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Sustainable Protocol for University Campuses

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Abstract (English)

This study is an integral part of a strategic institutional project of Politecnico di Torino, caried out in cooperation with iiSBE Italia, aiming to develop and implement asustainability assessment systems specific for university campuses.

Universities known as essential institutions for global sustainability through their implementation of environmental social and governance principles across educational programs and operational infrastructure. The assessment tools like STARS and UI GreenMetric because the lack of context-specific adaptation, and methodological depth faces difficulties in their ability to measure campus sustainability assessment.

The research develops two generic frameworks named SBTool Campus for building-scale assessment and SNTool Campus for urban-scale frameworks which stem from the Sustainable Built Environment (SBE) Method. The methodological process consists of three stages which include (1) evaluating existing higher education tools and indicators (2) expert workshop-based co-design of hierarchical structures (issues, categories, criteria, indicators) and (3) generic framework implementation on the Sustainable MED Cities (SMC) digital platform.

With these frameworks, universities have the possibility to generate contextualized assessment tools to conduct sustainability performance assessments at different scales supporting both local and international sustainability goals. The SBTool and SNTool Campus frameworks emerged from evidence-based procedures and participatory validation to advance integrated transparent adaptable tools for sustainability governance in higher education institutions.

In realtion to the Italian context, the two generic frameworks (SBTool and SNTool Campus) will be used to develop a version of the public national assessment system Protocollo ITACA for campus buildings and urban areas. ITACA is the Federation of the Italian Regions supporting the Conference of the Regions in the field of sustainability. Protocollo ITACA is an institutional assessment and certification system used by regional and public authorities to support their policies and initiatives for improving the sustainability of the built environment.

Keywords: Sustainable campus; SBTool Campus; SNTool Campus; Sustainable Built Environment (SBE) Method; Protocollo ITACA; University sustainability assessment; Multi-criteria evaluation; Higher Education Institutions (HEIs); Institutional sustainability governance; Digital assessment platform.

Abstract (Italian)

Questo studio è parte integrante di un progetto istituzionale strategico del Politecnico di Torino, condotto in cooperazione con iiSBE Italia, volto a sviluppare e implementare un sistema di valutazione della sostenibilita' specifico per i campus universitari.

Le università sono attori di primo piano per la promozione dei principi della sostenibilità, attraverso la loro applicazione e inclusione nei programmi formativi e nella progettazione e gestione delle infrastrutture accademiche. Strumenti di valutazione come STARS e UI GreenMetric incontrano difficoltà nella misurazione della sostenibilità dei campus a causa della mancanza di adattamento al contesto, del dettaglio spaziale e della profondità metodologica.

La ricerca sviluppa due quadri generici denominati SBTool Campus per la valutazione alla scala dell'edificio e SNTool Campus per la valutazione alla scala urbana, entrambi derivati dal Metodo per l'Ambiente Costruito Sostenibile (SBE Method). Il processo metodologico si articola in tre fasi: (1) valutazione degli strumenti e indicatori esistenti per l'istruzione superiore, (2) co-progettazione tramite workshop esperti della struttura gerarchica (temi, categorie, criteri, indicatori), e (3) implementazione dei quadri generici sulla piattaforma digitale Sustainable MED Cities (SMC).

Grazie a questi strumenti, le università hanno la possibilità di generare strumenti di valutazione contestualizzati e condurre valutazioni delle prestazioni di sostenibilità a diverse scale, supportando sia gli obiettivi locali che quelli internazionali di sostenibilità. I quadri SBTool e SNTool Campus sono il risultato di procedure basate su evidenze e validazioni partecipative, con l'obiettivo di promuovere strumenti integrati, trasparenti e adattabili per la governance della sostenibilità nelle istituzioni dell'istruzione superiore.

Nel contesto italiano, i due quadri generici (SBTool e SNTool Campus) saranno utilizzati per sviluppare una versione del sistema nazionale pubblico di valutazione Protocollo ITACA, dedicata agli edifici e alle aree urbane dei campus. ITACA è la federazione delle Regioni italiane che supporta la Conferenza delle Regioni nel campo della sostenibilità. Il Protocollo ITACA è un sistema istituzionale di valutazione e certificazione utilizzato da autorità regionali e pubbliche per sostenere politiche e iniziative volte a migliorare la sostenibilità dell'ambiente costruito.

Parole chiave: Campus sostenibile; SBTool Campus; SNTool Campus; Metodo per l'Ambiente Costruito Sostenibile (SBE Method); Protocollo ITACA; Valutazione della sostenibilità universitaria; Valutazione multicriterio; Istituzioni di istruzione superiore (HEIs); Governance istituzionale della sostenibilità; Piattaforma digitale di valutazione.

Table of Contents

List of Figures

List of Tables

Chapter 1. Introduction

In the past decades, sustainability has become a strategic priority for higher education institutions (HEIs) with the worldwide imperative to tackle mounting environmental and social problems. Universities occupy a privileged status as institutions of knowledge generation, hubs of technological innovation, and opinion-formers in society and, therefore, can play the role of leading sustainable development (Stephens et al., 2008). They are also among the most significant stakeholders in knowledge exchange and preservation, innovation, and implementation of new technology (Stephens et al., 2008). The 1972 Stockholm Declaration formally recognized the critical role of universities in advancing environmental responsibility and promoting social equity (Handl, 2012).

The function that HEIs play in sustainability guidance has, nonetheless, changed with global initiatives such as the United Nations Higher Education Sustainability Initiative (HESI) and the Sustainable Development Solutions Network (SDSN) that advocate for mainstreaming the Sustainable Development Goals (SDGs) in education, operations, and even community practice (United Nations, 2025). These frameworks have placed universities in the role of not only being teaching providers but also sustainability transition leaders both within and beyond university boundaries (Lozano et al., 2013). When sustainability is embedded in decision-making, infrastructure, research agendas, and community life, universities are reaffirming their purpose of building a more sustainable and just future.

The campus increasingly becomes a microcosm of society, a living laboratory where comprehensive solutions to sustainability are imagined, tested, and scaled up. This strategy, referred to as the campus as a living lab, allows institutions to pilot sustainable practices in governance, energy consumption, mobility, and resources and provide scalable models for application in larger urban and regional contexts (Du Preez et al., 2022). These integrated approaches make universities key stakeholders in national and global sustainability objectives, especially with support from evidence-based protocols and performance benchmarks.

Within the European context, Italy has been very institutionally engaged with the sustainability of campuses, precisely by way of the Italian Network of Universities for Sustainable Development (RUS). Politecnico di Torino, Italy's leading technical university and the focus of this study, has taken national leadership in this respect. It was the president of RUS between 2019 and 2024 and co-chair of SDSN Italy, elected in 2024, as a strategic demonstration of its commitment to spearheading sustainable development through education, research, and operations (Politecnico di Torino, 2025). The commitment of the university manifests itself by way of community-based initiatives, international partnerships, and the incorporation of sustainability in governance mechanisms.

The international initiative for a Sustainable Built Environment (iiSBE) has made significant contributions to the development of generic frameworks for assessing sustainability in the built environment in recent days. It has developed two main tools: SBTool (Sustainable Building Tool) and SNTool (Sustainable Neighbourhood Tool) which offer structured, multi-criteria methodologies for assessing environmental performance at both building and urban scales.(iiSBE Italia R&D, 2023; Politecnico di Torino, 2023).

1.1. Problem Statement

Although sustainability assessment tools have become increasingly use within Higher Education Institutions (HEIs), assessment tools such as STARS and UI GreenMetric, still show some limitations in terms of scope and flexibility. These frameworks mainly focus on internal performance aspects like energy use, waste reduction, or student activities and often do not fully consider broader social and environmental impacts (Findler et al., 2018, 2019). Because of this narrow focus, their ability to reflect how universities contribute to sustainability at a wider, regional or systemic level remains limited.

A further limitation concerns the generalist and context-insensitive nature of many current tools. Sustainability in academic settings is intrinsically multidimensional, involving environmental responsibility, social equity, economic viability, and institutional governance (Basheer et al., 2025). Many existing frameworks rely on a standard model that overlooks how institutions differ and how local policies vary across places (Dawodu et al., 2022). Studies show that factors like location, the type of infrastructure, and how a campus is organized all effect sustainability goals, something most common assessment systems tend to overlook (de Jesus Lopes et al., 2024; Frizon & Eugénio, 2022).

The case of Politecnico di Torino shows why it's important to have tailored approaches. In the course of an ambitious campus transformation project, the university became aware of the limitations of traditional tools in assessing complicated and multifunctional academic settings. Accordingly, a joint effort was undertaken with the international initiative for a Sustainable Built Environment (iiSBE) to investigate the use of the SBTool and SNTool generic frameworks in the context of higher education campuses. Their purpose is to make sustainability assessments possible at scales from the individual building up to the whole campus landscape, creating a flexible system that can be tailored to address individual institutional and regional needs.

This thesis looks at two main gaps: one in real-world practice and one in research methods. It responds to the limits of current assessment tools and the lack of clear, well-documented ways to develop new tools for higher education. By creating generic frameworks that can fit different contexts and used in other places, based on SBTool and SNTool generic frameworks, this research aims to improve scientific quality, and make the generic frameworks more useful for universities. This work also follows recent suggestions to make generic frameworks more integrated, participatory, and based on evidence, while ensuring they can be adapted to how universities actually work (Putra & Ulkhaq, 2024; Fischer et al., 2015; Sonetti et al., 2016).

1.2. Identification of the Methodological Process

The research methodology used in this thesis emerged from a strategic joint project between Politecnico di Torino and iiSBE (international initiative for a Sustainable Built Environment) (Torabi Moghadam et al., 2024). The process follows a structured multi-scalar interdisciplinary framework to develop sustainability assessment tools for university campuses. The Sustainable Built Environment Method (SBE Method) serves as the foundation for this approach which combines analytical research with participatory co-design and digital implementation to develop context-specific customizable versions of SBTool and SNTool for higher education settings. The process consists of three connected phases which work together as a whole:

1. The first phase involves a thorough evaluation of sustainability assessment tools and indicator systems which exist for institutions of higher education.This analytical process

provides the foundation for placing SBTool and SNTool generic frameworks in the specific operating and spatial universes of university campuses. The process requires the combination of peer-reviewed literature with technical recommendations and institutional activity to determine thematic domains and evaluation deficiency areas and structural demands.

2.The second phase requires the development of generic frameworks. Experts participate in organized workshops to define and verify the generic framework of issues, categories, criteria, and indicators through tools including game boards, semantic cards, and questionnaires. To preserve the distinct characteristics of the transnational SBE Method framework, the generic frameworks are developed independently: SBTool for the building scale and SNTool for the urban scale.

3. The Sustainable MED Cities (SMC) web platform receives the generic frameworks during its final implementation step. Digital translation enables the system to become functional and adaptable so institutions can establish and modify it according to their existing infrastructure. Here the generic framework is ready to carry out the assessment, while staying easy to use and flexible enough to fit real campus conditions.

1.3. Thesis Objectives

The principal objective of this research is to formulate a version of the sustainability generic frameworks SBTool and SNTool for university campuses. These generic frameworks aim to work at both the building scale and urban scale. They consider the unique layouts, different functions, and management styles of universities.

The research reveals why performance-based flexible frameworks are important for different environmental conditions. The current assessment frameworks for university sustainability assessment fail to meet this requirement. This thesis uses the Sustainable Built Environment Method (SBE Method) with its defined structure and multiple criteria to develop general frameworks. These frameworks maintain strong research methods but also allows for changes to fit local contexts.

The study focuses on these main objectives:

- To critically examine SBTool and SNTool's theoretical foundations and operating mechanisms, specifically their hierarchical structures (issues, categories, criteria, indicators) and mapping to the campus sustainability needs;
- To define the most relevant sustainability themes, evaluative criteria, and indicators for university campuses at both building and neighborhood scales;
- To construct two integrated and adaptable generic frameworks, one for buildings (SBTool Campus) and one for urban-scale (SNTool Campus), grounded in the SBE methodology;
- To implement these frameworks within the Sustainable MED Cities (SMC) digital platform, enabling their operational use through an interactive, scalable, and customizable system;
- To offer a methodological reference model that can inform the development of localized campus sustainability tools in other institutional or regional contexts.

The thesis achieves its objectives by advancing structured evidence-based methods for sustainability evaluation and improvement in academic settings. The research provides a basis for unified decision-making and planning processes that span both built and urban aspects of university campuses.

1.4. Research Questions

The formulation of a comprehensive sustainability generic frameworks for university campuses requires an integrated methodological approach that aligns rigorous evaluation standards with the spatial, operational, and governance realities of higher education institutions. Guided by the overarching aim of constructing SBTool Campus and SNTool Campus generic frameworks adapted to the university scale, this thesis is structured around the following research questions:
RQ1: What are the necessary methodological steps to create scientifically valid and flexible sustainability assessment tools for university campuses from the SBTool and SNTool generic frameworks?
RQ2: How well do current sustainability assessment frameworks recognize the unique challenges faced by university campuses?

RQ3:Which sustainability criteria and types of indicators should we focus on to make sure the generic framework effectively cover the environmental, social, economic, and governance aspects of university campuses?

1.5. Structure of the Thesis

The thesis is composed of five chapters incrementally advancing in the direction of developing, testing, and implementing sustainability assessment tools for university campuses using the SBTool and SNTool generic frameworks assessment tools. The structure is logical in progression from theoretical frameworks to methodological design and digital implementation.

Chapter one of the study provides background information while defining the research problem and specifying the objectives and research questions and explaining the organisation of the thesis.

Chapter two Literature Review takes a close look at sustainable development in universities. It explores the important role universities play in pushing sustainability forward and examines popular evaluation tools like STARS and UI GreenMetric. The chapter also mention where these common frameworks are not fully effective and introduces SBTool and SNTool as promising alternatives.

Chapter three discusses how the Campus Sustainability Assessment Tool sets out the methodology for making generic frameworks customized to university environments. The Sustainable Built Environment Method (SBE Method) is organized in a clear hierarchy made up of issues, categories, criteria, and indicators. This chapter also describes the development of two generic frameworks: SBTool Campus targets building assessment while SNTool Campus provides measurements for the urban scale. The development of both generic frameworks occurred through expert consultation and participatory approaches.

Chapter four shows how the developed tools operate as a real-time digital platform based on the Sustainable MED Cities platform. The chapter contains operational documentation to establish thematic areas and balance criteria and to set up the evaluation interface for SBTool Campus and SNTool Campus applications.

Chapter five presents the overall results of the study and discusses both methodological aspects and practical application potential while it outlines future research opportunities and applications for various academic and regional contexts.

The organisation establishes rational cohesion and methodological precision which enables the creation of scalable and context-aware sustainability generic frameworks for university campuses.

Chapter 2.Literature Review

2.1. The Role of Universities in Sustainability

Higher education institutions (HEIs) are important for sustainable development because they are the main producers of knowledge, they are involved in civic engagement, and they have institutional power. Higher education institutions serve as demonstration zones that integrate sustainability principles into governance frameworks and physical campus design and educational curriculum and research activities, and community engagement (Oliveira & Proença, 2025; Dawodu et al., 2022).

Higher education institutions practice SDG 4 (Quality Education) and SDG 11 (Sustainable Cities and Communities), and SDG 13 (Climate Action), which positions universities to lead global environmental and social challenge mitigation efforts (Umar et al., 2024; Oliveira & Proença, 2025). Sustainability has, therefore, shifted from a peripheral policy matter to a superordinate organizational priority that is integrated into strategic planning, academic programs, and organizational practice.

The consumption of large amounts of natural resources and the substantial environmental impact of campuses mirrors urban systems, so the implementation of environmental management systems and sustainable operations becomes essential (Putra & Ulkhaq, 2025; Dawodu et al., 2022). The sustainable operations involve carbon reduction strategies, energy efficiency initiatives, green building practices, sustainable transportation, and circular waste management. Oliveira and Proença (2025) point out that these efforts need to be supported by institutional frameworks that embed sustainability into leadership structures, governance, and decision-making processes.

The pedagogical dimension is equally important. According to Sugiarto et al. (2022) and Oliveira and Proença (2025) sustainability integration into curricula through transdisciplinary and experiential learning enables students to develop critical systems thinking abilities along with analytical competencies and environmental responsibility. Student-led projects and co-curricular programs develop sustainability-oriented mindsets while building leadership competencies required to handle complex societal problems (Biancardi et al., 2023).

The way universities adopt sustainability strategies varies by region. Higher Education Institutions (HEIs) in Southeast Asia focus predominantly on environmental sustainability according to research findings. The research study demonstrated that governance systems together with inclusivity and mobility systems need further development (Mansor et al., 2023). Higher Education Institutions worldwide face three major structural barriers which include limited institutional funding and unclear policy frameworks and inadequate stakeholder involvement (Putra & Ulkhaq, 2025; Freidenfelds et al., 2018).

To address these challenges, various assessment and benchmarking tools have been adopted, including UI GreenMetric, STARS (Sustainability Tracking, Assessment and Rating System), and ISO 14001. explain that these instruments generally do not reflect contextual relevance and manage comprehensive indicator coverage, which has led recommendations for better performing indicator-based systems designed for the campus.

Sustainability practice in the university has transcended the challenge of responding to legislation and delivering a series of one-off projects. HEIs should be an institution in entirety being about sustainability. Given the intersection of academic, operational, and community practices, the campus can both support and demonstrate progress towards global sustainability aspirations.

2.2. Sustainability in Higher Education

Global sustainable development efforts depend on Higher Education Institutions (HEIs) since they perform essential functions in knowledge development and model institutions while connecting with communities. University strategies and global agendas have positioned Higher Education Institutions as essential agents for sustainability transitions because they adopted United Nations Sustainable Development Goals (SDGs) according to Lozano et al. (2013) and Trevisan et al. (2024).

The sustainability initiatives of HEIs have progressed from academic programs to now include operational management of campuses and research activities and community outreach and governance functions (Lozano et al., 2015; Trevisan et al., 2024). The model presented by Lozano et al. (2015) outlines seven essential sustainability areas that include institutional frameworks together with campus practices and education and research and outreach and student experiences and sustainability reporting. Most sustainability initiatives exist in disconnected fragments because they develop either through independent efforts or from centralized policies instead of unified strategic frameworks.

