRL in 2019 compared to the baseline.

Table 8-3 - Performance achieved by Dimension 1.3 - Procurement (contracting).

Dimension 1.3 - Procurement										
	Quantitative criteria						Qualitative Criteria			
Indicator	**BL mean**	**2019 mean**	**PV_{oa} (eq. 3)**	**Rel. Value x Impact (P/N)**	**Soa (0-1)**	**qtS_{oa} (Eq. 4)**	**Ic**	**(Ic/n_{oa})**	**qIS_{oa} (Eq. 4)**	**Total**
BAS_Obj3_Act1							1	5,882%	0,018	0,018
BAS_Obj3_Act2							1	5,882%	0,018	0,018
BAS_Obj3_Act3	7,919.44	9,060.42	14.407	Negative	0.4	0,022	1	5,882%	0,018	0,039
BAS_Obj3_Act4							1	5,882%	0,018	0,018
EXT_Obj3_Act5	639,922.95	686,303.51	7.248	Negative	0.5	0,027	1	5,882%	0,018	0,045
EXT_Obj3_Act6	100.73	108.03	7.248	Negative	0.5	0,027	1	5,882%	0,018	0,045
EXT_Obj3_Act7	14.51	15.56	7.258	Negative	0.5	0,027	1	5,882%	0,018	0,045
BAS_Obj3_Act8	0.011	0.011	0.000	Negative	0.6	0,032	1	5,882%	0,018	0,050
BAS_Obj3_Act9							1	5,882%	0,018	0,018
EXT_Obj3_Act10	379,032.26	473,731.40	24.984	Negative	0.3	0,016	1	5,882%	0,018	0,034
EXT_Obj3_Act11	59.66	69.15	15.905	Negative	0.4	0,022	1	5,882%	0,018	0,039
EXT_Obj3_Act12	8.60	9.96	15.916	Negative	0.4	0,022	1	5,882%	0,018	0,039
BAS_Obj3_Act13							0	5.882%	0.000	0.000
BAS_Obj3_Act14							0	5.882%	0.000	0.000
EXT_Obj3_Act15							1	5.882%	0.018	0,018
EXT_Obj3_Act16							1	5.882%	0.018	0,018
EXT_Obj3_Act17							1	5.882%	0.018	0,018
			TOTAL	**qtS_d (Eq. 5)**		0.194	**qIS_d (Eq. 7)**		0.300	0.459

For the indicator EXT_Obj2_Act15, the variation in the security contract is lower (7,248), but as the contract value is higher, the increase causes an impact of R$ 46,380.56 BRL on the monthly amount paid for the service, as shown in the table above.

The significant or moderate increases in the values of the contracts make the "procurement" dimension the second worst performing among the dimensions of the framework. The dimension obtained a final score equal to 0.459.

8.2. Component 2 - Outreach & On-campus experience

The Outreach & On-campus experience component comprises the dimensions of "quality of life at work", "extension programmes", and "networking". The NI10, 12/11/12 requires only the first of these three dimensions (R11, Article 8, V, available in Table 6-3). The dimension of extension programmes, being highly specific to the higher education environment, could not be included in the NI10, 12/11/12, which applies to all Brazilian federal public bodies. In the development of normative instruction, the approach of networking or benchmarking, which would allow for data integration and comparison, was not operationalised in the regulation. However, the CISAP has created a portal for collecting and distributing the plans and reports prepared by Brazilian public institutions.

The outreach and on-campus experience components of HEI's sustainability efforts are essential to creating a sustainable and equitable future. The on-campus experience reflects the institution's commitment to sustainability in its daily practices, while the outreach efforts aim to create synergies with external stakeholders towards sustainable development (Dlouhá et al., 2018; Lozano, 2006a). Both components are crucial for HEI to become leaders in sustainable development and promote a holistic approach to sustainability.

8.2.1. Dimension 2.1. Quality of life at work

Quality of life at work is a multi-faceted concept that refers to the overall well-being and satisfaction of employees in their work environment. It encompasses various dimensions of the workplace, including physical, emotional, social, and psychological factors that contribute to employee satisfaction and productivity (Abdi et al., 2021; Bagtasos, 2011).

HEI are characterised by high levels of work-related stress in academics regarding to abrupt changes in digital technologies, rising job demand, rapid growth of students number, difficulties in funding research and even competition with colleagues are exposing academic to risks related to higher level of work stress (Brondino et al., 2022; Kinman & Wray, 2020; Wray & Kinman, 2022).

Several studies have examined the impact of quality of life on stress levels, sleep patterns, and academic performance among members of the academic community(Pascoe et al., 2020; Pedro et al., 2022). This issue can also have a significant effect on the mental health of individuals within higher education institutions(Alsubaie et al., 2019).

Academics in Higher Education Institutions (HEI) face significant work-related stress due to a range of factors including sudden shifts in digital technologies accelerated in pandemic period, increasing job demands, a rapid growth in the number of students, funding difficulties for research, and even competition among colleagues. These stressors are putting academics at risk of experiencing higher levels of work-related stress, as evidenced by recent studies conducted by Brondino et al. (2022), Kinman & Wray (2020), and Wray & Kinman (2022).

What is required?

The dimension of Quality of life at work encompasses two indicators, one that is basic and quantitative and another that is extended and qualitative. The first indicator aims to evaluate the "Participation of public servants in programs and/or actions focused on the quality of life at the workplace." Its objective is to ensure that a minimum of 10% of servers receive annual training (see Table 9-10). To collect the necessary data, annual management reports from both the UFPB (UFPB, 2014, 2019d, 2020) and the Pro-Rectory of People Management (PROGEP/UFPB, 2017, 2018, 2019) are utilised.

The second indicator seeks to assess the effectiveness of the "Campaigns to promote quality of life at the workplace." Its objective is to ensure that at least four campaigns are created per semester.

Analysis of the results

According to the 2017 Management Report, 2510 university employees (faculty and administrative staff) participated in quality of life programs in the workplace, out of a total of 6,350 employees (UFPB, 2018, pp. 204–205). This represents 39.53% of employees who were served through quality of life programs or actions in the workplace. In 2018, the proportion was 21.56%, and in 2019, it was 39.35%, according to data from the 2019 management report (UFPB, 2020, p. 80). Therefore, the average for the considered baseline period (2017 and 2018) is 30.54%. As shown in Table 8-4, the performance for the quantitative indicator (BAS_Obj4_Act1) was 0.560, and for the qualitative indicator (EXT_Obj4_Act2), it was 8.860, resulting in an overall performance of 8.860 for this dimension.

In addition to the programs and actions developed under the division of Quality of life at work, the University offers various activities to improve the quality of life for its employees and the entire academic community and public surroundings. In the year 2019, 116 training courses were offered to servers, with a total of 4,051 certifications granted in various studies, among which are the course of preparation for retirement, Yoga, Emotional Education, Stress Assessment, Reiki Massage, Active Learning Methodologies, English, Personal Marketing, in addition to offering free classes in various sports practices to example access to the gym, indoor football classes, swimming and tennis (PROGEP/UFPB, 2019).

Table 8-4 - Performance achieved by Dimension 2.1 - Quality of life at work.

Dimension 2.1 - QLW										
			Quantitative criteria					Qualitative Criteria		
Indicator	**BL mean**	**2019 mean**	**PV_{oa} (eq. 3)**	**Rel. Value x Impact (P/N)**	**Soa (0-1)**	**qtS_{oa} (Eq. 4)**	**Ic**	**(Ic/n_{oa})**	**qlS_{oa} (Eq. 6)**	**Total**
BAS_Obj4_Act1	30.54	39.35	28.847	Positive	0.8	0.560	1	50.000%	0.150	0.570
EXT_Obj4_Act2							1	50.000%	0.150	0.150
			TOTAL	**qtS_d(Eq. 5)**		0.560	**qlS_d (Eq. 7)**		0.300	0.860

These campaigns are aimed at improving the "Quality of life at work" and are broadcasted through various social media platforms of UFPB. The most prominent of these include the Instagram accounts of PROGEP (https://www.instagram.com/progepufpb/?hl=en), TV UFPB channel (https://www.instagram.com/tvufpb/) (https://www.youtube.com/user/TVUFPB), and the Environmental Management Commission (CGA) (https://www.instagram.com/cgaufpb/).

In 2019 an agenda of institutional campaigns was aired to promote the quality of life of the academic community. Primary campaigns: White January, for a mental health culture - Mental Health all year round!; Yellow September, suicide prevention month - Life is the Best Choice; Pink October, breast cancer prevention month - Let's Talk about Breast Cancer?; Blue November, an awareness month about men's health, aiming to alert to the importance of early diagnosis of prostate cancer; and Red December, a month to combat HIV and AIDS and other sexually transmitted infections. Besides campaigns on moral harassment and smoking, among others (PROGEP/UFPB, 2019; UFPB, 2020). Figure 8-4 (left image) depicts the lecture offered during the month of September for the promotion of the Yellow September

Campaign: Promotion of Life and Suicide Prevention. Figure 8-4 (right image) shows the campaign of a training offered to lectures and staff regarding the use of meditation and self-care.

Figure 8-4 – Campaigns, lectures, and courses offered by UFPB to promote quality of life at work.

(Source: (UFPB, 2019a, 2019c) Yellow September Campaign: Promotion of Life and Suicide Prevention (left image); Training on self-care with meditation and yoga practices (right image).

8.2.2. Dimension 2.2. Extension programmes

University outreach or third mission activities, refers to the various activities and initiatives undertaken by universities to engage with external communities, individuals, and organisations beyond the academic institution itself (Knudsen et al., 2021). The goal of university outreach is to gain value by share knowledge and expertise with the wider world, foster mutually beneficial collaborations, and contribute to societal development and progress.

According to Lange Salvia et al. (2020), since the United Nations Decade of Education for Sustainable Development (2005-2014), HEI have been called upon to assume their role in promoting sustainable development and contributing to society and external stakeholders. As suggested by Berchin et al. (2019), the concept of outreach on sustainability can be defined as universities' endeavours to engage with the communities in their surroundings through a mutually beneficial process of sustainable development.

What is required?

The extended indicator (EXT_Obj5_Act1) is qualitative and aims to assess whether the institution has mechanisms to measure the sustainability of university extension activities.

Analysis of the results

The Federal University of Paraíba has a web platform that monitors the integration of outreach actions developed by the university with the objectives of sustainable development (SDGs). According to the data provided by the platform, there are currently 231 extension activities related to SDGs (UFPB, 2023).

Table 8-5 - Performance achieved by Dimension 2.2 - Extensions programme.

Dimension 2.2 - Extensions programme											
	Quantitative criteria						Qualitative Criteria				
Indicator	**BL mean**	**2019 mean**	**PV_{oa} (eq. 3)**	**Rel. Value x Impact (P/N)**	**S_{oa} (0-1)**	**qtS_{oa} (Eq. 4)**	**Ic**	**(Ic/n_{oa})**	**qlS_{oa} (Eq. 6)**	**Total**
EXT_Obj5_Act1							1	100%	0.300	0.300
			TOTAL	**qtS_d (Eq. 5)**		0.700	**qlS_d (Eq. 7)**		0.300	1.000

As indicated in Table 8-5, the university obtained a score of 1.0 for the Extension Programme dimension, having fulfilled the indicator requirements.

8.2.3. Dimension 2.3. Networking

Kleve (2017, p. 354) suggests that networking occurs when the specialised expert systems are unable to stimulate problem-solving, when organisations require collaboration with external entities, or when the formal organisation's ability to create solutions is in question. In these situations, affected citizens are often asked to network and support each other to address their problems. Giesenbauer and Müller-Christ (2020) acknowledge that in order to effectively meet the complex challenge of SD in HEI, there is a need to enhance their general capacity to deal with complexity. This involves not only finding ways to integrate sustainable development within the internal operating system of HEI (horizontal integration), but also opening up to various stakeholders. To achieve this, HEI needs to improve their ability to collaborate across organisations, and one of the ways to do this is to invest in creating or being part of a network (vertical integration – see section 7.1.6).

Aleixo et al. (2016) conducted a study to analyse how key stakeholders in public Portuguese HEI perceive the role of institutions in promoting sustainable development, as well as the main barriers, challenges, and obstacles in implementing sustainable development initiatives. Among the findings, the authors recognised the importance of being part of networks of sustainable universities, as having access to best practices for integrating sustainable development initiatives can accelerate actions that will enable Portuguese universities to achieve their expected goals.

What is required?

The extended indicator (EXT_Obj6_Act1) intends to assess whether the HEI is part of a network of sustainable universities. The goal is to be part of at least one sustainable universities network (see Table 9-16).

Analysis of the results

The Federal University of Paraíba is one of the 520 signatories of the Talloires Declaration, thus becoming a member of the Association of University Leaders for Sustainable Development (ULSF). In August 2020, it also joined the Inter-University Sustainable Development Research Programme (IUSDRP), a global network consisting of more than 100 higher education institutions that are committed to the sustainable development of the planet. This consortium is led by the University of Manchester Metropolitan, England, and the Hamburg University of Applied Sciences, Germany.

Table 8-6 - Performance achieved by Dimension 2.3 - Networking.

Dimension 2.3 - Networking										
			Quantitative criteria					Qualitative Criteria		
Indicator	**BL mean**	**2019 mean**	**PV_{oa} (eq. 3)**	**Rel. Value x Impact (P/N)**	**Soa (0-1)**	**qtS_{oa} (Eq. 4)**	**Ic**	**(n_c/n_{oa})**	**qlS_{oa} (Eq. 6)**	**Total**
EXT_Obj6_Act1							1	100.00%	0.300	0.300
			TOTAL	**qtS_d (Eq. 5)**		0.700	**qlS_d (Eq. 7)**		0.300	1.000

As shown in Table 8-6 the HEI has met the requirement of indicator EXT_Obj6_Act1, the institution obtained a score of 1.0 for dimension Networking.

8.3. Component 3 - Campus Operations

Anthony Jnr (2021) acknowledge that there is a call for HEI to implement SDI in supporting sustainability attainment for waste decrease, energy efficiency, water utilisation reduction, healthy working surroundings as well as clean indoor air

The component Campus Operations is the largest component of the designed framework, comprising the following four dimensions, Energy, Water and sewage, Waste and Displacement. Another specificity of this component is that it is the only one with all action plans required in the NI10, 12/11/12. The action plan Energy is required in the requisite R08, the action plan Water and sewage is demanded in the requisite R09, while the action plans Waste and Displacement are required by the requisites R10 and R13, respectively.

8.3.1. Dimension 3.1. Energy

Ensuring sustainability in HEI demands that universities promote green practices that reduce energy consumptions while having a minimal carbon footprint. According to Leal Filho et al. (2015), there are two commonly targeted areas for campus greening initiatives that are seen as easy to implement and serve as a starting point for sustainable practices: solid waste and energy management. Rebelatto et al. (2019), acknowledge that HEI have a significant impact on the environment through their activities, operations, and support services, resulting in high energy consumption. However, by implementing organisational, technological, and energy optimisation measures, this impact can be considerably reduced.

What is required?

The energy dimension comprises eleven indicators, of which seven are basic and four are extended. Indicators BAS_Obj7_Act1 and BAS_Obj7_Act4 aim to quantify the monthly consumption of electric energy in BRL and in kWh, respectively. Indicators BAS_Obj7_Act2 and EXT_Obj7_Act3 aim to calculate per capita expenditure in BRL, with the former considering only public servants, and outsourced workers, and the latter including the entire academic community, i.e., in addition to the aforementioned groups, it also includes students. Indicators BAS_Obj7_Act5 and EXT_Obj7_Act6 perform calculations like those previously mentioned, except that instead of calculating per capita expenditure in BRL, they calculate per capita consumption in kWh. Indicators BAS_Obj7_Act7 and BAS_Obj7_Act8 evaluate the effectiveness of peak and off-peak contracts. Indicator BAS_Obj7_Act9 quantifies the energy expenditure in BRL per m^2. Indicator EXT_OBJ7_Act10 aims to identify research investments to improve energy efficiency through the implementation of renewable energy sources in the HEI. Finally, indicator EXT_OBJ7_Act11 evaluates the development of educational campaigns to rationalise electricity use.

Analysis of the results

Among the indicators that make up the energy dimension, the one with the highest variation was the value paid in BRL for energy (BAS_Obj7_Act1), which increased by R$191,637.30 BRL. However, this increase was much lower than the variation resulting from the consumption of kWh (BAS_Obj7_Act4), with a difference of only 1,297.53 between 2019 and the baseline. The disproportionate difference between the value paid in BRL and the quantity of kWh consumed is due to the complex pricing policy of the Brazilian electricity market, which has adopted the tariff flag system that causes prices to vary according to the system's supply capacity (Acende Brasil, 2020).

Table 8-7 illustrates the improvement in on-peak contract adequacy (BAS_Obj7_Act8), which showed a negative variation of 9,302 between 2019 and the baseline. The 2019 result is only 0.021 points away from perfect adequacy, meaning a situation in which consumption is equal to the contracted amount (1.0). The data also show a slight reduction in the per capita amount paid by the academic community (EXT_Obj7_Act3) in 2019 compared to the baseline. The average value paid in BRL in 2017 and 2018 was R$27,433 BRL, while in 2019 it was R$26,460 BRL.

Regarding the indicator (EXT_OBJ7_Act10) that seeks to analyse whether UFPB encourages studies on the viability of alternative energy sources (solar, thermoelectric, and wind), a master's dissertation defended in 2018 entitled "Evaluation of lighting for educational environments aimed at energy efficiency: a case study of the Renewable Energy Centre building" by Camila Sales Nóbrega de Santana was identified (Santana, 2018).

Table 8-7 - Performance achieved by Dimension 3.1 - Energy.

Dimension 3.1 - Energy										
Quantitative criteria							Qualitative Criteria			
Indicator	**BL mean**	**2019 mean**	**PV_{oa} (eq. 3)**	**Rel. Value x Impact (P/N)**	**Soa (0-1)**	**qtS_{oa} (Eq. 4)**	**n_c**	**(n_c/n_{oa})**	**qlS_{oa} (Eq. 6)**	**Total**
BAS_Obj7_Act1	997,781.180	1,189,418.478	19,206	Negative	0,4	0,031	1	9,091%	0,027	997781,18
BAS_Obj7_Act2	163.252	195.147	19,537	Negative	0,4	0,031	1	9,091%	0,027	163,25
EXT_Obj7_Act3	27.433	26.460	-3,547	Negative	0,6	0,047	1	9,091%	0,027	27,43
BAS_Obj7_Act4	1,531,062.968	1,532,360.500	0,085	Negative	0,5	0,039	1	9,091%	0,027	1531062,96
BAS_Obj7_Act5	241,174	251,413	4,246	Negative	0,5	0,039	1	9,091%	0,027	241,17
EXT_Obj7_Act6	35,855	34,088	-4,926	Negative	0,6	0,047	1	9,091%	0,027	35,85
BAS_Obj7_Act7	0,932	0,929	-0,313	Positive	0,5	0,039	1	9,091%	0,027	0,93
BAS_Obj7_Act8	0,906	0,979	9,302	Positive	0,6	0,047	1	9,091%	0,027	0,90
BAS_Obj7_Act9	0,086	0,085	12,088	Negative	0,5	0,039	1	9,091%	0,027	0,08
EXT_Obj7_Act10							1	9.091%	0.027	0.027
EXT_Obj7_Act11							1	9.091%	0.027	0.027
			TOTAL	**qtS_d (Eq. 5)**		0.358	**qlS_d (Eq. 7)**		0.300	0.658

To reduce energy consumption on its campuses, UFPB has implemented a range of strategies, such as replacing fluorescent bulbs with LED bulbs, publishing Office Memo No. 419/2019 from the Office of the Rector, which restricts the use of air conditioning appliances and establishes temperature limits to guide their use. The HEI has also contracted an enterprise for the installation of photovoltaic panels (UFPB, 2020).

8.3.2. Dimension 3.2. Water

The utilisation of water in HEI is considered a fundamental indicator for evaluating sustainability (Abu Qdais et al., 2019). The principal SAT reviewed in chapter 3 have specific indicators for measuring water consumption. For instance, GASU includes an indicator associated with water consumption in the environmental dimension (N. Alghamdi et al., 2017). The SAQ tool assesses water conservation in the campus operation dimension (Du et al., 2020). The STARS, within the "campus operation" dimension, comprises a sub-dimension with indicators that evaluate sustainability in water use (AASHE, 2019a). Furthermore, one of the six dimensions of UI-Greenmetrics focuses on "water," which underlines the significance of SDI actions associated with water use (Parvez & Agrawal, 2019; Suwartha & Berawi, 2019).

What is required?

The NI10, 12/11/12 that requires the development of the SLMP also mandates the monitoring of water use (see requirement nine in Table 7-1). Within the framework, the water dimension comprises eight indicators, of which four are basic. The indicators BAS_Obj8_Act1 and BAS_Obj8_Act4 aim to quantify monthly water use in m^2 and the associated BRL expenditure, respectively. BAS_Obj8_Act2 and EXT_Obj8_Act3 quantify the volume in m^2 per capita, considering public servants and the entire academic community, respectively. BAS_Obj8_Act5 and EXT_Obj8_Act6 evaluate the BRL expenditure per capita for public servants and for the whole academic community. EXT_Obj8_Act7 identifies the existence of a communication channel to report water leakages. The final indicator in this dimension, EXT_Obj8_Act8, assesses whether there are campaigns to raise awareness within the academic community about the rational use of water available at the HEI.

Analysis of the results

The water dimension is the one that scores the weakest among all dimensions in the framework. For all quantitative indicators, there was a decline in sustainable performance when comparing the year 2019 with the two years of the baseline. The four campuses of UFPB are supplied with water provided by the state-owned company and by its own artesian wells. However, in the years 2016 to 2018, there was more intensive use of water from wells to reduce spending on services provided by the state-owned company. The increase in consumption of piped water from the state-owned company, according to the UFPB's 2019 Management Report, was mainly due to "the inactivity of artesian wells due to contamination of the water table and/or silting up." Actions taken include well cleaning and drilling of deep wells (>60 m)(UFPB, 2020, p. 103). The UFPB's Management Report for the following year states that there was a reduction in piped water consumption "around 28%" in 2020 (UFPB, 2021, p. 103)

Table 8-8 - Performance achieved by Dimension 3.2 - Water.

Dimension 3.2 - Water										
Quantitative criteria							Qualitative Criteria			
Indicator	**BL mean**	**2019 mean**	**PV_{oa} (eq. 3)**	**Rel. Value x Impact (P/N)**	**Soa (0-1)**	**qtS_{oa} (Eq. 4)**	**n_c**	**(n_c/n_{oa})**	**qlS_{oa} (Eq. 6)**	**Total**
BAS_Obj8_Act1	6621,000	12705,000	91,889	Negative	0,1	0,012	1	12,500%	0,038	0,049
BAS_Obj8_Act2	1,044	2,084	99,601	Negative	0,1	0,012	1	12,500%	0,038	0,049
EXT_Obj8_Act3	0,145	0,282	94,253	Negative	0,1	0,012	1	12,500%	0,038	0,049
BAS_Obj8_Act4	186952,349	259080,305	38,581	Negative	0,2	0,023	1	12,500%	0,038	0,061
BAS_Obj8_Act5	27,784	42,507	52,989	Negative	0,1	0,012	1	12,500%	0,038	0,049
EXT_Obj8_Act6	4,120	5,763	39,852	Negative	0,2	0,023	1	12,500%	0,038	0,061
EXT_Obj8_Act7							1	12.500%	0.038	0.038
EXT_Obj8_Act8							1	12.500%	0.038	0.038
			TOTAL	**qtS_d (Eq. 5)**		0.093	**qlS_d (Eq. 7)**		0.300	0.393

Regarding indicator EXT_Obj8_Act7, barcode signs have been placed in the restrooms of the Technology Centre, for example, to allow communication of water leaks to the maintenance department of the institution. Awareness campaigns are disseminated on the social media platforms of UFPB and the Environmental Management Committee. As demonstrated in Table 8-8, UFPB achieved a performance of 0.393, significantly boosted by the performance of the two qualitative indicators.

8.3.3. Dimension 3.3. Waste

In Brazil, waste management typically involves the participation of both formal actors in regular waste collection and informal actors in selective waste collection and recovery. The major challenge in this context is to integrate the informal waste sector by providing suitable working conditions, enhancing collection efficiency, and improving waste treatment techniques (Campos, 2014).

To fill this gap, the Brazilian government instituted the Presidential Decree 5940/2006 which establishes the separation of recyclable waste discarded by direct and indirect federal public administration agencies and entities at the source of generation, and their destination to associations and cooperatives of recyclable materials collectors (Decree No. 5940, of October 25, 2006). This action intends to strengthen the national network of waste pickers by making public institutions obliged to donate their recyclable waste to these associations or cooperatives.

What is required?

The waste dimension consists of seven indicators, only one of which is extended. Waste management corresponds to requirement 09 in Table 6-3 and is addressed in Article 8, IV of the NI10, 12/11/12 that establishes rules for the preparation of the SLMP (Normative Instruction No. 10, 2012).

The first indicator (BAS_Obj9_Act1) measures the monthly volume of paper intended for recycling. The second (BAS_Obj9_Act2) calculates the volume of cardboard intended for recycling. The third (BAS_Obj9_Act3) quantifies the number of toners sent for recycling. The volume of plastic intended for recycling is calculated by the fourth indicator (BAS_Obj9_Act4). The fifth (BAS_Obj9_Act5) corresponds to the total of all recyclable material destined for cooperatives or associations. The sixth (BAS_Obj9_Act6) quantifies the total amount of paper reused monthly by the institution. The final indicator (EXT_Obj9_Act7) deals with the development of campaigns to promote the proper disposal of recyclables in appropriate containers.

Analysis of the results

The data presented in Table 8-9 shows a reduction in the quantities of cardboard and plastic, which are recyclables intended for cooperatives. No data was found to calculate the number of toners sent for recycling. The only recyclable that was destined in greater value in 2019 than in the baseline was paper, which had a monthly increase of 184.05. However, the increase in paper volume was not sufficient to change the trend of reduction in the total quantities of recyclable waste. As shown in indicator

(BAS_Obj9_Act5), the total monthly volume in 2019 was 1,303.78 kilograms, while during the baseline period, the total volume recycled was higher (1,601.86 kilograms).

Table 8-9 - Performance achieved by Dimension 3.3 - Waste.

Dimension 3.3 - Waste										
Quantitative criteria							Qualitative Criteria			
Indicator	**BL mean**	**2019 mean**	**PV_{oa} (eq. 3)**	**Rel. Value x Impact (P/N)**	**S_{oa} (0-1)**	**qtS_{oa} (Eq. 4)**	**Ic**	**(Ic/n_{oa})**	**qIS_{oa} (Eq. 6)**	**Total**
BAS_Obj9_Act1	580.850	764.900	31.686	Positive	0.9	0.158	1	14.286%	0.043	0.200
BAS_Obj9_Act2	868.848	467.767	**-46.162**	Positive	0.1	0.018	1	14.286%	0.043	0.060
BAS_Obj9_Act3							0	0,000%	0,000	0,000
BAS_Obj9_Act4	152.160	71.117	**-53.262**	Positive	0.1	0.018	1	14.286%	0.043	0.060
BAS_Obj9_Act5	1601.857	1303.783	**-18.608**	Positive	0.1	0.018	1	14.286%	0.043	0.060
BAS_Obj9_Act6							1	14.286%	0.043	0.043
EXT_Obj9_Act7							1	14.286%	0.043	0.043
			TOTAL	**qtS_d (Eq. 5)**		0.210	**qIS_d (Eq. 7)**		0,257	0,467

No data were found in the management reports that allow us to infer whether the reduction in the quantities of recyclables occurred due to a decrease in the amount of waste generated or if it was motivated by some failure in the appropriate disposal of recyclables' waste.

To solve this issue, we added a request in the report template requiring the HEI to explain the motive of variation on the indicators regarding waste dimension.

8.3.4. Dimension 3.4. Displacement

There has been a notable focus on literature measuring the greenhouse gas emissions produced by HEI to facilitate the implementation of campus-wide carbon reduction or carbon neutrality initiatives (Davies & Dunk, 2015; Deda et al., 2023; Minutolo et al., 2021). These production acknowledge that universities, similar to other large-scale institutions, are among the contributors to greenhouse gas pollution due to managing a considerable number of individuals that requires constant displacement (Atherton & Giurco, 2011).

According to Robinson et al. (2018), despite attempts in developed nations to transition towards low-carbon HEI systems, the gap between institutions located in less economically developed countries (LEDC) and those placed in more economically developed countries (MEDCs) remains significant. It is imperative to address the challenge of climate change on a global scale to fulfil the agreements made.

Numerous studies have been conducted to shed some light on emissions from fossil fuel at universities (Appleyard et al., 2018; C. J. Cleveland & Reibstein, 2015). A recent study acknowledge that over the past few decades, numerous HEI around the world have devised creative approaches to measuring their ecological and carbon footprint (Leal Filho et al., 2023). In addition to managing emissions, the fleet management of a HEI should take into account other factors that impact financial expenditures and overall sustainability. Therefore, the management should consider whether to own or lease vehicles, organise driver management, fuel management, route planning, fleet size, as well as expenses related to maintenance and fleet renewal, to name a few (Yoon & Cherry, 2018).

What is required?

This dimension has seven indicators, all extended since the NI10, 12/11/12 (Article 8, VII) determines the monitoring of displacement without providing indicators to measure performance related to spending in BRL and emissions (refer to Table 6-3, requirement 13).

The indicator EXT_Obj10_Act1 intends to quantify the monthly operational costs with the use of the HEI's vehicle fleet. The operational costs include fuel, lubricant, material for maintenance and maintenance services. The indicator EXT_Obj10_Act2 aims at measuring the CO2 emission index of UFPB's vehicle fleet. The indicator EXT_Obj10_Act2 intends to quantify the volume of fuel consumed monthly. The fourth indicator (EXT_Obj10_Act4) aims at quantifying the monthly fuel expenses in BRL. The Indicator EXT_Obj10_Act5 intends to estimate the compensation of CO2 emissions by planting seedlings. The fifth indicator (EXT_Obj10_Act5) aims at asses if the HEI is developing educational campaigns to arise awareness about the use of institutional fleet. The last indicator (EXT_Obj10_Act6) intends to monitor the native seedlings planting. Table 9-28 shows the detailed action plan designed to implement and monitor SDI regarding HEI’s displacement.

Analysis of the results

As illustrated in Table 8-10, there was a significant increase in the variation between the average monthly price practiced in 2019 and the average price applied in the corresponding baseline years. In 2019, the displacement contract paid an average monthly amount of R$ 134,901.96 more than in the baseline period. This difference is likely due to an increase in fleet maintenance expenses. The other indicators point to a reduction in spending or volume. For example, there was a 29.67 tCO2e reduction in 2019 compared to the baseline. The EXT_Obj10_Act4 and EXT_Obj10_Act5 indicators show a significant reduction in volume (m3) and financial spending on fuel acquisition.

Table 8-10 - Performance achieved by Dimension 3.3 - Displacement.

Dimension 3.4 - Displacement										
Quantitative criteria							Qualitative Criteria			
Indicator	**BL mean**	**2019 mean**	**PV_{oa} (eq. 3)**	**Rel. Value x Impact (P/N)**	**S_{oa} (0-1)**	**qtS_{oa} (Eq. 4)**	**Ic**	**(Ic/n_{oa})**	**qIS_{oa} (Eq. 6)**	**Total**
EXT_Obj10_Act1	277,291.462	412,193.417	48.650	Negative	0.1	0.014	1	14.286%	0.043	0.057
EXT_Obj10_Act2	76.252	46.580	**-38.913**	Negative	0.9	0.126	1	14.286%	0.043	0.169
EXT_Obj10_Act3	32106.063	18833.209	**-41.341**	Negative	0.9	0.126	1	14.286%	0.043	0.169
EXT_Obj10_Act4	115310.060	73932.892	**-35.883**	Negative	0.9	0.126	1	14.286%	0.043	0.169
EXT_Obj10_Act5	60294.827	28174.913	**-53.271**	Positive	0.1	0,014	1	14,286%	0,043	0,057
EXT_Obj10_Act6							0	0,000%	0,000	0,000
EXT_Obj10_Act7				Positive		0.000	0	0,000%	0,000	0,000
			TOTAL	**qtS_d (Eq. 5)**		0.406			**qIS_d (Eq. 7)**	**0.620**

The EXT_Obj10_Act5 indicator shows a decrease in the compensation strategies adopted to reduce greenhouse gas emissions. This was the indicator with the highest variation between the analysed periods (53.271). Data regarding the planting of native species and campaigns to raise awareness about the use of vehicles in the UFPB fleet were not found. In this context, the HEI's performance in the "displacement" dimension was 0.620.