Strong governance practices form the essential base which enables successful sustainability implementation. According to Fernández-Sánchez et al. (2014) institutions must match their missions to their decision-making processes to execute sustainability principles. The combination of financial constraints and poor leadership together with insufficient faculty participation creates obstacles for universities to advance sustainability initiatives. The resolution of these challenges needs collaborative work between different fields and the promotion of innovative ideas that will engage all university members. The process faces major challenges because of insufficient leadership combined with financial constraints and limited faculty participation. Educational innovation needs collaborative interdisciplinary approaches to tackle these institutional challenges.

Competency-based education has become the main focus of educational development. The framework developed by Lozano et al. (2017) presents twelve sustainability competencies which integrate systems thinking with strategic foresight through educational approaches including service learning and problem-based learning. According to Probst (2022) the Higher Education for Sustainable Development (HESD) literature faces criticism because it emphasizes knowledge transmission over behavioral transformation and reflective thinking. Students clearly have an important role in helping universities become more sustainable, but their efforts are often ignored. For instance, Murray (2018) found that student-led projects can actually make a difference by mixing knowledge from different subjects with simple, grassroots actions. Still, students often struggle to get involved because university systems can be quite restrictive. A study at the University of Calgary by Lee et al. (2023) shows how student initiatives connected to the Sustainable Development Goals not only empower students but also support the university's sustainability goals. Also, Mouchrek (2018) points out that design-based learning works well because it links what students care about with real actions in their own environment.

Biancardi et al. (2023) place Higher Education Institutions inside the European Green Deal framework to achieve SDGs by teaching students through transformative educational methods. Their tetrahedron framework positions students as the central component while academic partnerships and faculty engagement and teaching innovation and critical skills development support them. Sustainability education needs experiential learning environments such as "living labs" to teach practical skills (see Figure 1).

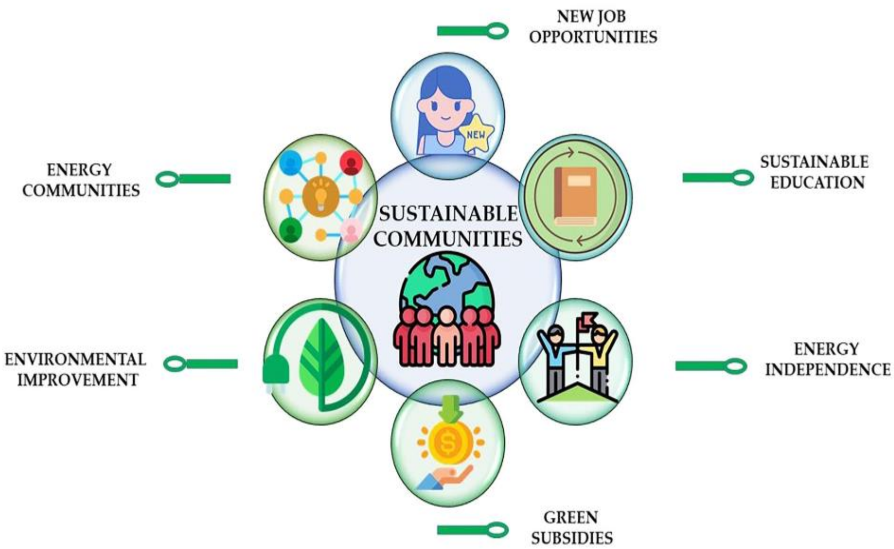


Figure 1.The Role of Sustainable Communities in HEIs (Biancardi et al., 2023).

There are six key elements to be considered in establishing sustainable HEI communities, including the integration of sustainability into education and research, renewable energy-based energy independence, green project funding, carbon emission reduction through optimized infrastructure and transportation, promotion of participatory governance, and tailored training and partnership-based green career development (Biancardi et al., 2023). The framework demonstrates that HEIs must transform their internal culture and infrastructure and their external relationships to achieve sustainability.

According to Trevisan et al. (2024) transformative organizational learning represents the foundation for implementing sustainability at institutional levels. They use research from 15 European universities to demonstrate that personal learning combined with supportive policy and experimental strategy drives systemic transformation.

HEIs can progress global sustainability goals through their adoption of innovative teaching methods and inclusive governance systems. They should use Interdisciplinary learning and flexible learning environments which adapt to different contexts to engage students.

2.3. Evolution of Green and Smart Campus Initiatives

Higher education institutions progressed their campus sustainability development from basic environmental approaches of green campus models to the integrated smart campus framework that uses digital technology. The former green campus initiatives focused on behavioral change through environmental awareness combined with operational practices that involved energy conservation and recycling programs as well as infrastructure greening (Sugiarto et al., 2022). The programs were structured to enhance ecological accountability while improving campus management and student educational understanding through physical modifications and behavioral transformations.

The implementation of Internet of Things devices along with artificial intelligence and big data and cloud computing systems in campus operations began when digital technology reached its maturity stage. The deployment of smart campuses integrates various technologies to improve building efficiency and energy systems and user satisfaction and support human-centric institutional decision processes according to Zhang et al. (2022). The implemented systems use student and faculty perspectives to build digital campus solutions that meet stakeholder needs in both practical and emotional ways.

The integration of environmental metrics with digital infrastructure enables the development of innovative methods for campus sustainability planning and assessment. The combination of Digital Twin technologies with green metrics allows universities to perform real-time assessments of resource consumption and carbon emissions and space management according to Teke et al. (2023). The approach shows promise for creating intelligent campus systems which merge environmental factors with data-driven choices.

The establishment of smart campus systems requires organization through four essential domains according to Polin et al. (2023): environment, economy, society and governance. The framework provides multiple dimensions to help institutions develop technological solutions that match educational and sustainability requirements and enhance institutional supervision capabilities. The successful development of a smart campus demands institutional transformation which needs active digital participation and thoughtful policies and inclusive management practices.

Digital transformation brings numerous advantages yet it creates specific problems mainly affecting cybersecurity and governance practices. Majid et al. (2023) emphasize the necessity of developing strong cybersecurity frameworks which should identify IoT device weaknesses to safeguard digital infrastructure. The fast growth of IoT devices on campus requires immediate attention to protect data privacy and system security since these measures protect against cyberattacks and build trust and support sustainable digital governance systems. The importance of technology requires human oversight and careful planning for sustainability because these elements ensure success.

2.4. Challenges in Measuring and Implementing Campus Sustainability

Higher education institutions face substantial obstacles in their sustainability transition efforts when they try to assess and execute campus sustainability initiatives. The path toward university sustainability faces various complex barriers which create obstacles through methodological issues and institutional barriers and cultural obstacles and resource constraints.

The main difficulty of sustainability assessment tools stems from the poor integration of different methods and systems. Many Campus Sustainability Assessment Tools (CSATs) lack comprehensive frameworks that cover all sustainability indicators (Dawodu et al., 2022). The separation between institutional components and social factors hinders the implementation of effective measurement and evaluation practices. The assessment systems studied by Lad and Akerlof (2022) demonstrate weak connections between institutional targets and rely on limited proxy data. The mismatch between assessment tools hampers their strategic planning capabilities while making it difficult for them to lead policy or curriculum development. Organizational structures together with cultural elements create persistent difficulties for change implementation. The change implementation process in HEIs faces institutional barriers because their disciplinary structure and inadequate communication channels and poor interdepartmental coordination create obstacles as described by Nogueiro et al. (2022). The achievement of sustainability becomes more difficult because institutional stagnation and cultural resistance create barriers to departmental collaboration and delay sustainability practice adoption.

These issues become more severe because institutions lack sufficient analytical capabilities. According to Lad and Akerlof (2022) universities currently employ a small number of staff members who work on sustainability initiatives. Insufficient staff numbers lead to inadequate technical capacity and reduced opportunities for detailed sustainability assessments. Organizations often suffer from a lack of sufficient sustainability data, which leads to difficulties in collecting and analyzing information, and ultimately prevents well-informed, evidence-based decision-making.

Policy fragmentation also plays a notable role. The priorities between national sustainability policies and institutional strategies differ according to Wilhelm and Pilatti (2024) thus leading to fragmented sustainability efforts. Sustainability initiatives lose their transformative power because different levels of governance fail to coordinate effectively which turns them into meaningless symbolic gestures.

The long-term sustainability of university practices remains challenging because funding and staffing limitations continue to exist. Sustainability framework development face challenges obstacles because of limited budgets and insufficient dedicated personnel and inadequate administrative support (Nogueiro et al. ,2022). Institutional conditions create barriers that hinder the long-term continuity and expansion of sustainability initiatives.

The resistance to change continues as a long-standing issue that affects cultural and operational aspects. Established traditions and bureaucratic procedures along with faculty members' hesitation delay sustainability transitions. Long-term dedication and institutional ownership become possible through the implementation of inclusive governance systems with continuous stakeholder engagement.

Campus sustainability challenges extend beyond infrastructure and technology because they stem from the complex relationships between governance systems and institutional readiness and cultural factors and data management systems. Success in overcoming barriers needs complete strategies that develop analytical capacity while transforming organizations and maintain institutional alignment with global and national sustainability requirements.

2.5. Existing Sustainability Assessment Frameworks

The global drive to establish sustainability practices in higher education began after UNESCO and UNEP launched their International Environmental Education Programme in 1975. UNESCO and UNEP launched this program in 1975 to introduce sustainability as a formal educational concept at the international level (UNESCO, 1984). The program established important policy documents beginning with the Tbilisi Declaration (1977), and Talloires Declaration (1990), and the Halifax Declaration (1991) that identified universities as key drivers for sustainable development (Husaini, Jusoh, & Kassim, 2018). Since the 1990s, universities have started to develop specific strategies for sustainability through the implementation of performance evaluation and institutional benchmarking tools.

The number of Sustainability Assessment Tools (SATs) designed for higher education institutions has grown significantly since the 1990s to help implement sustainability initiatives. These tools help universities evaluate their operational and educational, and social performance through technical guidelines and assessment frameworks, and benchmarking protocols (Caeiro et al., 2020). Different SATs have various levels of scope and thematic coverage, together with methodological complexity, but they work together to enhance institutional capacity-building and transparency, and strategic alignment (Berzosa et al., 2017).

STARS (Sustainability Tracking, Assessment & Rating System) and the UI GreenMetric World University Ranking represent the most recognized frameworks for higher education sustainability because of their wide adoption across the sector. According to Deliverable 1.3 of the strategic institutional project jointly developed by Politecnico di Torino and iiSBE (Torabi Moghadam et al., 2024), the two tools stand alone as the SATs currently in use that evaluate sustainability across entire institutions while excluding building-specific and neighborhood-level assessments.

The Association for the Advancement of Sustainability in Higher Education (AASHE) developed STARS as a point-based system that evaluates sustainability performance across academic activities and campus operations and community engagement, and institutional planning. UI GreenMetric from Universitas Indonesia operates with a score-based system that uses measurable metrics to evaluate campus performance regarding infrastructure and energy consumption and transportation systems and waste management, and sustainability education practices (Torabi Moghadam et al., 2024). The assessment framework includes BREEAM and LEED, WELL, and ISO 14001, but these frameworks evaluate buildings and technical standards and environmental management systems, so they do not align with the institutional assessment needs of this study.

The subsequent sections examine STARS and UI GreenMetric because these assessment tools provide the most suitable framework for creating a generic sustainability evaluation system that covers entire campuses.

2.5.1. STARS

Sustainability Tracking, Assessment & Rating System (STARS) is an Association for the Advancement of Sustainability in Higher Education (AASHE) developed, self-assessment and voluntary system of measuring and informing the colleges and universities' sustainability performance (AASHE, 2024). STARS has specifically been formulated for the different missions and organizational configurations of the colleges and universities. It enables institutions to benchmark their sustainability efforts, track change over time, and identify areas for improvement against a shared set of criteria. STARS membership is open to all post-secondary institutions worldwide, and the tool is built to be used with institutions at all levels of sustainability integration, from new programs through seasoned leaders. The template aids in strategic planning and learning within institutions by promoting collaboration between different sectors, including students, and open sharing of data. STARS is a comprehensive and integrated definition of sustainability that addresses environmental, social, and economic dimensions. In addition, alignment with the United Nations Sustainable Development Goals (SDGs) gives relevance at the international level and helps institutions to identify how they are advancing larger sustainability efforts (AASHE, 2024). STARS allows institutions to participate within their capacity and resources by providing scored and unscored options.

Categories and Subcategories

The STARS framework groups campus sustainability into four main focus areas according to AASHE (2024) which include Academics (AC), Engagement (EN), Operations (OP) and Planning & Administration (PA) with an optional category for Innovation & Leadership (IL). The four sustainability performance areas represent different aspects of sustainability measurement. The Academics category evaluates how sustainability themes become integrated into teaching practices and scholarly research activities. The Engagement category focuses on the process of involving students and staff together with the broader community in sustainability practices. The Operations category evaluates physical infrastructure management and resource utilization through measurements of energy use and water consumption and building maintenance and mobility systems. Planning & Administration assesses leadership together with policy direction and equity commitments and financial alignment with sustainability goals. The framework enables complete sustainability assessments of campus life through its structured format.

The points system of institutions operates through specific qualitative and quantitative reporting credits which exist within each subcategory. The credits define specific performance indicators together with established data collection procedures. Moreover, the frameworks helps institutions to create sustainability reports through standardized assessment procedures while allowing them to modify the system according to their requirements. The STARS framework structure includes categories and subcategories with credit titles and their corresponding point values as described by AASHE (2024) according to Table 1.

Table 1.STARS Categories, Subcategories, Credits, and Point Allocations (AASHE, 2024).

Category and Impact Area	No.	Credit title	Points available
Report Preface(PRE)			
Report Preface	PRE 1	Executive Letter*	-
	PRE 2	Point of Distinction	-
	PRE 3	Institutional Characteristics	-
	PRE 4	Reporting Methodologies	-
Academics (AC)			
Curriculum Max. 45 points available	AC 1	Sustainability Course Offerings*	14
	AC 2	Undergraduate Programs*	15 or 11**
	AC 3	graduate Programs*	8

	AC 4	Applied Learning	4
	AC 5	Sustainability Literacy Assessment	4
Research Max.23 points available	AC 6	Sustainability Research*	10
	AC 7	Center for sustainability Research	6
	AC 8	Responsible Research and Innovation	7
Engagement (EN)			
Campus Engagement Max. 25 points available	EN 1	Outreach and Communications	5
	EN 2	Co-Curricular Activities	9
	EN 3	Staff Engagement and Training	8
	EN 4	Sustainability Culture Assessment	3
Public Engagement Max. 25 points available	EN 5	Civic Engagement	8
	EN 6	Community Partnership	9
	EN 7	Continuing Education	3
	EN 8	Shared Facilities	2
	EN 14	Inter-Campus Collaboration	3
Operations(OP)			
Buildings & Grounds Max. 20 points available	OP 1	Building Design and Construction*	3
	OP 2	Building Operations and Maintenance	5
	OP 3	Water Use	7 or 6**
	OP 4	Ecologically Managed Grounds*	5
Energy & Climate Max. 26 points available	OP 5	Energy Use	10
	OP 6	Greenhouse Gas Emissions	16
Food & Dining Max. 10 points available	OP 7	Dining Service Procurement*	8
	OP 8	Food Recovery*	2
Procurement & Waste Max. 20 points available	OP 9	Sustainable Procurement System	7
	OP 10	Purchased Goods	4
	OP 11	Materials Management	4
	OP 12	Waste Generation and Recovery	5 or 4**
Transportation Max. 10 points available	OP 13	Vehicle Fleet*	2
	OP 14	Commute Modal Split	6
	OP 15	Air Travel*	2
Planning & Administration (PA)			
Coordination & Planning Max. 11 points available	PA 1	Sustainability Coordination	1
	PA 2	Commitments and Planning	6
	PA 3	Institutional Governance	4
Investment Max. 10 points available	PA 4	Sustainable Investment Program*	4
	PA 5	Investment Holdings*	6 or 3**
	PA 6	Institutional Climate	3

Social Equity Max. 14 points available	PA 7	Racial and Ethnic Diversity*	3
	PA 8	Gender Parity	2
	PA 9	Affordability and Access	3
	PA 10	Student Success	3
Wellbeing & Work Max. 11 points available	PA 11	Health, Safety and Wellbeing	3
	PA 12	Employee Rights	3
	PA 13	Pay Equity and Living Wage	5 or 4**
Innovation & Leadership (IL)			
Innovation & Leadership Max. 10 bonus points available	IL 1 to IL 69	Catalog of optional credits published separately and available on the stars website	1 each

Recognition and Scoring

STARS operates an official recognition system based on the overall number of points attained via completed credits. Institutions reporting a scored report obtain one of four possible ratings: Bronze (≥25 points), Silver (≥45 points), Gold (≥65 points), or Platinum (≥85 points). In addition, institutions can earn up to 10 bonus points in the Innovation & Leadership category for best practices that exceed the highest performance level or are new initiatives (AASHE, 2024). Institutions can also function as STARS Reporters, submitting unscored reports for transparency and benchmarking without requesting a rating. The rating is only valid for up to three years, although institutions are encouraged to resubmit annually to ensure their performance data remains current. The following Figure 2 illustrates the STARS recognition system, which classifies institutions into four rating levels based on total points earned, and includes additional provisions for innovation credits and unscored reporting status (AASHE, 2024).

Figure 2.STARS Recognition System: Rating Levels and Scoring Thresholds (AASHE,2024)

2.5.2. UI GreenMetric Ranking

The UI GreenMetric World University Rankings, created by Universitas Indonesia in 2010, provide an international framework to benchmark sustainability performance in higher education institutions worldwide. UI GreenMetric focuses more on a university's commitment to environmental responsibility and sustainable campus practices, Unlike traditional academic rankings. This initiative arose in response to growing demand for global sustainability indicators that universities could use for comparison.

According to UI GreenMetric (2024), the framework promotes institutional self-assessment and international collaboration by using standardized indicators covering Environment, Economy, and Equity. Participating universities complete an annual online questionnaire that requires evidence-based responses to generate scores across key operational and academic areas. Since its launch, the system has grown significantly, with 1,183 universities from 84 countries taking part in the 2023 edition. The rankings not only support strategic planning but also raise awareness and foster global discussions about sustainable development in higher education.

Criteria and Subcategories

The UI GreenMetric framework evaluates institutional performance through six main categories (see Table 2):

Table 2.Categories used in the rankings and their weighting (UI GreenMetric, 2024).

No	Category	Percentage of total Points (%)
1	Setting and Infrastructure (SI)	15
2	Energy and Climate Change (EC)	21
3	Waste (WS)	18
4	Water (WR)	10
5	Transportation (TR)	18
6	Education and Research (ED)	18
	Total	100

The 2024 framework includes 39 indicators spread across five categories with their respective specific indicators and sub-indicators. The Energy and Climate Change (21%) and Education and Research (18%) categories have the highest importance, followed by Setting and Infrastructure (15%), Waste (18%), Water (10%), and Transportation (18%). The scores depend on both quantitative data and supporting evidence that participating institutions submit. The evaluation system provides standardized benchmarking while considering the different regional contexts of institutions (UI GreenMetric, 2024; see Table 3).

Table 3.Indicators and categories suggested for use in the 2024 rankings (UI GreenMetric, 2024).

No	CRITERIA	Point	Weighting
1	**Setting and Infrastructure (SI)**		**15%**
SI1	The ratio of open space area to total area	200	
SI2	Total area on campus covered in forest vegetation	100	
SI3	Total area on campus covered in planted vegetation	200	
SI4	Total area on campus for water absorption besides the forest and plante vegetation	100	
SI5	The total open space area divided by total campus population	200	
SI6	Percentage of university budget for sustainability efforts	200	
SI7	Percentage of operation and maintenance activities of building in one year period	100	
SI8	Campus facilities for disabled, special needs and/or maternity care	100	
SI9	Security and safety facilities	100	
SI10	Health infrastructure facilities for students, academics and administrative staffs' well-being	100	
SI11	Conservation: plant (flora), animal (fauna), or wildlife, genetic resources for food and agriculture secured in either medium or long-term conservation facilities	100	

	Total	**1500**	
2	**Energy and Climate Change (EC)**		**21%**
EC1	Energy efficient appliances usage	200	
EC2	Smart building implementation	300	
EC3	Number of renewable energy sources on campus	300	
EC4	Total electricity usage divided by total campus population (kWh per person)	300	
EC5	The ratio of renewable energy production divided by total energy usage per year	200	
EC6	Elements of green building implementation as reflected in all construction and renovation policies	200	
EC7	Greenhouse gas emission reduction program	200	
EC8	Total carbon footprint divided by total campus population (metric tons per person)	200	
EC9	Number of innovative programs) in energy and climate change	100	
EC10	Impactful university programs) on climate change	100	
	Total	**2100**	
3	**Waste (WS)**		**18%**
WS1	3R (Reduce, Reuse, Recycle) program for university's waste	300	
WS2	Program to reduce the use of paper and plastic on campus	300	
WS3	Organic waste treatment	300	
WS4	Inorganic waste treatment	300	
WS5	Toxic waste treatment	300	
WS6	Sewage disposal	300	
	Total	**1800**	
4	**Water (WR)**		**10%**
WR1	Water conservation program & implementations	200*	
WR2	Water recycling program implementation	200	
WR3	Water efficient appliances usage	200	
WR4	Consumption of treated water	200	
WR5	Water pollution control in the campus area	200	
	Total	**1000**	
5	**Transportation(TR)**		**10%**
TR1	The total number of vehicles (cars and motorcycles) divided by total campus' population	200	
TR2	Shuttle services	300	
TR3	Zero Emission Vehicles (ZEV) availability on campus	200	
TR4	The total number of Zero Emission Vehicles (ZEV) divided by total campus population	200	
TR5	Ratio of the ground parking area to the total campus area	200	

TR6	Program to limit or decrease the parking area on campus for the last 3 years (from 2021 to 2023)	200	
TR7	Number of initiatives to decrease private vehicles on campus	200	
TR8	The pedestrian path on campus	300	
	Total	**1800**	
6	**Education and Research (ED)**		**18%**
ED1	The ratio of sustainability courses to total courses/subjects	300	
ED2	The ratio of sustainability research funding to total research funding	200	
ED3	Number of scholarly publications on sustainability	200	
ED4	Number of events related to sustainability (environment)	200	
ED5	Number of activities organized by student organizations related to sustainability per year	200	
ED6	University-run sustainability website	200	
ED7	Sustainability report	100	
ED8	Number of cultural activities on campus (e.g.Cultural Festival)	100	
ED9	Number of university sustainability programs) with international collaborations	100	
ED10	Number of community services related to sustainability organized by university and involving students	100	
ED11	Number of sustainability-related startups	100	
	Total	**1800**	

2.6. Limitations of Existing Sustainability Tools

The existing sustainability assessment tools STARS and UI GreenMetric encounter widespread criticism because they fail to fully account for sustainability complexities across different institutional settings. Experts criticize these frameworks because they prioritize environmental data over social and governance metrics. The current indicators produce unbalanced results which create challenges when universities try to assess sustainability due to their varying goals and resource capacities and geographical restrictions.

According to Lauder and Sari (2015) developing country universities have failed to properly implement the STARS system. The STARS indicators were designed for institutions with abundant resources yet these indicators may not be suitable for universities with restricted technical capabilities and administrative capacities (Boiocchi et al., 2023). STARS evaluation system gives more significance to environmental performance than to social and economic sustainability aspects in sustainability assessments. The STARS assessment method deviates from sustainable development principles because it focuses exclusively on environmental performance without providing equal weight to equity governance and financial sustainability which higher education institutions require. STARS exists mainly for institutional self-assessment instead of serving as a comparison tool for different institutions. The framework does not support global benchmarking or ranking because it fails to establish proper comparisons between institutions (Boiocchi et al., 2023).

Based on researchers' observations during the implementation of the UI GreenMetric ranking system, which was designed for international sustainability benchmarking, there are multiple methodological challenges. According to Boiocchi et al. (2023) the energy diversity focus of the framework gives institutions located in areas with limited renewable energy access a disadvantage. The results of sustainability assessments depend on structural factors which include climate and existing infrastructure that universities cannot manage effectively. Data inflation occurs due to quantitative sustainability program numbers because the reported figures do not necessarily reflect real institutional performance effectiveness. The ranking criteria have evolved through time which makes it challenging to achieve consistent results between different evaluation years.

The research shows that STARS and UI GreenMetric contribute to the worldwide sustainable campus dialogue but need significant changes. STARS and UI GreenMetric should create indicators tailored to specific contexts and establish stronger data verification procedures to achieve equal evaluation of sustainability dimensions for improving their reliability and fairness in higher education sustainability assessments.

2.7. The Role of iiSBE's SNTool and SBTool in Campus Sustainability

The Sustainable Building Tool (SBTool) and Sustainable Neighbourhood Tool (SNTool) which belong to the international initiative for a Sustainable Built Environment (iiSBE) enable sustainability assessment at both building and neighborhood levels. The SBE Method serves as the foundation for these tools to use a hierarchical structure that includes issues, categories, criteria and indicators which enables performance assessment to reflect local conditions.

The tools allow university campuses to systematize building evaluations through their interactions with urban systems. The main purpose of SBTool is to evaluate building sustainability through assessments of energy consumption and environmental quality and occupant comfort. SNTool extends the analysis beyond buildings to study neighborhood aspects including mobility systems and land use patterns and climate resilience measures and governance frameworks. The two tools allow institutions to track sustainability challenges together with institutional opportunities at both physical and institutional levels.
SNTool and SBTool, developed by iiSBE, are flexible assessment tools designed to evaluate sustainability across multiple spatial levels These tools use the SBE Method structure to evaluate sustainability through issues, categories, criteria and indicators which enables comprehensive assessments and supports diverse contextual needs.

University campuses use these assessment tools to obtain an additional sustainability evaluation system which analyzes the complex relationships between constructed facilities and urban environments. The primary objective of SBTool focuses on conducting assessments at the building level which evaluates architectural assets through environmental and energy and comfort-based dimensions. The SNTool assessment system extends analysis to the urban or neighbourhood scale to evaluate essential sustainability factors which include mobility systems and land use patterns and climate resilience and governance structures that define campus sustainability profiles.

The assessment tools provide essential methodological standards which solve existing sustainability assessment deficiencies for higher education institutions. The two widely used frameworks STARS and UI GreenMetric provide benchmarking capabilities but they do not deliver the necessary technical detail and spatial differentiation and process-oriented evaluation elements needed for complete performance-based assessments. Through their strong localization features both SBTool and SNTool enable institutions to create assessment protocols which integrate global sustainability targets with site-specific priorities.

In this thesis, the SNTool and SBTool generic frameworks are used as base models to conduct sustainability assessments in university campuses. These tools provide strong analytical capabilities together with adaptability to evaluate the unique architectural features and operational procedures and governance systems found in higher education institutions.

The frameworks adapt to these unique characteristics to provide a more detailed and flexible method for assessing university campus sustainability.

Chapter 3: Campus Sustainability Assessment Tool

3.1. Research Methodology and Process

The section presents the procedures used to establish a standard sustainability assessment framework for university campuses. The proposed general framework draws from essential components and structural elements within international tools SBTool MED and SNTool MED which stem from the Sustainable Built Environment Method (SBE Method). These sustainability tools were selected for their structured organization while thoroughly evaluating environmental social and economic sustainability factors. This research focuses on extracting the hierarchical structure which includes issues and categories as well as criteria and indicators. A flexible generic framework will be developed to enable the creation of specific sustainability assessments for various campuses while maintaining uniformity between academic and geographical environments.

3.1.1. Overview of SBTool & SNTool

The SBTool MED and SNTool MED frameworks serve as sustainability generic tools which use the internationally validated Sustainable Built Environment Method (SBE Method) from the Green Building Challenge (GBC) research process under iiSBE international initiative for a Sustainable Built Environment. The two comprehensive assessment tools exist to handle sustainability complexities of buildings and neighborhoods in Mediterranean areas and other regions (Moro et al., 2023a; Moro et al., 2023b).

The SBTool MED framework specifically assesses building performance through environmental social and economic aspects. This tool serves both public authorities and private sector stakeholders by offering a structured decision-making process which enables sustainable design implementation and regulatory benchmarking support. The integrated dimensions of SBTool MED enable sustainable assessments that adapt to different building settings.

The logic behind SNTool MED expands to neighborhood level assessment which focuses on urban systems through their operational features as well as spatial elements and infrastructural aspects. The main purpose of this tool is to support municipalities when they evaluate and implement and monitor district-level sustainability policies (Moro et al., 2023b).

These evaluation tools share the same methodological structure which contains four hierarchical levels of issues, categories, criteria and indicators and perform three assessment phases of characterisation, normalisation and aggregation. The tools feature architectural designs that enable local modifications yet maintain international evaluation possibilities which follow the "think globally, act locally" principle (Moro et al., 2023a, 2023b). These tools achieve standardization which maintains context awareness to establish critical frameworks for sustainability strategy implementation across different urban and architectural scales.

3.1.2. Objective

In this section we present the strategy employed in creating an adaptable framework, for university campuses. This method is inspired by the frameworks of SBTool and SNTool which're recognized tools for evaluating sustainability in building and urban settings. The purpose of this work is not to create a tool for a particular site but to establish a basic framework which universities can modify to meet their needs in various locations. By taking this approach the project enables modifications that cater to the requirements of different organizations and local environments.

The chapter is divided into four related parts, for clarity and coherence purposes; In section 3 of the chapter focuses on examining tools and indicators used for assessing sustainability in the context of education institutions by looking at past methods and their limitations. Section 3 continues by explaining the structure of the SBE Method that serves as the foundation, for both SBTool and SNTool systems; it delves into its framework and operational phases. Furthermore; Section 4 details how the SBTool general framework was modified for evaluating sustainability at a campus building level by considering building types and performance metrics. In Section 3.6 of the analysis expands on this idea by looking at sustainability on a scale such, as within a neighborhood or campus using the SNTool framework which focuses on sustainability aspects and assessment frameworks applicable at that level of scale combined together forming a holistic approach for evaluating sustainability, within university settings.

3.2. Compilation of Sustainability Indicators

The methodology, for identifying and categorizing sustainability assessment tools and indicators for university campuses was built on the PRISMA framework by Page et al., 2021

in an transparent approach that integrated academic and non academic resources to establish a comprehensive and practical framework, for assessing campus sustainability effectively.
The academic study of academic literature drew from Scopus and Web of Science (WoS) databases by implementing structured database searches. The research query contained sustainability terms together with assessment words as well as framework and indicator and university campus. The search results produced a total of 388 peer-reviewed articles. The evaluation of 44 full-text articles followed the removal of duplicates and the screening of abstracts and keywords. The chosen research articles showed dual sustainability orientation in higher education infrastructure and European and worldwide applicability according to Torabi Moghadam et al. (2024).

The authors performed a deep examination of their selected sources to identify 442 indicators which were organized through the SNTool hierarchical system (iiSBE Italia, 2023). A total of 258 different indicators existed after removing duplicate entries. The indicators spanned across ten sustainability categories with "Energy" having 46 indicators and "Social Aspects" having 66 indicators and "Governance" having 29 indicators and other categories such as "Use of Land and Biodiversity," "Water," "Solid Waste," "Climate Change: Mitigation and Adaptation," and "Transportation and Mobility." Eight indicators could not be assigned to existing SNTool categories. The academic literature indicates that energy and social sustainability dominate as the principal fields according to Torabi Moghadam et al. (2024).

The desk research revealed 57 different tools which were analyzed from non-academic tools and standards and technical guidelines. The recognized instruments consisted of SNTool along with BREEAM-Communities and WELL Building Standard and STARS (AASHE) and UI GreenMetric and LEED-NB and GRI Standards and ISO 14001:2015 and Net Zero on Campus and EMAS. The authors picked 10 tools from the original list based on their thematic connection and documentation availability and practical implementation in higher education. The assessment of each tool included information about its rating approach between point-based and score-based and compliance-based systems and its range of application between building and neighborhood and campus levels and its thematic grouping. The indicator alignment process generated 434 unique indicators which matched the categories of SNTool (Torabi Moghadam et al., 2024).
The research methodology involved building a table to merge indicators which came from academic and non-academic sources. The table followed SNTool categories and

subcategories to facilitate the identification of sustainability indicators that apply to campus environments. The complete indicator table containing 651 entries is not included in this work although the final version presents indicators by theme after eliminating duplicates. The processed indicator list served as the foundation for developing the framework which this chapter presents. The complete list of original indicators can be found in the work by Torabi Moghadam et al. (2024).

3.3. SBE Method

The Sustainable Built Environment Method (SBE Method) serves as a complete analytical framework which evaluates built environment sustainability across various spatial ranges including single buildings and their neighborhoods and entire cities. The Green Building Challenge of 1998 introduced this method which iiSBE later developed into its current form through international testing across multiple case studies. The framework exists within multiple tools including SBTool and SNTool and SCTool (iiSBE Italia R&D, 2023). The framework bases its approach on the "think globally, act locally" principle to establish a unified direction which allows for local adjustments that support national policies and environmental conditions and strategic objectives.

With the aid of SBE Method, users are able to convert various sustainability data into a single unified performance score through its structured framework. The assessment process follows a four-step framework according to this method. The first step defines essential sustainability factors which encompass environmental and social and economic aspects. The second step of the process links criteria to measurable indicators which receive benchmark comparisons. The third step of normalisation standardizes indicator values to a -1 to +5 scale for scoring consistency. The final performance score is then obtained through an aggregation process that combines results from different categories.

3.3.1. Hierarchical Levels

The SBE Method enables sustainability evaluation through its four-tiered structure that begins with issues before moving to categories then criteria and ends with indicators. The evaluation framework based on layers provides standardized methods for sustainability assessment that work across various geographical areas and institutional settings which includes university campuses. The assessment system implements distinct functions at each level to achieve strategic alignment and practical measurability as explained by iiSBE Italia R&D (2023). The assessment process receives its overall direction from issues that represent broad thematic domains at the highest level. The strategic anchors known as issues show the global community's sustainability priorities which maintain alignment with environmental and social and governance agendas. The assessment process starts with issues at the highest level which serve as adaptable strategic anchors for building, neighbourhood and campus applications. The assessment process establishes these categories as its second tier which divides broad topics into smaller analysis areas. The categories organize campus spaces into teaching research and administration categories for simpler sustainability evaluation across diverse contexts. These categories enable general goals to relate directly to campus infrastructure design.

The third step of the SBE Method's criteria level sets performance targets for all categories. The criteria establish quantifiable targets which adjust to local situations to allow evaluators to convert broad targets into specific measurable objectives. Official standards and internal policies serve as the foundation for selecting indicators that use these criteria.

The evaluation process requires each indicator to connect with a specific criterion through which evaluators obtain necessary data. Quantitative indicators use energy consumption in kWh/m²/year measurements yet qualitative indicators use compliance score ratings. The selection of indicators depends on available data sources as well as contextual suitability. The hierarchical structure appears in Figure 3 as a visual representation.

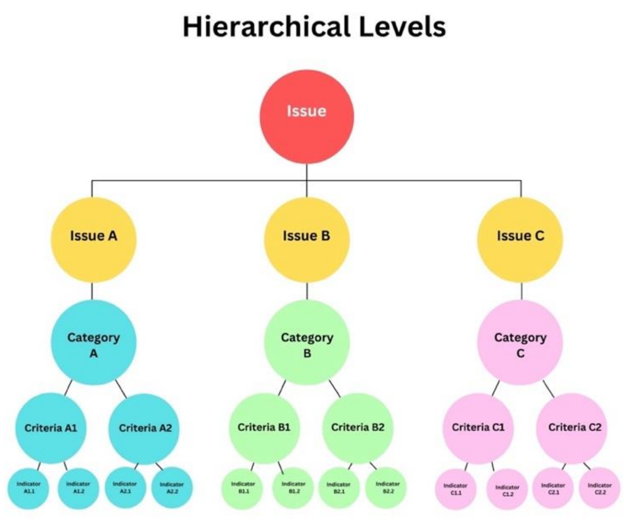


Figure 3.Hierarchical levels framework (iiSBE Italia R&D, 2023).