8.4. Component 4 - Teaching & Research

Goal 4 of the United Nations' Sustainable Development Goals (SDGs) has set a specific target, namely Target 7, which aims to ensure that

> By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development (UN, 2017, p. 8).

The implementation of this target is vital for the cultivation of professionals who are equipped with the knowledge and skills necessary to effectuate positive change in their respective fields, thereby contributing to the realisation of a sustainable future.

8.4.1. Dimension 4.1. Teaching

In order to facilitate the realisation of sustainable development objectives, there is an expectation that HEI will adapt their curricula to incorporate essential skills that enable the training of professionals who are cognizant of the global commitment to sustainable development (Bascopé et al., 2019). Such professionals should be competent in implementing the necessary structural changes that are required to accelerate the transition towards social models that are more aligned with the sustainable development paradigm.

To achieve this, Goal 4 of the United Nations' Sustainable Development Goals (SDGs) has set a specific target, namely Target 7, which aims to ensure that

> By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development (UN, 2017, p. 8).

The acquirement of knowledge and skills required to boost sustainable development goals could be achieved through the application of the university as living lab approach.

A university as a living lab for sustainable development is a concept that promotes the use of university campuses and surrounding communities as testbeds for sustainable practices and technologies (Leal Filho et al., 2020). By adopting this approach, universities can provide a platform for testing and implementing sustainable solutions and technologies that can have a positive impact on the environment, society, and the economy. It also provides opportunities for engage students, faculty, and staff to participate in sustainability efforts and gain practical experience in implementing sustainable practices and technologies (Purcell et al., 2019). Ultimately, the goal of a university as a living lab for sustainable development is to create a culture of sustainability that can have lasting positive impacts on the environment, society, and the economy.

What is required?

Despite the importance of the teaching dimension, it is composed of four extended indicators since any specific approach to teaching is not part of the original scope of the NI10, 12/11/12 that gives rise to the SLMP. The first indicator (EXT_Obj11_Act1) aims to raise the percentage of courses committed intensively or peripherally to SD. The goal is to verify if at least 20% of the courses are intensively or peripherally dedicated to the development of DS-related skills.

The second indicator (EXT_Obj11_Act2) aims to evaluate the institutionalization of programs to promote the campus as a living laboratory for SD. The expected outcome is to have at least 20 institutionalised programs to promote the campus as a living laboratory.

The third indicator evaluates whether there are monitoring mechanisms for adherence to the curriculum concerning SD-related content. Finally, the last indicator is focused on evaluating the performance of campaigns aimed at raising awareness regarding the integration of SD into the curricula. The goal is to have at least four campaigns created per semester.

Analysis of the results

The UFPB offers 116 undergraduate courses on its four campuses, of which twelve are committed intensively to SD. Among these, "Environmental Engineering", "Renewable Energy Engineering", "Agroecology", "Agricultural Sciences" and "Ecology" are those with more curricular components related to sustainable development. Additionally, more than 70% of the offered courses provide at least one curricular component focused on promoting sustainable development, among which the following components stand out: "Environmental Education", "Design and Sustainable Development", "Environmental Sciences", "Management of Natural and Environmental Resources", "Environmental Management", "Methodology of Environmental Impact Studies", "Ecology" and its variants, such as "Agroecology" and "General Ecology", "Bioethics", "Environmental Policy and Legislation", "Biological Impacts of Environmental Pollution". Therefore, the HEI met the requirements of the EXT_Obj11_Act1 indicator, having been attributed the corresponding score 0.075.

Table 7-1 presents an extensive list of programs that are implemented on campus through the living-lab approach, which demonstrates that the HEI meets the requirement stipulated by indicator EXT_Obj11_Act2. No systematic monitoring mechanism for integrating sustainable development into the curriculum of courses offered by the HEI was identified.

Table 8-11 - Performance achieved by the Dimension 4.1 - Teaching.

Dimension 4.1 - Teaching										
Quantitative criteria							Qualitative Criteria			
Indicator	BL mean	2019 mean	PV_{oa} (eq. 3)	Rel. Value x Impact (P/N)	S_{oa} (0-1)	qtS_{oa} (Eq. 4)	Ic	(Ic/n_{oa})	qlS_{oa} (Eq. 6)	Total
EXT_Obj11_Act1							1	25.000%	0.075	0.075
EXT_Obj11_Act2							1	25.000%	0.075	0.075
EXT_Obj11_Act3							0	0,000%	0,000	0,000
EXT_Obj11_Act4							1	25.000%	0.075	0.075
			TOTAL	qtS_d (Eq. 5)		0.700	qlS_d (Eq. 7)		0.300	0.925

Campaigns to raise awareness of the need to include content related to sustainable development, which is the indicator EXT_Obj11_Act4 are widely disseminated on the institution's social media. As shown in Table 8-11, UFPB obtained a total score of 0.925 for the Teaching dimension.

8.4.2. Dimension 4.2. Research & Innovation

As detailed in the second chapter of this PhD research, since the Stockholm Declaration, the first global agreement to address issues related to the environmental crisis, its eighteenth principle established that "Science and technology, as part of their contribution to economic and social development, must be applied to the identification, avoidance and control of environmental risks and the solution of environmental problems (...)" (UNEP, 1972, p. 5).

Additionally, the twentieth principle recognises the role of national and international scientific research, development, and innovation in addressing environmental problems in both MEDCs and LEDC. In this context, the twentieth principle establishes that "the free flow of up-to-date scientific information and transfer of experience must be supported and assisted, to facilitate the solution of environmental problems" (UNEP, 1972, p. 5).

Silvestre and Ţîrcă (Silvestre & Ţîrcă, 2019), assessed the role of innovation in improving sustainability. According to the authors, although the innovation process is complex, dynamic, and uncertain, innovation is a key driver for sustainability, as sustainable development is an urgent issue that demands immediate action and changes from the whole social layers.

What is required?

This dimension is evaluated through three extended qualitative indicators. The first indicator, EXT_Obj12_Act1, assesses whether the HEI has specific funding for research or innovation aimed at promoting sustainable development. The second indicator evaluates whether the institution has mechanisms in place to monitor the adherence of research and innovation to the scope of sustainable development. Finally, the third indicator, EXT_Obj12_Act3, examines the campaigns developed by the HEI to raise awareness of the research and innovation commitment to SD.

Analysis of the results

Some of the research projects developed within the postgraduate programs at UFPB are funded by national and international agencies, such as the Coordination for the Improvement of Higher Education Personnel (CAPES), the Foundation for the Support of Research in the State of Paraíba (FAPESQ), the National Council for Scientific and Technological Development (CNPq), and the Financier of Studies and Projects (FINEP), as well as international agencies such as the Commonwealth Scientific and Industrial Research Organisation (CSIRO), the Natural Sciences and Engineering Research Council (NSERC), the Social Science and Humanities Research Council (SSHRC), and UK Research and Innovation (UKRI).

Although no funding line has been identified with its own and exclusive resources for promoting sustainable development, calls for the "Programa de Doutorado Sanduiche no Exterior" (PDSE) scholarships for the year 2019 were found on the postgraduate website, aimed exclusively at selected UFPB postgraduate programs for the Capes-Print-UFPB. For example, in the CAPES-PRINT-UFPB/no001/2019 – Bolsas de PDSE-Doutorado Sanduíche no Exterior call, sandwich PhD scholarships were offered for topics related to the promotion of sustainable development, such as (i) "Caatinga Biome, Biodiversity and Sustainability"; (ii) Innovation in materials, products, and processes associated with environmental conservation and sustainability; (iii) Sustainability and quality of urban centres and territorial and socio-environmental management; (iv) Impacts of climate change on the management of vegetation cover and on (socio)biodiversity in the Caatinga biome in Northeast Brazil (PRPG/UFPB, 2019, pp. 3–4). In this respect, the Institution fulfils the criteria set forth in the EXT_Obj12_Act1 indicator.

Concerning the EXT_Obj12_Act2 indicator, the institution engages in monitoring the performance of research and innovation actions by evaluating their alignment with the Sustainable Development Goals (SDGs). This is accomplished through a platform designed by UFPB researchers, which permits the tracking of research projects, scientific initiatives, and patents related to the SDGs. The platform is accessible via the website http://ods.ufpb.br/#odss.

Table 8-12 - Performance achieved by Dimension 4.2 - Research & Innovation.

Dimension 4.2 - Research & innovation										
			Quantitative criteria				Qualitative Criteria			
Indicator	**BL mean**	**2019 mean**	**PV_{oa} (eq. 3)**	**Rel. Value x Impact (P/N)**	**S_{oa} (0-1)**	**qtS_{oa} (Eq. 4)**	**Ic**	**(Ic/n_{oa})**	**qlS_{oa} (Eq. 6)**	**Total**
EXT_Obj12_Act1							1	33.333%	0.100	0.100
EXT_Obj12_Act2							1	33.333%	0.100	0.100
EXT_Obj12_Act3							1	33.333%	0.100	0.100
			TOTAL	**qtS_d (Eq. 5)**		0.700	**qlS_d (Eq. 7)**		0.300	1.000

Evaluation of the EXT_Obj12_Act3 indicator involves assessing campaigns aimed at disseminating the commitment of research and innovation to the SDGs. This evaluation is conducted by analysing publications on the social media channels of the Postgraduate Pro-Rectory and the Environmental Postgraduate Program (PRODEMA). These entities promote events associated with sustainable development, in addition to delivering lectures and mini courses on innovation. However, despite the SDGs emerging as a peripheral theme, with more than four publications per semester, in the posts of the Postgraduate Pro-Rectory, a specific focus on sustainable development issues is absent.

8.5. Component 5 - Assessment & Reporting

According to Caeiro, Sandoval Hamón, et al. (2020), one crucial aspect of implementing Education for Sustainable Development (ESD) in HEI is to assess their sustainability. Boud (2000, p. 151) stated that "assessment involves identifying appropriate standards and criteria and making judgements about quality". In this case is evaluated the quality of the integration of SDI in HEI.

Yáñez et al. (2019), Huber and Bassen (2018), Ramísio et al. (Ramísio et al., 2019b) acknowledge that sustainability report plays a crucial role in promoting sustainability practices in HEI by facilitating a comprehensive approach towards sustainability, aiding in the definition and improvement of strategic plans, supporting the transmission of sustainability values throughout the organisation, and enabling stakeholder participation in a bidirectional way.

8.5.1. Dimension 5.1. Assessment Protocol

The design of sustainable indicators can serve to three primary purposes: firstly, to collect and consolidate information from diverse sources; secondly, to enhance public understanding of environmental issues; and thirdly, to furnish decision-makers with appropriate, dependable, and timely information to support their decision-making (Rosenström & Lyytimäki, 2006).

Several tools have been developed to evaluate the sustainability performance of HEI (Du et al., 2020; Findler, Schönherr, Lozano, & Stacherl, 2019b; Husaini et al., 2018). The third chapter of this doctoral research reviews tools designed to assess the HEIs' sustainability, describing the main metrics and the main mathematical models used to calculate their performance.

In the system formulation phase (refer to Figure 6-2), that is, in the conceptual design phase of the framework, a set of indicators were assigned to evaluate the performance of HEI in the integration of SDI. Subsequently, in the system formulation phase presented in chapter 7, assessment protocols with specific and detailed metrics were designed through action plans (Table 7-2), flow diagrams (Figure 7-7), and standard operating procedures (Table 7-3).

What is required?

The dimension referred to as "Assessment Protocol" encompasses two extended indicators that serve to evaluate the sustainability performance of HEI. The first indicator (EXT_Obj13_Act1) ascertains whether the HEI has a formal structure in place to monitor its environmental performance. This is evaluated via a dichotomous metric that determines whether such a structure exists or not. The second indicator (EXT_Obj13_Act2) aims to assess the breadth and formality of the HEI's system of key performance indicators that are central to its sustainable performance evaluation. The indicator system should encompass key areas such as energy, water, curriculum, research, and waste. The performance of this second indicator is similarly measured using a dichotomous metric, identical to that used for the first indicator.

Analysis of the results

On September 13th, 2013, the Federal University of Paraiba (UFPB) implemented its Sustainable Logistics Management Plan, which provides a formal framework for monitoring material acquisition (paper, disposable cups, cartridges and toners), electricity, water and sewage, waste, workplace quality of life programs, and the inclusion of sustainability practices in procurement and contracting processes (fixed telephony, mobile telephony, surveillance, and cleaning) (UFPB, 2013).

Table 8-13 -Performance achieved by Dimension 5.1 - Assessment Protocol.

Dimension 5.1 - Assessment Protocol										
Quantitative criteria							Qualitative Criteria			
Indicator	**BL mean**	**2019 mean**	**PV_{oa} (eq. 3)**	**Rel. Value x Impact (P/N)**	**S_{oa} (0-1)**	**qtS_{oa} (Eq. 4)**	**Ic**	**(Ic/n_{oa})**	**qIS_{oa} (Eq. 6)**	**Total**
EXT_Obj13_Act1							1	50.000%	0.150	0.150
EXT_Obj13_Act2							1	50.000%	0.150	0.150
			TOTAL	**qtS_d (Eq. 5)**		0.700	**qIS_d (Eq. 7)**		0.300	1.000

The Plan is available in the university webpage, through the following link: https://www.ufpb.br/cga/contents/pgls/pgls-ufpb.pdf. The public university publishes biannual reports on its website detailing the results of monitoring the implementation of the Sustainable Logistics Management Plan. These monitoring reports cover each of the objectives of the plan and provide a detailed description of the university's performance in the various dimensions that make up the broad scope of the plan's activities.

In doing so, the University meets the requirements of the two indicators of the "Assessment Protocol" dimension, thus obtaining a score of 1, as illustrated in Table 8-2.

8.5.2. Dimension 5.2. Reporting on SD

By providing transparent and comprehensive information on the institution's sustainable practices and initiatives, the report serves as a tool for accountability, engagement, and continuous improvement towards sustainable practices (K. Ceulemans et al., 2015; del Mar Alonso-Almeida et al., 2015). Therefore, sustainable development reporting has become an essential tool for HEI in communicating their environmental, social, and economic impacts to stakeholders (An et al., 2019; Sepasi et al., 2019).

What is required?

The dimension is composed of three qualitative indicators. The first intends to verify whether the HEI has comprehensive data coverage on the sustainability assessment reports. The second aims to assess whether the HEI publishes information on the institutional website, and the third and last are related to awareness campaigns. Thus, the third intends to evaluate whether HEI elaborates a campaign highlighting HEI's environmental performance.

Analysis of the results

The public university publishes biannual reports on its website detailing the results of monitoring the implementation of the Sustainable Logistics Management Plan. These monitoring reports cover each of the objectives of the plan and provide a detailed description of the university's performance in the various dimensions that make up the broad scope of the plan's activities. The publication of these reports reflects the university's commitment to sustainable development. By providing a comprehensive overview of its sustainable practices and initiatives, the university demonstrates its dedication to promoting sustainable development.

Table 8-14 - Performance achieved by Dimension 5.2 - Reporting.

Dimension 5.2 - Reporting SD										
Quantitative criteria							Qualitative Criteria			
Indicator	**BL mean**	**2019 mean**	**PV_{oa} (eq. 3)**	**Rel. Value x Impact (P/N)**	**Soa (0-1)**	**qtS_{oa} (Eq. 4)**	**Ic**	**(Ic/n_{oa})**	**qlS_{oa} (Eq. 6)**	**Total**
EXT_Obj14_Act1							1	33.333%	0.100	0.100
EXT_Obj14_Act2							1	33.333%	0.100	0.100
EXT_Obj14_Act3							1	33.333%	0.100	0.100
		TOTAL			**qtS_d (Eq. 5)**	0.700	**qlS_d (Eq. 7)**		0.300	1.000

The campaigns designed to inform the academic community about the performance of HEI in integrating sustainable development initiatives are disseminated through the social media channels of the Environmental Management Commission. Through the publication of these campaigns, the university promotes a culture of sustainability and encourages stakeholder engagement in the implementation and monitoring of sustainable practices.

As demonstrated in Table 8-14, the HEI achieved a score of 1 for the dimension of “Reporting on SD”.

8.6. Computing the overall score and discussing the results

This section details the integration of the results regarding performance obtained by the Institution in the various indicators presented in the previous topics to assign a global score and subsequently classify the institution in one of the five ratings of the framework. After the classification it will be carried out a brief discussion on the framework application test at UFPB which was the typical case chosen.

Equations developed in chapter 7 were used for the calculations. As shown in Figure 8-5, the first column of each component (Component 1 to 5) indicates the dimensions. The second column provides the weight of each dimension within its respective component. The third column shows the sum of the performance assigned by quantitative and qualitative indicators. In the fourth column, Equation 8 is used to multiply the achieved performance by its weight. The final row of each component shows the result of Equation 9, which corresponds to the performance obtained by the HEI in each component.

Starting from the line titled "TOTAL SCORE," a similar procedure to the one described above is carried out, this time to calculate the performance of indicators, the performance of each component is calculated. Thus, in the first column, the components are listed. In the second column, the weight of each component for the framework is indicated. The third column replicates the previously calculated performance of each component. In the fourth and ultimate column, the performance is multiplied by the assigned weight for each component, resulting in the final rating displayed in the last row of this series. This final rating, 79.101, corresponds to the global performance of the institution, which is classified in the rating Strategic.

COMPONENT 1 - GOVERNANCE/ PROCUREMENT			
Dimensions	**W_d**	**$qtS_d + qlS_d$**	**Sd (Eq. 8)**
1.1 - Institutional Framework	20	1	20.000
1.2 - Material Acquisition	40	0.669	26.747
1.3 - Procurement	40	0.494	19.754
Total	**100**	**Cn (Eq. 9)**	**66.501**

COMPONENT 2 - OUTREACH & ON CAMPUS EXPERIENCE			
Dimensions	**Weight**	**Score obtained**	**Partial Score**
2.1 - QLW	33.33	0.86	28.6638
2.2 - Extensions programme	33.33	1	33,33
2.3 - Networking	33.33	1	33.33
Total	**100**	**95.324**	**90.658**

COMPONENT 3 - CAMPUS OPERATION			
Dimensions	**Weight**	**Score obtained**	**Partial Score**
3.1 - Energy	25	0.658	16.445
3.2 - Water	25	0.393	9.833
3.3 - Waste	25	0.467	11.675
3.4 - Displacement	25	0.776	19.400
Total	**100**	**2.294**	**57.353**

COMPONENT 4 - TEACHING AND RESEARCH			
Dimensions	**Weight**	**Score obtained**	**Partial Score**
Dimension 4.1 - Teaching	50	0.925	46.25
Dimension 4.2 - Research & innovation	50	1	50
Total	**100**	**1.925**	**96.25**

COMPONENT 5 - ASSESSMENT AND REPORTING			
Dimensions	**Weight**	**Score obtained**	**Partial Score**
5.1 - Assessment Protocol	40	1	40
5.2 - Reporting SD	60	1	60
Total	**100**	**2**	**100**

TOTAL SCORE			
Components	**Wc**	**Cn**	**Cn * Wc**
1 - Governance/ Procurement	0.20	66,501	13,300
2 - Outreach & on campus experience	0.10	95.324	9,532
3 - Campus operation	0.30	57,353	17,206
4 - Teaching and Research	0.25	96.250	24,063
5 - Assessment and Reporting	0.15	100	15,000
	TOTAL	**S (Eq. 10)**	**79,101**

FINAL RATING		
Rating	**Score**	**Overall Rating**
LATENT	Less than or equal to 24.9	**STRATEGIC (79,101)**
PIONEER	Between 25 and 39.9	
ENHANCED	Between 40 and 59.9	
STRATEGIC	Between 60 and 79.9	
EMBEDDED	Greater than or equal to 80	

Figure 8-5 - UFPB's Overall Score

In the analysis of the available documents, it was possible to verify that UFPB has demonstrated a consistent effort in integrating sustainable development initiatives. This endeavour is evidenced by implementing over ten years of environmental management programs, such as those listed in Table 7-1.

In 2013 it developed its Sustainable Logistic Management Plan to meet NI10, 12/11/12. Since then, the Institution has been producing its monitoring reports and implementing continuous improvement actions. In this period, the university has been maturing its environmental management system, with a focus on vertical integration, i.e., on (i) campus operations, (ii) procurement of sustainable materials, the inclusion of sustainability criteria in the contracting of services and has culminated in the (iv) development of its environmental management policy and the inclusion of sustainable development initiatives in strategic plans. More recently, the Institution has sought to increase participation in a number of sustainable university networks, thus investing in its horizontal integration. In addition to being a signatory of the Tailloires Declaration, it is now part of the Inter-University Sustainable Development Research Programme (IUSDRP), a network led by Manchester Metropolitan University (United Kingdom) and HAW - Hamburg (Germany).

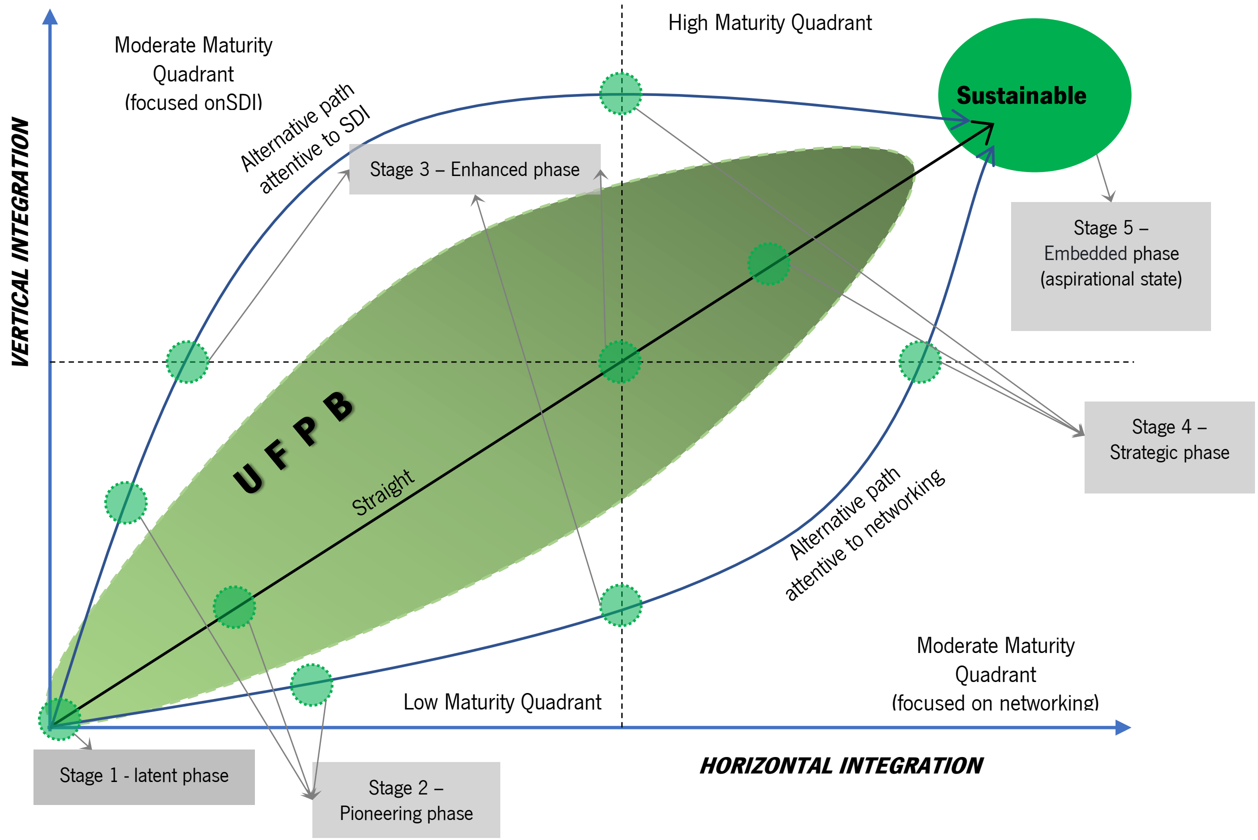

Figure 8-6 - Holistic position of the UFPB in implementing SDI.

Figure 8-6 synthesises conceptually the path established by UFPB in holistically integrating sustainable development in its management processes and interconnections with external organisms. Figure 8-6 shows that the UFPB, instead of following the "Straight path," which would be the optimal path towards achieving a sustainable HEI position, has adopted an alternative path. In the low maturity phase, it chose to invest its efforts in SDI, creating a set of internal actions to promote the integration of sustainable development into its core systems. Subsequently, in the Moderate Maturity phase, in addition to continuing to invest in SDI, the HEI became part of networks of sustainable universities as a means to accelerate its progress towards a high maturity position in adopting a sustainable university stance.

The framework met what the expected one. All data collected was processed without significant difficulties. The scale created to assign scores to positive and negative impacts worked rationally without needing adjustments in the set scores. The weighting system, based on existing frameworks, namely Sustainability Tracking, Assessment & Rating System (STARS) and UI-GreenMetrics, weighted the dimensions appropriately in order to consider the importance of the dimensions for SDI integration as well as the difficulty of generating and analysing data.

Due to the wide variety of data provided by various institutional sources, such as management reports, SLMP monitoring reports, reports on courses offered, contract management reports, bid notices, bid price records, and other sources, there is always the risk that the data does not correspond to reality or that there is a conflict between the reports. However, the procedures created for preliminary analysis and data cleansing properly highlighted the discrepant data, allowing its correction, which is a positive point in the use of the FIMARSHEI. Additionally, to mitigate the risk, preference was given to data which was available on the Government Transparency Portal.

In the analysis of the data related to the "waste" dimension, a reduction in the volume of recyclable waste made available to the association was identified but the reason for this reduction was not explained in the available reports. It is then important to know if in fact a reduction in waste generation was achieved, which is positive for the sustainability of HEI, or if there was a failure in waste distribution, causing, for example, part of the waste to be destined to the municipal collection system. To clarify this point, a request for an explanatory note was included in the "waste" report template (Table 5-6).

The modularised approach chosen to develop the mathematical model of integration, composed by a set of weights which allowed for the calculation of indicators unifying the metrics of measurement. This approach focuses on the independent scoring between qualitative and quantitative indicators, dimensions, and components and brings a series of benefits, among which we highlight:

a) possibility to carry out the detailed adjustment of the framework to the reality of each adhering university to the extent that the inclusion or exclusion of indicators according to pertinence is allowed, especially concerning extended indicators. That is, those indicators that are not considered mandatory by the Brazilian norm.

b) The NI10, 12/11/12 that establishes the requirements for creating SLMPs was initially developed to be applied in all federal public agencies and not only in HEI, the focus of this study. Thus, the modularised approach adopted in the design of this framework also allows its rapid adaptation so that the framework can be applied in public institutions of sectors other than higher education.

Finally, the employment of the System Approach Framework, used for designing complex systems that emulate characteristics of natural systems, is another critical differential of this framework. As occurs in natural complex systems, the framework is expected to be improved as longitudinal data from a given institution or even data from several institutions are included. Thus, with the continued use of the framework, it will be possible to establish more accurate baselines that consider, for instance, size, geographical location, and type of courses offered. In this sense, the conceptual ballast is a point that distinguishes this framework from the existing ones.

Chapter 9. Conclusions

In the wake of the escalating environmental crisis, the imperative for sustainable development and ecosystem balance responsibility has permeated global education systems, prompting HEI to assume a decisive role in catalysing societal transformation. These institutions have embarked on a journey to integrate SDI into their core strategies, systems, processes, and routines while forging connections within networks of sustainable HEI. This endeavour, although noble, is not without its formidable challenges and barriers, particularly in regions such as Brazil, where the government has established intricate regulations to guide public HEI in their pursuit of sustainability integration. Consequently, Brazilian federal public HEI have grappled with the complexities of meeting these sustainable legal mandates.

Within this intricate backdrop, the primary aim of this PhD research has been to develop a comprehensive and holistic framework that empowers Brazilian federal public HEI with the tools and strategies necessary to successfully integrate, monitor, assess, and report sustainability within their institutional frameworks. This framework, denoted as the Framework to Integrate, Monitor, Assess and Report Sustainability in HEI (FIMARSHEI), represents a novel approach to addressing the challenges posed by sustainability integration in the higher education context. The principles of a complex adaptive system underpinned the development of FIMARSHEI were guided by a deductive approach to modelling a sustainable solution to assist Brazilian federal public HEI in surpassing the identified gaps. Central to this research endeavour was using a typical case study, namely, the Federal University of Paraíba, as a focal point for understanding the intricacies of sustainability integration in Brazilian federal public HEI. However, without losing sight of the international scenario, as addressed in chapters 2 and 3 through two systematic literature reviews, as well as the national context. Chapter 5 describes the study conducted through desk research that analysed documents from more than half of the Brazilian federal public HEI to understand how these institutions were integrating national regulations, their main challenges, and drivers.

In this context, delivering an integrated solution is an immense challenge. Integrating should mean substituting the linear and positivist approach and the management by contingencies for the complexity theory approaches and good integrated planning practices. Actions for integrating SDI should incorporate in a combined and juxtaposed way the processes of planning, execution, monitoring, assessment and reporting of the results so that the interdependencies and interconnections of these processes become evident. Beyond this procedural/managerial panorama, there is the need to think, with the same inclusive approach, not only about all the dimensions of sustainability of each campus but also the need to stimulate the interconnections between different universities to develop a network of mutual support and constant improvement of best practices. We believe that this is the path that will consistently lead to sustainable HEI.

Thus, the development of FIMARSHEI was possible thanks to adopting these three stances. First, understanding the limits of the Cartesian approach and seeking solutions based on complex systems. Second, designing an integrated solution that combines planning, monitoring, evaluation and reporting of the various aspects of sustainability of HEI. And third was encouraging the emergence of networks of universities that collaborate to improve sustainable development initiatives. The realisation of this work was not unfeasible only because the NI10, 12/11/12 was, in some way, allowing, or at least did not prevent, this type of approach in its implementation.

This chapter is divided into three sections. The first provides comments to justify the achievement of the research questions established. The second sheds some light about the general implications do the designed framework. The third comments on the limitations and suggestions for future work. The last section presents the main deliverables, focused on publication, that happened during the period of PhD research.

9.1. Concluding comments on the established research questions

This research provides new insights into integrating sustainable development initiatives in Brazilian public federal higher education institutions. The framework developed can assist HEI in achieving compliance with Normative Instruction NI10, 12/11/12 (2012) and support them in assuming the leadership role that society expects in transitioning to a more sustainable world.

In conclusion, this study will summarise the main findings by revisiting each issue related to the three research questions posed in chapter 1.

9.1.1. Issues concerning research question 1.

Research question 1, " How can a sustainable assessment framework be conceptualised given the relationship between HEI organisational strategies and the implementation of SLMPs in Brazilian federal public universities?", is addressed through issues A and B, which analyse the integration of sustainable development initiatives into HEI's institutional documents, as well as the current state of integration, from a broader perspective encompassing the sustainable development initiatives mandated by NI10, 12/11/12.

(a) To what extent do organisational strategic documents support the development of a SLMP in HEI?

Ávila et al. (2016) and Sant'Ana et al. (2017) recognise that effective sustainable planning tools can enhance public management by optimising resource utilisation and providing clear direction to managers, thereby improving transparency and governance to deliver quality services. Correspondingly, Sroufe (2018, p. xxi) emphasises the importance of incorporating sustainability into business strategy and management practices, as it is an integral part of a dynamic and continuously improving strategy. Thus, it is essential to integrate sustainability initiatives into institutional strategic documents to facilitate their successful implementation.

As illustrated in Figure 5-1, 74% of the analysed HEI incorporate the promotion of sustainable development in their Institutional Development Plans (IDPs). Moreover, 51% of these institutions have specific policies aimed at promoting sustainable development, and 71% have established a formal structure to address sustainable development issues (Figure 5-2). According to Table 5-1, 71% of the HEI possess SLMPs, and 63% of these SLMPs have defined objectives for sustainable development. Additionally, the table also shows that the same percentage has set goals for each action designed in the SLMPs. Overall, most HEI studied demonstrate a commitment to including SDI in their institutional documents, which according to literature, has a positive effect on organisational performance as a whole (George et al., 2019). However, as discussed in the following section, the inclusion of SDI in strategic documents, while positively impacting environmental performance, is not sufficient to guarantee organisational success in integrating SDI. Other factors such as the organisational culture or the ability to implement strategic plans will influence the success rate. Therefore, HEI must overcome those barriers to implementing strategic plans adequately (Fernandez et al., 2019; Hudson et al., 2019; Nazemi et al., 2015).

(b) What is the current status of SLMP implementation in Brazilian federal public universities?

The detailed analysis of the current status of the SLMP implementation in Brazilian federal public HEI is presented in chapter 5. It was found that although most HEI have designed their SLMPs, upon analysing data regarding plan implementation and report disclosure, there is a significant limitation in the operationalisation of the plans developed. This limitation in the adequate fulfilment of the requirements of Instruction Normative no. 10/2012 is evidenced in various ways. Firstly, there is a lack of standardisation among the published reports. Secondly, there are incomplete reports, meaning that the number of analysed indicators is much lower than required by the Instruction Normative. For example, only 6% of the analysed HEI presented data on telephone expenses (Table 5-8), only 17% reported the expenditure in BRL on electricity consumption (Table 5-4), and only 31% reported the volume of water consumed (Table 5-5). All these indicators are compulsorily disclosed, as determined by the Instruction Normative, and the non-disclosure constitutes non-compliance with the regulation. Another evidence of the difficulty encountered by Brazilian federal public HEI in complying with the Instruction Normative is related to the number of published reports. Out of the 35 universities that comprise the sample, corresponding to 55.5% of the universe, only 15 institutions published two or more reports by 2019, when 14 reports should have been published (Figure 5-4, and Figure 5-5). Only three HEI in the analysed sample managed to publish 14 reports: the Federal University of Paraíba, the Federal University of Mato Grosso, and the Federal University of São Paulo.

9.1.2. Issues concerning research question 2.

Research question 2, " How can NI10, 12/11/12 be effectively operationalised in HEI to promote sustainability, considering key dimensions, actions, indicators, and integration of multiple sectors, while addressing incongruences and conflicts and aligning with international literature?", emerges as a natural continuation of the previous research question. Achieving its scope will require conducting systematic literature reviews to identify the primary descriptors of sustainability in HEIs and the underlying structures that support the development of an integrated framework. On the other hand, considering the specific context of Brazilian federal public HEIs and the national regulations governing the creation of sustainability plans in these institutions, it becomes necessary to juxtapose the literature review with the requirements of the normative instruction. Thus the building of a context in which it was possible to answer this research question was performed through the development of issues C and D, described below.

(c) What are the key dimensions, actions, and indicators required to effectively operationalise the NI10, 12/11/12and develop a coherent and feasible structure for planning, assessing, and reporting the sustainability of HEI in an integrated manner that

aligns with international literature on planning and Sustainable Assessment Tools (SAT) for promoting SDI in HEI?

This is the broadest issue related to the research question two formulated in this PhD study, and its answer is achieved through the contents arranged in various chapters of this PhD research. In chapters 2 and 3, a systematic literature review was conducted on commitments (Figure 2-4; Table 2-4), and models for integrating sustainable development into the organisational structure of HEI (Figure 2-6, Figure 2-7, and Figure 2-8). The systematic literature review also served to identify the main sustainability dimensions of HEI (Table 2-6, and Table 2-7) and the manners of integrating SDI through the holistic approach (Figure 2-11), as well as to survey the sustainability assessment tools available in the literature. In this phase, over seventy SAT were compiled (Table 3-10) The most referred to in the international literature were analysed in detail to understand the relevance of each of their indicators and metrics in operationalising the sustainability assessment of HEI (Table 3-3, and Table 3-4). The in-deep analysis of the SAT allows for building the preliminary list of indicators of the proposed framework posed in chapter 6 (Table 6-4). Also, in chapter 3, mathematical models of integration of indicators were compiled for the formation of scores in the form of rankings or ratings, which later served as starting points for the preparation of the mathematical modelling of the proposed framework (Brousmiche et al., 2020; Nardo et al., 2005; OECD, 2008; Schlossarek et al., 2019).

The prospective analysis of all the elements mentioned earlier in the context of integrating sustainable development initiatives at HEI acted as the background upon which it was possible to design the FIMARSHEI, considering the interdependence relations between the constituent elements and the complexity arising from this analysis. At that time, it was possible to realise that (i) the linear approach on which the existing SAT were based and (ii) the fragmented conception of the integration of SDIs in HEI, which, despite using the rhetoric of the holistic approach, had no success in putting it into practice, were not the most appropriate way to design a framework that could contribute to overcoming the limits of the existing tools. In this sense, it was needed to assume a new look that would grant us to envisioning the complex and interdependent circumstances involving the integration of SDI in HEI.

(d) What are the incongruences and conflicts of the NI10, 12/11/12, which was created with a general spectrum, when applied to HEI?

As detailed in section 6.1.3.1 of this research, the normative instruction that gave rise to the SLMP was not designed to incorporate the nuances of a specific public agency but to address the main aspects of sustainable development in public sector agencies in general. In this sense, it was necessary to assess the adherence to the requirements and indicators of the NI10, 12/11/12 with the dimensions of sustainability of HEI reported in the literature. Table 6-3 compiles all the requirements of the normative instruction. Figure 6-3 illustrates the connection of the SLMP dimensions, as proposed by the normative instruction, with the main areas of sustainability of HEI, highlighting the intervention points.

For example, the figure shows no connection between the SLMP and aspects related to teaching and research, which are core elements of the higher education service. Even when there was a relationship between the SLMP and dimensions of sustainability of HEI, as in the case of the relationship between "sustainable procurement" envisaged in the SLMP and related to aspects of the "governance/procurement" dimension, the relationship did not fully meet what existed in the SAT analysed. To ameliorate this situation, extended indicators were added to the designed framework in order to improve its adherence.

Therefore, to adjust the framework to address the most critical aspects of the sustainability of HEI, it was necessary to create auxiliary indicators to those defined by the instruction and even a rearrangement between the SLMP and the most referred to areas of campus sustainability. The solution developed comprises 88 indicators, of which 32 are basic, that is, required by the NI10, 12/11/12, and 56 are extended, created to guarantee adherence between the proposed framework and the main areas of operation of the HEI. Besides the 88 indicators, 14 dimensions were designed and grouped into five components. The general conceptual model is illustrated in Figure 6-4.

In summary, the first step was to analyse the points of convergence and divergence between the NI10, 12/11/12 and the international literature that indicated the main areas of campus sustainability. The next step was to design a conceptual model that would provide an improved solution to the alignment between the two.

9.1.3. Issues concerning research question 3.

Research question 2 is formulated as follows: " How a methodology for data collection and systematising can be developed to integrating different dimensions mathematically, and utilising a benchmarking approach to compare the progress of every Brazilian federal public HEI?"

While research question 2 was focused on the development of the theoretical or conceptual model, research question 3 is devoted to the development and application of the underlying mathematical model of the proposed framework for creating an integrated system that enables planning, execution, monitoring, assessment, and reporting applied to the integration of sustainable development initiatives in HEI. Constructing the answer to research question three involved deepening the matters. This deepening is detailed in issues E, F, G and H.

(e) What is the most effective and credible methodology for data collection?

Considering the number and variety of indicators in the proposed model, the concern arose with developing strategies to streamline the data collection process while improving the accuracy of the data collected. Data were available in fragmented and sometimes overlapping databases, and when compared, inconsistent data emerged. To overcome this difficulty, ten interviews were conducted with representatives of the sectors which created the data used to feed the indicators of the proposed framework. As a result, besides pre-validating the indicators presented, the interviewees suggested more appropriate data collection methods. Among the suggestions, the most valuable one given by several interviewees was, when possible, to collect the data directly from the government transparency portal. This would guarantee the collection of official and consolidated data. When the data were unavailable on the Portal, interviewers suggested the use of internal institutional reports, such as the annual management report that every Brazilian federal public HEI must prepare to submit to the control bodies, such as the Federal Audit Court or the SLMP report that is also sent to the control bodies.

This improvement in data collection is a differential that allowed the progress of the process while resulting in more accurate data. For example, it was verified that the values referring to electric energy consumption sometimes did not correspond to those available at the Portal. During the interview, they noticed that the values of interest and fees for invoices paid in arrears were negotiated between UFPB and the energy provider after the invoice was issued, which explained the difference. Thus, using the transparency portal, it was possible to collect reliable data that allowed a more accurate analysis of the performance in terms of sustainability of HEI.

(f) How can multiple sectors within each university be integrated into the process of developing the plan, monitoring indicators, and preparing semi-annual and annual reports?

The primary focus of this work was to develop a framework that met the requirements of Brazilian normative instruction while considering the nuances of the international literature on the integration of development initiatives in HEI. The NI10, 12/11/12 foresaw the implementation of SDI in seven areas, namely: acquisition of materials, electrical energy, water and sewage, waste, quality of life in the work environment, sustainable procurement, and displacement of personnel. In addition to these seven areas required by the NI10, 12/11/12, the international literature pointed to the importance of including the core activities of an HEI, that is, teaching, research and extension and sustainable university networks. These distinct elements were conceptually grouped into a systematic framework based on the principles of complex adaptive systems, which encompasses planning, monitoring and reporting in the terms illustrated in Figure 6-4. In this context, a scope comprising 88 indicators, 14 dimensions and 5 components is developed in a conceptual perspective that incorporates the planning, assessment and reporting processes. Subsequently, as described below, this conceptual framework is mathematically modelled to give rise to an integrated rating system.

(g) How can different dimensions be mathematically integrated to formulate a single system?

The mathematical modelling design for integrating indicators, dimensions, and components of the framework considered existing SAT models in the literature, namely STARS and UI-Greenmetrics. To ensure consistency, the rationality of weights assigned in these tools was transposed into a modular and flexible modelling approach. This approach allows for continuous updating, inclusion, or exclusion of indicators without compromising the underlying rationality for calculating the performance of HEI.

To create a standardised scale, we considered the variation between the baseline and reference year and whether the variation's effect on sustainability performance was positive or negative. This scale assigns weights to quantitative variables added to the variable's qualitative performance to integrate variables of different metrics. Quantitative performance was assigned a weight of 0.7, while qualitative performance was assigned a weight of 0.3. Using this methodology, we were able to group variables of distinct metrics and attribute scores to qualitative variables such as awareness campaigns to promote sustainable development on campus.

The framework underwent a preliminary validation process, as detailed in chapter 8, and presented satisfactory results for this phase. However, future comparative tests between different HEI and longitudinal analyses with more data can further advance the validation process.

(h) Can a benchmarking approach be utilised to develop a system for comparing the progress of every Brazilian federal public HEI?

The data collection and analysis processes were considered critical in developing the framework. Ten interviews were conducted with experts from various areas responsible for data generation to ensure the accuracy of the data. In these interviews, it was possible to identify the most reliable data sources and realise that much of the data is available on the government transparency portal and that the other part can be collected in institutional reports, as previously stated. Considering that the framework was applied in a typical case of a Brazilian federal public university, of which 68 universities are part. All these HEI have uniform governance rules and systems defined by the Ministry of Education and control bodies, such as the Federal Audit Court. For example, they all need to feed the government transparency portal with data about the services contracted, materials purchased, fuel, building maintenance, construction contracts, and all the expenses incurred by the institution. They all have Institutional Development Plans and must prepare their management reports annually.

In this context, the organisational structure of these institutions is identical to the Federal University of Paraiba in that they are maintained through budgets prepared by the Ministry of Education and controlled by standard evaluation protocols. Therefore, it is reasonable to assume that data from different HEI in this segment can be collected, analysed and compared regarding sustainability performance through the framework developed.

In the future, with more data from this HEI, it will be possible to improve the tool's accuracy. The proposed framework also holds the potential to be used within the benchmarking approach, to be achieved by including data from other Brazilian HEI. With this approach, it will be possible to compare the performance of different HEI, establishing rankings of best practices in each of the dimensions analysed.

9.2. Limitations and Suggestions for Future Work

The main limitation identified in this study concerns the inability to perform comparative testing of the framework in more than one Brazilian public university (a typical case) to subject it to classical validation tests. In this study, it was only possible to perform an application test in a typical case, which consisted of a pre-validation process. This limitation arose due to the extensive nature of the work, which managed to group 88 indicators of sustainability development integration initiatives in HEI, which were grouped into 14 dimensions and 5 components. All elements that comprise the framework were justified through an extensive and systematic literature review, which involved the revision of more than 70 sustainability assessment tools. To achieve this result, over a thousand indicators and metrics were analysed. Recognising that this additional work would exceed the common scope of a doctoral research project, it is suggested that comparative tests be carried out as future work. Another suggestion for future work is to adapt the framework for application in other HEI that are not part of the typical case, such as private universities and educational centres, and other federal public institutions, for example, hospitals, courts, canteens, aid services, to name a few, that need to implement the NI10, 12/11/12, as well as any institution that needs to integrate sustainable development initiatives. Finally, it is suggested to analyse the applicability of the framework in international HEI to analyse the convergences and divergences of the sustainable development integration model in Brazilian HEI with what has been happening in other countries and regions.

In more practical terms, to assist Brazilian federal public HEI in overcoming the difficulty of complying with the NI10, 12/11/12 through the application of the developed framework, it is possible, in addition to the guides provided in the appendices, to digitise the framework in the form of a computer application and, additionally, offer training to HEI and monitor implementation through a Brazilian network of sustainable universities.

Chapter 10. References

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Chapter 11. SUPPLEMENTARY MATERIAL

11.1. APPENDIX A - Detailed Outcomes from VOSviewer

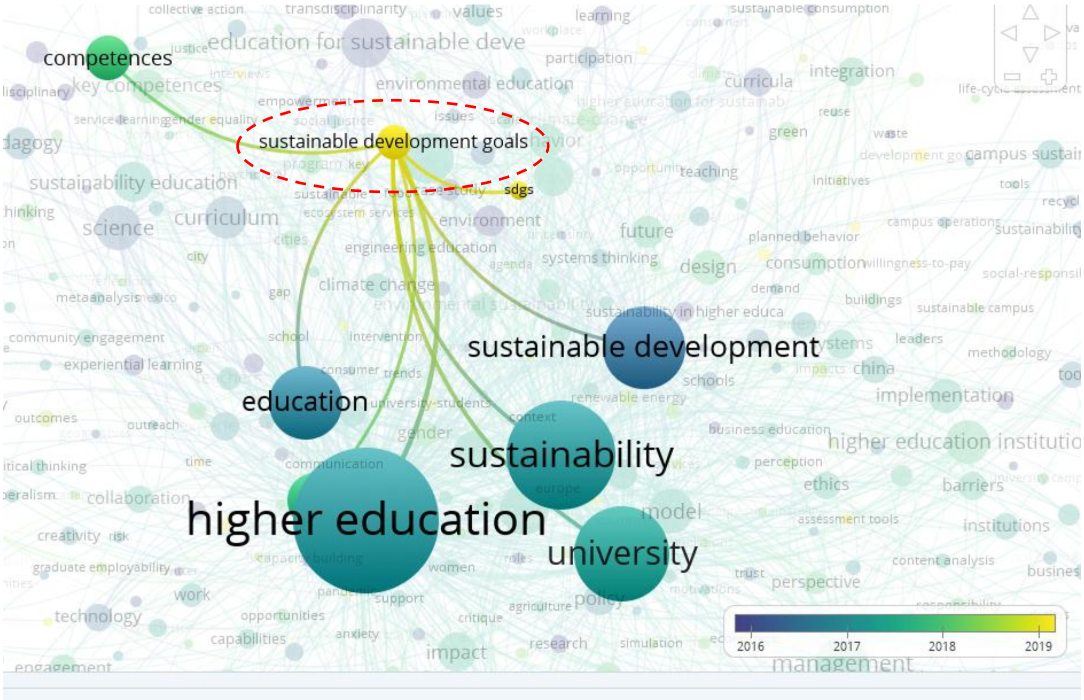
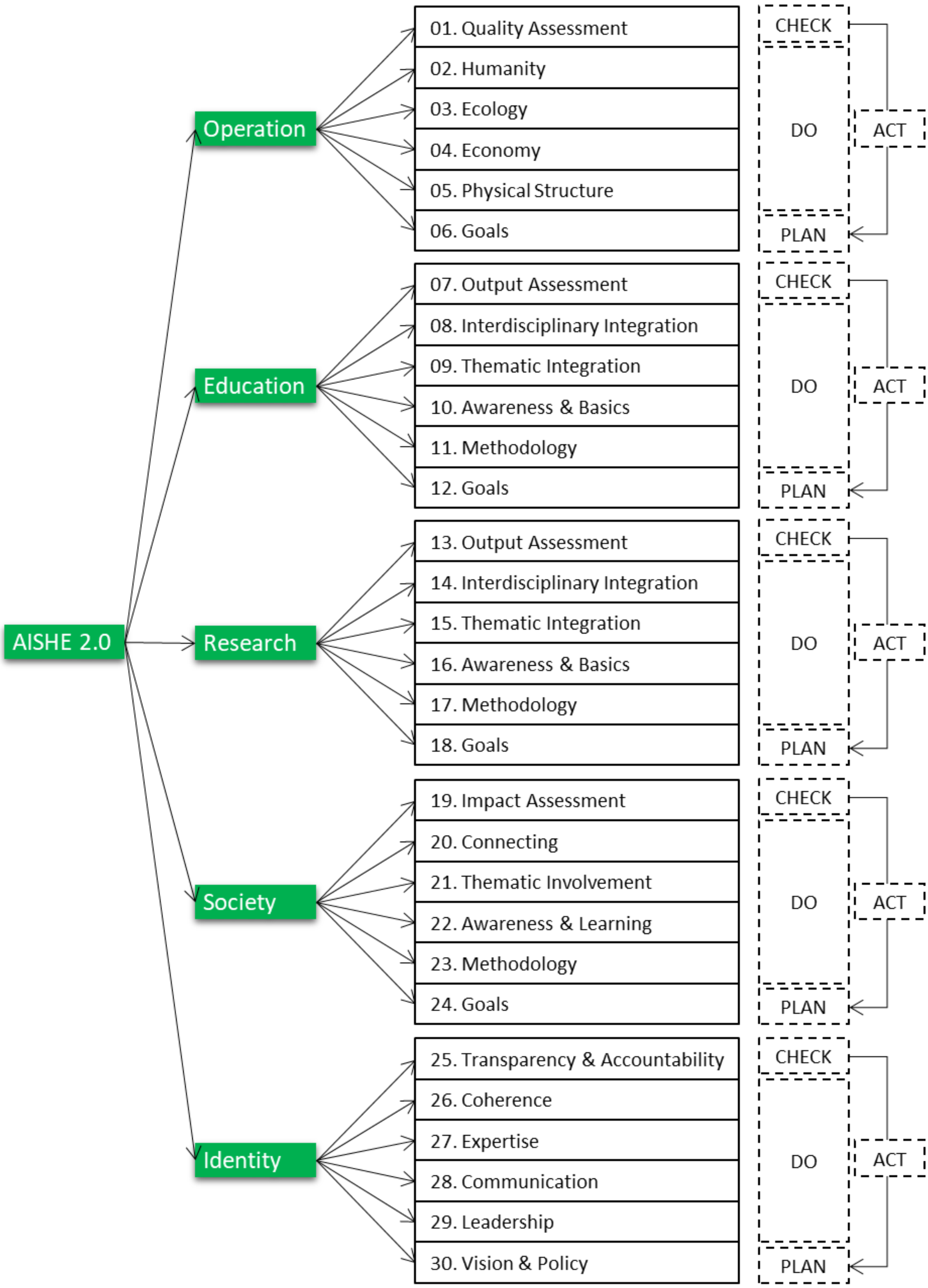


Figure 9-1 Detail of a VOSviewer display highlighting the interconnections of a node.

11.2. Appendix B - Graphical representation of the five highly reported SAT

SAT 1 - **AUDITING INSTRUMENT FOR SUSTAINABILITY IN HIGHER EDUCATION**



(Based on: N. Alghamdi et al., 2017)

Acronym: AISHE

Year of creation: 1.0: 2001 / 2.0: 2009

Description: The Assessment Instrument for Sustainability in Higher Education originates from the Netherlands. The current version, AISHE 2.0, was created by an international group of consultants based in the Netherlands, Sweden, Austria, and Spain. The tool comprises five dimensions, and their items are designed in a five range Guttmann format. It is available for free use.

Dimensions: identity, education, research, operations, and Societal Outreach

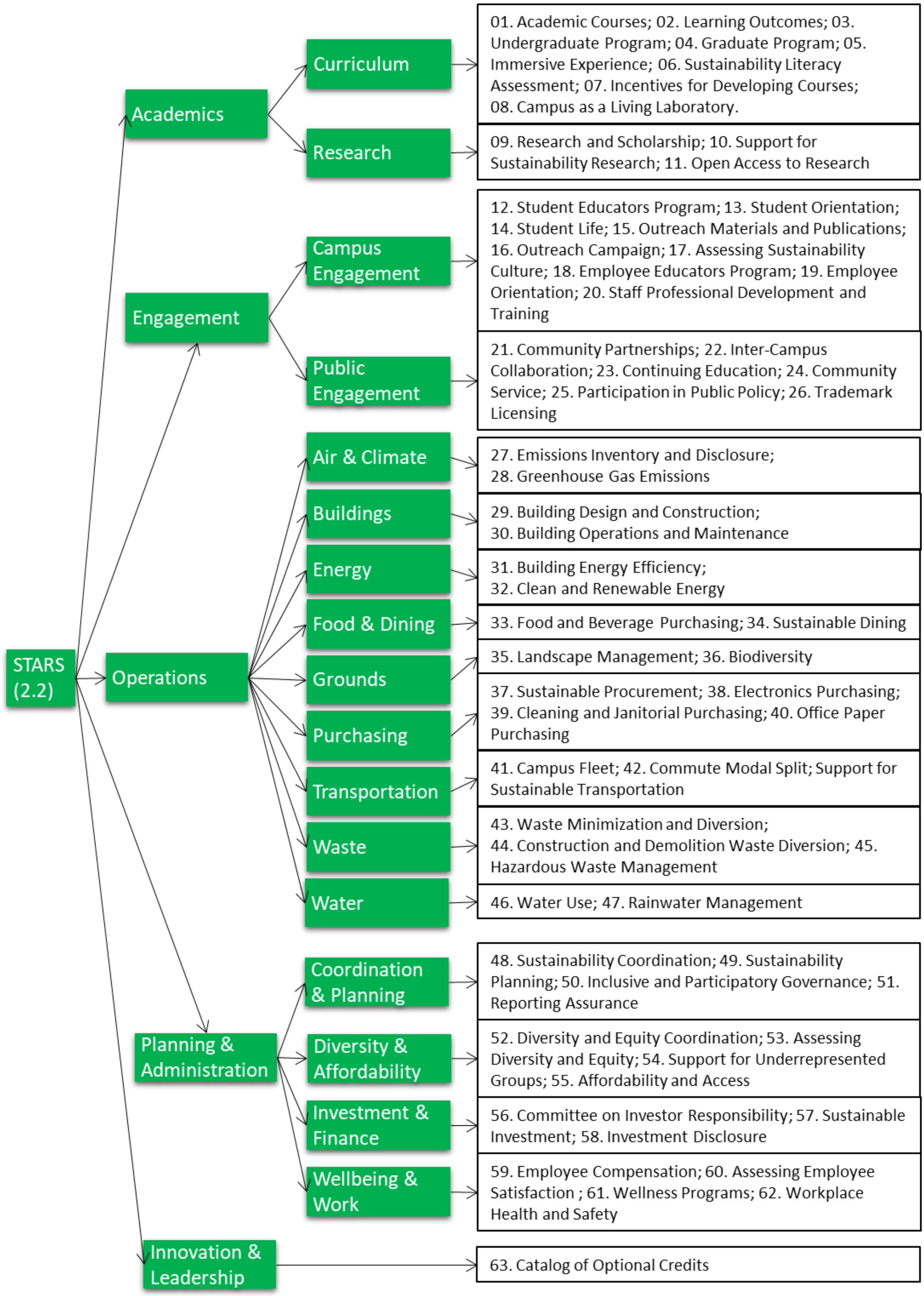
Number of indicators: 30

Strengths: Allows comparative analysis between; can be used as for self-evaluation purpose or through an external evaluation (audit) to be certified; it is modular and process-oriented, which helps in prioritising and setting goals; Based on continuous improvement

Weaknesses: Indicators based on narrative evaluation; curricula oriented.

Coverage (countries): Unrestricted, most used in Europe and USA

SAT 2 - SUSTAINABILITY TRACKING, ASSESSMENT & RATING SYSTEM



(Based on: N. Alghamdi et al., 2017)

Acronym: STARS

Year of creation: 1.

Description: The Sustainability Tracking, Assessment & Rating System was created by the Association for the advancement of Sustainability in Higher Education (AASHE). It is a self-reporting framework for HEI to measure their sustainability performance. Through with benchmarks approach that determines a possible raking. HEI that submits a self-assessment using STARS may achieve a gold, silver, or bronze rating.

Dimensions: academic; engagement; operations; planning and administration; and innovation

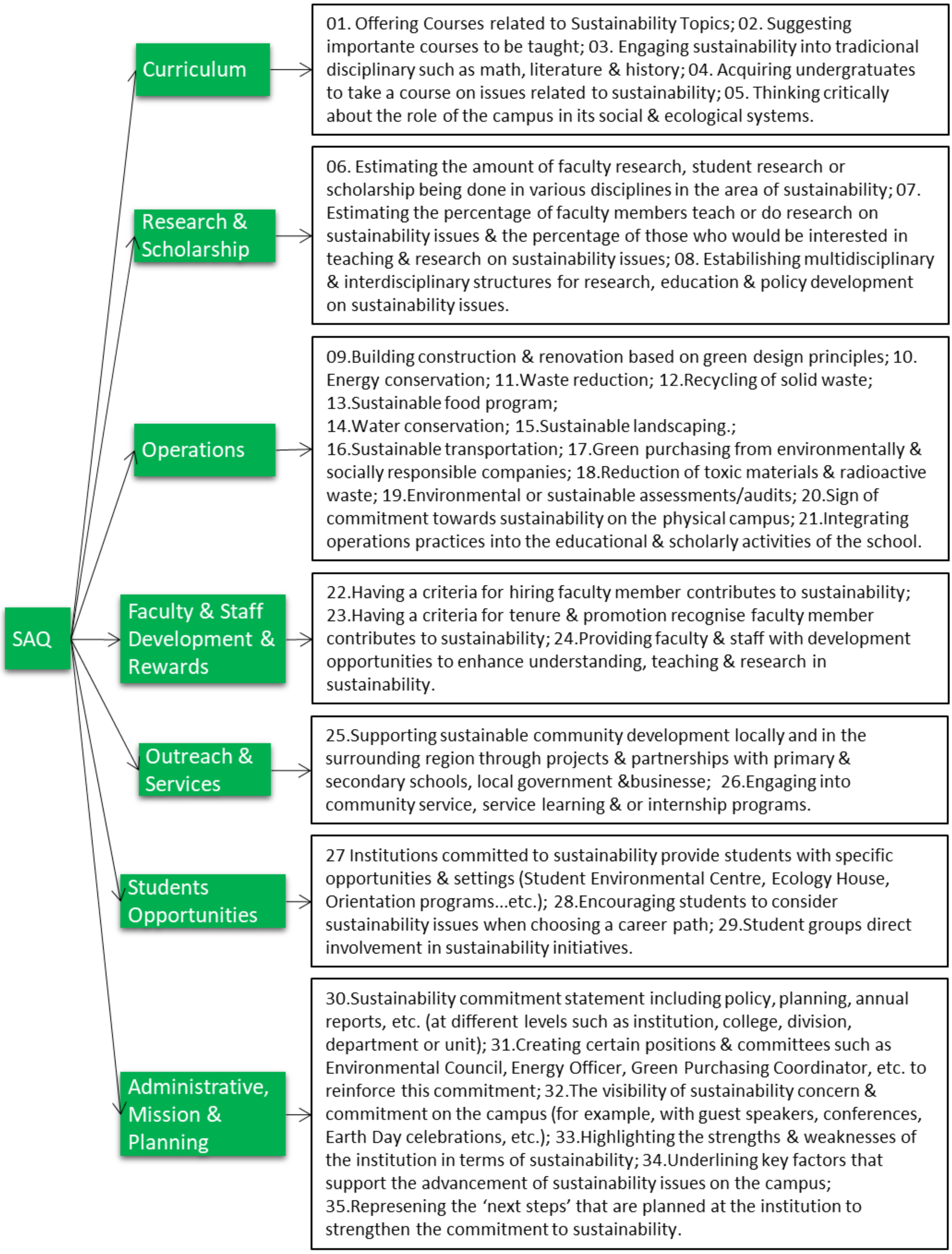
Number of indicators: 74

Strengths: Offer online application to collect and report data; cover broad aspects of sustainability in HEI; offer a technical manual with a detailed explanation about measurement process.

Weaknesses: Complex assessment procedure; accreditation costs; a complex system of scores evaluation weights; not quite suitable for beginners.

Coverage (countries): Unrestricted, most used in Europe and USA; It has not been used widely in developing countries.

SAT 3 - SUSTAINABILITY ASSESSMENT QUESTIONNAIRE



(Based on: N. Alghamdi et al., 2017)

Acronym: SAQ

Year of creation: 1999

Description: The sustainability assessment questionnaire (SAQ) was designed by the Association of University Leaders for a Sustainable Future (ULSF). It is a qualitative questionnaire designed to assess the extent to which HEI are sustainable in seven critical areas.

Dimensions: Curriculum; research and scholarship; operations; faculty and staff development and rewards; outreach and service; student opportunities; and institutional mission, structure, and planning

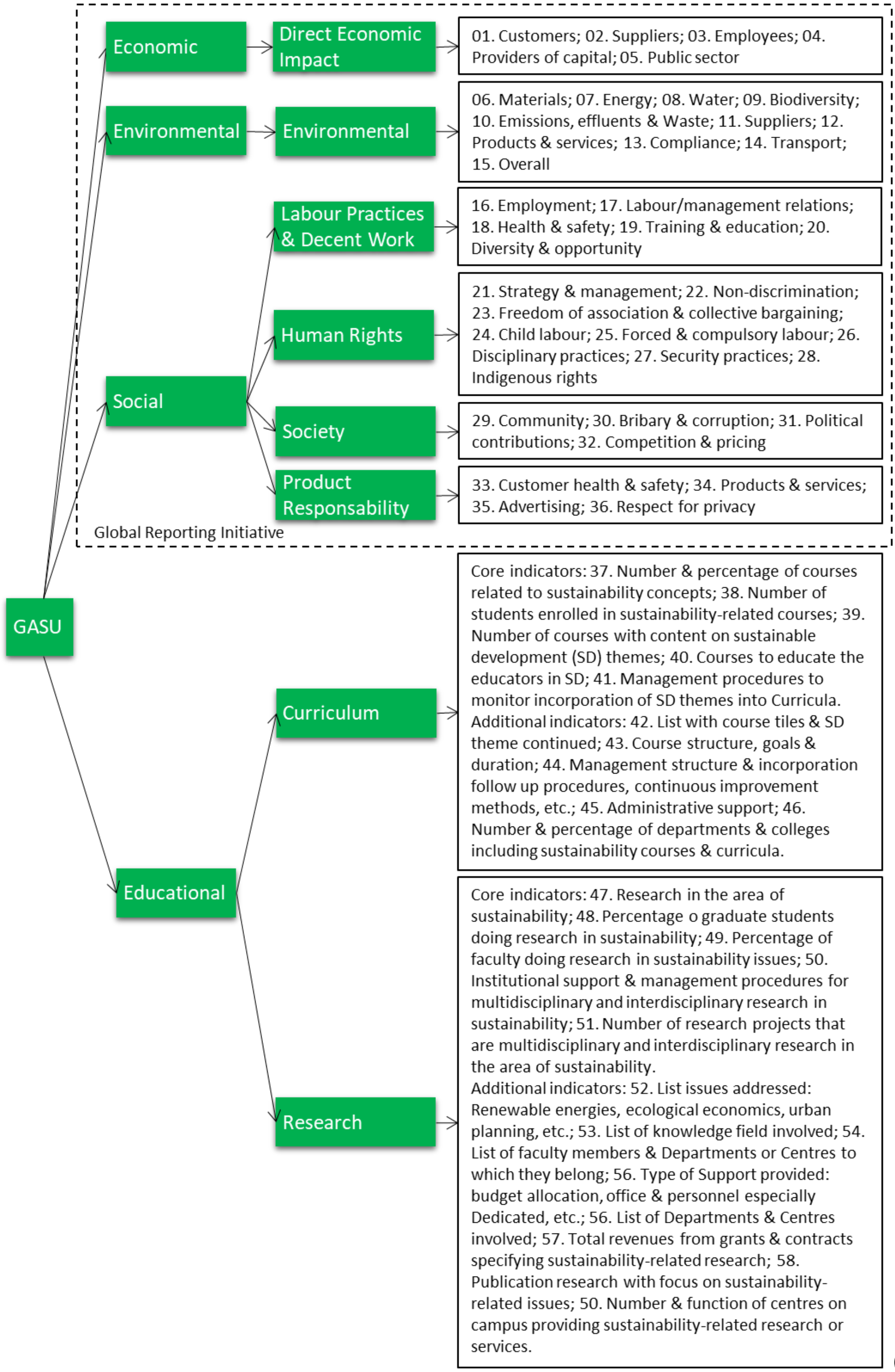
Number of indicators: 28

Strengths: process-based tool; Its application provides a diagnosis highlighting weaknesses, supporting the definition of goals; it might be used as a pilot and strategic planning tool; defines sustainability from comprehensive perspectives.