3.3.2. Assessment Procedure

The SBE Method performs its assessment in three seperate phases, which include Characterization, then Normalization, and Aggregation. These procedures work together to provide both a clear and measurable context-based assessment of sustainability performance (iiSBE Italia R&D, 2023).

Characterization

The assessment process begins with characterization which demands empirical measurement of indicator values using monitoring activity data and experimental measurements together with design documentation. The measurement of quantitative indicators such as energy consumption expressed in kilowatt-hours per square metre per year (kWh/m²/year) uses directly measurable parameters for their calculation. Structured reference scenarios and evaluation matrices assess qualitative indicators by converting complex or subjective phenomena into predefined evaluative scales. This phase ensures that each criterion is grounded in verifiable evidence and aligned with the methodological framework of the selected tool variant.

Normalization

This phase creates standardized performance scores from the quantitative or qualitative value of indicators. The transformation process enables standardized interpretation of various indicators and supports meaningful spatial and scale-based comparisons for individual buildings and districts, and university campus applications (iiSBE Italia R&D, 2023).

The assessment system uses a -1 to +5 score normalization which enables the measurement of performance results across the entire spectrum from very poor to excellent. The evaluation method shows which projects meet higher standards and which aspects need further improvement. The linear interpolation method enables the calculation of measurable indicator scores. The positioning system uses distance measurements between minimum and maximum benchmarks to enable consistent evaluation of different criteria. Two separate functions exist to interpret indicator values based on their performance ratings:

- The Higher Is Better (HIB) function applies when indicator values increase to produce better sustainability results. The normalization method works for indicators like green space per capita and share of renewable energy use because they need increasing functions to function properly.

- The Lower Is Better (LIB) function applies to indicators which show better performance through reduced values such as greenhouse gas emissions and potable water consumption and waste generation. These indicators use decreasing functions for normalization.

Two benchmark thresholds are established for each indicator in both models: The score 0 benchmark establishes the minimum performance level required by regulatory standards and institutional policies while the score 5 benchmark shows ideal performance through best practice benchmarks or aspirational goals.

The scoring of indicator values occurs through linear interpolation methods between the two established benchmarks. An indicator value that falls below the score 0 benchmark (in HIB criteria) or above it (in LIB criteria) results in a score of -1. The maximum score of +5 is awarded to values that exceed the score 5 benchmark (HIB) or fall below it (LIB).

For qualitative indicators, scores are set by comparing real-world conditions to a set of predefined scenarios. The scoring process depends on reference cases which present different performance levels until the actual situation matches one to receive a score between -1 and +5. This approach makes it possible to assess aspects that cannot be measured directly, such as how users experience a space or how governance systems function. At the same time, it ensures consistency with the broader scoring framework used for quantitative indicators.

The scoring scale is defined as follows (see Table 4):

Table 4.Scoring scale (iiSBE Italia R&D, 2023).

Score	**Interpretation**
–1	Performance is significantly below the minimum acceptable threshold.
0	Minimum acceptable performance; typically aligned with regulatory or standard limits.
1	Minor improvement beyond the baseline; indicative of incremental progress.
2	Moderate and measurable enhancement compared to minimum performance.
3	Alignment with established best practices in sustainability performance.
4	Advanced performance beyond best practices, showing substantial improvement.
5	Excellent or ideal performance; representative of exemplary or innovative outcomes.

This well structured normalisation framework makes a unique assessment scale for explanation different type of indicators. It supports transparency, reproducibility, and contextual sensitivity, forming the methodological basis for aggregating performance across categories and issues in the subsequent assessment stages.

Aggregation

The SBE Method concludes with aggregation which combines all normalized indicator scores into one unified sustainability score. The system operates at three levels of criteria, categories and issues to produce results that show both detailed information and hierarchical structure. The weighted formula operates at each level to enable the adjustment of final scores according to specific contextual priorities. The method enables standardized assessment while allowing users to set their own local priorities (iiSBE Italia R&D, 2023).

A. Aggregation Through Criteria

   At the most granular level, the normalized scores of individual criteria within a given category are aggregated to produce a composite category score. Each criterion is assigned a weight that reflects its relative importance within the category, typically determined based on impact assessments or expert consultation. The score of a category $S_{i,j}$ is thus calculated as the sum of the normalized scores of its criteria Si, j, k , each multiplied by its respective weight $w_{i,j,k}$:

$$S_{i,j} = \sum_{k=1}^{N_c^{(i,j)}} w_{i,j,kSi,j,k}$$

   Where:

   $S_{i,j}$: the score resulting from the aggregation of the criteria’s scores included in the category Ci,j

   Si, j, k : the score of the criterion ci,j,k in the category Ci,j

   $w_{i,j,k}$: the weight of the criterion ci,j,k in the category Ci,j

B. Aggregation Through Categories

   In the second phase, the category scores for a given issue are aggregated to produce an overall score. Each category is similarly assigned a weight $w_{i,j}$, established through a prioritization process considering contextual relevance and stakeholder-defined priorities. The resulting issue score S_i is computed as follows:

$$S_i = \sum_{j=1}^{N_c^{(i)}} w_{i,j} S\,i,j$$

Where :

$w_{i,j}$: the weight of each category included in issue Xi.

Si,j: the score of each category included in issue Xi;

S_i: the score resulting from aggregating the category's scores included in issue Xi.

C. Aggregation Through Issues

Finally, the issue scores are synthesized into a single overall sustainability score. This final output represents the global performance of the project or area under evaluation. The score is calculated as a weighted sum of the issue scores si , using issue-specific weights w_i derived from priority values that reflect local policy objectives, environmental sensitivity, and strategic emphasis:

$$\Sigma = \sum_{i=1}^{N_A} w_{i,si}$$

Where:

w_i: The weight of each issue is included in SBTool, SNTool, and SCTool

si: The score of each issue included in SBTool, SNTool, and SCTool

Visualization and Reporting

The SBE Method includes formalized visualization tools which serve as part of its results interpretation and transparent communication process. The graphical results through these tools display sustainability performance data of buildings and neighborhoods and cities in a format which supports decision-making and easy understanding.The assessment process utilizes four visualization tools to help interpret results as follows:

- The Spider Chart gives a quick overview of how each of the ten sustainability issues performs on a scale from 0 to 5.

- The Pie Chart demonstrates how each issue contributes to the final sustainability score based on weight. Moreover, helps users to figure out which priorities determine the final outcome.

- The Score Table shows individual assessment results together with their corresponding weights and overall score for each issue. It is enables users to evaluate assessment results between different evaluation periods.

- The use of Key Performance Indicators (KPIs) enables organizations to monitor their progress through a systematic framework. The SMC Passport format includes indicators which enable neighborhood comparisons and support policy alignment with sustainability targets at the local and national levels.

3.3.3. Contextualization

Contextualization is a key component of the SBE Method. It aims to tailor its generic frameworks, SBTool, SNTool, and SCTool, to local contexts' specific geographical, climatic, socio-economic, and regulatory conditions. Although methodologically standardized, the generic frameworks are designed to be adaptive and to respond to regional priorities and focused sustainability challenges. The ultimate goal of contextualization is to put in place an assessment system appropriately tailored locally that is scientifically based but more appropriate to enhance relevance and applicability at the building, neighborhood, and city levels (iiSBE Italia R&D, 2023).

The contextualization process occurs through three sequential steps: active criteria selection followed by benchmark establishment and finally weighting factor determination. The assessment of sustainability becomes scientifically based while remaining policy-aware and place-specific through three distinct steps.

Active Criteria Selection

Stakeholders identify appropriate criteria from the Generic Framework to be used in the local tool version during the initial contextualization phase. Stakeholders need to select a predefined set of Key Performance Indicators (KPIs) even though there is no fixed number of criteria that they must choose from. These KPIs represent core sustainability domains aligned with transnational goals and form the basis for each contextualized tool. The decision-making process should be justified in terms of contextual applicability (e.g., environmental hazards, economic concerns, cultural heritage, or urban morphology) and must be supported by relevant reasoning. Justification usually invokes existing policies, territorial development strategies, or local planning tools (iiSBE Italia R&D, 2023).

Benchmarking

The assessment process requires each selected criterion to receive a performance scale during its second step. The assessment tool uses two benchmark points to evaluate performance where the minimum acceptable outcome receives a score of 0 and the best possible outcome receives a score of 5. The benchmarks derive from official regulations and technical norms and scientific data. The assessment tool uses these defined thresholds to perform consistent comparisons between different cases while maintaining awareness of the local environment (iiSBE Italia R&D, 2023).

Weighting

The assessment hierarchy receives priority-based weights during the final contextualization phase which includes issues and categories and criteria. The weights show how important each sustainability dimension is to the local context. The weighting procedure requires assigning priority scores and calculating relative weights to produce a sustainability score which accurately represents local developmental goals and policy imperatives. The assessment process becomes balanced through this step because contextually important aspects receive increased influence on the final assessment result.

The SBE Method maintains its international scientific validity through these contextualization activities which produce sustainability assessments that are both locally actionable and policy-aligned for Mediterranean urban environments (iiSBE Italia R&D, 2023).

3.4. SBTool Campus

This section of the thesis presents the fundamental methodological steps for building the SBTool Campus generic framework.

3.4.1. Building Typologies and Functional Spaces

The development of a standard framework for university campuses begins by recognizing the various types of spaces which appear throughout campus environments. A classification system was created to organize spaces according to their operational functions and physical attributes.

The typology consists of ten main categories which include teaching areas together with laboratories and technical spaces and offices and outdoor environments (see Table 5). The actual campus space usage becomes visible through specific room types such as classrooms (AULA), didactic labs (LAB_DIDAT) and green or pedestrian zones (VERDE, PEDONALE).

The proposed organizational system enables direct relationships between built environments and sustainability performance metrics. The framework enables sustainability measurement through space-type connections to energy consumption and accessibility areas which accommodates diverse campus layouts. By using this approach, the uniformaty between different campuses can be easy even the building designs differ.

Table 5.Typological Classification of Campus Spaces: Categories, Abbreviations, and Functions.

Category	Abbreviation	Type of Space
A – Vertical Circulation	SCALA	Stair
	ASCENSORE	Elevator
B – Service Area	ARCHIVIO	Archive
	ATRIO	Atrium
	CAB_CONTR	Control Room
	CAB_ELETTR	Electrical Room
	CEN_CLIMA	Climate Center
	CEN_TELEF	Telephon Center
	CEN_TERM	Thermal Center
	CORRID	Corridor
	DEP_COMB	Fuel Storage
	DEP_GEN	Central Storage
	LOC_TECN	Technical Room
	MAGAZ	Warehouse
	RETE_SERV	Service Network
	RIPOSTIGL	Storage Room

	SPOGL	Changing Room
	WC	Toilets
C – Support Area	LOC_MULT	Multipurpose Room
	S_RIUN	Meeting Room
	S_RICREAZ	Recreation Room
	S_CONFEREN	Conference Room
D – Office	UFF_PE_EST	Personnel Office
	UFF_DOC	Faculty Office
	UFF_TEC_AM	Technical/Administrative Office
	UFF_PHD	PhD Office
	UFF_PUBB	Public Office
E – Teaching Area	AULA	Classroom
	AULA_INF	Computer Room
F – Laboratory	LAB_DIDAT	Teaching Laboratory
G – Study Area	BIBLIO	Library
	S_STUD	Study Room
H – Technical Support Area	SUPPOR_LAB	Laboratory Support
	SUPPOR_UFF	Office Support
I – Special Use	BAR	Bar
	CEN_STMAP	Press Center
	INFERM	Infirmary
	MENSA	Cafeteria
	POSTA	Post Office
M – Outdoor Area	AREA_TECNI	Technical Area
	ASCEN	Elevator
	COPERTURA	Roof
	CORTILE	Courtyard
	ISOLA_ECO	Ecological Area
	PARK_EST	Outdoor Parking
	PEDONALE	Pedestrian Area
	PORTICATO	Portico
	SOCALA_EST	Outdoor Social Area
	SIEPE_AIUO	Billboard Area
	STUD_EST	Outdoor Study Area
	TERRAZZO	Terrace
	VERDE	Green Area

	VIAB	Road Network

3.4.2. Thematic Areas: Issues and Categories of SBTool Campus

The initial coordinated activity of developing the SBTool Campus generic framework for university buildings involved identifying and selecting the most important issues and categories for the evaluation protocol. The goal was to create a thematic structure which would maintain both the methodological standards of the SBE Method and the particular operational characteristics of university campuses.

The interdisciplinary working group performed a focused validation process which drew from the theoretical framework of SBTool. The activity focused on transforming SBTool's theoretical sustainability concepts into a structure that aligns with university building architectural characteristics and operational and institutional needs.

The participatory process included a workshop with two essential tools which were a game board and semantic cards. The game board enabled participants to structure and visualize sustainability themes by placing issues on the Y-axis and Categories on the X-axis. The layout structure promoted team discussions and simplified the process of choosing elements for selection or modification or elimination. The activity maintained SBE Method compliance through its adherence to the recommended ten issues and maximum ten Categories per issue. The activity maintained SBE Method compliance through its adherence to the recommended structure which included ten issues together with up to ten Categories for each issue.

Additional structure came from semantic cards delivering common definitions and semantic explanations together with contextual information pertaining to each proposed theme. The cards maintained disciplinary consistency while improving stakeholder communication between professionals with different academic and professional backgrounds.

Group 2 which focused on the building scale consisted of experts from architecture, engineering, sustainability planning and university campus management fields. The team's combined knowledge base enabled a systematic and multi-disciplinary assessment of the proposed thematic framework. In table 6, the validated configuration is presented.

Table 6.Validated Thematic Structure for University Buildings: Issues and Corresponding Categories.

Issue	**Category**

A. SITE REGENERATION AND DEVELOPMENT, URBAN DESIGN AND INFRASTRUCTURE	A.1 Site Selection
	A.2 Site development
B. ENERGY AND RESOURCES CONSUMPTION	B.1 Energy
	B.2 Electrical peak demand
	B.3 Materials
	B.4 Use of potable water, stormwater and greywater
C. ENVIRONMENTAL LOADINGS	C.1 Greenhouse Gas Emissions
	C.2 Other Atmospheric Emissions
	C.3 Solid Wastes
D. INDOOR ENVIRONMENTAL QUALITY	D.1 Indoor Air Quality and Ventilation
	D.2 Air Temperature and Relative Humidity
	D.3 Daylighting and Illumination
	D.4 Noise and Acoustics
	D.5 Noise and Acoustics
E. SERVICE QUALITY	E.1 Controllability
	E.2 Optimization and Maintenance of Operating Performance
F. SOCIAL, CULTURAL AND PERCEPTUAL ASPECTS	F.1 Social Aspects
	F.2 Perceptual
G. COST AND ECONOMIC ASPECTS	G.1 Cost and Economics
H. ADAPTATION TO CLIMATE CHANGE	H.1 Climatic action: increase of temperature
	H.2 Climatic action: pluvial flood
	H.3 Climatic action:fluvial and coastal flood
	H.4 Climatic action: drought
	H.5 Climatic action: fire exposure
	H.6 Climatic action: wind action

3.4.3. Criteria and Indicators of SBTool Campus

Following the validation of issues and categories presented in the previous section, the evaluation process proceeded to select specific criteria at the building scale. This stage was designed to ensure that the hierarchical structure, defined according to the SBTool framework, would be fully operationalized through measurable and contextually appropriate criteria.

To carry out this task, the interdisciplinary team, already subdivided into thematic working groups, was assigned to assess and validate the criteria associated with each of the previously confirmed issues and categories. These working groups comprised academic experts and institutional professionals from iiSBE Italia, SAIL, PROGES, DENERG, DIST, and DAD, each contributing domain-specific expertise to support a comprehensive and technically grounded evaluation process. Each group received a dedicated Excel-based questionnaire tailored to a specific issue. These questionnaires provided a structured format for evaluating each proposed criterion's relevance, applicability, and measurability within the context of university buildings. The format included the following fields: issue, related categories, accepted criteria, rejected criteria, accepted with modifications (including detailed recommendations), proposed Indicator, and proposed unit of measure. This structured format ensured transparency in decision-making and facilitated consistent documentation across thematic groups. Notably, identifying indicators associated with each selected criterion drew upon the outcomes of Activity 3.2. Compilation of Sustainability Indicators, which had previously consolidated a dataset of 651 distinct indicators and their corresponding units of measure. These pre-existing resources were systematically consulted to ensure that each criterion was supported by an appropriate and context-sensitive indicator and its standardised evaluation unit.

Participants were asked to engage in critical discussions and collaborative analyses, guided by the objective of identifying criteria that would be scientifically robust and practically implementable. Discussions focused on aligning the criteria with regulatory frameworks, ensuring reliable data availability, and determining each criterion's adaptability to various spatial configurations and building typologies within the university setting. Each working group was assigned to one of the nine thematic issues validated in the previous phase (see Table7):

Table 7. Assignment of Thematic Working Groups by Issue and Affiliated Institutions (Building Scale).