Weaknesses: It was not designed to be a tool for comparisons or benchmarking; cannot be used for rating or compare institutions.

Coverage (countries): Unrestricted

SAT 4 - GRAPHICAL ASSESSMENT OF SUSTAINABILITY IN UNIVERSITIES



(Based on: N. Alghamdi et al., 2017)

Acronym: GASU

Year of creation: 2006

Description: The Graphical Assessment of Sustainability in Universities (GASU) developed a new version in 2010 and has been designed to provide an analysis of current sustainability efforts, based on the GRI G3 Sustainability Guidelines, complemented with two additional dimensions. The tool is based on comparing the SD of universities according to selected sustainability variables using a graphical tool.

Dimensions: profile; economic dimension; environmental dimension; and social dimension, educational dimension; and Interlinking issues and dimensions

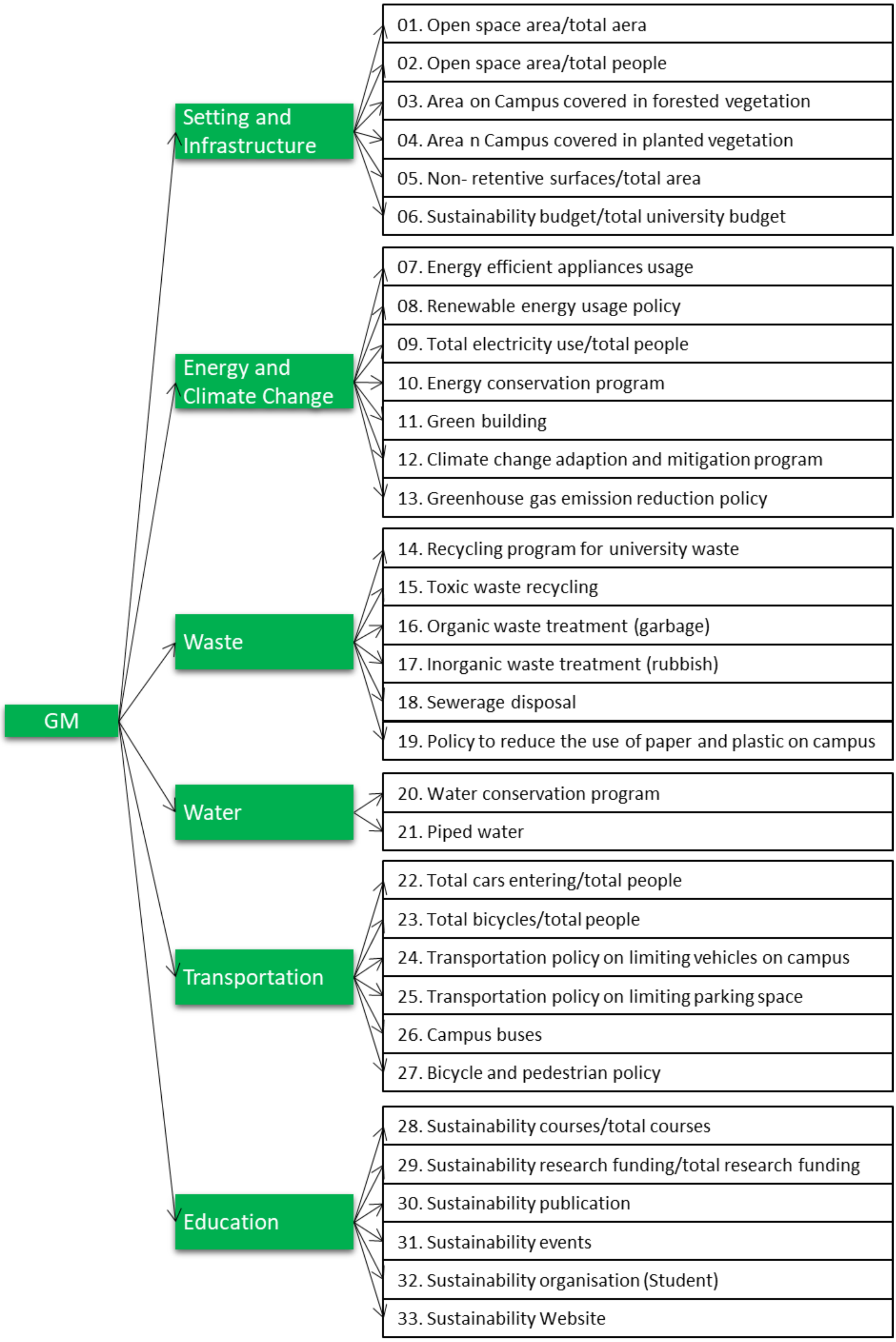
Number of indicators: 56

Strengths: The results are shown in 12 charts to facilitate comparison between HEI; It benchmarks universities for SD.

Weaknesses: Demand large amounts of data; Not easily applied in HEI that do not have GRI reports on sustainability; There is limited coverage in terms of variety of indicators

Coverage (countries): Unrestricted, most used in a developed country.

SAT 5 - UNIVERSITAS INDONESIA GREENMETRIC



(Based on: N. Alghamdi et al., 2017)

Acronym: UI-GM

Year of creation: 2010

Description: The Universitas Indonesia GreenMetric is a world university ranking system for HEI to assess and compare campus efforts towards sustainability. The tool was based on a broad philosophy encompassing the three E's: environment, economics, and equity and education.

Dimensions: setting and infrastructure; energy and climate change; waste; water; transportation; and education and research.

Number of indicators: 33

Strengths: It is a self-reported tool to ranking His's efforts towards sustainability as a result of its easiness of application is widely used throughout the world.

Weaknesses: It focuses on environmental aspects at the expense of social aspects.

Coverage (countries): Unrestricted

11.3. APPENDIX C – Detailed System formulation (Action Plan, Assessment Protocols, and Reporting Template

After the brief presentation of the procedures involved in the actions related to the formulation phase of the system (stage three), we will now specify the structure of the proposed framework. Present the five components, the fourteen action plans and their respective assessment protocols and report templates in detail. Further, in this chapter, the mathematical procedure is delineated to integrate the indicators into the proposed framework's action plans and components.

11.3.1. APPENDIX C.1. Component Governance & Procurement

The first component of the framework, Governance & Procurement, consists of three action plans, Institutional framework, Materials acquisition, and Procurement & Contract. The action plan regarding materials acquisition comprises the following items paper, disposable cups, and cartridges. The action plan contracting encompasses the services contracted by public procurement, namely telephony, surveillance, cleaning services and construction and maintenance services. The individual action plans are presented below, followed by the assessment protocols and the report template.

11.3.1.1. APPENDIX C.1.1. Dimension Institutional framework.

a) *Action Plan regarding institutional framework*

Table 9-1 - Action plan for dimension 1.1 - Institutional Framework

ACTION PLAN - Institutional framework													
Objective 1 – To establish sustainable practices for Institutional framework.													
Dimension 1: Quantify and monitor consumption									**TIMELINE**				
ID	**Action**	**Name of indicator**	**Metric**	**Goal (Period)**	**Start**	**End**	**Y 1**	**Y 2**	**Y 3**	**Y 4**	**Y 5**	**SD**	**SI**
EXT_Obj1_Act1	To revise strategic plan to include commitment to SD initiatives	Strategic commitment to integrate SD initiatives	Is SD commitment included in the Strategic Plan? (Y/N)	Have it or agree with including the SD commitment until the next revision (punctual)	At the next revision, up to Y5	Y 5					100%	EMC	PROPLAN
EXT_Obj1_Act2	To create institutional SD policy	Institutional SD policy	Has the institution SD policy? (Y/N)	To have Institutional SD policy (punctual)		Y 2		100%					
Dimension 2: Promote the reduction of use													
Dimension 3 – SD Campaigns													
EXT_Obj1_Act3	To develop a campaign to disseminate the institutional commitment to the SD	Campaigns to raise awareness of the institutional commitment to the SD	Number of campaigns about institutional commitment to the SD created per semester	To have at least 4 campaigns created per semester (continuous)	Entry into force	Conti-nuous	100%	100%	100%	100%	100%	EMC	

b) Assessment Protocols Regarding Institutional framework

The business process modelling notation employed to evaluate the indicators constituting the action plan institutional framework is depicted in Figure 9-2. Subsequently, the standard operating procedure is delineated to provide guidance for the execution of the designed workflow, as illustrated in Table 9-2.

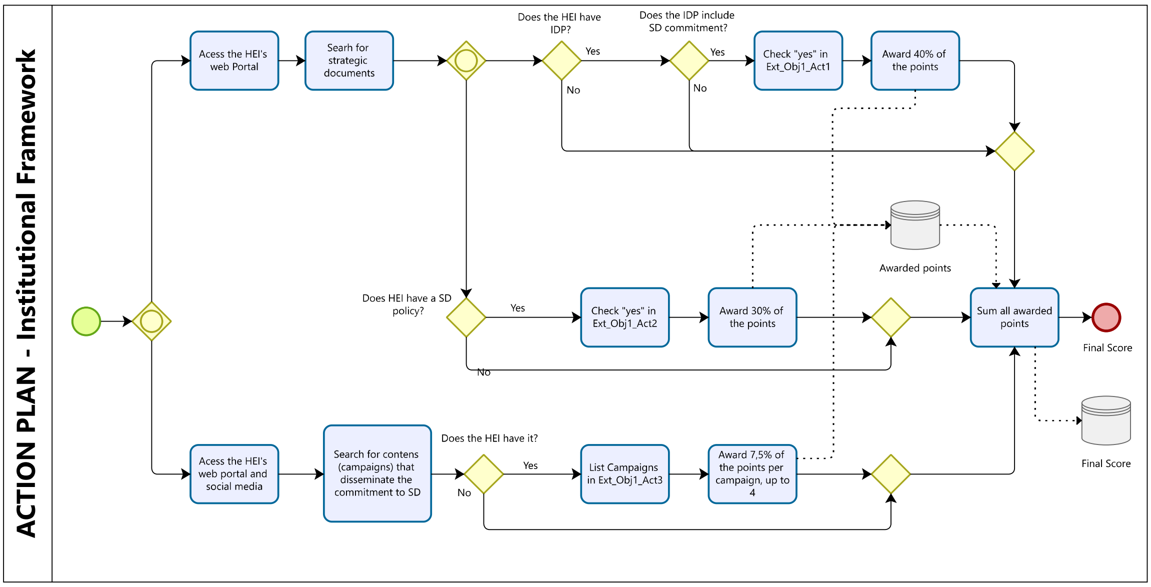


Figure 9-2 - Diagram for Dimension 1.1. Institutional Framework

Table 9-2 - Standard Operating Procedure for Action Plan 1.1. Institutional Framework

STANDARD OPERATING PROCEDURE (SOP)		
Action Plan: Institutional Framework	**Code:**	**Review:** 00
Date: 24/11/2021	**Page:** 1 of 1	

Objective
To describe the stages of data collection and calculation of indicators related to Objective 1 - To establish sustainable practices for Institutional framework. The primary purpose of these indicators is to measure the degree of integration of sustainable development initiatives in the institutional framework.

Normative Reference
Decree No. 7,746, of 5 June 2012
Normative Instruction N° 10, from November 12, 2012

Application
It covers the collection of data on the institutional framework of a HEI, for the subsequent analyses.

Areas Involved
Sector responsible for collecting the SLMP data.

Documents involved in the process.

Type of Document:	Institutional Development Plan (IDP), available in the institutional website. Institutional Policies (Resolutions), available in the institutional website. Publicity campaigns available in the official web portal and social media.

Definitions

The Institutional Development Plan (IDP) is the strategic document that the results necessary for the development of the institution.

Procedure
1) Search the institution's website for strategic documents, namely the Institutional Development Plan (IDP) and the Sustainable Development Policy.
2) If the IDP is available and this document mentions the institution's commitment to sustainable development, 33.33% of the points attributed to the Action Plan should be attributed.
3) If a policy related to the institutional commitment to sustainable development is available on the institution's website, attribute 33.33% of the total points attributed to the action plan.
4) Search the institution's website and social media for content and campaigns that promote commitment to sustainable development in the institution. For each available campaign, attribute 8.3325% of the total points attributed to the action plan, up to a total of 33.33%.

Responsibilities
Sector responsible for collecting the SLMP data.

Revision Control

Revision n°	Date	Description	Person responsible to approve the SOP
00	10/09/2021		

a) Reporting Template Regarding institutional framework

Table 9-3 - Reporting Template: 1.1. Institutional framework

Reporting on the action plan Institutional Framework

Brief description of the institutional framework of the analysed institution and main sectors responsible to implement SD initiatives. Indicate the institutional places where contents regarding SD commitments are shared with internal and external stakeholders.

ID	Indicator	Current status	Max. score	Awarded score
EXT_Obj1_Act1	Strategic commitment to SD initiatives		33.33%	0
EXT_Obj1_Act2	Institutional SD policy		33.33%	30
EXT_Obj1_Act3	Campaigns to raise awareness of the institutional commitment to the SD		33.33%	30
	SUM 100%			60

.

11.3.1.2. APPENDIX C.1.2. Dimension Materials acquisition.

a) *Action plan regarding material acquisition*

Table 9-4- Action plan for dimension 1.2 - Material acquisition

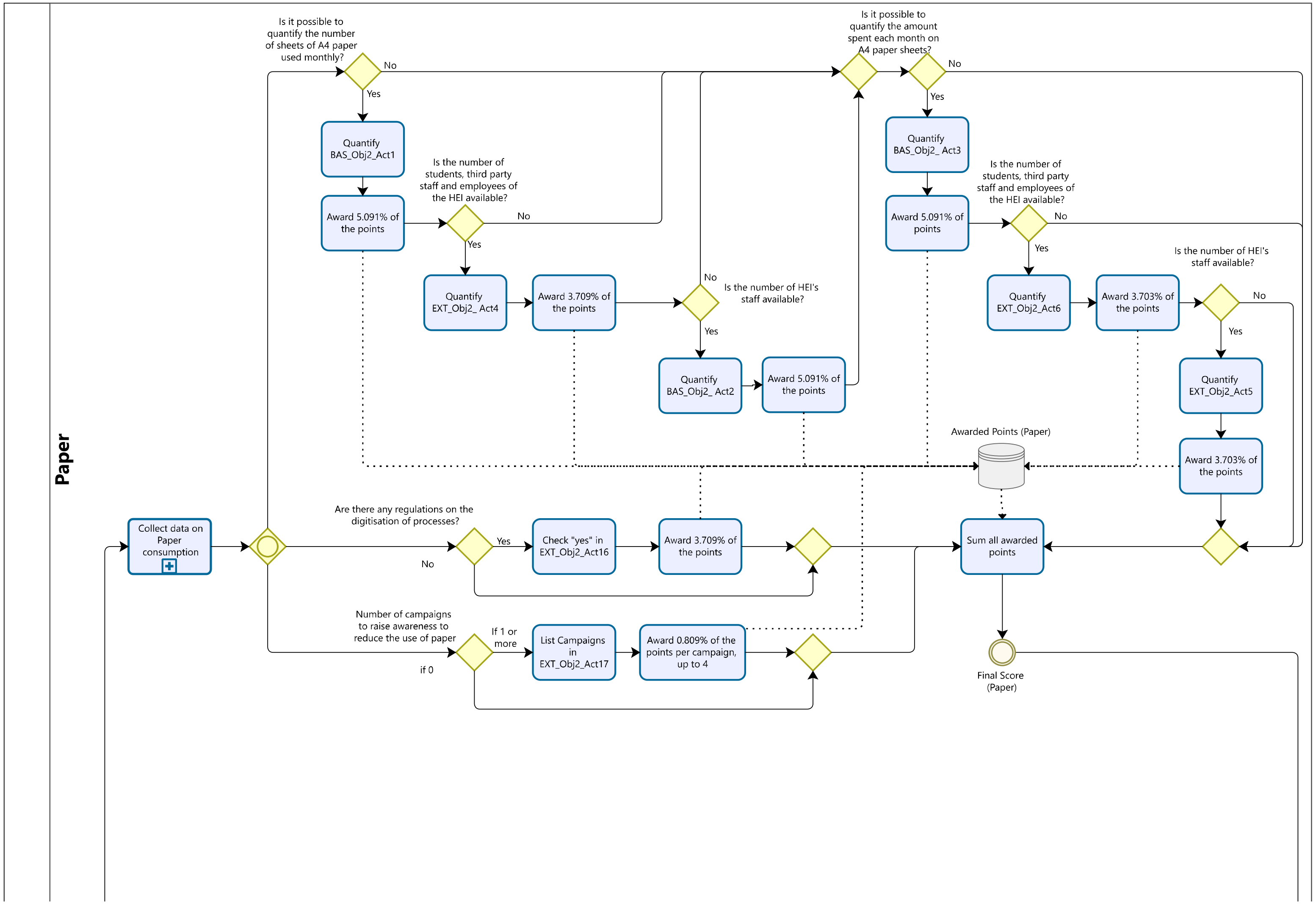
ACTION PLAN – Material acquisition													
Objective 2 – To establish sustainable practices for material acquisition.													
Dimension 1: Quantify and monitor consumption							**TIMELINE**						
ID	**Action**	**Name of indicator**	**Metric**	**Goal (Period)**	**Start**	**End**	**Y 1**	**Y 2**	**Y 3**	**Y 4**	**Y 5**	**SD**	**SI**
BAS_Obj2_Act1	To quantify the overall monthly consumption of white paper (bleached) in sheets	Total quantity of sheets of white paper used.	Quantity (units) of sheets of white paper used	Accounting for 100% of consumption (monthly and half-yearly)	Entry into force	Conti-nuous	100%	100%	100%	100%	100%		
BAS_Obj2_ Act2	To quantify the monthly per capita consumption of white paper (bleached) in sheets consumed by public servants in the Institution	Number of sheets of white paper per capita used by public servants	N° of white sheets/ N° of servers	Accounting for 100% of consumption (monthly and half-yearly)	Entry into force	Conti-nuous	100%	100%	100%	100%	100%		
BAS_Obj2_ Act3	To quantify the monthly expenditure, in R$, on the purchase of white paper (bleached)	Total expenditure with the acquisition of white paper	Expenditure in R$ with the acquisition of white paper	Accounting for 100% of consumption (monthly and half-yearly)	Entry into force	Conti-nuous	100%	100%	100%	100%	100%		
EXT_Obj2_ Act4	To quantify the monthly per capita consumption of white paper (bleached) consumed by the community (public servants, students, and outsourced workers) in the Institution	Number of sheets of white paper per capita used by the community	N° of white sheets/ N° of public servants + students + outsourced workers	Accounting for 100% of consumption (monthly and half-yearly)	Entry into force	Conti-nuous	100%	100%	100%	100%	100%		
EXT_Obj2_Act5	To quantify the monthly per capita spending, in BRL, of public servants on the purchase of white paper (bleached)	Expenditure per capita of servant on white paper	Expenditure, in BRL, with the acquisition of white paper /No. of public servants	Accounting for 100% of consumption (monthly and half-yearly)	Entry into force	Conti-nuous	100%	100%	100%	100%	100%		
EXT_Obj2_Act6	To quantify the monthly per capita spending, in R$, of the community (public servants, students and outsourced workers) on the purchase of white paper (bleached)	Expenditure per capita of the academic community on white paper	Expenditure in R$/ N° of employees + students + outsourced staff	Accounting for 100% of consumption (monthly and half-yearly)	Entry into force	Conti-nuous	100%	100%	100%	100%	100%		

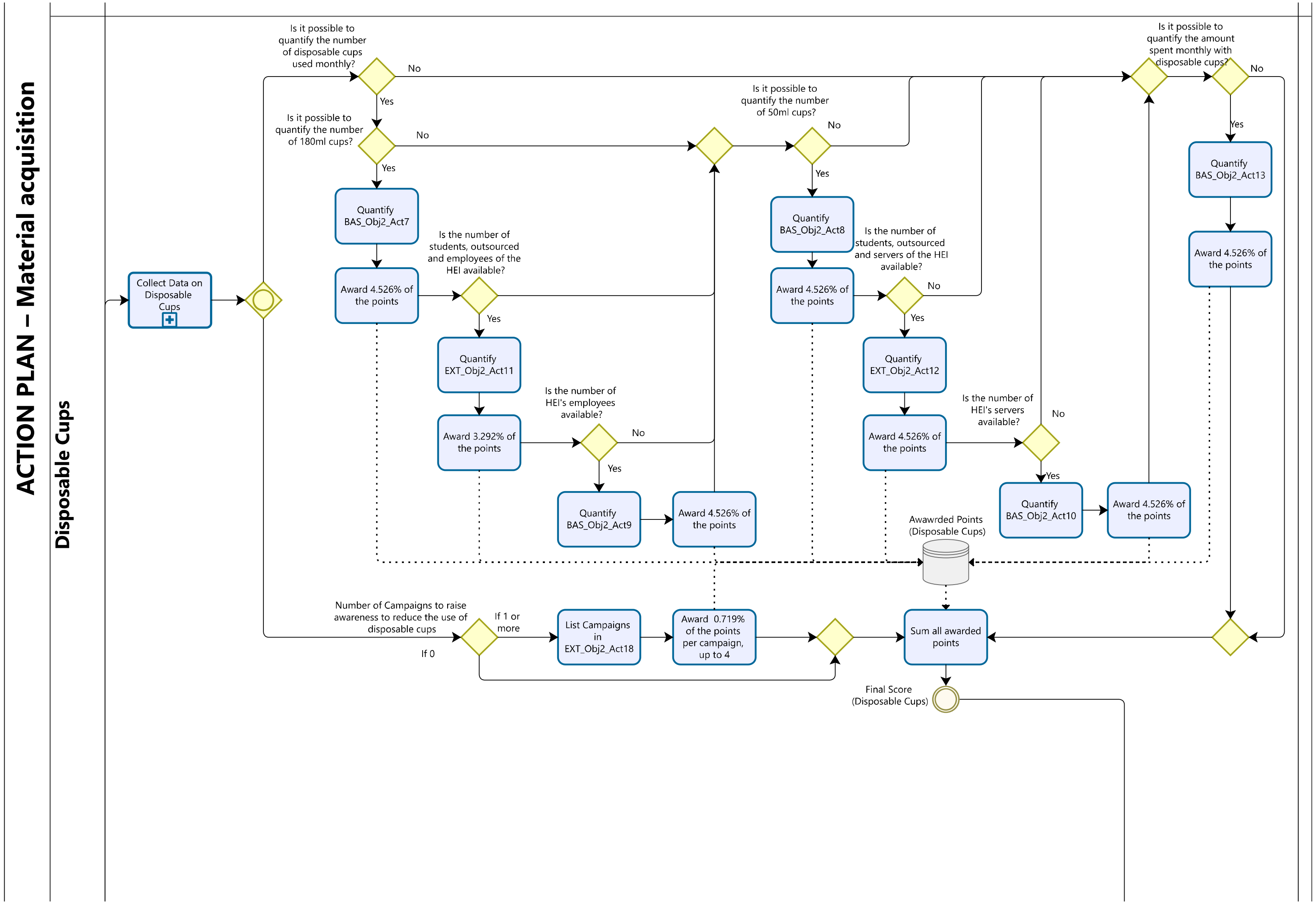
BAS_Obj2_Act7	To quantify the overall monthly consumption of 180 ml disposable cups	Consumption of 180 ml disposable cups	Quantity (units) of 180 ml disposable cups used	Accounting for 100% of consumption (monthly and half-yearly)	Entry into force	Conti-nuous	100%	100%	100%	100%	100%	
BAS_Obj2_Act8	To quantify the overall monthly consumption of 50 ml disposable cups	Consumption of 50 ml disposable cups	Quantity (units) of 50 ml disposable cups used	Accounting for 100% of consumption (monthly and half-yearly)	Entry into force	Conti-nuous	100%	100%	100%	100%	100%	
BAS_Obj2_Act9	To quantify the monthly per capita consumption of disposable 180ml cups by public servants	Per capita consumption of disposable 180ml cups per servant	Quantity (units) of 180 ml cups / total number of servers	Accounting for 100% of consumption (monthly and half-yearly)	Entry into force	Conti-nuous	100%	100%	100%	100%	100%	
BAS_Obj2_Act10	To quantify the monthly per capita consumption of 50 ml disposable cups per public servant	Per capita consumption of 50 ml disposable cups per public servant	Quantity (units) of 50 ml cups / total number of servers	Accounting for 100% of consumption (monthly and half-yearly)	Entry into force	Conti-nuous	100%	100%	100%	100%	100%	
EXT_Obj2_Act11	To quantify the monthly per capita consumption of disposable 180ml cups by the community (employees, students, and outsourced workers)	Per capita consumption of disposable 180ml cups by the community	Quantity (units) of 180 ml cups / total community (employees, students, and outsourced workers)	Accounting for 100% of consumption (monthly and half-yearly)	Entry into force	Conti-nuous	100%	100%	100%	100%	100%	
EXT_Obj2_Act12	To quantify the monthly per capita consumption of 50 ml disposable cups by the community (employees, students and outsourced workers)	Per capita consumption of 50 ml disposable cups by the community	Quantity (units) of 50 ml cups / total community (employees, students and outsourced workers)	Accounting for 100% of consumption (monthly and half-yearly)	Entry into force	Conti-nuous	100%	100%	100%	100%	100%	
BAS_Obj2_Act13	To quantify the monthly expenditure, in BRL, on the purchase of 180ml	Spending on the purchase of disposable cups	Amount (R$) spent to purchase disposable cups (180ml)	Accounting for 100% of consumption (monthly and half-yearly)	Entry into force	Conti-nuous	100%	100%	100%	100%	100%	
EXT_Obj2_Act14	To quantify the global monthly consumption of cartridges and toner	Monthly consumption of printing cartridges and toner	Quantity (units) of cartridges and toners used	Accounting for 100% of consumption (monthly and half-yearly)	Entry into force	Conti-nuous	100%	100%	100%	100%	100%	
EXT_Obj2_Act15	To quantify the monthly expenses, in BRL, with the purchase of printer cartridges and toners	Spending on the purchase of cartridges and toners	Amount (R$) spent to purchase cartridges and toners	Accounting for 100% of consumption (monthly and half-yearly)	Entry into force	Conti-nuous	100%	100%	100%	100%	100%	
Dimension 2: Promote the reduction of use												
EXT_Obj2_Act16	To promote the reduction of paper use by regulating the digitalisation of processes	Regulation of the digitalisation of processes	Does the institution have resolutions and/or ordinances on the subject? (y/n)	To have regulation to promote the digitalisation of the processes (punctual)	Entry into force	Conti-nuous	100%	100%	100%	100%	100%	
Dimension 3 – SD Campaigns												
EXT_Obj2_Act17	To develop campaign to disseminate awareness to reduce the use of paper	Campaigns to raise awareness to reduce the use of paper	Number of campaigns to raise awareness to reduce the use of paper	To have at least 4 campaigns created per semester (continuous)	Entry into force	Conti-nuous	100%	100%	100%	100%	100%	EMC

EXT_Obj2_Act18	To develop campaign to disseminate awareness to reduce the use of disposable cups	Campaign to raise awareness to reduce the use of disposable cups	Number of campaigns to raise awareness to reduce the use of disposable cups	To have at least 4 campaigns created per semester (continuous)	Entry into force	Conti-nuous	100%	100%	100%	100%	100%
EXT_Obj2_Act19	To develop campaign to disseminate awareness to reduce the use of cartridges and toners	Campaign to raise awareness to reduce the use of cartridges and toners	Number of campaigns to raise awareness to reduce the use of cartridges and toners	To have at least 4 campaigns created per semester (continuous)	Entry into force	Conti-nuous	100%	100%	100%	100%	100%

b) *Assessment protocols for materials acquisition*

The business process modelling notation employed to evaluate the indicators constituting the action plan materials acquisition is depicted in Figure 9-3. Subsequently, the standard operating procedure (SOP) is delineated to provide guidance for the execution of the designed workflow, as illustrated in Table 9-5.