Building Scale Issue	**Group**	**Members**
Site Regeneration	DAD	Antonio De Rossi, Carlo Deregibus, Sara Manganelli

Indoor Environmental Quality	DENERG	Sara Viazzo, Cristina Becchio, Enrico Fabrizio
Adaptation to Climate Change	DENERG	Sara Viazzo, Cristina Becchio, Enrico Fabrizio
Water	PROGES	Gregorio Cangialosi, Concetta Di Napoli
Materials	PROGES	Gregorio Cangialosi, Concetta Di Napoli
Energy	DENERG	Sara Viazzo, Cristina Becchio, Enrico Fabrizio, Mario Ravera; Enrico Borgo; Paola Biglia; Valentina Colaleo; Barbara Spataro
Service Quality	SAIL – Green Team	Giuseppina Emma Puglisi; Chiara Genta; Mario Ravera; Enrico Borgo; Paola Biglia; Valentina Colaleo; Barbara Spataro
Social, Cultural, and Perceptual Aspects	SAIL – Green Team	Giuseppina Emma Puglisi; Chiara Genta
Financial and Economic Aspects	DIST	Francesca Abastante, Beatrice Mecca

The final outcomes were classified into three categories which included accepted or rejected or required additional modification. The following table contains the review findings:

- The evaluation process accepted three criteria for climate change adaptation but rejected six others. The assessment of criteria for pluvial and fluvial flooding proved less relevant at the single-building scale and researchers suggested evaluating these criteria at the campus level.
- The energy category included five approved criteria together with one conditionally approved criterion and eight disapproved criteria. The elimination of one criterion

occurred because of functional differences while "Other Atmospheric Emissions" indicators lost all their indicators which revealed potential classification gaps.

- After reviewing Financial and Economic Aspects one criterion was accepted while four were rejected. The "Benefits" category continued to undergo evaluation because of its absence of measurable indicators and LCC criteria was presented as the consolidated possibility.
- The acceptance rate for Indoor Environmental Quality criteria reached fifteen but twenty criteria received rejection status. The operational phase required additional clarification regarding the application of these criteria. Acoustic insulation received treatment as a single flexible verification measure through aggregation.
- Materials criteria acceptance rate rose to twelve and rejection rate climbed to nine. The assessment process for Urban-scale Environmental Quality themes needed careful attention to scale coherence because of existing overlaps.
- Service Quality received acceptance for four criteria but one criterion received provisional rejection. The Smart Readiness Indicator needed additional clarification about its methodology.
- In Site Regeneration three criteria together with three more criteria were accepted and one criterion received rejection status. The original indicators designed for campus-level evaluation received validation for individual building implementation.
- The Social, Cultural, and Perceptual Aspects criteria received acceptance for three of them with no rejection. The researchers proposed additional clarification about the analytical unit that should be used (room, building, etc.).
- The Water criteria consisted of three accepted standards and one rejected standard. Two indicators which were first categorized under climate adaptation were suggested for reclassification as Water indicators for thematic alignment.

The building-scale validation process produced a set of criteria that matches the SBE Method through indicators and measurement units which maintain transparency and consistency. After the collaborative issues and categories definition and criteria and indicators validation process the group held a final integrative session to enhance thematic structure quality. The final phase of this process removed unimportant components while adding specific context-related aspects to improve the semantic quality of chosen terms. The collaborative effort produced a refined thematic structure which appears in Figure 4 to display the customized issues and categories structure for university buildings using the SBTool generic framework.

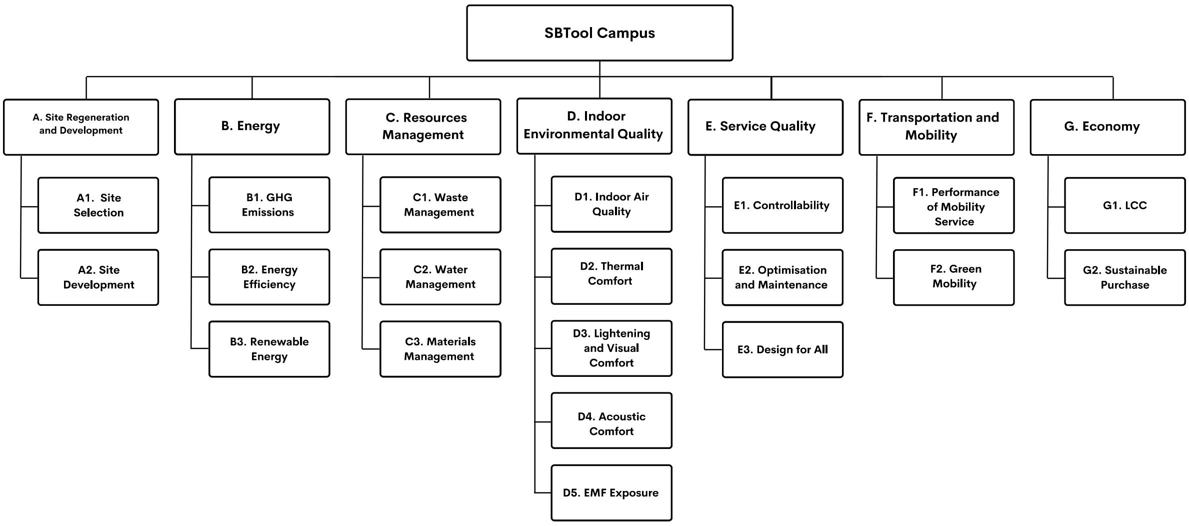


Figure 4.Final Validated Hierarchy of Issues and Categories for University Buildings (SBTool Campus).

The complete list of the criteria that constitute the SBTool Campus generic framework is presented below. The table 8 also includes, for each criterion, the corresponding indicator name and its associated unit of measure.

Table 8.SBTool Campus Criteria list.

A	**Site Regeneration and Development**		
A1	Site Selection		
CODE	CRITERION	INDICATOR	UNIT
A1.1	Ecological value of land	Pre-development ecological value of land	Index
A1.2	Adjacency to existing service infrastructures	Average distance between the site and key existing infrastructures	m
A1.3	Proximity to key services	Average distance from key services	m
A2	Site Development		
CODE	CRITERION	INDICATOR	UNIT
A2.1	Use of native plantings	The extent of vegetated landscaped area that is planted with native plants	%
A2.2	Provision of outdoor recreation areas	Number of recreation services offered in outdoor areas of the building	n
B	**Energy**		

B1	GHG Emissions		
CODE	CRITERION	INDICATOR	UNIT
B1.1	GHG gas emissions during operation	CO_2 equivalent emissions per useful internal floor area per year	Kg CO_2eq/m²/yr
B1.2	Life Cycle Global Warming Potential	CO_2 equivalent emissions per useful internal floor area for a period of 50 years	Kg CO_2eq/m²
B2	Energy Efficency		
CODE	CRITERION	INDICATOR	UNIT
B2.1	Primary Energy Consumption	Primary energy consumption per internal useful floor area per year	Kwh/m²/ yr
B2.2	Electrical Energy Consumption	Electrical energy consumption per internal useful floor area per year.	Kwh/m²/ yr
B2.3	Thermal energy consumption	Thermal energy consumption per internal useful floor area per year	Kwh/m²/ yr
B2.4	Heating need	Heat to be delivered to a conditioned space to maintain the intended temperature during a year	Kwh/m²/ yr
B2.5	Cooling need	Heat to be extracted from a conditioned space to maintain the intended temperature during a year	Kwh/m²/ yr
B3	Renewable Energy		
CODE	CRITERION	INDICATOR	UNIT
B3.1	Energy from renewable sources in total final energy consumption	Share of renewable energy in final energy consumptions.	%
C	**Resources and Environmental Loads Management**		
C1	Waste Management		
CODE	CRITERION	INDICATOR	UNIT
C1.1	Solid waste from building operations	Ratio of the number of collectable solid waste categories within a 100m distance from the building's entrance to the reference solid waste categories	%
C1.2	Construction waste	Weight of waste and materials generated per m² of internal useful floor area	Kg/m²
C2	Water Management		

CODE	CRITERION	INDICATOR	UNIT
C2.1	Potable water consumption for indoor uses	Potable water consumption per occupant per year	m^3/occupant/yr
C2.2	Capacity of rainwater collection and storage for non-potable uses	Share of rainwater collected and stored for reuse from roofs and plot's paved area	%
C2.3	Embodied water	Net fresh water per useful internal floor area	Kg/m^2
C2.4	Total water consumption	Total consumption of water per occupant per year	m^3/occupant/yr
C2.5	Capacity of greywater collection and storage for non-potable uses	Share of greywater collected and cleaned for reuse	%
C3	Materials Management		

CODE	CRITERION	INDICATOR	UNIT
C3.1	Renewable materials	Weight of renewable materials on total weigh of construction materials.	%
C3.2	Recycled materials	Weight of recycled materials on total weight of materials	%
C3.3	Design for deconstruction	Circularity potential.	Score
C3.4	Local materials	Weight of local materials on total weight of materials	%
C3.5	Design for adaptability	Adaptability potential	Score
C3.6	Materials Transparency	Number of materials or components with manufacturing certification	n
C3.7	Materials Optimization	Number of materials or components with certified enhanced chemical restrictions	n
D	**Indoor Environmental Quality**		
D1	Indoor Air Quality		

CODE	CRITERION	INDICATOR	UNIT
D1.1	TVOC concentration	TVOC concentration in indoor air	µg/m^3
D1.2	Mechanical Ventilation	Mechanical ventilation rate per useful internal floor area	l/s/m^2
D1.3	CO_2 concentrations	CO_2 concentration in indoor air	ppm
D1.4	Low emitting materials	Mean emission class of finishing materials	Index
D1.5	Radon	Radon concentration in indoor air	Bq/m^3
D1.6	Pollution infiltration management	Number of design features implemented for reducing pollution infiltration	Score
D1.7	Formaldehyde concentration	Formaldehyde concentration in indoor air	µg/m^3

D2	Thermal Comfort		
CODE	CRITERION	INDICATOR	UNIT
D2.1	Thermal comfort index	Predicted Percentage of Dissatisfied in cooling season	%
D2.2	Heat island effect	Mean Solar Reflectance Index of paved surfaces and roofs in the area	SRI
D2.3	Thermal Comfort Monitoring	Percentage of aggregated indoor useful floor area monitored for thermal comfort	%
D2.4	Humidity Control	Relative humidity maintained between 30–60% for at least 98% of operating hours, either through mechanical control or validated modeling.	RH%
D3	Lighting and Visual Comfort		
CODE	CRITERION	INDICATOR	UNIT
D3.1	Daylight	Mean Daylight Factor	%
D3.2	Daylight Provision	Level of daylight provision	level
D3.3	Protection from Glare	DGP (Daylight Glare Probability)	n
D3.4	High-Quality Electric Lighting Performance	Compliance with short-term flicker severity and color rendering thresholds for indoor electric lighting systems.	Pst_{LM} / CRI or TM-30 R_f/R_g
D4	Acoustic Comfort		
CODE	CRITERION	INDICATOR	UNIT
D4.1	Protection from noise: facade insulation	D2m,nT,w - Weighted standardized level difference for traffic noise (sound insulation)	dB
D4.2	Maximum noise levels	Percentage of area over noise limit (in respect to noise generated within the campus)	%
D4.3	Sound reducing surfaces	Percentage of indoor surface covered by sound-absorbing materials	%
D4.4	Protection from airborne noise within adjacent spaces	R'w - Weighted apparent sound reduction index	dB
D4.5	Protection from the sound of impacts within adjacent spaces	L'n,w - Weighted normalized impact sound pressure level	dB
D4.6	Protection from noise generated by service equipment	LAeq,nT - A-weighted standardized continuous sound pressure level	dB
D4.7	Reverberation time	T - Reverberation time	%

D5	EMF Exposure		
CODE	CRITERION	INDICATOR	UNIT
D5.1	Level of ELF magnetic fields	Mean level of magnetic induction (50/60 Hz)	µt
D5.2	Level of High Frequency Electromagnetic Fields	Mean level of electric filed (100 kHz-3GHz)	V/m
E	**Service Quality**		
E1	Controllability		
CODE	CRITERION	INDICATOR	UNIT
E1.1	Effectiveness of facility management control system	Percentage of control functions within class A	%
E1.2	Smart Readiness Indicator	Total smart readiness of buildings for responding to the needs of occupants, optimizing energy performance, and interacting with energy grids	%
E2	Optimization and Maintenance		
CODE	CRITERION	INDICATOR	UNIT
E2.1	Existence and implementation of a maintenance management plan	The availability of a comprehensive and long-term plan at the end of Design phase, and evidence of its implementation during Operations phase	Score
E2.2	On-going monitoring and verification of performance	The provision of energy sub-metering systems and water consumption monitoring systems, according to design documentation	Score
E2.3	Retention of as-built documentation	The scope and quality of design documentation retained for use by building operators, according to design documentation	Score
E3	Design for All		
CODE	CRITERION	INDICATOR	UNIT
E3.1	Universal access on site and within the building	The scope and quality of design measures planned to facilitate access and use of building facilities by persons with disabilities	Score
F	**Transportation and Mobility**		
F1	Performance of Mobility Services		

CODE	CRITERION	INDICATOR	UNIT
F1.1	Proximity of site to public transportation	Accessibility index	index
F1.2	Electric-vehicle infrastructure (charging stations)	Electric vehicle's charging stations per occupant	N/occupant
F2	Green Mobility		

CODE	CRITERION	INDICATOR	UNIT
F2.1	Support for Bicycle Use	Percentage of bicycle parking spaces available per total parking spaces	%
G	**Economy**		

G1	LCC		

CODE	CRITERION	INDICATOR	UNIT
G1.1	Life-cycle cost	Life cycle cost (production and construction, operation, maintenance, and end of life) per useful internal floor area per year	€/m2/yr
G1.2	Documenting Sustainable Building Cost Impacts	Documentation of historical (last 5 years or duration of use) and ongoing operational costs and financial impacts for campus buildings	Qualitative scale (0–3–5)
G2	Sustainable Purchase		

CODE	CRITERION	INDICATOR	UNIT
G2.1	Sustainable Purchasing – Facility Alteration and Addiction	Presence and scope of a sustainable purchasing program for building renovation and construction materials, based on compliance with defined sustainability criteria (e.g., recycled content, low-VOC, certified wood, local sourcing)	Qualitative scale (0–3–5)
G2.2	Sustainable Purchasing – Furniture	Presence and extent of a sustainable purchasing program for durable goods and furniture, based on adherence to sustainability criteria (e.g., recycled content, renewable materials, certified wood, local sourcing)	Qualitative scale (0–3–5)
G2.3	Sustainable Purchasing – Electric Power Equipment	Presence and extent of a sustainable purchasing program for electric equipment, based on conformity to defined sustainability criteria (e.g., ENERGY STAR®, gas-free	Qualitative scale (0–3–5)

		models, certified environmental equivalence)	
G2.4	Sustainable Purchasing - Ongoing consumable	The indicator evaluates whether the institution has a sustainable purchasing program for regularly used consumables (e.g., paper, toner, batteries). Purchases are considered sustainable if they meet criteria such as recycled content, local sourcing, FSC certification, or rechargeability.	Qualitative scale (0–3–5)

3.4.4. Detailed Criteria Desciption by Issue – SBTool Campus

The following section contains detailed thematic profiles for all issues within the SBTool Campus generic framework. The profiles present categories and criteria with defined criterion intent and performance indicators and unit of measure and assessment methodology summaries. The profiles enable practical application of the generic framework through indicator connections to university building performance areas (see Figure 5 to 11).

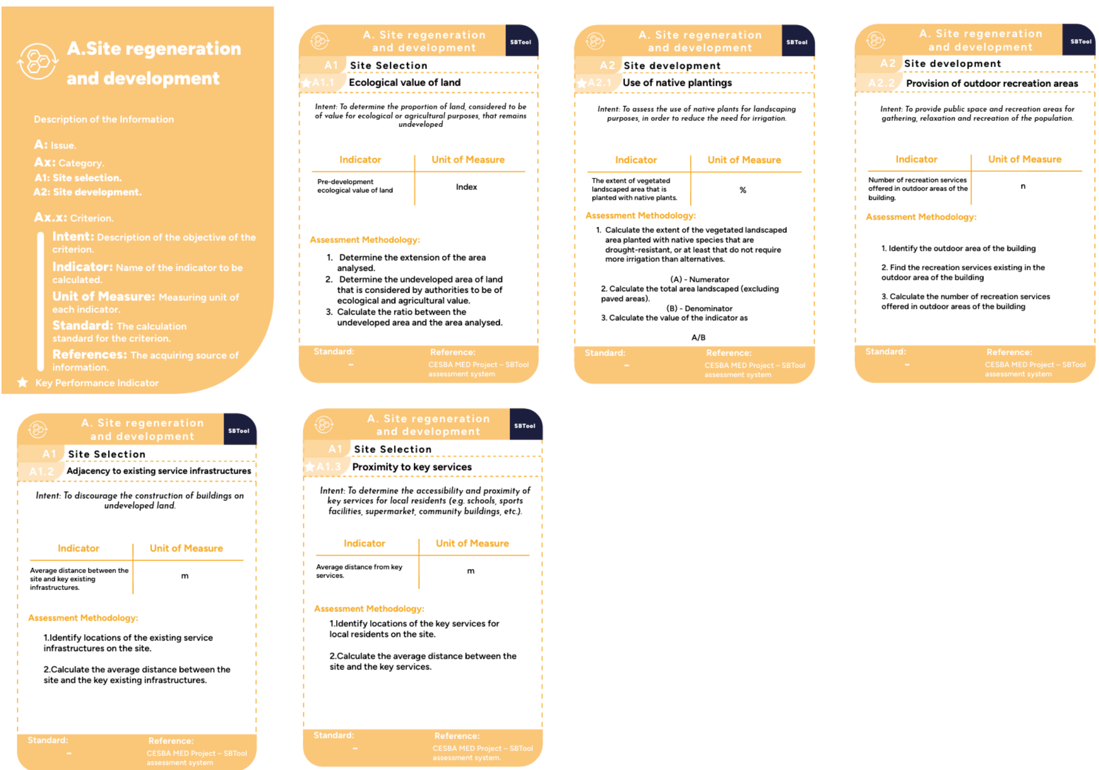


Figure 5.Thematic Profile – A. Site Regeneration and Development (SBTool Campus).

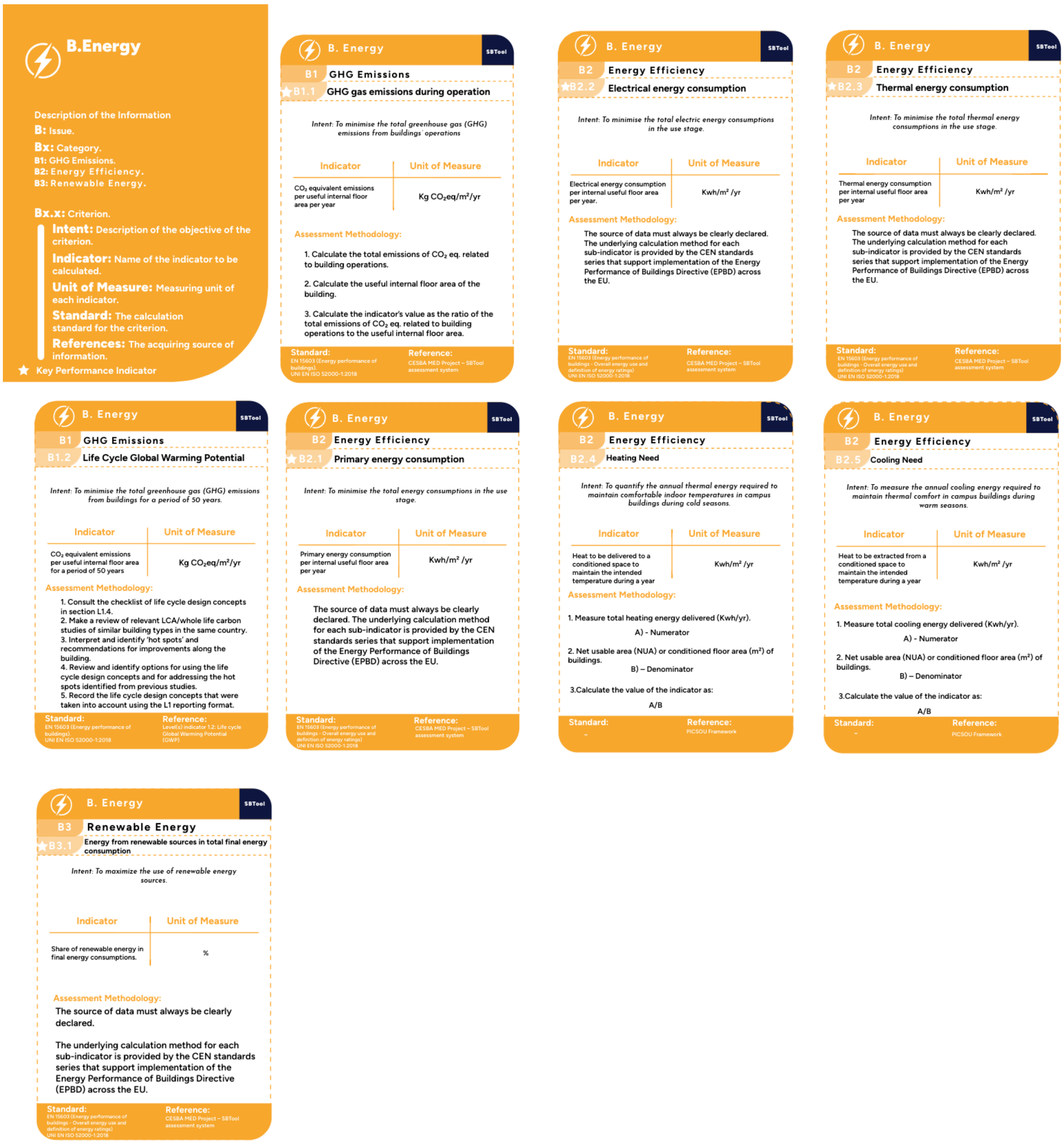


Figure 6.Thematic Profile – B. Energy (SBTool Campus).

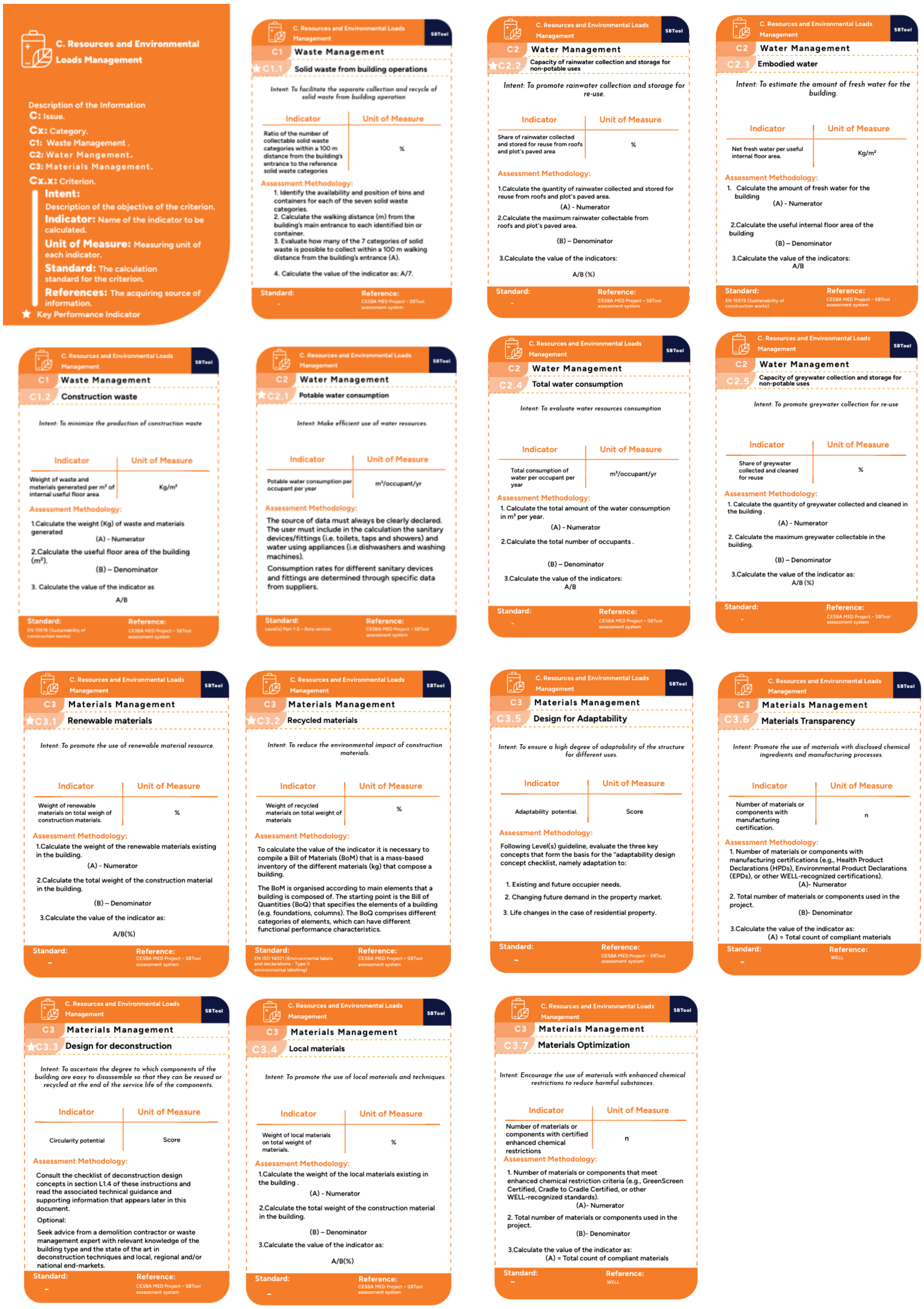


Figure 7.Thematic Profile – C. Resources Management (SBTool Campus).

D.Indoor Environmental Quality

Description of the Information

D: Issue.

Dx: Category.
D1: Indoor Air Quality.
D2: Thermal Comfort.
D3: Lighting And Visual Comfort.
D4: Acoustic comfort.
D5: EMF Exposure.

Dx.x: Criterion.

- **Intent:** Description of the objective of the criterion.
- **Indicator:** Name of the indicator to be calculated.
- **Unit of Measure:** Measuring unit of each indicator.
- **Standard:** The calculation standard for the criterion.
- **References:** The acquiring source of information.

★ Key Performance Indicator

D.Indoor Environmental Quality — SBTool

D1 Indoor Air Quality

★D1.1 TVOC concentration

Intent: To facilitate the assessment of indoor air quality.

Indicator	Unit of Measure
TVOC concentration in indoor air	$\mu g/m^3$

Assessment Methodology:

The indicator value for the building is then calculated as a weighted average of the corresponding measurements. For each pollutant measured, is to be checked the quantitative increase of the indoor air value in relation to the external air value. The instruments to be utilised for the measurement may vary in relation to what pollutant is necessary to assess, in most cases VOCs detectors are used, located on tripod at a height of 1.5 metres. It is recommended to perform the measurement for a period sufficient to establish the TVOCs concentration level trend (not less than a week)

Standard: EN 16516: Assessment of release of dangerous substances.Determi-nation of emissions into indoor air.

Reference: CESBA MED Project – SBTool assessment system

D.Indoor Environmental Quality — SBTool

D1 Indoor Air Quality

D1.4 Low emitting materials

Intent: To evaluate the emission class of finishing materials, promoting low emitting material

Indicator	Unit of Measure
Mean emission class of finishing materials.	Index

Assessment Methodology:

1. Calculate the extension (m^2) of the internal finishing materials of the building, identifying each of them.

2. For each finishing material identified, check its class of emission and the related index.

3. Make a weighted average for each finishing material, as described in the formula below:

$$Z_m = \frac{\sum(Zpj\ x\ Spj)}{\sum S_{pj}}$$

Standard: UNI EN ISO 16000-9:2006
UNI EN ISO 16000-10:2006
UNI EN ISO 16000-11:2006

Reference: CESBA MED Project – SBTool assessment system

D.Indoor Environmental Quality — SBTool

D1 Indoor Air Quality

D1.5 Radon

Intent: To reduce radon concentration in indoor air

Indicator	Unit of Measure
Radon concentration in indoor air	Bq/m^3

Assessment Methodology:

The measurement of the radon concentration must be performed in all the main rooms with full occupancy of the building, using a dosimeter that must be located:
1. At a height from the floor of about 1,5 m possibly hanging on the walls;
2. Away from windows and doors;
3. Away from heat sources and direct light;
4. Not inside cabinets or drawers.

Measurement duration can vary from 1 month up to 6 months.

Standard: Level(s) (the European framework for sustainable buildings)

Reference: -

D.Indoor Environmental Quality — SBTool

D1 Indoor Air Quality

★D1.2 Mechanical Ventilation

Intent: To assess indoor thermal comfort conditions in relation to the mechanical ventilation rate

Indicator	Unit of Measure
Mechanical ventilation rate per useful internal floor area	$l/s/m^2$

Assessment Methodology:

The standard defines three different methods for the assessment of the air quality.
Method 1: based on perceived air quality.
Method 2: based on the use of limit values for the concentration of pollutants.
Method 3: based on pre-defined ventilation flow rates.
In term of accuracy of the final result, method 1 is the one to be preferred and the calculation metho-dology is described in short below.
The ventilation rate is calculated by combining the share of ventilation to dilute and/or remove pollutants produced by occupants with the share of ventilation to dilute and/or remove pollutants produced by buildings (materials, components, etc.) and by the installations.

Standard: EN 16798-1: 2019
EN 12599: 2012
CEN/TR 16798-2

Reference: CESBA MED Project – SBTool assessment system

D.Indoor Environmental Quality — SBTool

D1 Indoor Air Quality

D1.3 CO^2 concentrations

Intent: To assess the predicted or actual carbon dioxide concentrations in typical primary occupancy areas.

Indicator	Unit of Measure
CO^2 concentration in indoor air.	ppm

Assessment Methodology:

The measurement of the CO^2 concentration must be performed in all the main rooms with full occupancy of the building, measuring at the same time the CO^2 concentration in indoor air and the CO^2 concentration in outdoor air.

The measurement is performed using carbon dioxide detectors.

Standard: EN 16798: 2019 Energy performance of buildings - Ventilation for buildings.

Reference: CESBA MED Project – SBTool assessment system

D.Indoor Environmental Quality — SBTool

D1 Indoor Air Quality

D1.6 Pollution infiltration management

Intent: To Minimize the infiltration of outdoor pollutants into the building.

Indicator	Unit of Measure
Number of design features implemented for reducing pollution infiltration	Score

Assessment Methodology:

1.Number of design features implemented (e.g., air filters, vestibules, pressurization systems).

(A) - Numerator

2.Total number of applicable design features recommended by WELL.

(B)-Denominator

Standard: -

Reference: WELL

D.Indoor Environmental Quality — SBTool

D1 Indoor Air Quality

D1.7 Formaldehyde concentration

Intent: To assess the risk of occupants being exposed to hazardous levels of mold spores

Indicator	Unit of Measure
Formaldehyde concentration in indoor air	$\mu g/m^3$

Assessment Methodology:

The measures must be performed within the longer permanence rooms and in the main areas of the building. At least 3 measures must be performed in the selected rooms, for a minimum duration of 30 minutes.

To properly conduct the measurement, the absorbing material tester for formaldehyde is located on a tripod, at a height of 1.5 metres. To assess the level of formaldehyde concentration, it must be evaluated the average concentration based on the sum of the individual measurements carried out.

Standard: EN 16516: Assessment of release of dangerous substances.Determi-nation of emissions into indoor air.

Reference: CESBA MED Project – SBTool assessment system

D.Indoor Environmental Quality — SBTool

D2 Thermal Comfort

★D2.1 Thermal comfort index

Intent: To facilitate the assessment of indoor thermal comfort conditions during the cooling season.

Indicator	Unit of Measure
Predicted Percentage of Dissatisfied in cooling season	%

Assessment Methodology:

The indicator can be calculated both at the design and at the in use stage, calculation steps are the following:

a) Estimate or Measure PMV
b) Calculate PPD

Calculations are performed in all spaces with characteristic functions of the building (e.g. office spaces, meeting room, cafeteria), different orientations (e.g. on the side of a façade facing the street), and floors (e.g. first, middle and last floor). Calculations are also performed in spaces where the most extreme values of the thermal parameters are observed or anticipated (e.g. occupied areas near windows, diffuser outlets, corners, entries). The indicator value for the building is then calculated as a weighted average of the corresponding values.

Standard: EN ISO 7730, EN 16798-1:2017
Reference: CESBA MED Project – SBTool assessment system

D.Indoor Environmental Quality — SBTool

D2 Thermal Comfort

★D2,2 Heat island effect

Intent: To reduce the heat island effect, to reduce the discomfort at ground level during summer

Indicator	Unit of Measure
Mean Solar Reflectance Index of paved surfaces and roofs in the area	SRI

Assessment Methodology:

1. Identify the boundaries of the building being assessed.
2. Identify all the horizontal surfaces and roofs in the area.
3. Calculate the extension (m²) of each surface identified and classify them in relation to the cover material.
4. Multiply each surface previously identified by the corresponding solar reflectance index.
5. Sum the weighed surfaces obtained.
6. Calculate the weighted value of the index for the building as the ratio of the sum of products to the total area of all horizontal surfaces and roofs.

Standard: -
Reference: CESBA MED Project – SBTool assessment system

D.Indoor Environmental Quality — SBTool

D3 Lighting And Visual Comfort

★D3.1 Daylight

Intent: To ensure an adequate level of daylighting in all primary occupied spaces

Indicator	Unit of Measure
Mean Daylight Factor	%

Assessment Methodology:

The daylight provision is calculated in new buildings and under major renovation buildings accordingly to EN 17037. Paragraph 5.1.3 fully describes the two possible calculation methods:
Method 1) Calculation method using daylight factors on the reference plane.
1. Identify the grid of points on the plane
2. Predict the daylight factors across the plane
3. Calculate the target daylight factor DT and DTM
4. Ensure that the daylight factors equal or exceed the target values (DTM and DT).

Standard: CEN European Daylight Standard EN 17037
Reference: CESBA MED Project – SBTool assessment system

D.Indoor Environmental Quality — SBTool

D3 Lighting And Visual Comfort

★D3.2 Daylight Provision

Intent: To evaluate if the level of daylight provision is sufficient to carry out the task

Indicator	Unit of Measure
Level of daylight provision	Level

Assessment Methodology:

Following what stated in EN 17037 (Section 5 Assessment of Daylight in Interior Spaces):

Calculate the level of daylight provision necessary to perform the task, also taking into account:
1. External obstruction.
2. Glazing transmittance.
3. Thickness of walls and roofs.
4. Internal partition and surface reflectance.

Standard: CEN European Daylight Standard EN 17037 – Daylighting in buildings
Reference: CESBA MED Project – SBTool assessment system

D.Indoor Environmental Quality — SBTool

D2 Thermal Comfort

D2.3 Thermal comfort Monitoring

Intent: Monitor thermal conditions to ensure occupant comfort.

Indicator	Unit of Measure
Percentage of aggregated indoor useful floor area monitored for thermal comfort	%

Assessment Methodology:

1.Floor area (in m² or ft²) monitored for thermal comfort (e.g., via sensors or manual measurements).

(A) - Numerator

2.Total indoor surface area (in m² or ft²).

(B)-Denominator

3.Calculate the value of the indicator as:

A/B(%)

Standard: -
Reference: WELL

D.Indoor Environmental Quality — SBTool

D2 Thermal Comfort

D2.4 Humidity Control

Intent: Maintain appropriate humidity levels for occupant comfort and health.

Indicator	Unit of Measure
Relative humidity maintained between 30–60% for at least 98% of operating hours, either through mechanical control or validated modeling.	RH%

Assessment Methodology:

Option1. Provide technical documents.

Option2:

1.Total functioning hours where relative humidity is within the recommended range (e.g., 30-60% RH).

(A) - Numerator

2.Total indoor surface area (in m² or ft²).

(B)-Denominator

3.Calculate the value of the indicator as: A/B(%)

Standard: -
Reference: WELL

D.Indoor Environmental Quality — SBTool

D3 Lighting And Visual Comfort

D3.3 Protection from Glare

Intent: To ensure that glare conditions are minimized in main occupancy areas during periods of maximum exterior brightness, through the use of exterior or interior shading

Indicator	Unit of Measure
DGP (Daylight Glare Probability)	n

Assessment Methodology:

Following what stated in EN 17037 (Section 5.4 Assessment of Daylight in Interior Spaces):

Glare shall be measured by the contrast between window areas and adjacent wall areas, as seen from the interior.