Paper
Is it possible to quantify the number of sheets of A4 paper used monthly?
No
Yes
Quantify BAS_Obj2_Act1
Award 5.091% of the points
Is the number of students, third party staff and employees of the HEI available?
No
Yes
Quantify EXT_Obj2_Act4
Award 3.709% of the points
No
Is the number of HEI's staff available?
Yes
Quantify BAS_Obj2_Act2
Award 5.091% of the points
Is it possible to quantify the amount spent each month on A4 paper sheets?
No
Yes
Quantify BAS_Obj2_Act3
Award 5.091% of points
Is the number of students, third party staff and employees of the HEI available?
No
Yes
Quantify EXT_Obj2_Act6
Award 3.703% of the points
Is the number of HEI's staff available?
No
Yes
Quantify EXT_Obj2_Act5
Award 3.703% of the points
Awarded Points (Paper)
Collect data on Paper consumption
Are there any regulations on the digitisation of processes?
Yes
No
Check "yes" in EXT_Obj2_Act16
Award 3.709% of the points
Sum all awarded points
Number of campaigns to raise awareness to reduce the use of paper
If 1 or more
if 0
List Campaigns in EXT_Obj2_Act17
Award 0.809% of the points per campaign, up to 4
Final Score (Paper)


ACTION PLAN – Material acquisition
Disposable Cups
Collect Data on Disposable Cups
Is it possible to quantify the number of disposable cups used monthly?
No
Yes
Is it possible to quantify the number of 180ml cups?
No
Yes
Quantify BAS_Obj2_Act7
Award 4.526% of the points
Is the number of students, outsourced and employees of the HEI available?
Yes
Quantify EXT_Obj2_Act11
Award 3.292% of the points
Is the number of HEI's employees available?
No
Yes
Quantify BAS_Obj2_Act9
Award 4.526% of the points
Is it possible to quantify the number of 50ml cups?
No
Yes
Quantify BAS_Obj2_Act8
Award 4.526% of the points
Is the number of students, outsourced and servers of the HEI available?
No
Yes
Quantify EXT_Obj2_Act12
Award 4.526% of the points
Is the number of HEI's servers available?
No
Yes
Quantify BAS_Obj2_Act10
Award 4.526% of the points
Is it possible to quantify the amount spent monthly with disposable cups?
No
Yes
Quantify BAS_Obj2_Act13
Award 4.526% of the points
Awawrded Points (Disposable Cups)
Number of Campaigns to raise awareness to reduce the use of disposable cups
If 1 or more
If 0
List Campaigns in EXT_Obj2_Act18
Award 0.719% of the points per campaign, up to 4
Sum all awarded points
Final Score (Disposable Cups)

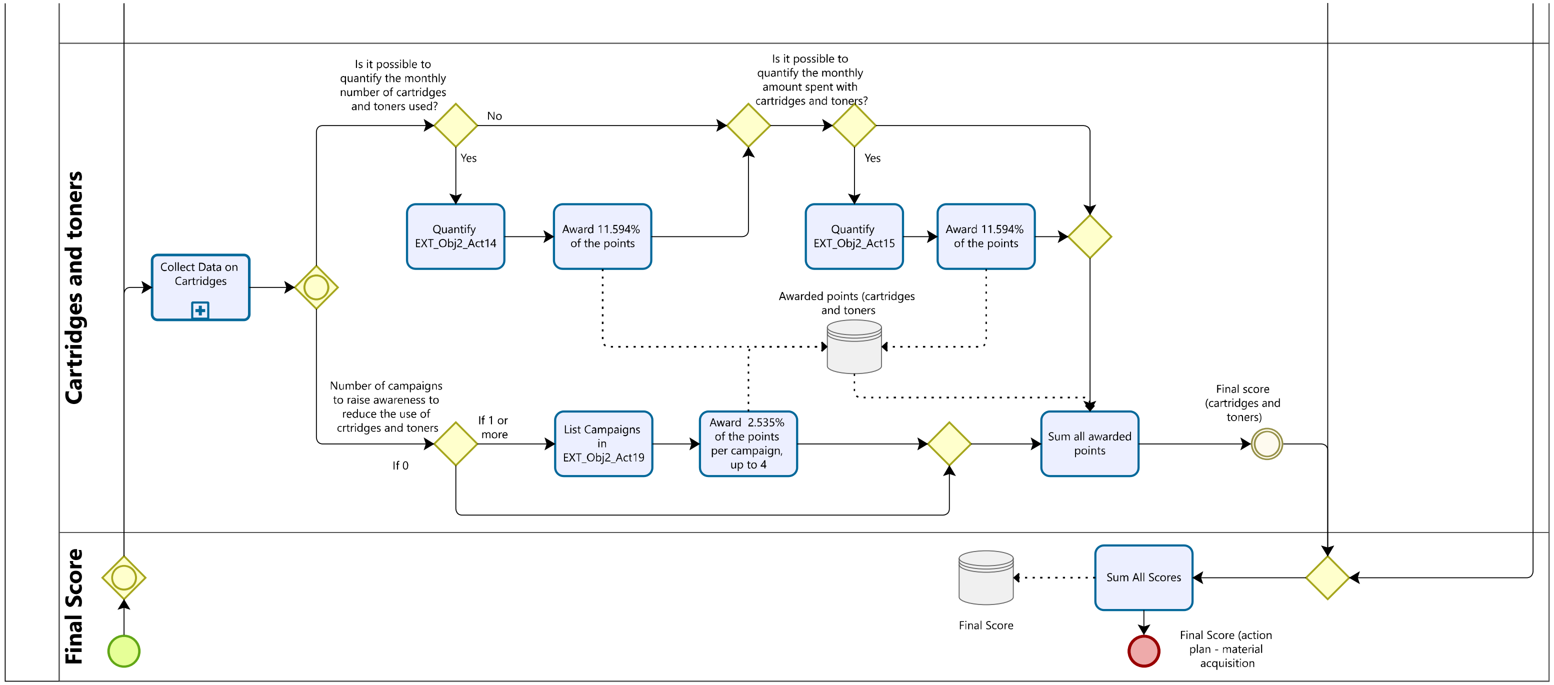


Figure 9-3 - Diagram for Dimension 1.2. Material acquisition.

Table 9-5 - Standard Operating Procedure for Action Plan 1.2. Material acquisition

STANDARD OPERATING PROCEDURE (SOP)		
Action Plan: Material Acquisition	**Code:**	**Review:** 00
Date: 24/11/2021	**Page:** 1 of 1	

Objective
To describe the stages of data collection and calculation of indicators related to Objective 2 – To establish sustainable practices for material acquisition. The main purpose of these indicators is to measure the degree of integration of sustainable development initiatives in material acquisition.

Normative Reference
Decree No. 7,746, of 5 June 2012
Normative Instruction N° 10, from November 12, 2012

Application
It covers the collection of data on material acquisition of a HEI, for the subsequent analyses.

Areas Involved
Sector responsible for collecting the SLMP data.

Documents involved in the process.

Type of Document:	

Definitions

Procedure
a) Paper

1) Collect A4 paper consumption data in the governmental public transparency portal.
2) If possible, quantify the number of A4 paper sheets consumed monthly by HEI; 5.263% of the points attributed to the Action Plan should be assigned to the following action: BAS_Obj2_Act1.
3) If possible, measure the number of students, outsourced and public servants of the HEI; 5.263% of the points attributed to the Action Plan should be attributed to the following action: EXT_Objj2_Act4.
4) If possible, measure the number of HEI public servants; 5.263% of the points attributed to the Action Plan should be attributed to the following action: BAS_Obbj2_Act2.
5) If possible, quantify the monthly amount spent with the consumption of A4 paper sheets; 5.263% of the points attributed to the Action Plan should be attributed to the following action: BAS_Obj2_Act3.
6) If possible, measure the number of students, outsourced and public servants at the HEI; 5.263% of the points attributed to the Action Plan should be attributed to the following action: EXT_Obj2_Act6.
7) If possible, measure the number of public servants; 5.263% of the points attributed to the Action Plan should be attributed to the following action: EXT_Obj2_Act5.
8) If there are any regulations regarding the digitalisation of processes; 5.263% of the points attributed to the Action Plan should be attributed to the following action: EXT_Obj2_Act16.
9) If there are campaigns to raise awareness to reduce the use of paper; Award 1.31575% of the points per campaign, up to 4 to the following action: EXT_Obj2_Act17.
10) Sum all awarded points to obtain the final score to paper consumption.

b) Disposable Cups

1) Collect disposable cups consumption data in the governmental public transparency portal.
2) If possible, quantify the number of 180 ml cups used monthly; 5.263% of the points attributed to the Action Plan should be attributed to the following action: BAS_Obj2_Act7
3) If possible, measure the number of students, outsourced and public servants of the HEI; 5.263% of the points attributed to the Action Plan should be attributed to the following action: EXT_Obj2_Ac11.
4) If possible, measure the number of public servants; 5.263% of the points attributed to the Action Plan should be attributed to the following action BAS_Obj2_Act9.
5) If possible, quantify the number of 50 ml cups used on a monthly basis; 5.263% of the points attributed to the Action Plan should be attributed to the following action BAS_Obj2_Act8.
6) If possible, measure the number of students, outsourced and public servants of the HEI; 5.263% of the points attributed to the Action Plan should be attributed to the following action EXT_Obj2_Act12.
7) If possible, measure the number of public servants; 5.263% of the points attributed to the Action Plan should be attributed to the following action BAS_Obj2_Act10.
8) If possible, quantify the monthly amount spent with the consumption of disposable cups; 5.263% of the points attributed to the Action Plan should be attributed to the following action BAS_Obj2_Act13.
9) If there are campaigns to raise awareness to reduce the use of disposable cups; Award 1.31575% of the points per campaign, up to 4. The points should be attributed to the following action EXT_Obj2_Act18.

10) Sum all awarded points to obtain the final score to disposable cups consumption.

c) Cartridges and Toners

1) Collect A4 paper consumption data in the governmental public transparency portal.
2) If possible, quantify the number of cartridges and toners used monthly; 5.263% of the points attributed to the Action Plan should be attributed to the following action EXT_Obj2_Act14.
3) If possible, quantify the monthly amount spent with the consumption of cartridges and toners; 5.263% % of the points attributed to the Action Plan should be attributed to the following action EXT_Obj2_Act15.
4) If there are campaigns to raise awareness to reduce the use of cartridges and toners; Award 1.31575% of the points per campaign, up to 4. The points should be attributed to the following action EXT_Obj2_Act19.
5) Sum all awarded points to obtain the final score to cartridge and toners consumption.

d) Final Score

1) Sum all points awarded by paper (a – step 10); disposable cups (b – step 10) and cartridges and toners (c – step 5) to obtain the final score to action plan – material acquisition.

Responsibilities
Sector responsible for collecting the SLMP data.

Revision Control

Revision n°	Date	Description	Person responsible to approve the SOP
00	10/09/2021		

c) *Reporting template for materials acquisition.*

Table 9-6 - Reporting Template: 1.2. Material acquisition

Reporting on the action plan Materials acquisition

a) Paper

Brief introduction explaining the elements that comprises the action plan and the institutional sectors involved in the implementations and most relevant achievements.

Table of indicators

ID – Indicator / Baseline	Months												Des. Stat.		Score
	1	2	3	4	5	6	7	8	9	10	11	12	$\bar{x}$	σ	
BAS_Obj2_Act1 - Total quantity of sheets of white paper used															2019
BAS_Obj2_Act1 – Baseline (2017- 2018)															2017-2018
BAS_Obj2_ Act2 - Number of sheets of white paper per capita used by public servants															
BAS_Obj2_ Act2 – Baseline (2017- 2018)															
Indicator n															
Baseline n															

1) Graphic of the indicator BAS_Obj2_Act1 and baseline

2) Graphic of the indicator BAS_Obj2_ Act2 and baseline

ID - Action	Status
BAS_Obj2_Act1 - To quantify the overall monthly consumption of white paper (bleached) in sheets	Complete/ incomplete…
Action n	

b) Disposable Cup

Brief introduction explaining the elements that comprises the action plan and the institutional sectors involved in the implementations and most relevant achievements.

Table of indicators

ID – Indicator / Baseline	Months												Des. Stat.		Score
	1	2	3	4	5	6	7	8	9	10	11	12	$\bar{x}$	σ	
BAS_Obj2_Act7 – Consumption of 180 ml disposable cups															
BAS_Obj2_Act7 – Baseline (2017- 2018)															
BAS_Obj2_Act8 – Consumption of 50 ml disposable cups															
BAS_Obj2_Act8 – Baseline (2017- 2018)															
Indicator n															
Baseline n															

1) Graphic of the indicator BAS_Obj2_Act13 and baseline

ID - Action	Status
BAS_Obj2_Act7 – Quantify the overall monthly consumption of 180 ml disposable cups	Complete/ incomplete…
Action n	

c) Cartridges

Brief introduction explaining the elements that comprises the action plan and the institutional sectors involved in the implementations and most relevant achievements.

Table of indicators

ID – Indicator / Baseline	Months												Des. Stat.		Score
	1	2	3	4	5	6	7	8	9	10	11	12	$\bar{x}$	σ	
EXT_Obj2_Act14 – Monthly consumption of printing cartridges and toner															
EXT_Obj2_Act14 – Baseline (2017- 2018)															
EXT_Obj2_Act15 – Spending on the purchase of cartridges and toners															
EXT_Obj2_Act15 – Baseline (2017- 2018)															
Indicator n															
Baseline n															

1) Graphic of the indicator BAS_Obj2_Act1 and baseline
2) Graphic of the indicator BAS_Obj2_ Act2 and baseline

ID - Action	Status
EXT_Obj2_Act14 – Quantify the global monthly consumption of cartridges and toner	Complete/ incomplete…
Action n	

11.3.1.3. APPENDIX C.1.3. Dimension Procurement (contracting)

a) *Action plan regarding Procurement (contracting)*

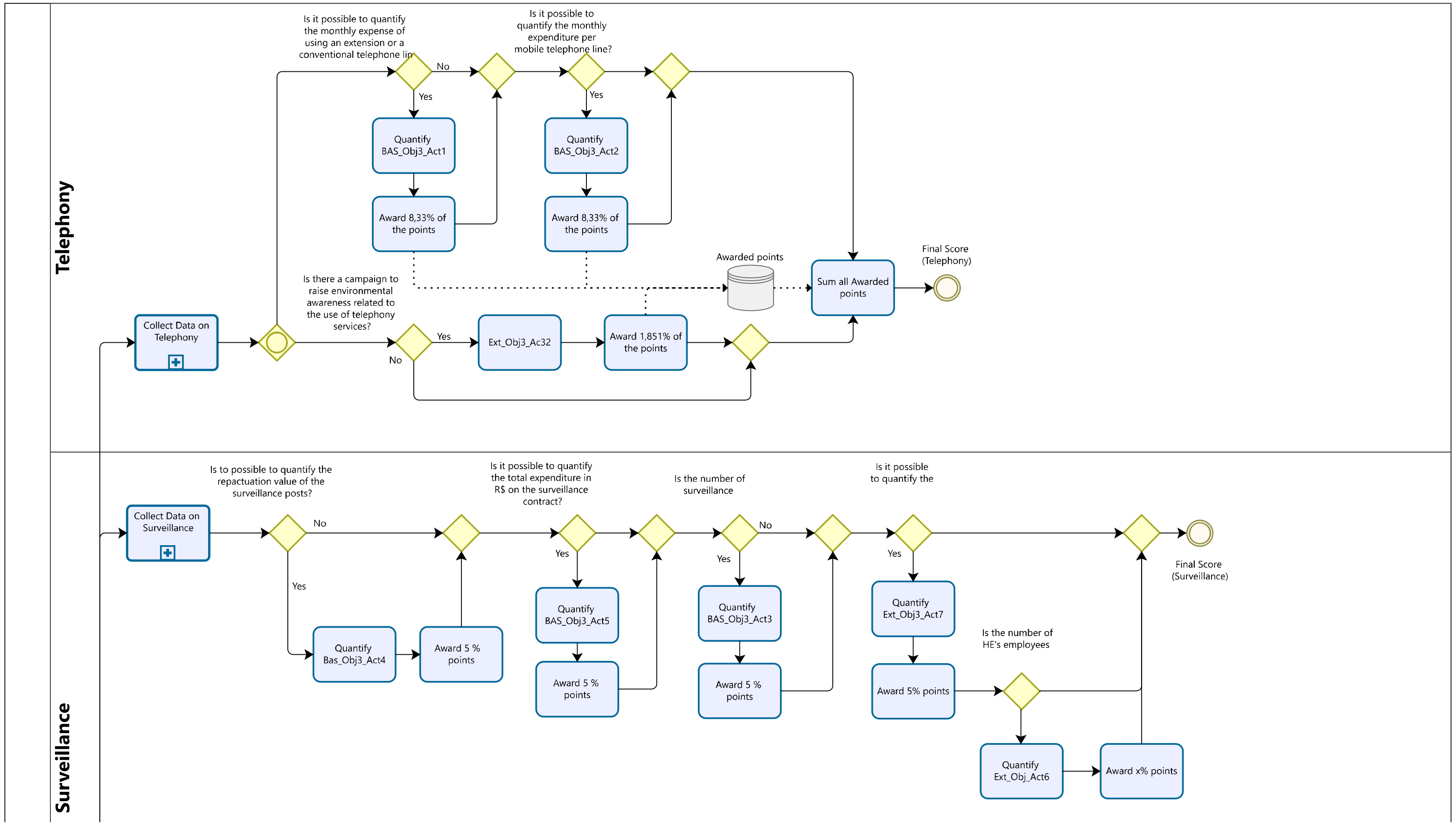
Table 9-7 - Action plan for dimension 1.3 - Procurement (contracting)

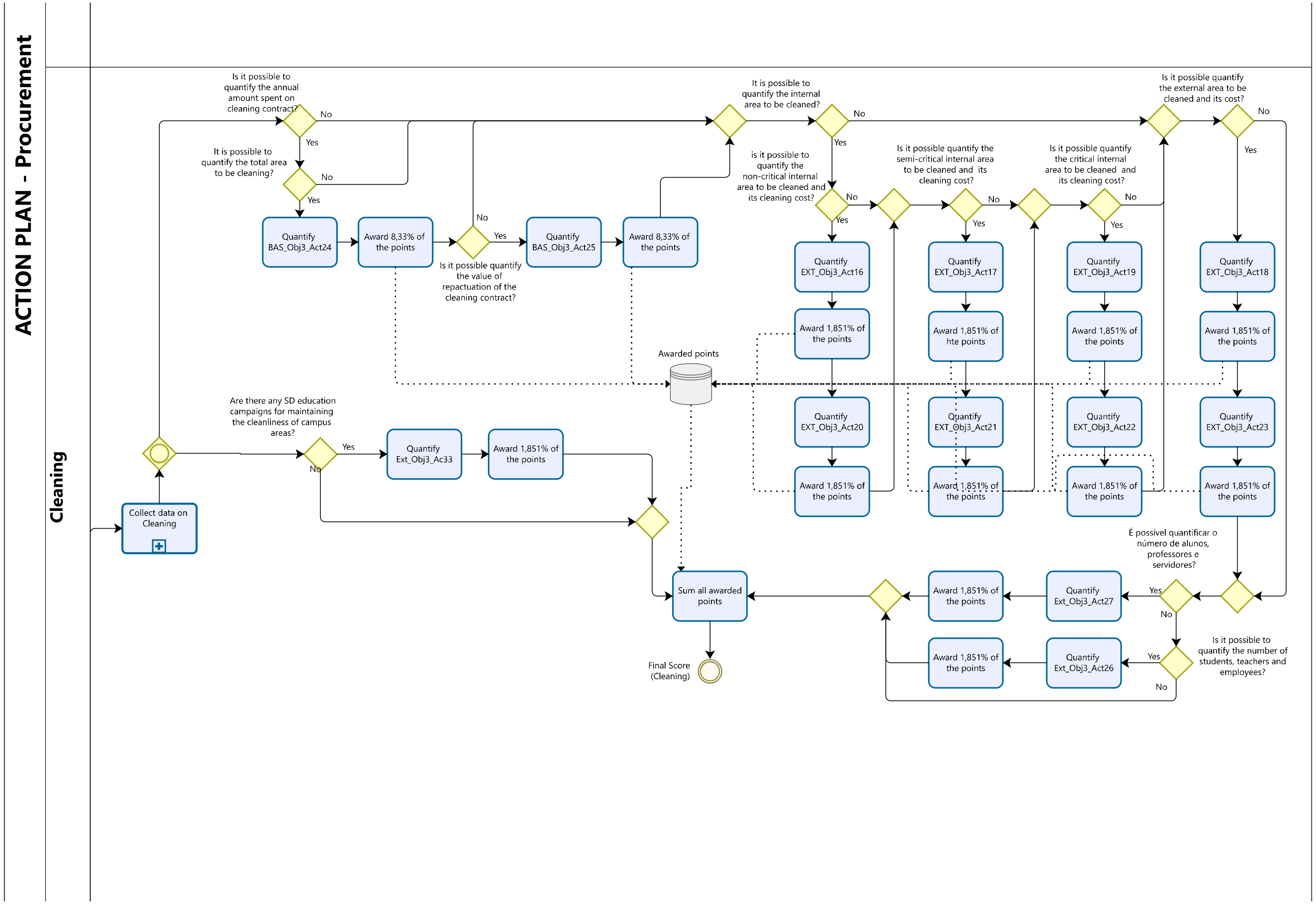
ACTION PLAN – Procurement (contracting)													
Objective 3 – To establish sustainable practices for procurement & contracting.													
Dimension 1: Quantify and monitor consumption							**TIMELINE**						
ID	**Action**	**Name of indicator**	**Metric**	**Goal (Period)**	**Start**	**End**	**Y 1**	**Y 2**	**Y 3**	**Y 4**	**Y 5**	**SD**	**SI**
BAS_Obj3_Act1	To quantify the monthly expenditure per extension or conventional telephone line use	Expenditure per extension and fixed telephone line	Amount in R$ / n° of landline	Accounting for 100% of consumption (monthly and half-yearly)	Entry into force	Conti-nuous	100%	100%	100%	100%	100%	EMC	PROPLAN
BAS_Obj3_Act2	To quantify the monthly expenditure per mobile telephone line	Expenditure per mobile line	Amount in R$ / n° of mobile lines	Accounting for 100% of consumption (monthly and half-yearly)	Entry into force	Conti-nuous	100%	100%	100%	100%	100%		
BAS_Obj3_Act3	To quantify the monthly average value of the surveillance post	Average value of the surveillance post	(Total annual value of the contract/ number of posts)/12	Accounting for 100% of consumption (monthly and half-yearly)	Entry into force	Conti-nuous	100%	100%	100%	100%	100%		
BAS_Obj3_Act4	To quantify the average current value of the surveillance post (repactuation)	Repactuation' estimate	Total value of the repactuated contract / annual value of the initial contract	Accounting for 100% of consumption (monthly and half-yearly)	Entry into force	Conti-nuous	100%	100%	100%	100%	100%		
EXT_Obj3_Act5	To quantify the monthly total expenditure in R$ on the surveillance contract	Total expenditure on hiring surveillance service	(Sum of the expenditure in R$ of all the posts on the campuses)	Accounting for 100% of consumption (monthly and half-yearly)	Entry into force	Conti-nuous	100%	100%	100%	100%	100%		
EXT_Obj3_Act6	To quantify the monthly expenditure per capita on security service per servant	Expenditure per capita of servant on security service contract	Expenditure, in Real R$, with hiring security service / n° of servant	Accounting for 100% of consumption (monthly and half-yearly)	Conti-nuous	Conti-nuous	100%	100%	100%	100%	100%		
EXT_Obj3_Act7	To quantify the monthly expenditure per capita on security service per community	Expenditure per capita of community on security service contract	Expenditure, in Real R$, with hiring security service / n° of community	Accounting for 100% of consumption (monthly and half-yearly)	Conti-nuous	Conti-nuous	100%	100%	100%	100%	100%		
BAS_Obj3_Act8	To quantify the average amount paid per square meter for cleaning all areas of the institution	Total expenditure paid per m^2 with the cleaning contract	Total amount spent with the contract/ m^2	Accounting for 100% of consumption (monthly and half-yearly)	Entry into force	Conti-nuous	100%	100%	100%	100%	100%		
BAS_Obj3_Act9	To quantify the repactuation of the cleaning contract	Repactuation of the cleaning contract	Total value of the repactuated contract /	Accounting for 100% of consumption (yearly)	Entry into force	Conti-nuous	100%	100%	100%	100%	100%		

			annual value of the initial contract									
EXT_Obj3_Act10	To quantify the total monthly expenditure in R$ on the cleaning service	Total monthly expenditure on contracting cleaning service	Sum of the monthly expenditure in R$	Accounting for 100% of consumption (monthly and half-yearly)	Entry into force	Conti-nuous	!00%	!00%	!00%	!00%	!00%	
EXT_Obj3_Act11	To quantify the monthly expenditure per capita on cleaning service per servant	Expenditure per capita of servant on cleaning service contract	Expenditure, in Real R$, with hiring cleaning service / n° of servant	Accounting for 100% of consumption (monthly and half-yearly)	Entry into force	Conti-nuous	!00%	!00%	!00%	!00%	!00%	
EXT_Obj3_Act12	To quantify the monthly expenditure per capita on cleaning service per community	Expenditure per capita of community on cleaning service contract	Expenditure, in Real R$, with hiring cleaning service / n° of community	Accounting for 100% of consumption (monthly and half-yearly)	Entry into force	Conti-nuous	!00%	!00%	!00%	!00%	!00%	
BAS_Obj3_Act13	To quantify the expenditure on construction contracts	Sum of the expenditure for construction contracts	Sum of the expenditure on works contracts	Accounting for 100% of consumption (monthly and half-yearly)	Entry into force	Conti-nuous	!00%	!00%	!00%	!00%	!00%	
BAS_Obj3_Act14	To quantify the expenditure on maintenance contracts	Sum of the expenditure on maintenance contracts	Sum of the expenditure with maintenance contracts	Accounting for 100% of consumption (monthly and half-yearly)	Entry into force	Conti-nuous	!00%	!00%	!00%	!00%	!00%	
Dimension 2: Promote the reduction of use												
EXT_Obj3_Ac15	To extend the installation of remote monitoring (cameras and emergency alarms) on campuses to reduce spending on the surveillance contract	Area covered by the camera's surveillance system.	Sum of the area covered by the camera system					100%				
Dimension 3 – SD Campaigns												
EXT_Obj3_Ac16	To develop campaign for rational use of telephone system	SD education campaigns for rational use of the telephone system	No. of SD education campaigns for rational use of telephony created	To have at least 4 campaigns created per semester (continuous)	Entry into force	Conti-nuous	100%	100%	100%	100%	100%	EMC
EXT_Obj3_Ac17	To develop a campaign to maintain the cleanliness of campus areas	SD education campaigns for maintain the cleanliness of campus areas	No. of SD education campaigns for maintain the cleanliness of campus areas	To have at least 4 campaigns created per semester (continuous)	Entry into force	Conti-nuous	100%	100%	100%	100%	100%	

b) *Assessment protocols for procurement (contracting)*

The business process modelling notation employed to evaluate the indicators constituting the action plan materials acquisition is depicted inFigure 9-4. Subsequently, the standard operating procedure (SOP) is delineated to provide guidance for the execution of the designed workflow, as illustrated in Table 9-8.




ACTION PLAN - Procurement
Cleaning
Collect data on Cleaning
Is it possible to quantify the annual amount spent on cleaning contract?
No
Yes
It is possible to quantify the total area to be cleaning?
Quantify BAS_Obj3_Act24
Award 8,33% of the points
Is it possible quantify the value of repactuation of the cleaning contract?
Quantify BAS_Obj3_Act25
Award 8,33% of the points
It is possible to quantify the internal area to be cleaned?
is it possible to quantify the non-critical internal area to be cleaned and its cleaning cost?
Is it possible quantify the semi-critical internal area to be cleaned and its cleaning cost?
Is it possible quantify the critical internal area to be cleaned and its cleaning cost?
Is it possible quantify the external area to be cleaned and its cost?
Quantify EXT_Obj3_Act16
Quantify EXT_Obj3_Act17
Quantify EXT_Obj3_Act19
Quantify EXT_Obj3_Act18
Award 1,851% of the points
Award 1,851% of hte points
Quantify EXT_Obj3_Act20
Quantify EXT_Obj3_Act21
Quantify EXT_Obj3_Act22
Quantify EXT_Obj3_Act23
Awarded points
Are there any SD education campaigns for maintaining the cleanliness of campus areas?
Quantify Ext_Obj3_Ac33
Award 1,851% of the points
É possivel quantificar o número de alunos, professores e servidores?
Quantify Ext_Obj3_Act27
Quantify Ext_Obj3_Act26
Is it possible to quantify the number of students, teachers and employees?
Sum all awarded points
Final Score (Cleaning)

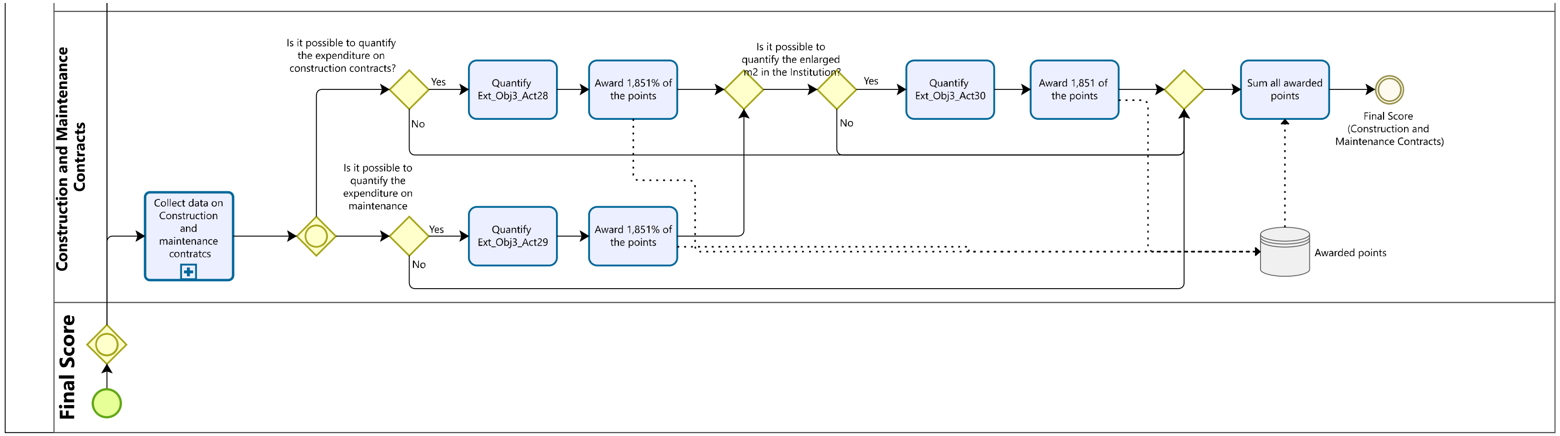


Figure 9-4 - Diagram for Dimension 1.3. Procurement (contracting).

Table 9-8 - Standard Operating Procedure for Action Plan 1.3. Procurement (contracting)

STANDARD OPERATING PROCEDURE (SOP)		
Action Plan: Procurement	**Code:**	**Review:** 00
Date: 24/11/2021	**Page:** 1 of 1	

Objective
To describe the stages of data collection and calculation of indicators related to Objective 3 – To establish sustainable practices for Procurement. The main purpose of these indicators is to measure the degree of integration of sustainable development initiatives in material acquisition.

Normative Reference
Decree No. 7,746, of 5 June 2012
Normative Instruction N° 10, from November 12, 2012

Application
It covers the collection of data on procurement of a HEI, for the subsequent analyses.

Areas Involved
Sector responsible for collecting the SLMP data.

Documents involved in the process.

Type of Document:	

Definitions

Procedure
a) Telephony
1) Collect telephony data from the University's procurement portal.
2) If it is possible to quantify Monthly expenditure per extension or conventional telephone line use, 5.882% of the points allocated to the Action Plan should be assigned (BAS_Obj3_Act1).
3) If it is possible to quantify Monthly expenditure per mobile telephone line use, 5.882% of the points allocated to the Action Plan should be assigned (BAS_Obj3_Act2).
4) If there is any campaign for the rational use of the telephony system, 2.5% of the points allocated to the Action Plan should be assigned (BAS_Obj3_Act17).
5) Sum all the awarded points to calculate the final Telephony score.

b) Surveillance

1) Collect surveillance data from the University's procurement portal.
2) If it is possible to quantify the average value of the surveillance post, allocate 5.882% of the points assigned to the Action Plan (BAS_Obj3_Act3).
3) If it is possible to quantify the average current value of the surveillance post (repactuation), allocate 5.882% of the points assigned to the Action Plan (BAS_Obj3_Act4).
4) If it is possible to quantify the total expenditure in R$ on the surveillance contract, allocate 5.882% of the points assigned to the Action Plan (BAS_Obj3_Act5).
5) If it is possible to quantify the monthly expenditure per capita on security service per employee, allocate 5.882% of the points assigned to the Action Plan (BAS_Obj3_Act6).
6) If it is possible to quantify the monthly expenditure per capita on security service per community, allocate 5.882% of the points assigned to the Action Plan (BAS_Obj3_Act7).
7) Sum all awarded points to calculate the final Surveillance score.

c) Cleaning

1) Collect cleaning data from the University's procurement portal.
2) If it is possible to quantify the total expenditure paid per m2 with the cleaning contract, allocate 5.882% of the points assigned to the Action Plan (BAS_Obj3_Act8).
3) If it is possible to quantify the value of repactuation of the cleaning contract, allocate 5.882% of the points assigned to the Action Plan (BAS_Obj3_Act9).
4) If it is possible to quantify the total expenditure on contracting cleaning service, allocate 5.882% of the points assigned to the Action Plan (BAS_Obj3_Act10).
5) If it is possible to measure the expenditure per capita of employees on the cleaning service contract, allocate 5.882% of the points assigned to the Action Plan (BAS_Obj3_Act11).
6) If it is possible to measure the expenditure per capita of the community (public servants, students, and outsourced employees) on the cleaning service contract, allocate 5.882% of the points assigned to the Action Plan (BAS_Obj3_Act12).
7) If there are sustainable development campaigns to maintain the cleanliness of campus areas, allocate 5.882% of the points assigned to the Action Plan (EXT_Obj3_Ac17).
8) Sum all awarded points to calculate the final Cleaning score.

d) Construction and maintenance contracts
1) Collect data on construction and maintenance contracts from the University's procurement portal.
2) If it is possible to quantify expenditure on construction contracts, allocate 5.882% of the points assigned to the Action Plan (BAS_Obj3_Act13).
3) If it is possible to quantify expenditure on maintenance contracts, allocate 5.882% of the points assigned to the Action Plan (BAS_Obj3_Act14).
4) If it is possible to quantify the area covered by the camera surveillance system, allocate 5.882% of the points assigned to the Action Plan (EXT_Obj3_Act15).
5) Sum all awarded points to calculate the final score for Construction and Maintenance Contracts.

e) Final Score
1) Sum all points awarded by telephony, surveillance, cleaning and construction and maintenance contracts to obtain the final score to action plan – procurement.

Responsibilities
Sector responsible for collecting the SLMP data.

Revision Control

Revision n°	Date	Description	Person responsible to approve the SOP
00	10/09/2021		

c) *Reporting template for procurement (contracting)*

Table 9-9 - Reporting Template: 1.3. Procurement (contracting)

Reporting on the action plan Materials acquisition

a) Service of telephony

Brief introduction explaining the elements that comprises the action plan and the institutional sectors involved in the implementations and most relevant achievements.

Table of indicators

ID – Indicator / Baseline	Months												Des. Stat.		Score
	1	2	3	4	5	6	7	8	9	10	11	12	$\bar{x}$	σ	
BAS_Obj3_Act1 – Expenditure per extension and fixed telephone line															
BAS_Obj3_Act1 – Baseline (2017- 2018)															
BAS_Obj3_Act2 – Expenditure per mobile line															
BAS_Obj3_Act2 – Baseline (2017- 2018)															
Indicator n															
Baseline n															

3) Graphic of the indicator BAS_Obj3_Act1 and baseline
4) Graphic of the indicator BAS_Obj3_Act2 and baseline

ID - Action	Status
BAS_Obj3_Act1 – To quantify the monthly expenditure per extension or conventional telephone line use	Complete/ incomplete...
Action n	

b) Service of surveillance

Brief introduction explaining the elements that comprises the action plan and the institutional sectors involved in the implementations and most relevant achievements.

Table of indicators

ID – Indicator / Baseline	Months												Des. Stat.		Score
	1	2	3	4	5	6	7	8	9	10	11	12	$\bar{x}$	σ	
EXT_Obj3_Act5 – Total expenditure on hiring surveillance service															
EXT_Obj3_Act5 – Baseline (2017- 2018)															
EXT_Obj3_Act6 – Expenditure per capita of servant on security service contract															
EXT_Obj3_Act6 – Baseline (2017- 2018)															
Indicator n															
Baseline n															

2) Graphic of the indicator EXT_Obj3_Act5 and baseline

ID - Action	Status
EXT_Obj3_Act5 – To quantify the total expenditure in R$ on the surveillance contract	Complete/ incomplete...
Action n	

c) Service of cleaning

Brief introduction explaining the elements that comprises the action plan and the institutional sectors involved in the implementations and most relevant achievements.

Table of indicators

ID – Indicator / Baseline	Months												Des. Stat.		Score
	1	2	3	4	5	6	7	8	9	10	11	12	$\bar{x}$	σ	
BAS_Obj3_Act8 – Total expenditure paid per m^2 with the cleaning contract															
BAS_Obj3_Act8 – Baseline (2017- 2018)															
EXT_Obj3_Act10 – Total expenditure on hiring cleaning service															
EXT_Obj3_Act10 – Baseline (2017- 2018)															
Indicator n															
Baseline n															

3) Graphic of the indicator BAS_Obj3_Act8 and baseline
4) Graphic of the indicator EXT_Obj3_Act10 and baseline

ID - Action	Status
BAS_Obj3_Act8 – To quantify the average amount paid per m^2 for cleaning all areas of the institution	Complete/ incomplete...
Action n	

c) Service of construction and maintenance

Brief introduction explaining the elements that comprises the action plan and the institutional sectors involved in the implementations and most relevant achievements.

Table of indicators

ID – Indicator / Baseline	Months												Des. Stat.		Score
	1	2	3	4	5	6	7	8	9	10	11	12	$\bar{x}$	σ	
BAS_Obj3_Act13 – Sum of the expenditure for construction contracts															
BAS_Obj3_Act13 – Baseline (2017- 2018)															
EXT_Obj3_Act15 – Sum of the expenditure on maintenance contracts															
EXT_Obj3_Act15 – Baseline (2017- 2018)															

Indicator n															
Baseline n															

1) Graphic of the indicator EXT_Obj3_Act28 and baseline
2) Graphic of the indicator EXT_Obj3_Act29 and baseline

ID - Action	Status
BAS_Obj3_Act13 – To quantify the expenditure on construction contracts	Complete/ incomplete…
Action n	

11.3.2. APPENDIX C.2. Component Outreach & on campus experience.

The second component of the proposed framework comprises the following three action pans: Quality of life at workplace, Extension programmes, and networking. Quality of life at workplace is the only one component required in the Normative Instruction (R11, Table 6-3).

11.3.2.1. APPENDIX C.2.1. Dimension Quality of life at workplace.

Quality of life at the workplace, within an academic context, refers to the holistic assessment of various factors that contribute to the overall well-being, satisfaction, and fulfilment of individuals in their professional environments. It encompasses a multidimensional evaluation. Key elements contributing to the quality of life at the workplace may include a positive work environment, effective leadership, opportunities for professional development, and employee engagement.

a) *Action Plan Regarding Quality of life at work*

Table 9-10 – Action plan for dimension 2.1 - Quality of life at work

ACTION PLAN – Quality of life at work														
Objective 4 – To establish sustainable practices for quality of life in the workplace														
Dimension 1: Quantify and monitor consumption								**TIMELINE**						
ID	**Action**	**Name of indicator**	**Metric**	**Goal (Period)**	**Start**	**End**	**Y 1**	**Y 2**	**Y 3**	**Y 4**	**Y 5**	**SD**	**SI**	
BAS_Obj4_Act1	To quantify the number of public servants that attended the programmes and/or actions focused on the quality of life at workplace each year	Participation of public servants in programmes and/or actions focused on the quality of life at workplace	Total servers trained / Total number of servers * 100	To have at least 10% of the servers trained yearly (continuous)	Entry into force	Conti-nuous	!00%	!00%	!00%	!00%	!00%	EMC	PROPLAN	
Dimension 2: Promote the reduction of use														
Dimension 3 – SD Campaigns														
EXT_Obj4_Act2	To develop a campaign to promote quality of life at workplace	Campaigns to promote quality of life at workplace	Number of campaigns about quality of life at workplace created per semester	To have at least 4 campaigns created per semester (continuous)	Entry into force	Conti-nuous	100%	100%	100%	100%	100%	EMC		

b) Assessment Protocols Regarding Quality of life at work

The business process modelling notation employed to evaluate the indicators constituting the action plan institutional framework is depicted in Figure 9-5. Subsequently, the standard operating procedure is delineated to provide guidance for the execution of the designed workflow, as illustrated in Table 9-11.

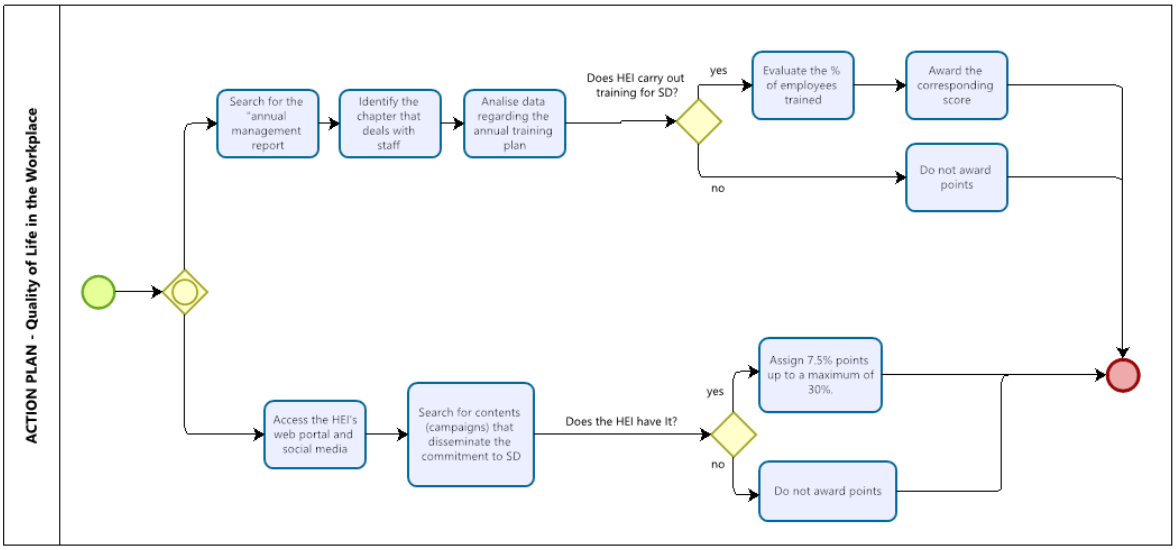


Figure 9-5 - Diagram for Dimension 2.1. Quality of life at work.

Table 9-11 - Standard Operating Procedure for Action Plan 2.1. Quality of life at work

STANDARD OPERATING PROCEDURE (SOP)		
Action Plan: Quality of life at work	**Code:**	**Review:** 00
Date: 24/11/2021	**Page:** 1 of 1	

Objective
To describe the stages of data collection and calculation of indicators related to Objective 4 – To establish sustainable practices for Quality of life at work. The primary purpose of these indicators is to measure the degree of integration of sustainable development initiatives related to promoting activities and training concerning the improvement of the Quality of life at work.

Normative Reference
Decree No. 7,746, of 5 June 2012
Normative Instruction N° 10, from November 12, 2012

Application
It covers the collection of data on the institutional framework of a HEI, for the subsequent analyses.

Areas Involved
Sector responsible for collecting the SLMP data.

Documents involved in the process.

Type of Document:	Annual Management Report is, available in the institutional website. Publicity campaigns available in the official web portal and social media.

Definitions
The Annual Management Report is a mandatory institutional document that Brazilian federal public HEI must prepare in order to be accountable to the auditing agencies.

Procedure

1) Search for the Annual Management Report, available at the institution's website.
2) In the chapter concerning staff management, look for the output of the annual training plan to identify the number of staff that have participated in actions related to improving their Quality of life at work.
3) Compute the percentage of trained staff to the total staff members.
4) Assign 70% if 10% of staff or more have participated in the actions. Assign 35% if up to 5% have experienced, or 10% if up to 2% have participated of Quality of life at work' activities.
5) Search the institution's website and social media for content and campaigns that promote commitment to sustainable development in the institution. For each available campaign, attribute 12.5% of the total points attributed to the action plan, up to a total of 50%.

Responsibilities
Sector responsible for collecting the SLMP data.

Revision Control

Revision n°	Date	Description	Person responsible to approve the SOP
00	10/09/2021		

c) *Reporting Template Regarding Quality of life at work*

Table 9-12 - Reporting Template: 2.1 Quality of life at work.

Reporting on the action plan Quality of life at work

Brief description of the sector responsible to offering training to the servers. List the most relevant courses and outline the main tools and places used to disseminate campaigns.

ID	Indicator	Current status	Max. score	Awarded score
BAS_Obj4_Act1	Participation of public servants in programmes and/or actions focused on the quality of life at workplace		70%	
BAS_Obj4_Act1	Baseline			
EXT_Obj4_Act2	Campaigns to promote quality of life at workplace		30%	
	SUM			

11.3.2.2. APPENDIX C.2.2. Dimension Extension Programmes

a) *Action Plan Regarding Extension Programme*

Extension programs in higher education play a pivotal role in fostering sustainable development by serving as conduits for disseminating knowledge, expertise, and innovative solutions to broader societal contexts. These programs bridge the gap between academic institutions and the community, facilitating the application of research findings and academic insights to address real-world challenges. By engaging with diverse stakeholders, extension programs contribute to the cultivation of a sustainable ethos, promoting environmental stewardship, social equity, and economic resilience.

Table 9-13 - Action plan for dimension 2.2 - Extension programme

Action plan for dimension 2.2 - Extension programme													
Objective 5 – To establish sustainable practices for extension programme.													
Dimension 1: Quantify and monitor consumption								**TIMELINE**					
ID	**Action**	**Name of indicator**	**Metric**	**Goal (Period)**	**Start**	**End**	**Y 1**	**Y 2**	**Y 3**	**Y 4**	**Y 5**	**SD**	**SI**
EXT_Obj5_Act1	To assess whether the institution has mechanisms to measure the sustainability of university extension activities	Sustainability of university extension activities	Does the institution have mechanisms to measure the sustainability of university extension activities? (y/n)		Entry into force	Conti-nuous	!00%	!00%	!00%	!00%	!00%		
Dimension 2: Promote the reduction of use													
Dimension 3 – SD Campaigns													

b) *Assessment Protocols Regarding Extension Programme*

Figure 9-6 depicts the business process modelling notation employed to evaluate the indicators constituting the action plan institutional framework. Subsequently, the standard operating procedure is delineated to provide guidance for executing the designed workflow, as illustrated in Table 9-14.

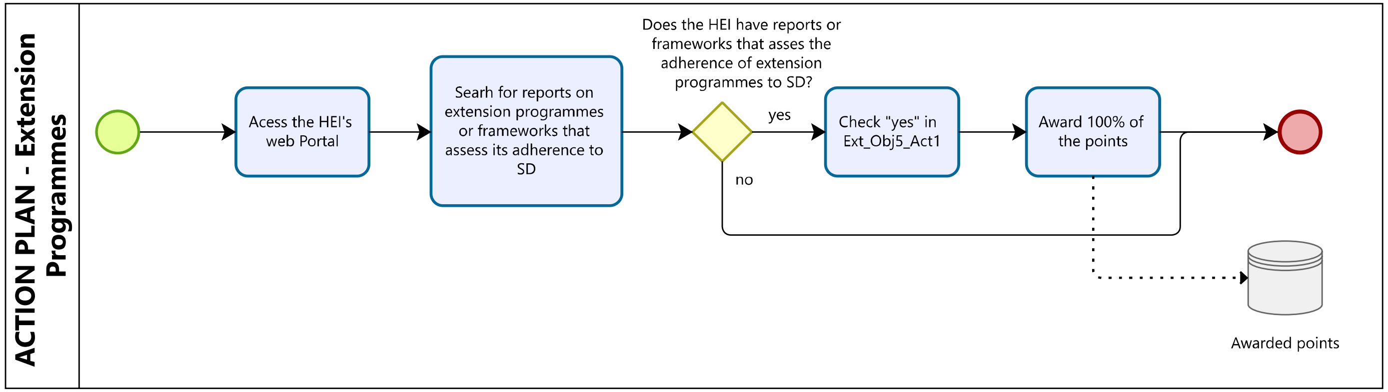


Figure 9-6- Diagram for Dimension 2.2.Extension Progremmes.

Table 9-14 - Standard Operating Procedure for Action Plan 2.2. Extension Programme.

STANDARD OPERATING PROCEDURE (SOP)		
Action Plan: Extension Programmes	**Code:**	**Review:** 00
Date: 24/11/2021	**Page:** 1 of 1	

Objective
To describe the stages of data collection and calculation of indicators related to Objective 5 - To establish sustainable practices for Extension Programmes. The primary purpose of these indicators is to measure the degree of integration of sustainable development initiatives in the Extension Programmes.

Normative Reference
Decree No. 7,746, of 5 June 2012
Normative Instruction N° 10, from November 12, 2012

Application
It covers the collection of data on the institutional framework of a HEI, for the subsequent analyses.

Areas Involved
Sector responsible for collecting the SLMP data.

Documents involved in the process.

Type of Document:	HEI's Annual Report or Extension Programme Report available in the institutional website.

Definitions
The HEI's Annual Report is the formal report elaborated by Brazilian HEIs the present to the governmental control board.

Procedure
1) Search the institution's website for HEI's Annual Report and or Extension Programme Report.
2) If these documents are available and asses the adherence of Extension Programme to the promotion of Sustainable Development 100% of the points attributed to the Action Plan should be attributed.

Responsibilities
Sector responsible for collecting the SLMP data.

Revision Control

Revision n°	Date	Description	Person responsible to approve the SOP
00	10/09/2021		

c) Reporting Template Regarding Extension Programme

Table 9-15 - Reporting Template: 2.2. Extension Programme.

Reporting on the action plan Extension Programme

Brief description of the sector responsible to implementing action and policies related to university outreach. List the most relevant actions and outline the main aspects of promoting SD in this sector.

ID	Indicator	Current status	Max. score	Awarded score
EXT_Obj5_Act1	Sustainability of university extension activities		100%	
	SUM			

11.3.2.3. APPENDIX C.2.3. Dimension Networking

Establishing and maintaining networks among HEI hold profound relevance in advancing sustainable development. Collaborative networks serve as platforms for exchanging knowledge, expertise, and best practices, facilitating collective efforts to address complex challenges associated with sustainability. Through these networks, institutions can pool resources, share research findings, and collectively develop innovative solutions to global issues such as climate change, environmental degradation, and social inequality. Moreover, collaborative initiatives foster interdisciplinary approaches, encouraging a comprehensive understanding of sustainable development that could transcends traditional academic boundaries.

a) Action Plan Regarding Networking

Table 9-16 - Action plan for dimension 2.3 - Networking

Action plan for dimension 2.3 - Networking														
Objective 6 – To establish sustainable practices to improving networking.														
Dimension 1: Quantify and monitor consumption									**TIMELINE**					
ID	**Action**	**Name of indicator**	**Metric**	**Goal (Period)**	**Start**	**End**	**Y 1**	**Y 2**	**Y 3**	**Y 4**	**Y 5**	**SD**	**SI**	
EXT_Obj6_Act1	To assess whether the institution is part of a network of sustainable universities.	Network of sustainable universities.	Is the institution part of a network of sustainable universities? (y/n)	To be part of at least one sustainable universities network yearly (continuous)	Entry into force	Conti-nuous	!00%	!00%	!00%	!00%	!00%			
Dimension 2: Promote the reduction of use														
Dimension 3 – SD Campaigns														

b) Assessment Protocols Regarding Networking

Figure 9-7 depicts the business process modelling notation employed to evaluate the indicators constituting the action plan institutional framework. Subsequently, the standard operating procedure is delineated to provide guidance for executing the designed workflow, as illustrated in Table 9-17.

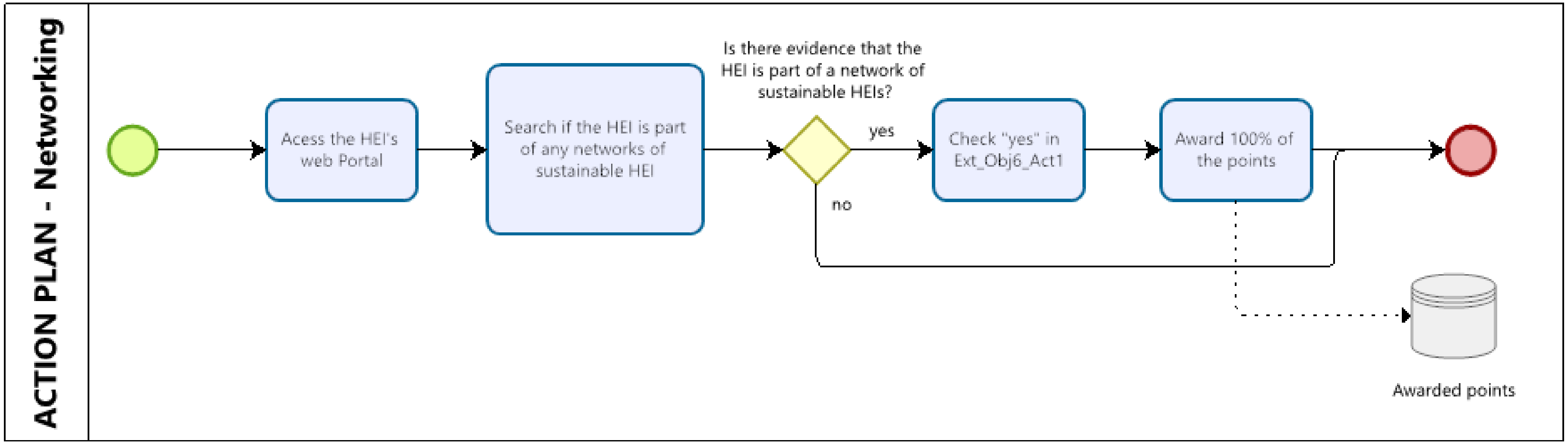


Figure 9-7 - Diagram for Dimension 2.3. Networking.

Table 9-17 - Standard Operating Procedure for Action Plan 2.3. Networking.

STANDARD OPERATING PROCEDURE (SOP)		
Action Plan: Networking	**Code:**	**Review:** 00
Date: 24/11/2021	**Page:** 1 of 1	

Objective

To describe the stages of data collection and calculation of indicators related to Objective 6 – To establish sustainable practices to improving networking. The primary purpose of these indicators is to measure the degree of integration of sustainable development initiatives in the Extension Programmes.

Normative Reference

Decree No. 7,746, of 5 June 2012
Normative Instruction N° 10, from November 12, 2012

Application

It covers the collection of data on the institutional framework of a HEI, for the subsequent analyses.

Areas Involved

Sector responsible for collecting the SLMP data.

Documents involved in the process.

Type of Document:	HEI's Annual Report or outreach Report available in the institutional website.

Definitions

The HEI's Annual Report is the formal report elaborated by Brazilian HEIs the present to the governmental control board.

Procedure

1) Search the institution's website for HEI's Annual Report or outreach Report.
2) If any document is available, asses if is there evidence that the HEI is part of at least one network of sustainable HEIs. If so 100% of the points should be attributed to the Action Plan.

Responsibilities

Sector responsible for collecting the SLMP data.

Revision Control

Revision n°	Date	Description	Person responsible to approve the SOP
00	10/09/2021		

c) Reporting Template Regarding Networking

Table 9-18 - Reporting Template: 2.3. Networking.

Reporting on the action plan Networking

Brief description of the sector responsible formalize the cooperation with networks and list the most relevant ones, describing, when possible, details related to scope and expertise of the network.

ID	Indicator	Current status	Max. score	Awarded score
EXT_Obj6_Act1	Network of sustainable universities.		100%	
	SUM			

11.3.3. APPENDIX C.3. Component Campus Operations

The campus operations component is the largest element of the designed framework regarding the number of dimensions encompassing four dimensions and the number of indicators. This component comprises 33 indicators. The dimensions constituting the campus operations are Energy, Water, Waste, and Displacement.

11.3.3.1. APPENDIX C.3.1. Dimension Energy

a) Action Plan Regarding Energy

Table 9-19 - Action plan for dimension 3.1 - Energy

ACTION PLAN - Energy													
Objective 7 – To establish sustainable practices for energy.													
Dimension 1: Quantify and monitor consumption							**TIMELINE**						
ID	**Action**	**Name of indicator**	**Metric**	**Goal (Period)**	**Start**	**End**	**Y 1**	**Y 2**	**Y 3**	**Y 4**	**Y 5**	**SD**	**SI**
BAS_Obj7_Act1	To quantify the monthly expenditure, in BRL, on electrical energy	Expenditure with energy	Invoice value in BRL (R$)	Accounting for 100% of consumption (monthly and half-yearly)	Entry into force	Conti-nuous	100%	100%	100%	100%	!00%	EMC	PROPLAN
BAS_Obj7_Act2	To quantify the monthly electricity expenditure, in BRL R$, per capita of public servers	Electric energy consumption, in BRL R$, per capita of public servers	Quantity the expenditure in R$ / total number of servers	Accounting for 100% of consumption (monthly and half-yearly)	Entry into force	Conti-nuous	100%	100%	100%	100%	100%		
EXT_Obj7_Act3	To quantify the monthly electricity expenditure, in BRL R$, per capita of the community (public servants, students and outsourced workers)	Per capita electricity expenditure by the community (public servants, students, and outsourced employees)	Quantity the expenditure in R$ / total of the community (employees, students, and outsourced workers)	Accounting for 100% of consumption (monthly and half-yearly)	Entry into force	Conti-nuous	100%	100%	100%	100%	!00%		
BAS_Obj7_Act4	To quantify the monthly consumption of electric energy in kWh	Electric energy consumption energy in kWh	Amount of kWh consumed	Accounting for 100% of consumption (monthly and half-yearly)	Entry into force	Conti-nuous	100%	100%	100%	100%	!00%		
BAS_Obj7_Act5	To quantify the monthly electricity consumption, in kWh, per capita of public servers	Electric power consumption per capita of public servers	Quantity of kWh consumed / total number of servers	Accounting for 100% of consumption (monthly and half-yearly)	Entry into force	Conti-nuous	100%	100%	100%	100%	!00%		
EXT_Obj7_Act6	To quantify the monthly electricity consumption per capita of the community (public servants, students, and outsourced workers)	Per capita consumption of electric energy by the community (public servants, students, and outsourced employees)	Quantity of kwh consumed / total of the community (employees, students, and outsourced workers)	Accounting for 100% of consumption (monthly and half-yearly)	Entry into force	Conti-nuous	100%	100%	100%	100%	!00%		
BAS_Obj7_Act7	To monitor and manage the demand contract (off-peak)	Adequacy of demand contract (off-peak)	Registered off-peak demand / Contracted off-peak demand	Accounting for 100% of consumption (monthly and half-yearly)	Entry into force	Conti-nuous	100%	100%	100%	100%	!00%		

BAS_Obj7_Act8	To monitor and Manage Demand Contract (Peak Load)	Demand Contract Adequacy (Peak)	Peak registered demand / Peak contracted demand	Accounting for 100% of consumption (monthly and half-yearly)	Entry into force	Conti-nuous	100%	100%	100%	100%	!00%	
BAS_Obj7_Act9	To quantify the Expenditure with energy by total area	Energy Expenditure by area	Expenditure in BRL / total area	Accounting for 100% of consumption (monthly and half-yearly)	Entry into force	Conti-nuous	100%	100%	100%	100%	!00%	
Dimension 2: Promote the reduction of use												
EXT_OBJ7_Act10	Encourage studies that analyse the viability of alternative energy sources (solar, thermoelectric and wind)	Analysis of the viability of alternative energy sources (solar, thermoelectric and wind)	Development of at least one study on alternative energy sources at HEI									
Dimension 3 – SD Campaigns												
EXT_OBJ7_Act11	Develop campaign for rational use of electricity	Environmental education campaigns for electricity consumption	To have at least 4 campaigns created per semester (continuous)		Entry into force	Conti-nuous	100%	100%	100%	100%	100%	EMC

b) Assessment Protocols Regarding Energy

Figure 9-8 depicts the business process modelling notation employed to evaluate the indicators constituting the action plan institutional framework. Subsequently, the standard operating procedure is delineated to provide guidance for executing the designed workflow, as illustrated in Table 9-20.

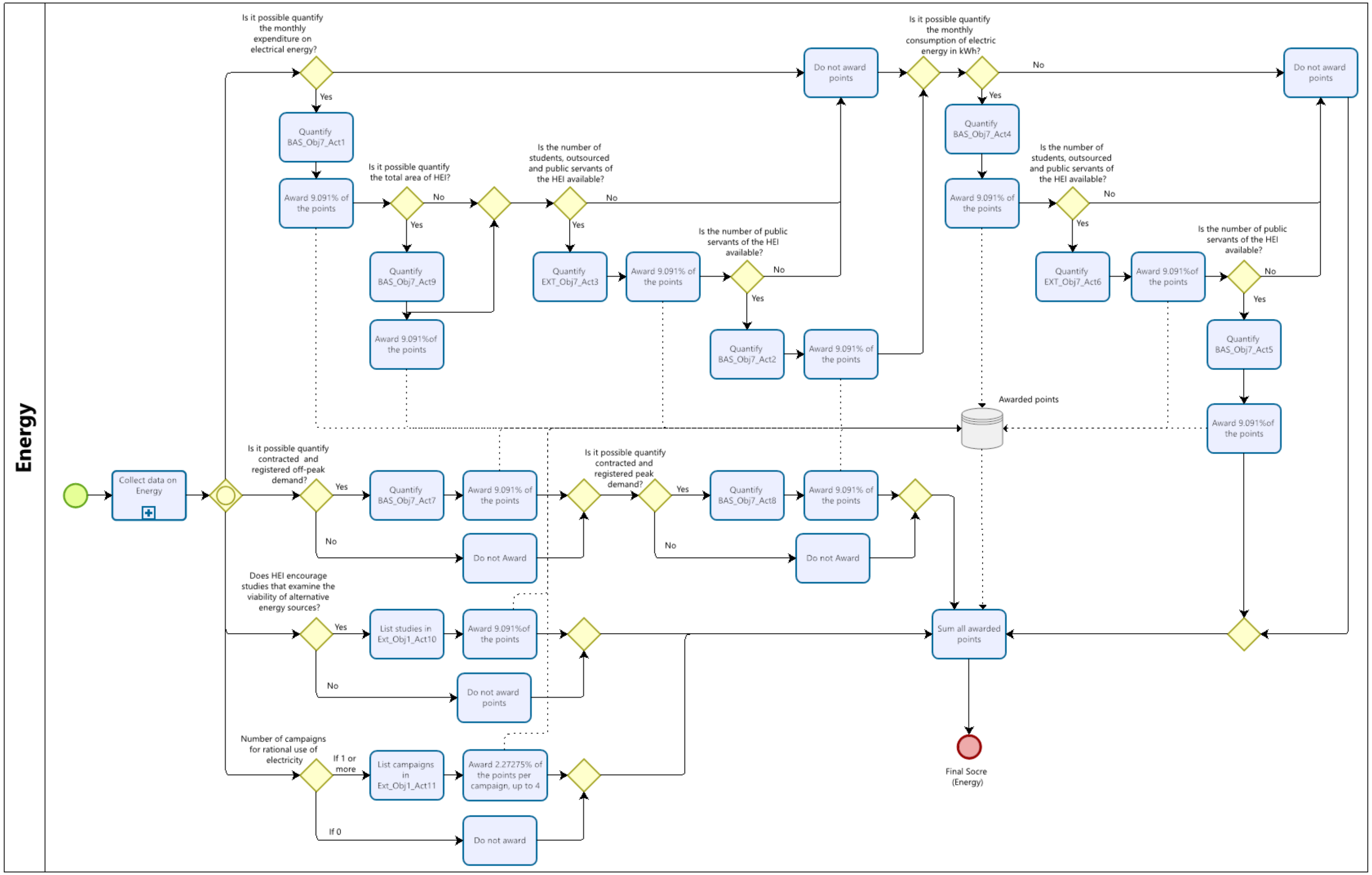


Figure 9-8 - Action plan for dimension 3.1 – Energy.

Table 9-20 - Standard Operating Procedure for Action Plan 3.1. Energy.

STANDARD OPERATING PROCEDURE (SOP)		
Action Plan: Energy	**Code:**	**Review:** 00
Date: 24/11/2021	**Page:** 1 of 1	

Objective
To describe the stages of data collection and calculation of indicators related to Objective 7 – "To establish sustainable practices for Energy". The main purpose of these indicators is to measure the degree of integration of sustainable development initiatives in Energy.

Normative Reference
Decree No. 7,746, of 5 June 2012
Normative Instruction N° 10, from November 12, 2012

Application
It covers the collection of data on Energy of a HEI, for the subsequent analyses.

Areas Involved
Sector responsible for collecting the SLMP data.

Documents involved in the process.

Type of Document:	None

Definitions
Peak electricity demand: Peak demand refers to the times of day when our electricity consumption is at its highest (typically from 6:00 to 9:00 p.m.).
Electricity demands off peak: Off-peak period covers the remaining 21 hours of the day or 24 hours a day for Saturdays, Sundays and national holidays.

Procedure
1) Collect energy consumption data from the government's institutional procurement portal.
2) If possible, quantify the monthly expenditure on electrical energy; 9,091% of the points attributed to the Action Plan should be attributed. (BAS_Obj7_Act1)
3) If possible, quantify the total area of HEI; 9,091% of the points attributed to the Action Plan should be attributed. (BAS_Obj7_Act9)
4) If possible, measure the number of students, outsourced and public servants of the HEI; 9,091% of the points attributed to the Action Plan should be attributed, referring to the monthly per capita expenditure of energy by community. (EXT_Obj7_Act3)
5) If possible, measure the number of public servants; 9,091% of the points attributed to the Action Plan should be attributed, referring to the monthly per capita expenditure energy by public servants. (BAS_Obj7_Act2)
6) If possible, quantify monthly consumption of electric energy in kWh; 9,091% of the points attributed to the Action Plan should be attributed. (BAS_Obj7_Act4)
7) If possible, measure the number of students, outsourced and public servants of the HEI; 9,091% of the points attributed to the Action Plan should be attributed referring to the monthly per capita consumption of energy by community. (EXT_Obj7_Act6)
8) If possible, measure the number of public servants; 9,091% of the points attributed to the Action Plan should be attributed referring to the monthly per capita consumption energy by public servants. (BAS_Obj7_Act5)
9) If possible, quantify contracted and registered off-peak demand; 9,091% of the points attributed to the Action Plan should be attributed. (BAS_Obj7_Act7)
10) If possible, quantify contracted and registered peak demand; 9,091% of the points attributed to the Action Plan should be attributed. (BAS_Obj7_Act8)
11) If there are studies that analyse the viability of alternative energy sources; 9,091% of the points attributed to the Action Plan should be attributed. (EXT_Obj7_Act10)
12) If there are campaigns for rational use of electricity; Award 2,27275% of the points per campaign, up to 4. (EXT_Obj7_Act11)
13) Sum all awarded points to obtain the final score to energy.