Standard: CEN European Daylight Standard EN 17037 – Daylighting in buildings
Reference: CESBA MED Project – SBTool assessment system

D.Indoor Environmental Quality — SBTool

D3 Lighting And Visual Comfort

D3.4 High-Quality Electric Lighting Performance

Intent: To ensure visual comfort and occupant health by minimizing light source flicker and promoting accurate color rendering, in alignment with best-practice lighting standards.

Indicator	Unit of Measure
Short term flicker severity value	Pst_{LM} / CRI or TM-30 R_f/R_g

Assessment Methodology:

1.Flicker Assessment:
- Measure the short-term flicker severity (Pst_{LM}) using a flicker meter as per IEC TR 61547-1.
- Lighting must demonstrate Pst_{LM} ≤ 1.0 across all regularly occupied spaces.

2.Color Rendering Assessment:
- Verify light source performance using:
- CRI ≥ 90, or
- TM-30 metrics: R_f ≥ 78 and R_g between 95 and 105.

Standard: -
Reference: WELL

D.Indoor Environmental Quality — SBTool

D4 Acoustic Comfort

★D4.1 Protection from noise: façade insulation

Intent: Ensure that noise attenuation through the wall facing the noisiest site boundary is adequate to provide interior noise levels that will not interfere with normal tasks

Indicator	Unit of Measure
D2m,nT,w - Weighted standardized level difference for traffic noise	dB

Assessment Methodology:

Evaluate the protection from noise coming from the outside using the calculation method described in EN 12354-3.

It is necessary to be aware of the design aspects and the related factors that influence the incorporation of design features and material selection to address acoustic performance. Each aspect informs what is required to ensure that the right decisions are made at concept design stage and in order to achieve better outcomes at later stages.

Standard: Level(s) indicator 4.4: Acoustics and protection against noise
Reference: EN 12354-3

D.Indoor Environmental Quality — SBTool

D4 Acoustic comfort

D4.2 Maximum noise levels

Intent: Ensure noise levels within the building do not exceed recommended thresholds.

Indicator	Unit of Measure
Percentage of area over noise limit (in respect to noise generated within the campus)	%

Assessment Methodology:

1.Total floor area (in m² or ft²) where noise levels exceed the recommended limit (e.g., > 35 dB for quiet spaces).

(A) - Numerator

2.Total indoor floor area (in m² or ft²).

(B)-Denominator

3.Calculate the value of the indicator as:

A/B(%)

Standard: -
Reference: WELL

D.Indoor Environmental Quality — SBTool

D4 Acoustics Comfort

D4.5 Protection from the sound of impacts within adjacent spaces

Intent: To ensure that measures have been taken to reduce noise impacts between all tenancies and occupancy types

Indicator	Unit of Measure
L'n,w - Weighted normalized impact sound pressure level	dB

Assessment Methodology:

Following what stated in Level(s):
- Evaluate the protection from the sound of impacts within adjacent spaces or on an adjacent floor or wall following the EN 12354-2.

It is necessary to be aware of the design aspects and the related factors that influence the incorporation of design features and material selection to address acoustic performance. Each aspect informs what is required to ensure that the right decisions are made at concept design stage and in order to achieve better outcomes at later stages.

Standard: Level(s) indicator 4.4: Acoustics and protection against noise
Reference: EN 12354-2

D.Indoor Environmental Quality — SBTool

D4 Acoustics Comfort

D4.6 Protection from noise generated by service equipment

Intent: To ensure that measures have been taken to reduce noise impacts generated by service equipment

Indicator	Unit of Measure
LAeq,nT - A-weighted standardized continuous sound pressure level	dB

Assessment Methodology:

Following what stated in Level(s):
- Evaluate the protection from noise generated by service equipment following the EN 12354-5.

It is necessary to be aware of the design aspects and the related factors that influence the incorporation of design features and material selection to address acoustic performance. Each aspect informs what is required to ensure that the right decisions are made at concept design stage and in order to achieve better outcomes at later stages.

Standard: Level(s) indicator 4.4: Acoustics and protection against noise
Reference: EN 12354-5

D.Indoor Environmental Quality — SBTool

D4 Acoustic comfort

D4.3 Sound reducing surfaces

Intent: Increase the use of sound-absorbing materials to improve acoustic comfort.

Indicator	Unit of Measure
Percentage of indoor surface covered by sound-absorbing materials	%

Assessment Methodology:

1.Total surface area (in m² or ft²) covered by sound-absorbing materials (e.g., acoustic panels, carpets, ceiling tiles).

(A) - Numerator

2.Total indoor surface area (in m² or ft²).

(B)-Denominator

3.Calculate the value of the indicator as:

A/B(%)

Standard: -
Reference: WELL

D.Indoor Environmental Quality — SBTool

D4 Acoustics Comfort

D4.4 Protection from airborne noise within adjacent spaces

Intent: To ensure that measures have been taken to reduce airborne noise impacts between all tenancies and occupancy types

Indicator	Unit of Measure
R'w - Weighted apparent sound reduction index	dB

Assessment Methodology:

Following what stated in Level(s):
- Evaluate the protection from airborne noise within adjacent rooms and spaces or buildings following the EN 12354-1.

It is necessary to be aware of the design aspects and the related factors that influence the incorporation of design features and material selection to address acoustic performance. Each aspect informs what is required to ensure that the right decisions are made at concept design stage and in order to achieve better outcomes at later stages.

Standard: Level(s) indicator 4.4: Acoustics and protection against noise
Reference: EN 12354-1

D.Indoor Environmental Quality — SBTool

D4 Acoustics Comfort

D4.7 Reverberation time

Intent: To evaluate the time required for the sound in a room to decay over a specific dynamic range when a source is suddenly interrupted

Indicator	Unit of Measure
T - Reverberation time	%

Assessment Methodology:

Calculate the time required for the sound pressure level in a room to decrease by 60dB after the sound source has stopped.

It is necessary to be aware of the design aspects and the related factors that influence the incorporation of design features and material selection to address acoustic performance. Each aspect informs what is required to ensure that the right decisions are made at concept design stage and in order to achieve better outcomes at later stages

Standard: Level(s) indicator 4.4: Acoustics and protection against noise
Reference: EN 12354-6

D.Indoor Environmental Quality — SBTool

D5 EMF Exposure

D5.1 Level of ELF magnetic fields

Intent: To minimise the exposure to the ELF magnetic fields

Indicator	Unit of Measure
Mean level of magnetic induction (50/60 Hz)	μt

Assessment Methodology:

1. Check for the presence and location of industrial frequency magnetic field sources inside or in the immediate proximity of the building
2. Measure the level of magnetic induction in all the main rooms adjacent to internal sources of industrial frequency magnetic field and in those close to external sources of industrial frequency magnetic field.

Exposure Level	Impact
> 2 μT in one or more rooms	-10
> 1 μT in one or more rooms	-5
< 1 μT in one or more rooms	0
< 0.5 μT in one or more rooms	+5
< 0.2 μT in one or more rooms	+10

Standard: -
Reference: CESBA MED Project – SBTool assessment system

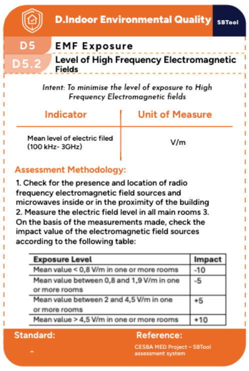


Figure 8.Thematic Profile – D. Indoor Environmental Quality (SBTool Campus).

Figure 9.Thematic Profile – E. Service Quality (SBTool Campus).

Figure 10.Thematic Profile – F. Transportation and Mobility (SBTool Campus).

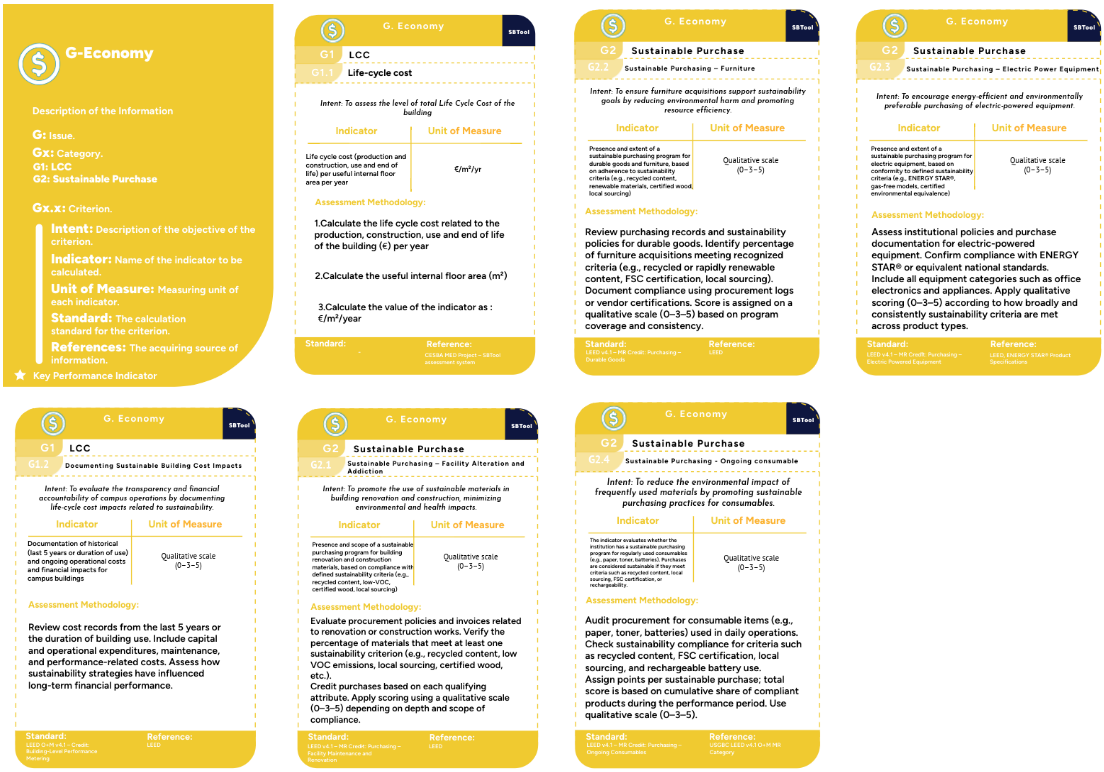


Figure 11.Thematic Profile – G. Economy (SBTool Campus).

3.5. SNTool Campus

3.5.1. Thematic Areas: issues and categories of SNTool Campus

The first coordinated activity of the SNTool Campus generic framework development for university campuses at the urban scale involved identifying and selecting the most appropriate issues and categories for assessment methodology. The goal was to preserve the SBE Method's methodological structure through a thematic framework which represents the spatial complexities and interdisciplinary relationships and functional systems found in campus environments.

The objective received support from two participatory tools which included the game board and semantic cards. The game board functioned as a collaborative platform which placed issues vertically on the Y-axis and Categories horizontally on the X-axis.The interactive format directed expert discussions about which elements to include or refine or exclude. The semantic card provided shared definitions and conceptual clarifications for each proposed element to establish terminological coherence and interdisciplinary understanding.
Group 1 consisted of twelve experts who represented different fields such as sustainable urban planning and energy systems and governance and social impact assessment.
The group developed a thematic structure for university campuses via their participatory sessions. The generic framework includes of twelve core issues and fifty-nine categories (see Table 9).

Table 9.Validated Thematic Structure for University Campuses: Issues and Corresponding Categories (SNTool Campus Framework)

Issue	Category
A. USE OF LAND AND BIODIVERSITY	A.1 Use of Land
	A.2 Green Urban Areas
	A.3 Biodiversity and ecosystems
B. ENERGY	B1. Energy infrastructure
	B.2 Energy consumptions
	B.3 Renewable energy

C. WATER	C.1 Water Infrastructure
	C.2 Water consumption
	C.3 Effluents management
D. SOLID Waste	D.1 Solid waste collection infrastructure
	D.2 Solid waste management
E. ENVIRONMENTAL QUALITY	E.1 Air quality
	E.2 Noise
	E.3 EMF exposure
	E.4 Environmental impacts
	E.5 Lighting and Visual Comfort
	E.6 Materials
	E.7 Thermal comfort
F. TRANSPORTATION AND MOBILITY	F.1 Performance of mobility service
	F.2 Green mobility
	F.3 Safety in mobility
	F.4 Urban morphology and transportation
G. SOCIAL ASPECTS	G.1 Accessibility
	G.2 Housing
	G.3 Availability of public and private facilities and services
	G.4 Education
	G.5 Social inclusion
	G.6 Safety
	G.7 Health
	G.8 Food security
	G.9 Cultural Heritage
	G.10 Perceptual
	G.11 Anti-Corruption
	G.12 Impacts on Society
H. ECONOMY	H.1 Economic Performance
	H.2 Employment
	H.3 Innovation
	H.4 ICT infrastructure
I. CLIMATE CHANGE: MITIGATION AND ADAPTATION	I.1 Climate change mitigation
	I.2 Adaptation to the climate action: heatwaves and increase of temperature
	I.3 Adaptation to the climatic action: pluvial flood

	I.4 Adaptation to the climatic action: fluvial and coastal flood
	I.5 Adaptation to the climatic action: drought
	I.6 Adaptation to the climatic hazard: wildfire
	I.7 Adaptation to the climatic hazard: Wind
J. GOVERNANCE	J.1 Urban planning
	J.2 Management and community involvement
	J.3 Public buildings cooperation
K. PRODUCT RESPONSIBILITY	K.1 Product Responsability
	K.2 Product and service labeling
	K.3 Marketing Communications
	K.4 Customer Privacy
	K.5 Compliance
L. HUMAN RIGHTS	L.1 Freedom of association and collective bargaining
	L.2 Child Labor
	L.3 Forced or Compulsory Labor
	L.4 Security Practices
	L.5 Indigenous rights
	L.6 Human Rights Assessment

3.5.2. Criteria and Indicators of SNTool Campus

The evaluation process included a verification step for campus (urban) scale issues and categories which participants completed after validation. The assessment procedure required a transformation of the general hierarchical framework into operational evaluation tools for assessing academic urban space spatial and functional characteristics.

The SNTool Campus generic framework received validation criteria from experts who worked together in interdisciplinary groups under thematic domain leadership at iiSBE Italia DENERG DAD PROGES SAIL and DIST. Experts worked together in structured Excel questionnaires to address one of the eight validated issues each. The assessment templates enabled systematic evaluation across multiple fields which included issue and related categories and accepted criteria and rejected criteria and accepted with modifications (with explanatory notes) and proposed indicator and proposed unit of measure. The format created standardized documentation procedures which allowed for straightforward decision-making methods.

Each criterion received its indicators through the indicator selection process which relied on Activity 3.2. Compilation of Sustainability Indicators results to access a consolidated database containing 651 unique indicators with measurement units. The assessment framework maintained internal coherence through the process and maintained its empirical robustness. The participants held analytical discussions to determine how each criterion matched regulatory practices alongside data availability and implementation possibilities. The thematic issue groups had to create an improved set of criteria that would measure sustainability performance at the campus level.The group composition is detailed below (see Table 10):

Table 10. Assignment of Thematic Working Groups by Issue and Affiliated Institutions (Campus Scale – SNTool Framework)

Campus Scale Issue	Group	Members
Environmental Quality	DENERG	Sara Viazzo, Cristina Becchio, Enrico Fabrizio
Transportation and Mobility	DAD	Antonio De Rossi, Carlo Deregibus, Sara Manganelli
Climate Adaptation	DAD	Antonio De Rossi, Carlo Deregibus, Sara Manganelli
Waste and Water	PROGES	Gregorio Cangialosi, Concetta Di Napoli
Climate Mitigation	DENERG	Sara Viazzo, Cristina Becchio, Enrico Fabrizio
Social Aspects	SAIL-GREEN TEAM	Mario Ravera, Enrico Borgo, Paola Biglia, Valentina Colaleo, Barbara Spataro, Giuseppina Emma Puglisi, Chiara Genta
Economic Performance	DIST	Francesca Abastante, Beatrice Mecca
Governance	DIST	Francesca Abastante, Beatrice Mecca

The final evaluation process generated three categories of proposed criteria that included accepted, rejected and needed refinement.rejected and needed refinement. The evaluation process revealed fundamental needs for adjusting assessment methods to match campus-level evaluation requirements. The outcomes of this workshop activity are represented below:

- For the Climate Adaptation category, twenty-five criteria were accepted and one criterion was proposed and thirty-five others were rejected.

- The climate mitigation criteria accepted six criteria with four new ones but rejecting eighty different criteria. The “Energy Infrastructure” subcategory failed to receive any selected criteria because it demonstrated weak suitability for the context. New criteria were introduced to address the methodological gaps which were identified in the assessment process.
- For Economic Performance, the members accepted thirty-seven criteria but rejected seventy-three criteria.
- In Environmental Quality accepted ten criteria with three proposed additional criteria but rejected thirty-eight others. Most of the eliminated criteria functioned best at the building scale. The indicators for air quality underwent integration into a single criterion to achieve coherence.
- The assessment accepted twenty-three criteria from Governance but rejected twenty-six other criteria, but did not include criteria under the “Anti-corruption” subcategory because institutional governance complexity and sustainability assessment visibility at the urban level made these criteria hard to assess.
- Twenty-eight criteria were accepted but hundred twenty-five were rejected in the Social Aspects category.
- The Transportation and Mobility section accepted nineteen criteria with one extra addition yet rejected twenty-one others. The group examined how cyclists could move through the campus grounds. The importance of developing integrated intermodal transport strategies became a main focus of discussion.
- Nine criteria were accepted from the Waste and Water category but thirty-three criteria were rejected. The remaining indicators after rejecting some granular or unsuitable measures for urban assessment showed current operational difficulties in water reuse and waste separation and circular economy strategies at the campus level.