Responsibilities
Sector responsible for collecting the SLMP data.

Revision Control

Revision n°	Date	Description	Person responsible to approve the SOP
00	10/09/2021		

c) Reporting Template Regarding Energy

Table 9-21 - Reporting Template: 3.1. Energy.

Reporting on the action plan Energy

Brief introduction explaining the elements that comprises the action plan and the institutional sectors involved in the implementations and most relevant achievements.

Table of indicators

ID – Indicator / Baseline	**Months**												**Des. Stat.**		**Score**
	1	2	3	4	5	6	7	8	9	10	11	12	$\bar{x}$	σ	
BAS_Obj7_Act1 - Expenditure with energy															
BAS_Obj7_Act1 – Baseline (2017- 2018)															
BAS_Obj7_ Act2 - Electric energy consumption, in BRL R$, per capita of public servers															
BAS_Obj7_ Act2 – Baseline (2017- 2018)															
Indicator n															
Baseline n															

- Graphic of the indicator BAS_Obj7_Act1 and baseline
- Graphic of the indicator BAS_Obj7_ Act4 and baseline

ID - Action	Status
BAS_Obj7_Act1 - To quantify the monthly expenditure, in BRL, on electrical energy	Complete/ incomplete...
Action n	

11.3.3.2. APPENDIX C.3.2. Dimension Water

a) Action Plan Regarding Water

Table 9-22 - Action plan for dimension 3.2 - Water

ACTION PLAN - Water													
Objective 8 – To establish sustainable practices for water													
Dimension 1: Quantify and monitor consumption								**TIMELINE**					
ID	**Action**	**Name of indicator**	**Metric**	**Goal (Period)**	**Start**	**End**	**Y 1**	**Y 2**	**Y 3**	**Y 4**	**Y 5**	**SD**	**SI**
BAS_Obj8_Act1	To quantify the volume of water consumed monthly	Volume of water used	Quantity of m³ of water		Entry into force	Conti-nuous	100%	100%	100%	100%	100%	EMC	PROPLAN
BAS_Obj8_Act2	To quantify the per capita volume of water consumed monthly by public servants	Per capita volume of water of public servants	Quantity of m³ of water/ total number of servers		Entry into force	Conti-nuous	100%	100%	100%	100%	100%		
EXT_Obj8_Act3	To quantify the per capita volume of water consumed monthly by the community (employees, students, and outsourced workers)	Per capita volume of water by the community (employees, students, and outsourced workers)	Quantity of m³ of water/ total of community members		Entry into force	Conti-nuous	100%	100%	100%	100%	100%		
BAS_Obj8_Act4	To quantify monthly expenditure, in BRL, with water supply	Expenditure with water	Invoice value in BRL (R$)		Entry into force	Conti-nuous	100%	100%	100%	100%	100%		
BAS_Obj8_Act5	To quantify the monthly per capita spending on water supply, in BRL, of public servants	Servers' per capita spending on water	Invoice value in BRL (R$) / public servants		Entry into force	Conti-nuous	100%	100%	100%	100%	100%		
EXT_Obj8_Act6	To quantify the monthly per capita water supply expense, in BRL, of the community (employees, students, and outsourced workers)	Per capita spending on water by the community (employees, students, and outsourced workers)	Invoice value in BRL (R$) / community (employees, students, and outsourced workers)		Entry into force	Conti-nuous	100%	100%	100%	100%	100%		
Dimension 2: Promote the reduction of use													
EXT_Obj8_Act7	To develop a communication channel for the community to inform about water leakages	Communication channel on water leaks	Identify the existence of a communication channel on water leakages		Entry into force	Conti-nuous	100%	100%	100%	100%	100%		
Dimension 3 – SD Campaigns													
EXT_Obj8_Act8	To develop a campaign for rational water use	Campaigns to promote sustainable development for water consumption	Number of sustainable development campaigns created	To have at least 4 campaigns created per	Entry into force	Conti-nuous	100%	100%	100%	100%	100%	EMC	

	for rational water use	semester (continuous)	

b) Assessment Protocols Regarding Water

Figure 9-9 depicts the business process modelling notation employed to evaluate the indicators constituting the action plan institutional framework. Subsequently, the standard operating procedure is delineated to provide guidance for executing the designed workflow, as illustrated in Table 9-23.

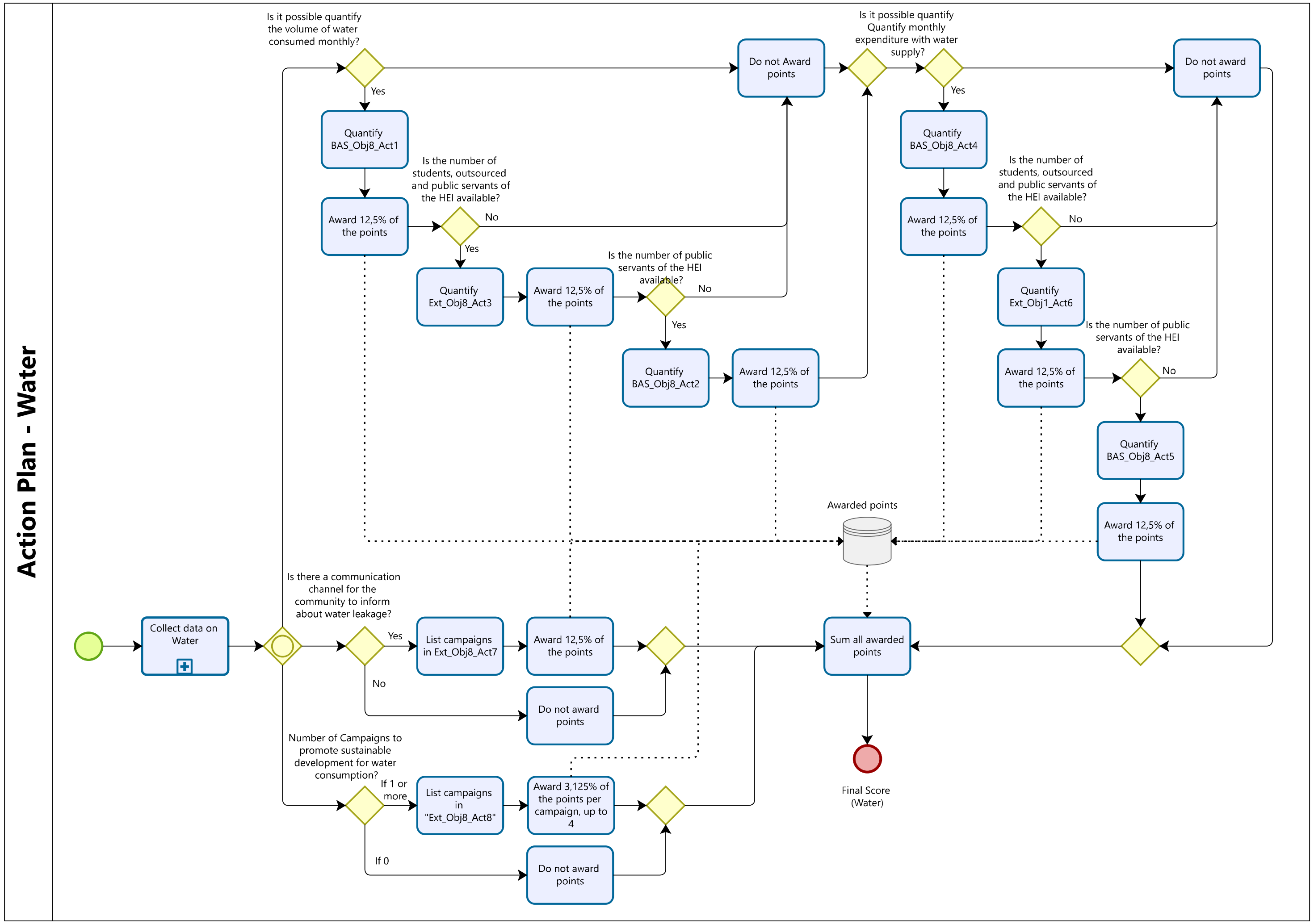


Figure 9-9 - Diagram for Dimension 3.2 - Water.

Table 9-23 - Standard Operating Procedure for Action Plan 3.2 - Water.

STANDARD OPERATING PROCEDURE (SOP)		
Action Plan: Water	**Code:**	**Review:** 00
Date: 24/11/2021	**Page:** 1 of 1	

Objective
To describe the stages of data collection and calculation of indicators related to Objective 8 – To establish sustainable practices for Water. The main purpose of these indicators is to measure the degree of integration of sustainable development initiatives in Water.

Normative Reference
Decree No. 7,746, of 5 June 2012
Normative Instruction N° 10, from November 12, 2012

Application
It covers the collection of data on Energy of a HEI, for the subsequent analyses.

Areas Involved
Sector responsible for collecting the SLMP data.

Documents involved in the process.

Type of Document:	

Definitions

Procedure

1) Collect water consumption data on the University purchasing portal.
2) If possible, quantify the monthly volume of water consumed; 12.5% of the points attributed to the Action Plan should be awarded. (BAS_Obj8_Act1)
3) If possible, measure the number of students, outsourced employees, and public servants of the institution; 12.5% of the points attributed to the Action Plan should be awarded, referring to the monthly per capita water expenditure by the community. (EXT_Obj8_Act3)
4) If possible, measure the number of public servants; 12.5% of the points attributed to the Action Plan should be awarded, referring to the monthly per capita water expenditure by public servants. (BAS_Obj8_Act2)
5) If possible, quantify the monthly water supply expenditure; 12.5% of the points attributed to the Action Plan should be awarded. (BAS_Obj8_Act4)
6) If possible, measure the number of public servants of the institution; 12.5% of the points attributed to the Action Plan should be awarded, referring to the monthly per capita water consumption by public servants. (BAS_Obj8_Act5)
7) If possible, measure the number of public servants in the higher education institution; 12.5% of the points assigned to the Action Plan should be assigned to the monthly per capita water consumption by public servants. (BAS_Obj8_Act5)
8) If possible, measure the number of students, third-party staff, and public servants in the higher education institution; 12.5% of the points assigned to the Action Plan should be assigned to the monthly per capita water consumption by the community. (EXT_Obj8_Act6)
9) If there is any communication channel for the community to report water leaks; 12.5% of the points assigned to the Action Plan should be assigned. (EXT_Obj8_Act7)
10) If there are any campaigns to promote sustainable development in water consumption; award 3.125% of the points per campaign, up to 4. (EXT_Obj8_Act8)
11) Add up all the awarded points to obtain the final score for water.

Responsibilities
Sector responsible for collecting the SLMP data.

Revision Control

Revision n°	Date	Description	Person responsible to approve the SOP
00	10/09/2021		

c) Reporting Template Regarding Water

Table 9-24 - Reporting Template: 3.2 - Water.

Reporting on the action plan Water

Brief introduction explaining the elements that comprises the action plan and the institutional sectors involved in the implementations and most relevant achievements.

Table of indicators

ID – Indicator / Baseline	Months												Des. Stat.		Score
	1	2	3	4	5	6	7	8	9	10	11	12	$\bar{x}$	σ	
BAS_Obj8_Act1 - Volume of water used															
BAS_Obj8_Act1 – Baseline (2017- 2018)															
BAS_Obj8_ Act2 - Per capita volume of water of public servants															
BAS_Obj8_ Act2 – Baseline (2017- 2018)															
Indicator n															
Baseline n															

1) Graphic of the indicator BAS_Obj8_Act1 and baseline
2) Graphic of the indicator BAS_Obj8_ Act4 and baseline

ID - Action	Status
BAS_Obj8_Act1 - Quantify the volume of water consumed monthly	Complete/ incomplete…
Action n	

11.3.3.3. APPENDIX C.3.3. Dimension Waste

a) Action Plan Regarding Waste

Table 9-25 - Action plan for dimension 3.3 - Waste

ACTION PLAN - Waste													
Objective 9 – To establish sustainable practices for waste													
Dimension 1: Quantify and monitor consumption									**TIMELINE**				
ID	**Action**	**Name of indicator**	**Metric**	**Goal (Period)**	**Start**	**End**	**Y 1**	**Y 2**	**Y 3**	**Y 4**	**Y 5**	**SD**	**SI**
BAS_Obj9_Act1	To quantify the monthly volume, in kilos, of paper destined for recycling	Destination of paper for recycling	Quantity (Kg) of paper destined for recycling		Entry into force	Conti-nuous	100%	100%	100%	100%	100%	EMC	PROPLAN
BAS_Obj9_Act2	To quantify the monthly volume, in kilos, of cardboard destined to recycling	Destination of cardboard for recycling	Quantity (Kg) of cardboard destined to recycling		Entry into force	Conti-nuous	100%	100%	100%	100%	100%		
BAS_Obj9_Act3	To quantify the monthly number of toners destined for recycling	Destination of toner for recycling	Quantity (units) of toner destined for recycling		Entry into force	Conti-nuous	100%	100%	100%	100%	100%		
BAS_Obj9_Act4	To quantify the monthly volume, in kilos, of plastics intended for recycling.	Destination of plastic for recycling	Quantity (Kg) of plastic intended for recycling		Entry into force	Conti-nuous	100%	100%	100%	100%	100%		
BAS_Obj9_Act5	To quantify the monthly total volume, in kilograms, of material destined to cooperatives	Total recyclable material destined to cooperatives	Kg of paper + Kg of cardboard + Kg of plastic+ Kg of plastic destined to recycling		Entry into force	Conti-nuous	100%	100%	100%	100%	100%		
BAS_Obj9_Act6	To quantify the total monthly volume, in kilos, of reused paper	Volume, of reused paper	Kg of paper reused monthly		Entry into force	Conti-nuous	100%	100%	100%	100%	100%		
Dimension 2: Promote the reduction of use													
Dimension 3 – SD Campaigns													
EXT_Obj9_Act7	To develop a campaign to promote the correct disposal of waste	Environmental education campaigns to promote selective collection	Number of environmental education campaigns created to promote selective collection	To have at least 4 campaigns created per semester (continuous)	Entry into force	Conti-nuous	100%	100%	100%	100%	100%	EMC	

b) Assessment Protocols Regarding Waste

Figure 9-10 depicts the business process modelling notation employed to evaluate the indicators constituting the action plan institutional framework. Subsequently, the standard operating procedure is delineated to provide guidance for executing the designed workflow, as illustrated in Table 9-26.

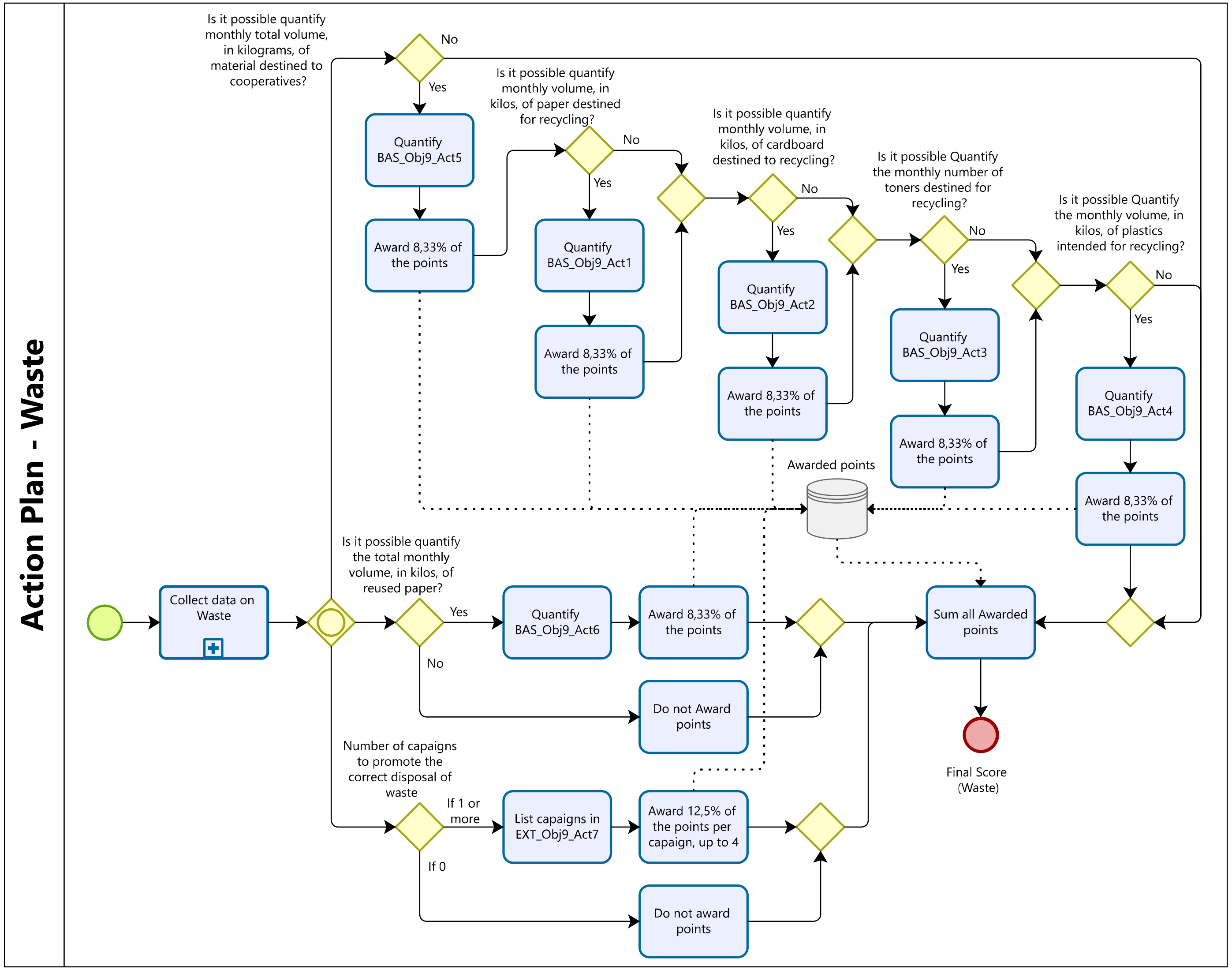


Figure 9-10 - Diagram for Dimension 3.3 - Waste.

Table 9-26 - Standard Operating Procedure for Action Plan 3.3 - Waste

STANDARD OPERATING PROCEDURE (SOP)		
Action Plan: Waste	**Code:**	**Review:** 00
Date: 24/11/2021	**Page:** 1 of 1	

Objective

To describe the stages of data collection and calculation of indicators related to Objective 9 – To establish sustainable practices for Waste. The main purpose of these indicators is to measure the degree of integration of sustainable development initiatives in Waste.

Normative Reference

Decree No. 7,746, of 5 June 2012
Normative Instruction N° 10, from November 12, 2012

Application

It covers the collection of data on Waste of a HEI, for the subsequent analyses.

Areas Involved

Sector responsible for collecting the SLMP data.

Documents involved in the process.

Type of Document:	

Definitions

Procedure

1. Collect waste data on the University purchasing portal.
2. If possible, quantify the total monthly volume, in kilograms, of materials sent to cooperatives; 14.286% of the points attributed to the Action Plan should be awarded. (BAS_Obj9_Act5)
3. If possible, quantify the monthly volume, in kilograms, of paper sent for recycling; 14.286% of the points attributed to the Action Plan should be awarded. (Bas_Obj9_Act1)
4. If possible, quantify the monthly volume, in kilograms, of cardboard sent for recycling; 14.286% of the points attributed to the Action Plan should be awarded. (Bas_Obj9_Act2)
5. If possible, quantify the monthly volume of toners sent for recycling; 14.286% of the points attributed to the Action Plan should be awarded. (Bas_Obj9_Act3)
6. If possible, quantify the monthly volume, in kilograms, of plastics sent for recycling; 14.286% of the points attributed to the Action Plan should be awarded. (BAS_Obj9_Act4)
7. If possible, quantify the total monthly volume, in kilograms, of reused paper; 14.286% of the points attributed to the Action Plan should be awarded. (BAS_Obj9_Act6)
8. If there are campaigns to promote the correct waste disposal, award 3.5715% of the points per campaign, up to a maximum of 4. (EXT_Obj9_Act7)
9. Add up all awarded points to obtain the final Waste score.

Responsibilities

Sector responsible for collecting the SLMP data.

Revision Control

Revision n°	Date	Description	Person responsible to approve the SOP
00	10/09/2021		

c) Reporting Template Regarding Waste

Table 9-27 - Reporting Template: 3.3 - Waste.

Reporting on the action plan Waste

Brief introduction explaining the elements that comprises the action plan and the institutional sectors involved in the implementations and most relevant achievements.

Table of indicators

ID – Indicator / Baseline	Months												Des. Stat.		Score
	1	2	3	4	5	6	7	8	9	10	11	12	$\bar{x}$	σ	
BAS_Obj9_Act1 - Destination of paper for recycling															
BAS_Obj9_Act1 – Baseline (2017- 2018)															
BAS_Obj9_ Act2 - Destination of cardboard for recycling															
BAS_Obj9_ Act2 – Baseline (2017- 2018)															
Indicator n															
Baseline n															

Briefly explanation about the motive of variation between the baseline and the year analysed.

1) Graphic of the indicator BAS_Obj9_Act1 and baseline
2) Graphic of the indicator BAS_Obj9_ Act6 and baseline

ID - Action	Status
BAS_Obj9_Act1 - Quantify the volume of water consumed monthly	Complete/ incomplete...
Action n	

11.3.3.4. APPENDIX C.3.4. Dimension Displacement

a) Action Plan Regarding Displacement

Table 9-28 - - Action plan for dimension 3.4 -Displacement

ACTION PLAN - Displacement														
Objective 10 – To establish sustainable practices for displacement														
Dimension 1: Quantify and monitor consumption					**TIMELINE**									
ID	**Action**	**Name of indicator**	**Metric**	**Goal (Period)**	**Start**	**End**	**Y 1**	**Y 2**	**Y 3**	**Y 4**	**Y 5**	**SD**	**SI**	
EXT_Obj10_Act1	To quantify the operational costs with the use of the HEI's vehicle fleet	Operational costs with the HEI fleet	Sum of expenses with: Fuel + lubricant + material for maintenance + maintenance services		Entry into force	Conti-nuous	100%	100%	100%	100%	100%	EMC	PROPLAN	
EXT_Obj10_Act2	To measure the CO_2 emission index of UFPB's vehicle fleet	CO_2 emissions by UFPB's vehicle fleet, total and by fuel type	Carbon dioxide emissions in ton - $tECO_2$		Entry into force	Conti-nuous	100%	100%	100%	100%	100%			
EXT_Obj10_Act3	To quantify the monthly fuel volume	Monitoring of fuel volume consumption	Total volume of litres consumed		Entry into force	Conti-nuous	100%	100%	100%	100%	100%			
EXT_Obj10_Act4	To quantify the monthly fuel expenses	Monitoring of fuel expense consumption	Total cost in R$		Entry into force	Conti-nuous	100%	100%	100%	100%	100%			
EXT_Obj10_Act5	To estimate the compensation of CO_2 emissions	CO_2 emissions after compensation by planting seedlings	Carbon dioxide emissions in ton - $tECO_2$ after compensation		Entry into force	Conti-nuous	100%	100%	100%	100%	100%			
Dimension 2: Promote the reduction of use														
Dimension 3 – SD Campaigns														
EXT_Obj10_Act6	To develop campaign to rationalize the use of the HEI fleet	Environmental education campaigns to promote awareness in the use of institutional transport	Number of environmental education campaigns to promote awareness in the use of institutional transport	To have at least 4 campaigns created per semester (continuous)	Entry into force	Conti-nuous	100%	100%	100%	100%	100%	EMC		
EXT_Obj10_Act7	To stimulate the planting of native seedlings at HEI	Seedlings planted.	Number of seedlings planted											

b) Assessment Protocols Regarding Displacement

Figure 9-10 depicts the business process modelling notation employed to evaluate the indicators constituting the action plan institutional framework. Subsequently, the standard operating procedure is delineated to provide guidance for executing the designed workflow, as illustrated in Table 9-26.

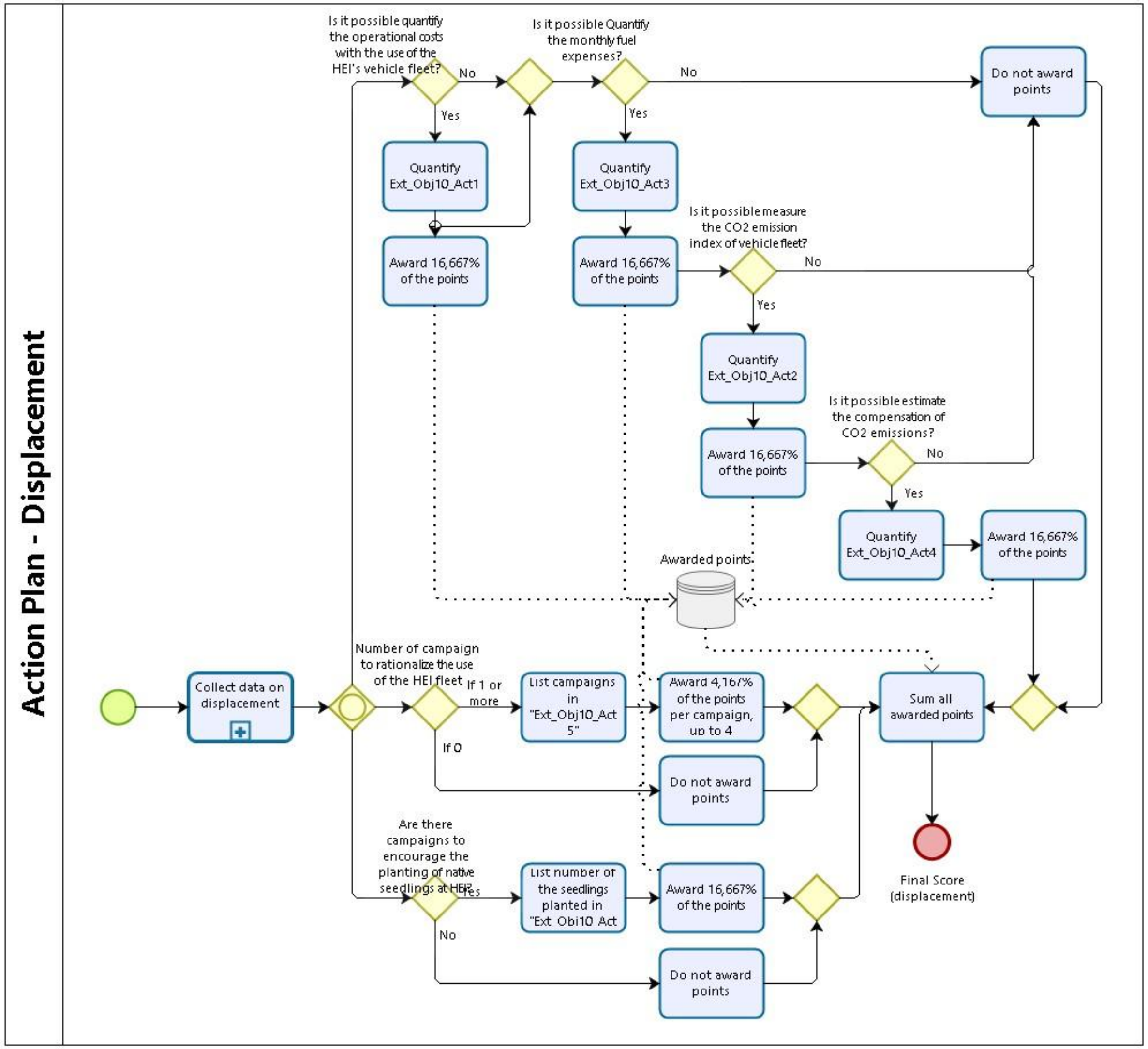


Figure 9-11 - Diagram for Dimension 3.4 -Displacement.

Table 9-29 - Standard Operating Procedure for Action Plan 3.4 -Displacement.

STANDARD OPERATING PROCEDURE (SOP)		
Action Plan: Displacement	**Code:**	**Review:** 00
Date: 24/11/2021	**Page:** 1 of 1	

Objective
To describe the stages of data collection and calculation of indicators related to Objective 9 – To establish sustainable practices for Displacement. The main purpose of these indicators is to measure the degree of integration of sustainable development initiatives in Displacement.

Normative Reference
Decree No. 7,746, of 5 June 2012
Normative Instruction N° 10, from November 12, 2012

Application
It covers the collection of data on Displacement of a HEI, for the subsequent analyses.

Areas Involved
Sector responsible for collecting the SLMP data.

Documents involved in the process.

Type of Document:	

Definitions

Procedure
1) Collect data on displacement consumption from the University's purchasing portal.
2) If possible, quantify the operational costs associated with the use of the HEI's vehicle fleet; 14.286% of the points assigned to the Action Plan should be allocated. (EXT_Obj10_Act1)
3) If possible, quantify the monthly fuel volume; 14.286% of the points assigned to the Action Plan should be allocated. (EXT_Obj10_Act3)
4) If possible, quantify the monthly fuel expenses; 14.286% of the points assigned to the Action Plan should be allocated. (EXT_Obj10_Act4)
5) If possible, measure the CO2 emission index of the vehicle fleet; 14.286% of the points assigned to the Action Plan should be allocated. (EXT_Obj10_Act2)
6) If possible, estimate the compensation for CO2 emissions from the vehicle fleet; 14.286% of the points assigned to the Action Plan should be allocated. (EXT_Obj10_Act5)
7) If there are campaigns to rationalise the use of the HEI fleet; award 14.286% of the points per campaign, up to 4. (EXT_Obj10_Act6)
8) If there are campaigns to stimulate the planting of native seedlings at HEI; award 3.5715% of the points assigned to the Action Plan. (EXT_Obj10_Act7)
9)Add up all the awarded points to obtain the final score for displacement.

Responsibilities
Sector responsible for collecting the SLMP data.

Revision Control

Revision n°	Date	Description	Person responsible to approve the SOP
00	10/09/2021		

c) Reporting Template Regarding Displacement

Table 9-30 - Reporting Template: 3.4 -Displacement.

Reporting on the action plan Displacement

Brief introduction explaining the elements that comprises the action plan and the institutional sectors involved in the implementations and most relevant achievements.

Table of indicators

ID – Indicator / Baseline	Months												Des. Stat.		Score
	1	2	3	4	5	6	7	8	9	10	11	12	$\bar{x}$	σ	
Ext _Obj10_Act1 - Operational costs with the HEI fleet															2019
Ext _Obj10_Act1 – Baseline (2017- 2018)															2017-2018
Ext _Obj10_ Act2 - CO2 emissions by UFPB's vehicle fleet, total and by fuel type															
Ext _Obj10_ Act2 – Baseline (2017- 2018)															
Indicator n															
Baseline n															

1) Graphic of the indicator EXT_Obj10_Act3 and baseline
2) Graphic of the indicator Ext _Obj9_ Act4 and baseline

ID - Action	Status
EXT_Obj10_Act1 - Quantify the operational costs with the use of the HEI's vehicle fleet	Complete/ incomplete…
Action n	

11.3.4. APPENDIX C.4. Component Teaching & Research

11.3.4.1. APPENDIX C.4.1. Dimension Teaching

a) Action Plan Regarding Teaching

Table 9-31 - Action plan for dimension 4.1 - Teaching

ACTION PLAN - Teaching													
Objective 11 – To establish sustainable practices for teaching													
Dimension 1: Quantify and monitor consumption							**TIMELINE**						
ID	**Action**	**Name of indicator**	**Metric**	**Goal (Period)**	**Start**	**End**	**Y 1**	**Y 2**	**Y 3**	**Y 4**	**Y 5**	**SD**	**SI**
EXT_Obj11_Act1	To Integrate sustainable development into course curricula	Courses committed intensively of peripherical to the SD	Percentage of courses intensively or peripherally dedicated to the development of DS-related skills.	To have at least 20% of the courses intensively or peripherally dedicated to the development of DS-related skills.	Entry into force	Conti-nuous	100%	100%	100%	100%	100%	EMC	PROPLAN
EXT_Obj11_Act2	To turn the university into an institutional living lab for the promotion of sustainable development initiatives	Institutionalised programmes to promote campus as a living laboratory	Number of institutionalised programmes devoted to promoting campus as a living lab	To have at least 20 institutionalised programmes to promote campus as a living laboratory	Entry into force	Conti-nuous							
EXT_Obj11_Act3	To assess whether the institution has mechanisms to measure the sustainability of the university curricula	Sustainability of HEI' curricula	Does the HEI have mechanisms to measure the sustainability of the curricula? (y/n)	Have some mechanism to monitor the integration of sustainability in the curricula	Entry into force	Conti-nuous							
Dimension 2: Promote the reduction of use													
Dimension 3 – SD Campaigns													
EXT_Obj11_Act4	To develop a campaign to raise awareness regarding the integration of SD into the curricula	Campaigns to raise awareness regarding the integration of SD into the curricula	Number of campaigns about the integration of SD into the curricula	To have at least 4 campaigns created per semester (continuous)	Entry into force	Conti-nuous	100%	100%	100%	100%	100%	EMC	

b) Assessment Protocols Regarding Teaching

Figure 9-12 depicts the BPMN employed to evaluate the indicators constituting the action plan institutional framework. Subsequently, the standard operating procedure is delineated to provide guidance for executing the designed workflow, as illustrated in Table 9-32.

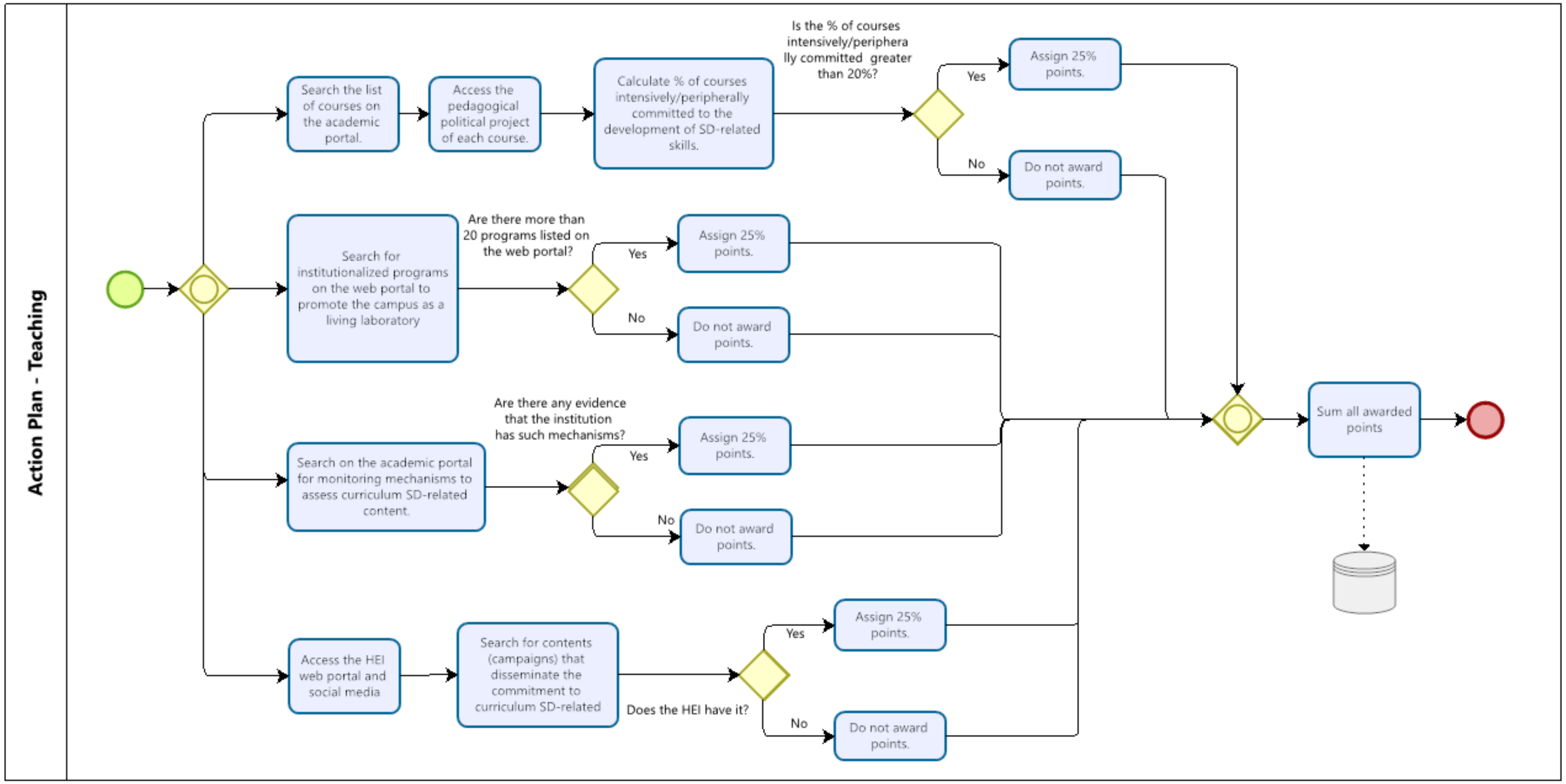


Figure 9-12 - Diagram for Dimension 4.1 - Teaching.

Table 9-32 - Standard Operating Procedure for Action Plan 4.1 - Teaching.

STANDARD OPERATING PROCEDURE (SOP)		
Action Plan: Teaching	**Code:**	**Review:** 00
Date: 24/11/2021	**Page:** 1 of 1	

Objective
To describe the stages of data collection and calculation of indicators related Objective 11 – To establish sustainable practices for teaching. The primary purpose of these indicators is to measure the degree of integration of sustainable development initiatives in the Curriculum.

Normative Reference
Decree No. 7,746, of 5 June 2012
Normative Instruction N° 10, from November 12, 2012

Application
It covers the collection of data on the institutional framework of a HEI, for the subsequent analyses.

Areas Involved
Sector responsible for collecting the SLMP data.

Documents involved in the process.

Type of Document:	HEI's web portal and social media; Institutional Annual Report; web academic portal; and Pedagogical political project of the courses .

Definitions

Procedure
Guidelines for calculating indicator Ext_Obj11_Act1:
1. Search the university's course list, in the case of UFPB it is available at the web address (https://sigaa.ufpb.br/sigaa/public/curso/lista.jsf?nivel=G&aba=p-graduacao).
2. Classify the pedagogical political projects of the courses as not committed, peripherally committed, or intensively committed to the development of SD-related Skills.
3. Calculate the percentage of courses peripherally and intensively committed to the development of SD-related Skills.
4. If the sum value is equal to or greater than 20%, assign 25% of the teaching dimension score to indicator Ext_Obj11_Act1.
Guidelines for calculating indicator Ext_Obj11_Act2:
1. On the institution's web portal, search for institutionalised programs to promote the campus as a living laboratory.
2. Sum the number of programs.
3. If the sum value is equal to or greater than 20, assign 25% of the teaching dimension score to indicator Ext_Obj11_Act2.
Guidelines for calculating indicator Ext_Obj11_Act3:
1. Search the academic portal for monitoring mechanisms to assess curriculum SD-related content.
2. If there is at least one institutional mechanism to monitor and assess curriculum SD-related content, assign 25% of the teaching dimension score to indicator Ext_Obj11_Act3.
Guidelines for calculating indicator Ext_Obj11_Act4:
1. Access the HEI web portal and social media.
2. Search for contents (campaigns) that disseminate the commitment to curriculum SD-related.
3. If there is any campaign, assign 25% of the teaching dimension score to indicator Ext_Obj11_Act4.

Add up all the awarded points to obtain the final score for Teaching.

Responsibilities
Sector responsible for collecting the SLMP data.

Revision Control

Revision n°	Date	Description	Person responsible to approve the SOP
00	10/09/2021		

c) Reporting Template Regarding Teaching

Reporting on the action plan Teaching

Brief description of the sectors responsible to provide practices and policies related to integration of SD into the curriculum highlighting the main manners employed to boost the implementation of SD initiatives in the curriculum.

ID	Indicator	Current status	Max. score	Awarded score
EXT_Obj11_Act1	Courses committed intensively of peripherical to the SD		25%	
EXT_Obj11_Act2	Institutionalised programmes to promote campus as a living laboratory		25%	
EXT_Obj11_Act3	Sustainability of HEIs' curricula		25%	
EXT_Obj11_Act4	Campaigns to raise awareness regarding the integration of SD into the curricula		25%	
	SUM 100%			

11.3.4.2. APPENDIX C.4.2. Dimension Research & Innovation

a) Action Plan Regarding Research & Innovation

Table 9-33 - Action plan for dimension 4.2 - Research & Innovation

ACTION PLAN - Research & Innovation													
Objective 12 – To establish sustainable practices for research & innovation													
Dimension 1: Quantify and monitor consumption								**TIMELINE**					
ID	**Action**	**Name of indicator**	**Metric**	**Goal (Period)**	**Start**	**End**	**Y 1**	**Y 2**	**Y 3**	**Y 4**	**Y 5**	**SD**	**SI**
EXT_Obj12_Act1	To assess whether the institution has funding policy to boost SD research and innovation	Funding for research and innovation into areas of SD	Does the HEI funding policy to boost SD research and innovation? (y/n)	Have some funding policy to boost SD research and innovation		Conti-nuous	100%	100%	100%	100%	100%	EMC	PROPLAN
EXT_Obj12_Act2	To assess whether the institution has mechanisms to measure the sustainability of the actions devoted to research and innovation	Sustainability of HEIs' research and innovation	Does the HEI have mechanisms to measure the sustainability of the actions devoted to research and innovation? (y/n)	Have some mechanism to monitor the integration of sustainability in research and innovation		Conti-nuous	100%	100%	100%	100%	100%		
Dimension 2: Promote the reduction of use													
Dimension 3 – SD Campaigns													
EXT_Obj12_Act3	To develop a campaign to disseminate the commitment of the research and innovation to the SD	Campaigns to raise awareness of the research and innovation commitment to the SD	Number of campaigns about the commitment of research and innovation to the SD created per semester	To have at least 4 campaigns created per semester (continuous)	Entry into force	Conti-nuous	100%	100%	100%	100%	100%	EMC	

b) Assessment Protocols Regarding Research & Innovation

Figure 9-12 depicts the BPMN employed to evaluate the indicators constituting the action plan institutional framework. Subsequently, the standard operating procedure is delineated to provide guidance for executing the designed workflow, as illustrated in Table 9-32.

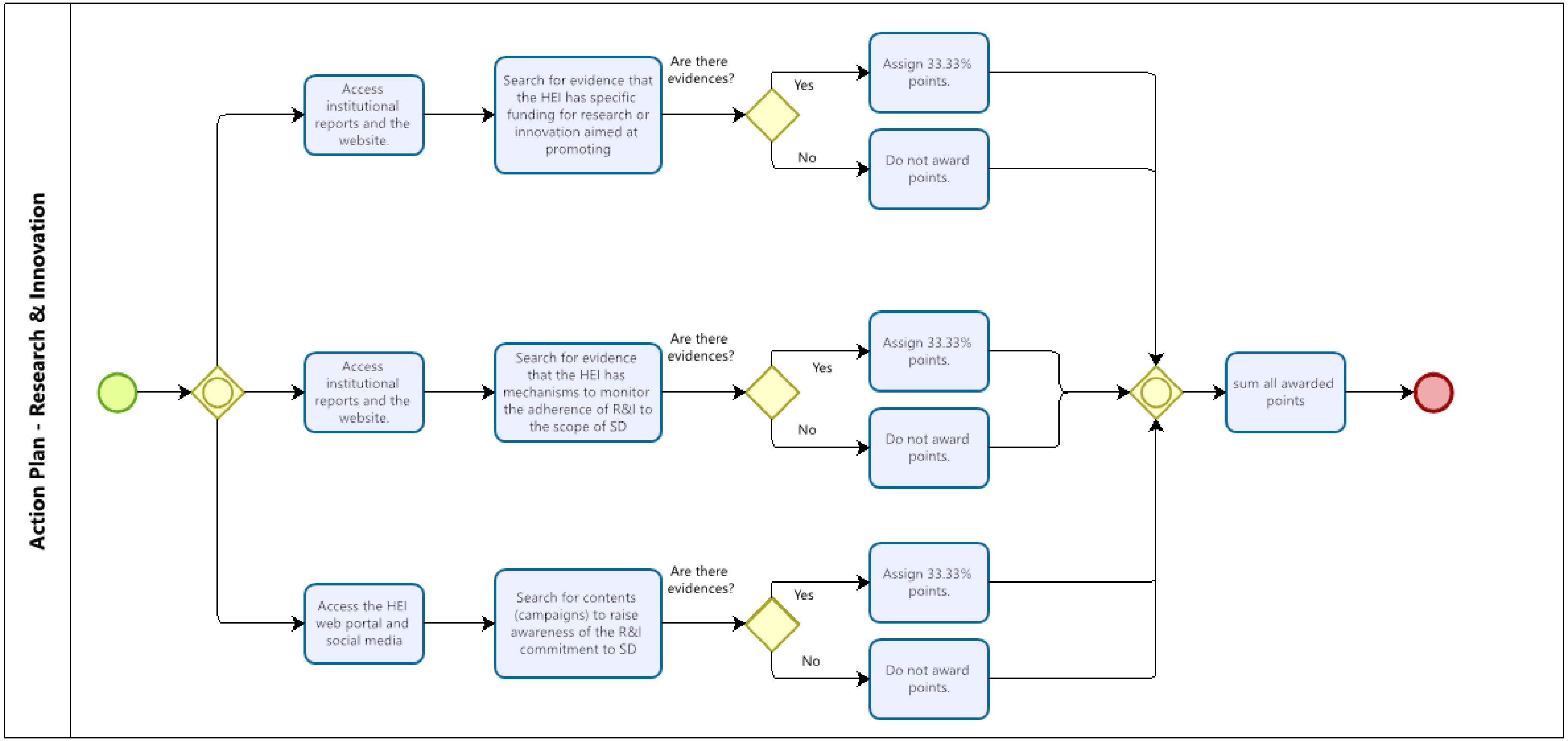


Figure 9-13 - Diagram for Dimension 4.2 - Research & Innovation.

Table 9-34 - Standard Operating Procedure for Action Plan 4.2 - Research & Innovation.

STANDARD OPERATING PROCEDURE (SOP)		
Action Plan: Research & Innovation	**Code:**	**Review:** 00
Date: 24/11/2021	**Page:** 1 of 1	

Objective

To describe the stages of data collection and calculation of indicators related Objective 12 – To establish sustainable practices for research & innovation. The primary purpose of these indicators is to measure the degree of integration of sustainable development initiatives in the field of Research & Innovation.

Normative Reference

Decree No. 7,746, of 5 June 2012
Normative Instruction N° 10, from November 12, 2012

Application

It covers the collection of data on the institutional framework of a HEI, for the subsequent analyses.

Areas Involved

Sector responsible for collecting the SLMP data.

Documents involved in the process.

Type of Document:	HEI's web portal and social media; Institutional Annual Report; web academic portal; and Pedagogical political project of the courses .

Definitions

Procedure

Guidelines for computing indicator Ext_Obj12_Act1:
1. Access institutional reports and the website.
2. Search for evidence that the HEI has specific funding for research or innovation aimed at promoting SD.
3. If there is, assign 33.33% of the Research & Innovation dimension score to indicator Ext_Obj12_Act1.

Guidelines for computing indicator Ext_Obj12_Act2:
1. Access institutional reports and the website.
2. Search for evidence that the HEI has mechanisms in place to monitor the adherence of research and innovation to the scope of SD.
3. If there is, assign 33.33% of the Research & Innovation dimension score to indicator Ext_Obj12_Act2.

Guidelines for computing indicator Ext_Obj12_Act3:
1. Access the HEI web portal and social media.
2. Search for contents (campaigns) that disseminate the commitment to curriculum SD-related.
3. If there is any campaign, assign 33.33% of the Research & Innovation dimension score to indicator Ext_Obj12_Act3.

Add up all the awarded points to obtain the final score for Research & Innovation.

Responsibilities

Sector responsible for collecting the SLMP data.

Revision Control

Revision n°	Date	Description	Person responsible to approve the SOP
00	10/09/2021		

c) Reporting Template Regarding Research & Innovation

Table 9-35- Reporting Template: 4.2 - Research & Innovation.

Reporting on the action plan Research & Innovation

Brief description of the sectors responsible to provide practices and policies related to integration of SD into the Research & Innovation highlighting the main manners employed to boost the implementation of SD initiatives in Research & Innovation.

ID	Indicator	Current status	Max. score	Awarded score
EXT_Obj12_Act1	Funding for research and innovation into areas of SD		33.33%	
EXT_Obj12_Act2	Sustainability of HEIs' research and innovation		33.33%	
EXT_Obj12_Act3	Campaigns to raise awareness of the research and innovation commitment to the SD		33.33%	
	SUM 100%			

11.3.5. APPENDIX C.5. Component Assessment & Reporting

11.3.5.1. APPENDIX C.5.1. Dimension Assessment Protocol

a) Action Plan Regarding Assessment Protocol

Table 9-36 - Action plan for dimension 5.1 - Assessment protocol

ACTION PLAN - Assessment Protocol													
Objective 13 – To establish sustainable practices for assessment													
Dimension 1: Quantify and monitor consumption									**TIMELINE**				
ID	**Action**	**Name of indicator**	**Metric**	**Goal (Period)**	**Start**	**End**	**Y 1**	**Y 2**	**Y 3**	**Y 4**	**Y 5**	**SD**	**SI**
EXT_Obj13_Act1	To assess whether the HEI has formal structure form monitoring the environmental performance	Existence of formal structure for monitoring the environmental performance of HEI	Has the HEI formal structure to monitor environmental performance? (y/n)	To have formal structure to monitor environmental performance	Conti-nuous							EMC	PROPLAN
EXT_Obj13_Act2	To assess whether the HEI has comprehensive system of formally stablished indicators for key sustainability aspects of HEI	Comprehensive system of formally stablished indicators for key sustainability aspects of HEI (including at least energy, water, curriculum, research, and waste)	Has the Hei comprehensive system of formally stablished indicators for key sustainability aspects of HEI? (y/n)	To have comprehensive system of formally stablished indicators for key sustainability aspects of HEI	Conti-nuous								
Dimension 2: Promote the reduction of use													
Dimension 3 – SD Campaigns													
												EMC	

b) Assessment Protocols Regarding Assessment Protocol

Figure 9-14 depicts the BPMN employed to evaluate the indicators constituting the action plan Assessment Protocol. Subsequently, the standard operating procedure is delineated to provide guidance for executing the designed workflow, as illustrated inTable 9-37.

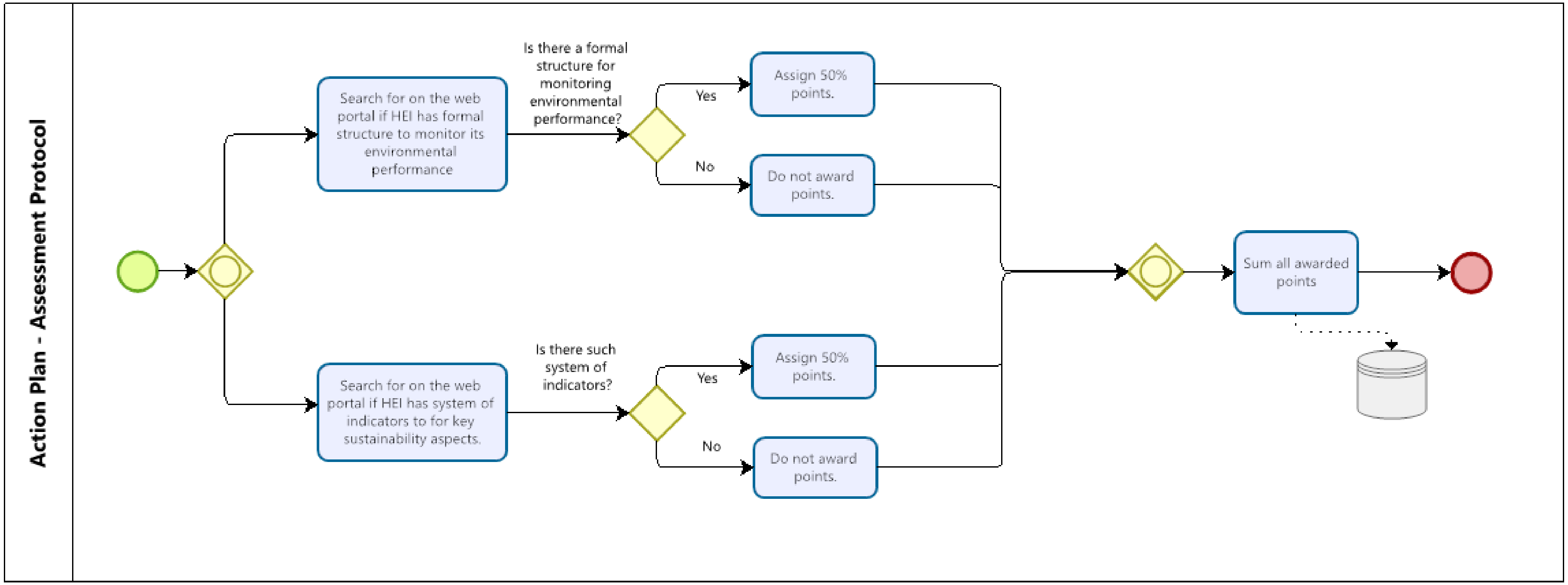


Figure 9-14 - Diagram for Dimension 5.1 - Assessment Protocol.

Table 9-37- Standard Operating Procedure for Action Plan 5.1 - Assessment Protocol.

STANDARD OPERATING PROCEDURE (SOP)		
Action Plan: Assessment Protocol	**Code:**	**Review:** 00
Date: 24/11/2021	**Page:** 1 of 1	

Objective
To describe the stages of data collection and calculation of indicators related Objective 13 – To establish sustainable practices for Assessment Protocol. The primary purpose of these indicators is to measure how HEI is assessing its sustainability performance.

Normative Reference
Decree No. 7,746, of 5 June 2012
Normative Instruction N° 10, from November 12, 2012

Application
It covers the collection of data on the institutional framework of a HEI, for the subsequent analyses.

Areas Involved
Sector responsible for collecting the SLMP data.

Documents involved in the process.

Type of Document:	HEI's web portal and Institutional Annual Report.

Definitions

Procedure
Guidelines for computing indicator Ext_Obj13_Act1:
1. Access institutional reports and the website.
2. Search for evidence that the HEI has formal structure to monitor environmental performance
3. If there is, assign 50% of the Assessment Protocol dimension score to indicator Ext_Obj13_Act1.
Guidelines for computing indicator Ext_Obj13_Act2:
1. Access institutional reports and the website.
2. Search for evidence that the HEI has comprehensive system with formally stablished indicators, addressing the key aspects of HEI sustainability.
3. If there is, assign 50% of the Research & Innovation dimension score to indicator Ext_Obj13_Act2.
Add up all the awarded points to obtain the final score for Research & Innovation.

Responsibilities
Sector responsible for collecting the SLMP data.

Revision Control

Revision n°	Date	Description	Person responsible to approve the SOP
00	10/09/2021		

c) Reporting Template Regarding Assessment Protocol

Table 9-38 - Reporting Template: 5.1 - Assessment Protocol.

Reporting on the action plan Research & Innovation

Brief description of the sectors responsible to perform the sustainable assessment, highlighting the principal protocols employed.

ID	Indicator	Current status	Max. score	Awarded score
EXT_Obj13_Act1	Existence of formal structure for monitoring the environmental performance of HEI		50%	
EXT_Obj13_Act2	Comprehensive system of formally stablished indicators for key sustainability aspects of HEI (including at least energy, water, curriculum, research, and waste)		50%	
	SUM 100%			

11.3.5.2. APPENDIX C.5.2. Dimension Reporting SD

a) Action Plan Regarding Reporting SD

Table 9-39 - Action plan for dimension 5.2 - Reporting SD

ACTION PLAN - Reporting SD													
Objective 14 – To establish sustainable practices for reporting SD													
Dimension 1: Quantify and monitor consumption									**TIMELINE**				
ID	**Action**	**Name of indicator**	**Metric**	**Goal (Period)**	**Start**	**End**	**Y 1**	**Y 2**	**Y 3**	**Y 4**	**Y 5**	**SD**	**SI**
EXT_Obj14_Act1	To assess whether the HEI has a comprehensive data coverage on the sustainability assessment reports	Comprehensive data coverage on the sustainability assessment reports (whether sectoral of HEI as a whole)	Has the HEI comprehensive data coverage of sustainability assessment reports? (y/n)	To have comprehensive data coverage of sustainability assessment reports		Conti-nuous					!00%	EMC	PROPLAN
EXT_Obj14_Act2	To assess whether the HEI publish reports on institutional website	Availability of reports on institutional website	Do Hei publish sustainability reports on institutional? (y/n)	To have published sustainability reports on institutional		Conti-nuous		100%					
Dimension 2: Promote the reduction of use													
Dimension 3 – SD Campaigns													
EXT_Obj14_Act3	To develop a campaign to disseminate the institutional commitment to the SD	Campaigns to publicise HEI environmental performance	Number of campaigns to publicise HEI environmental performance created per semester	To have at least 4 campaigns created per semester (continuous)	Entry into force	Conti-nuous	100%	100%	100%	100%	100%	EMC	

b) Assessment Protocols Regarding Reporting SD

Figure 9-15 illustrates the BPMN utilised to assess the indicators comprising the institutional framework of the action plan. Following this, the standard operating procedure is outlined to offer guidance on implementing the designed workflow, as depicted Table 9-40.

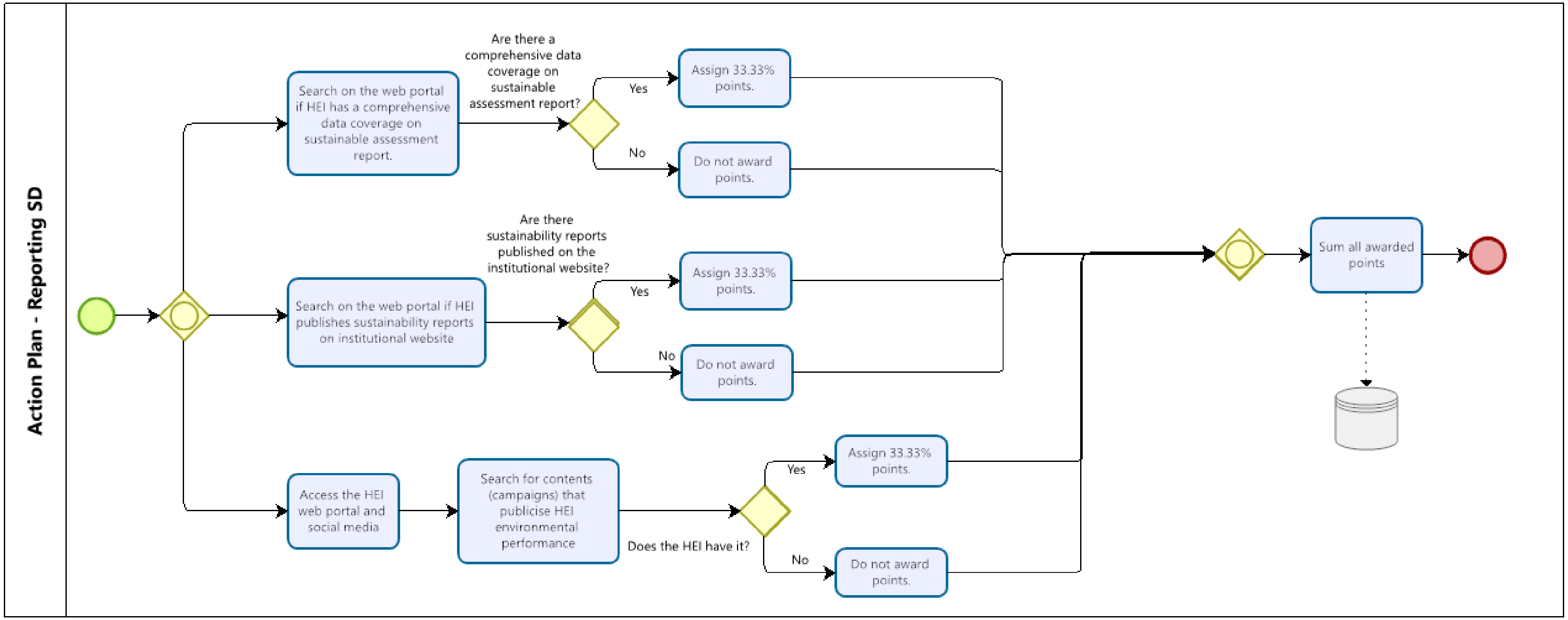


Figure 9-15 - Diagram for Dimension 5.2 - Reporting on SD.

Table 9-40 - Standard Operating Procedure for Action Plan 5.2 - Reporting on SD.

STANDARD OPERATING PROCEDURE (SOP)		
Action Plan: Reporting on SD	**Code:**	**Review:** 00
Date: 24/11/2021	**Page:** 1 of 1	

Objective

To describe the stages of data collection and calculation of indicators related Objective 13 – To establish sustainable practices for Reporting on SD. The primary purpose of these indicators is to measure the degree of integration of sustainable development initiatives in the field of Reporting on SD.

Normative Reference

Decree No. 7,746, of 5 June 2012
Normative Instruction N° 10, from November 12, 2012

Application

It covers the collection of data on the institutional framework of a HEI, for the subsequent analyses.

Areas Involved

Sector responsible for collecting the SLMP data.

Documents involved in the process.

Type of Document:	HEI's web portal and social media; Institutional Annual Report; web academic portal; and Pedagogical political project of the courses .

Definitions

Procedure

Guidelines for computing indicator Ext_Obj14_Act1:
1. Access institutional reports and the website.
2. Search for evidence that the HEI has comprehensive data coverage on the sustainability assessment reports (whether sectoral of HEI as a whole).
3. If there is, assign 33.33% of the Reporting on SD dimension score to indicator Ext_Obj14_Act1.

Guidelines for computing indicator Ext_Obj14_Act2:
1. Access institutional reports and the website.
2. Search for evidence that the HEI has published sustainable reports, regarding its performance in integrate sustainable development in several areas.
3. If there is, assign 33.33% of the Reporting on SD dimension score to indicator Ext_Obj14_Act2.

Guidelines for computing indicator Ext_Obj14_Act3:
1. Access the HEI web portal and social media.
2. Search for contents (campaigns) that disseminate the commitment to publicise through sustainability reports.
3. If there is any campaign, assign 33.33% of the sustainability reporting score to indicator Ext_Obj14_Act3.

Add up all the awarded points to obtain the final score for Research & Innovation.

Responsibilities

Sector responsible for collecting the SLMP data.

Revision Control

Revision n°	Date	Description	Person responsible to approve the SOP
00	10/09/2021		

c) Reporting Template Regarding Reporting SD

Table 9-41 - Reporting Template: 5.2 - Reporting on SD.

Reporting on the action plan Reporting SD

Brief description of the sectors responsible to plan monitor and reporting sustainable performance, highlighting the main manners employed to boost the reporting the SD initiatives.

ID	Indicator	Current status	Max. score	Awarded score
EXT_Obj14_Act1	Funding for research and innovation into areas of SD		33.33%	
EXT_Obj14_Act2	Sustainability of HEIs' research and innovation		33.33%	
EXT_Obj14_Act3	Campaigns to raise awareness of the research and innovation commitment to the SD		33.33%	
	SUM 100%			