The university campus framework developed through this process features validated criteria which match the urban context with defined measurement units for each criterion. The framework maintains SBE Method consistency through its indicator-based performance evaluation system which ensures transparent assessment results.

The issues and categories development through collaborative work led to a subsequent evaluation of related criteria and indicators before a thematic structure synthesis session was conducted. The generic framework is illustrated in Figure 12.

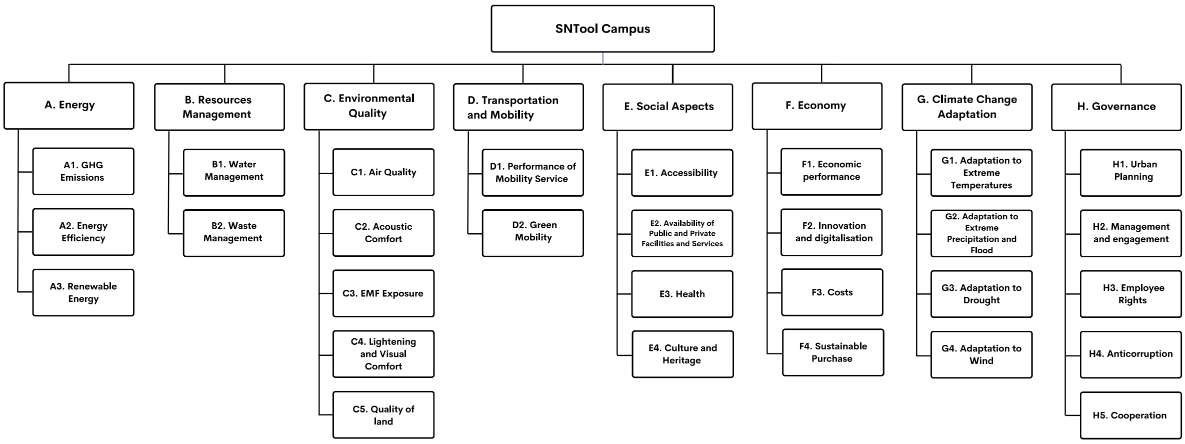


Figure 12. Final Validated Hierarchy of Issues and Categories for University Campuses (SNTool Campus)

In Table 11, the complete list of SNTool Campus issues, categories, criteria, and indicators is presented.

Table 11.SNTool Campus Criteria list

A	**Energy**		
A1	GHG Emissions		
CODE	CRITERION	INDICATOR	UNIT
A1.1	Greenhouse gas emissions	Total amount of greenhouse gases (equivalent carbon dioxide units) generated from building operations over a calendar year per user	t CO_2eq /user/yr
A1.2	CO2 sequestration	Potential CO_2 sequestraion in the campus per square meter	Kg CO_2eq/m²
A1.3	Campus carbon footprint (In case the calculation is already provided by the university)	Total amount of greenhouse gases (equivalent carbon dioxide units) generated from building operations over a calendar year per campus surface	t CO_2eq /m²/yr
A1.4	CO2 compensation	Total amount of carbon credits verified against recognized national or international quality standards	t CO2eq /ha
A1.5	Life cycle global warming potential	Total CO_2equivalent emissions per useful internal floor area for a period of 50 years	Kg CO_2eq/m²/yr
A2	Energy Efficency		
CODE	CRITERION	INDICATOR	UNIT
A2.1	Total primary energy consumption for building operations	Ratio of average total primary energy consumption of public office/educational buildings to the local minimum value	%

A2.2	Energy consumption of public lighting	Total electricity consumption of public street lighting divided by the total distance of streets where street lights are present	Kwh/Km/yr
A2.3	Performance Measurement-Building Automation System	Number of automation systems funcioning on campus (heating/cooling/ventilation/lighting etc.)	Score
A2.4	Energy monitoring for final uses	Presence of monitoring systems fo energy final use	Score
A3	Renewable Energy		
CODE	CRITERION	INDICATOR	UNIT
A3.1	Share of renewable energy on-site, relative to total final energy consumption for building operations	Total consumption of energy generated from renewable sources on-site divided by total energy consumption	%
A3.2	Exported renewable energy ratio	Percentage of total renewable energy produced on-site and exported	%
A3.3	Energy management and exchange	Shared electricity (ARERA Resolution 318/2020): Minimum value, calculated on an hourly basis, between the electricity fed into the grid by renewable energy production systems and the electricity withdrawn through the connection points that are relevant for a group of self-consumers.	Kwh
B	**Resources Management**		
B1	Water management		
CODE	CRITERION	INDICATOR	UNIT
B1.2	Consumption of potable water in educational buildings	Potable water consumption per occupant per year	L/Occupants/yr
B1.3	Solar powered water desalinisation	Percentage of water acceptable for human consumption or agriculture from solar desalination	%
B1.4	Efficiency in water use	Volume of water supplied minus the volume of utilized water divided by the total volume of water supplied	%
B1.5	Drinking Water Quality	Number of chemical thresholds met in drinking water	Score
B1.6	Drinking Water Promotion	Percentage of inhabitants with access within 30m to drinking water dispensers	%
B2	Waste management		
CODE	CRITERION	INDICATOR	UNIT
B2.1	Access to solid waste and recycling collection points	Percentage of the population that is located more than 50 meters from the waste collection points, compared to the main entrances of the buildings	%
B2.2	Construction and demolition waste management	Number of strategies for construction and demolition waste management	Score

C	Environmental Quality		
C1	Air Quality		
CODE	CRITERION	INDICATOR	UNIT
C1.1	Fine particulate matter ($PM_{2.5}$) concentration	Number of days within a year that $PM_{2.5}$ concentration exceeds the daily limit	days / yr
C1.2	Particulate matter (PM_{10}) concentration	Number of days within a year that PM_{10} concentration exceeds the daily limit	days / yr
C1.3	Nitrogen Dioxide concentration (NO_2)	Number of days within a year that NO_2 concentration exceeds the daily limit	µg/m³
C1.4	Sulfur Dioxide concentration (SO_2)	Number of days within a year that SO_2 concentration exceeds the daily limit	µg/m³
C1.5	Ozone concentration (O_3)	Number of days within a year thatO_3 concentration exceeds the daily limit	µg/m³
C1.6	Air Quality Monitoring and Awareness	Presence of air quality monitoring systems	Score
C2	Acoustic Comfort		
CODE	CRITERION	INDICATOR	UNIT
C2.1	Ambient daytime noise conditions	Percentage of building area over noise limit	%
C3	EMF Exposure		
CODE	CRITERION	INDICATOR	UNIT
C3.1	Exposure to ELF magnetic fields	Percentage of buildings in the area located not respecting the safety distance from high voltage lines	%
C4	Lighting and Visual Comfort		
CODE	CRITERION	INDICATOR	UNIT
C4.1	Design of external lighting	Indice Parametrizzato di Efficienza degli Impianti di illuminazione IPEI*	W/lx/ m²
C4.2	Degree of atmospheric light pollution caused by exterior public lighting systems	Percentage of lighting fixtures with upward luminous emission coefficient equal to 0%	%
C5	Quality of Land		
CODE	CRITERION	INDICATOR	UNIT
C5.1	Conservation of land	Pre-developed ecological value of land	Score
C5.2	Biodiversity in green zones	Dominance Index	Index
D	Transportation and Mobility		
D1	Performance of Mobility Services		
CODE	CRITERION	INDICATOR	UNIT
D1.1	Proximity of the campus to public transportation	Accessibility index	Index

D1.2	Campus fleet	Number of vehicles from campus fleet per employee	N/employee
D1.3	Intra-campus mobililty	Lenght of public transportation paths compared to the minimum path between the sites	Index
D2	Green Mobility		
CODE	CRITERION	INDICATOR	UNIT
D2.1	Bicycle network	Lenght of bicycle paths divided by the minimum path between the sites	n
D2.2	Pedestrian infrastructure	Percentage of the campus area designated as a pedestrian/car free zone	%
D2.3	Availability of bicycle parking facilities	Percentage of bicycle parking spaces (square meters) available per total parking spaces (square meters)	%
D2.4	Electric-vehicle infrastructure (charging stations)	Electric vehicle's charging stations per occupant	N/occupant
E	**Service Quality**		
E1	Accessibility		
CODE	CRITERION	INDICATOR	UNIT
E1.1	Sidewalks and other pedestrian paths that are accessible for use by physically disabled persons	Percent of sidewalks and other pedestrian ways that are accessible for use by physically disabled persons	%
E1.2	Barrier-free accessibility in local outdoor public areas	Adequacy of barrier-free accessible public outdoor areas compared to the total public area	%
E2	Availability of Public and Private Facilities and Services		
CODE	CRITERION	INDICATOR	UNIT
E2.1	Availability and proximity of key services	Number of key services accessible within 800 meters walking distance from the campus	Score (0–5)
E3	Health		
CODE	CRITERION	INDICATOR	UNIT
E3.1	Restorative Spaces	Availability of indoor or outdoor restorative spaces	Score
E4	Culture and Heritage		
CODE	CRITERION	INDICATOR	UNIT
E4.1	Historical buildings reused	Percentage of historical buildings reused with changing functions	%
F	**Economy**		
F1	Economic Performance		
CODE	CRITERION	INDICATOR	UNIT
F1.1	Financial implications and other risks and opportunities due to climate change	Financial implications and other risks and opportunities due to climate change	€

F1.2	Financial assistance recieved by the government	Financial assistance recieved by the government divided by total fundings	%
F1.3	Infrastructure investments and services supported	Extent to which infrastructure investments and supported services provide long-term benefits to stakeholders and the wider economy	Qualitative scale (0–1–3–5)
F1.4	Significant indirect economic impacts	Indirect economic impacts (GRI)	Qualitative scale (0–5)
F2	Innovation and Digitalisation		
CODE	CRITERION	INDICATOR	UNIT
F2.1	Sustainable Investment Program	The indicator observes investments that consider ESG or sustainability assessment	Qualitative scale (-1 – 4)
F2.2	Sustainability Course Inventory	The percentage of academic colleges that offer sustainability-related courses.	%
F2.3	Support for open access publishing	The indicator observes the support provided by the institution for open access research (e.g., transformative agreements).	Qualitative scale (0–3–5)
F2.4	Sustainability Projects Fund	The indicator assesses the extent to which the institution allocates funding to sustainability-related projects (e.g., research, architectural, and urban initiatives) relative to total project funding	Qualitative scale (0–3–5)
F2.5	Sustainability-Equity Coordination	The indicator assesses the presence of campus-based entities dedicated to sustainability and/or to Diversity, Equity, and Inclusion (DEI).	Qualitative scale (0–3–5)
F2.6	Student-Managed Sustainable Investment Fund	Percentage of sustainability funds managed by students	%
F2.7	Sustainable Retirement Plan	The indicator assesses the existence of an employee retirement plan with a focus on sustainability.	Qualitative scale (0–3–5)
F2.8	Fixed Broadband Subscriptions	Percentage of classrooms equipped with fixed (wired) broadband.	%
F2.9	Wireless Broadband Coverage	Percentage of the campus area covered by wireless broadband (3G, 4G, 5G). The indicator evaluates access to digital and technological connectivity.	%
F2.10	Availability of WIFI in Public Areas	Number of public WIFI hotspots on campus per 1,000 inhabitants.	No/1,000 inhabitants
F3	Costs		
CODE	CRITERION	INDICATOR	UNIT
F3.1	Investment cost	Total amount of expenditure incurred for the construction and realization of the campus.	€
F3.2	Maintenance cost	Total amount of expenditure incurred for maintenance interventions on campus buildings and outdoor areas.	€
F3.3	Operation cost	Total operational expenditure necessary for the functioning of the campus, including utilities, maintenance, staff salaries, supplies, food, and equipment.	€

CODE	CRITERION	INDICATOR	UNIT
F3.4	Replacement cost	Estimated current cost required to replace a given asset within the campus.	€
F3.5	Payback period	Estimated time required to recover the initial investment through expected revenues from campus facilities and services.	Years
F4	Sustainable Purchase		
CODE	CRITERION	INDICATOR	UNIT
F4.1	Sustainable Purchaising - Food	The indicator assesses whether the institution has a sustainable purchasing program covering food and beverage items.	Qualitative scale (0–3–5)
G	**Climate change adaptation**		
G1	Adaptation to Extreme Temperatures		
CODE	CRITERION	INDICATOR	UNIT
G1.1	Thermal Comfort Monitoring	Physiologal Equivalent Temperature (PET)	°C
G1.2	Heath island effect	Ratio between the area of surfaces capable of reducing the heat island effect and the total area of the intervention lot (external surfaces related to the property + roof)	%
G1.3	Area on campus covered by vegetation (including planted vegetation and trees)	Percentage of campus area covered by vegetation compare to total campus green areas	%
G2	Adaptation to Extreme Precipitation and Flood		
CODE	CRITERION	INDICATOR	UNIT
G2.1	Permeability of land	Percentage of weighted ground permeability	%
G2.2	Protection of vulnerable zones	Share of accessible Land in vulnerable areas protected by flooding barriers compared to total extension of campus area	%
G2.3	Population exposed to flood risk	Percentage of the occupants exposed to flood risk (Number of occupants exposed to flood risk compare to total number of occupants)	%
G3	Adaptation to Drought		
CODE	CRITERION	INDICATOR	UNIT
G3.1	Rainwater management	Share of rainwater collected from paved (non permeable) surfaces and buildings	%
G3.2	Use of climate compatible plantings	The extent of vegetated landscaped area that is planted with climate compatible plants compared to total landscaped area	%
G4	Adaptation to Wind		
CODE	CRITERION	INDICATOR	UNIT
G4.1	Windproof urban form	Strategies to minimize the impact of wind	Score

H	Governance		
H1	Urban Planning		
CODE	CRITERION	INDICATOR	UNIT
H1.1	Community involvement in urban planning activities	Percentage of occupants active in public urban planning	%
H1.2	Design review	Percentage of occupants consulted during masterplan design	%
H2	Management and Engagement		
CODE	CRITERION	INDICATOR	UNIT
H2.1	Environmental policy	Number of official initiatives for environmental protection	Qualitative scale (0-1)
H2.2	Competence, awareness, and communication	Percieved prioritization of climate change actions in campus by students	Qualitative scale (1-5)
H2.3	Internal audit	Actions developed by internal audit programme	Score
H2.4	Materials Management Recognition	Number of implemented surplus and reuse programs	Score
H2.5	Cleaning Products and Protocols	Number of implemented safe cleaning practices and protocols	Score
H2.6	Pest Management and Pesticide Use	Number of implemented pest management plans and actions based on Integrated Pest Management principles	Score
H2.7	Contact Reduction	Number of implemented contact reduction strategies	Score
H2.8	Participatory governance	Percentage of student seats in the university governing body per academic program	%
H3	Employee Rights		
CODE	CRITERION	INDICATOR	UNIT
H3.1	Paid maternity leave	Number of weeks of paid maternity leave	Number
H3.2	Eligibility for paid all-gender family/medical leave	Percentage of employees eligible for paid all-gender family/medical leave	%
H3.3	Employee rights protection	Published measures to protect employee rights	Score
H4	Anticorruption		
CODE	CRITERION	INDICATOR	UNIT
H4.1	Communication and training on anti-corruption policies and procedures	Percentage of member staff that received anti-corruption training	%
H5	Cooperation		
CODE	CRITERION	INDICATOR	UNIT
H5.1	Public Private Partership activated	Number of public-private partnership activated	Number
H5.2	Community Partnerships Inventory	Number of community partnership activated	Qualitative scale (0–1–3–5)

H5.3	Inter-Campus Collaboration	Number of inter-campus collaborations activated	Qualitative scale (0–1–3–5)

3.5.3. Detailed Criteria Description by Issue – SNTool Campus

This section introduces comprehensive thematic profiles for each issue within the SNTool Campus generic framework. Each profile methodically details the related categories and criteria, including clear definitions of each criterion's purpose, the relevant performance indicator, unit of measurement, and a concise overview of the assessment method. These structured profiles help implement the evaluation framework effectively, promoting transparency, consistency, and alignment with the SBE Method, while addressing the specific performance needs of university buildings (see Figures 13 to 20).

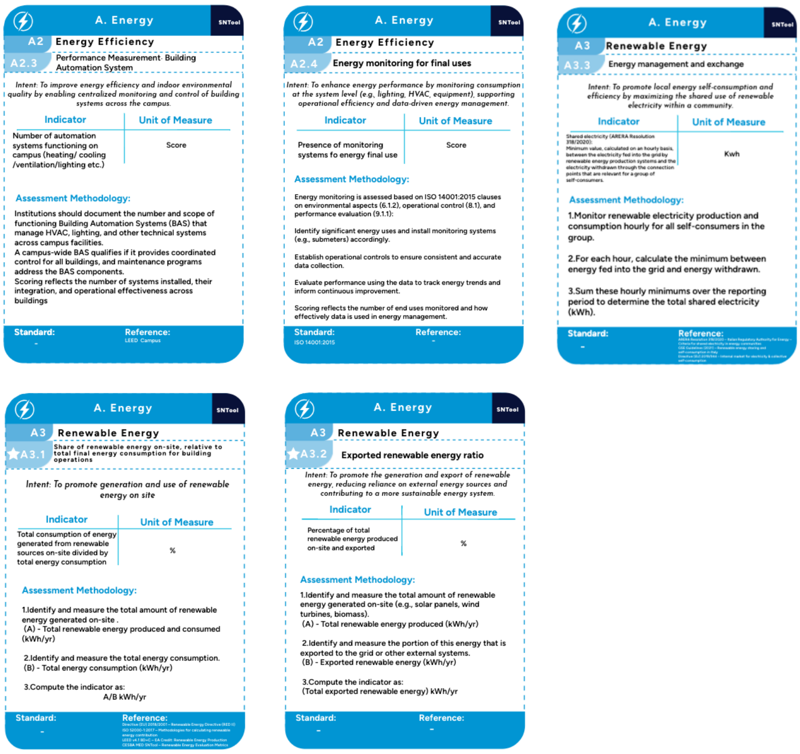


Figure 13.Thematic Profile – A. Energy (SNTool Campus – Urban Scale)

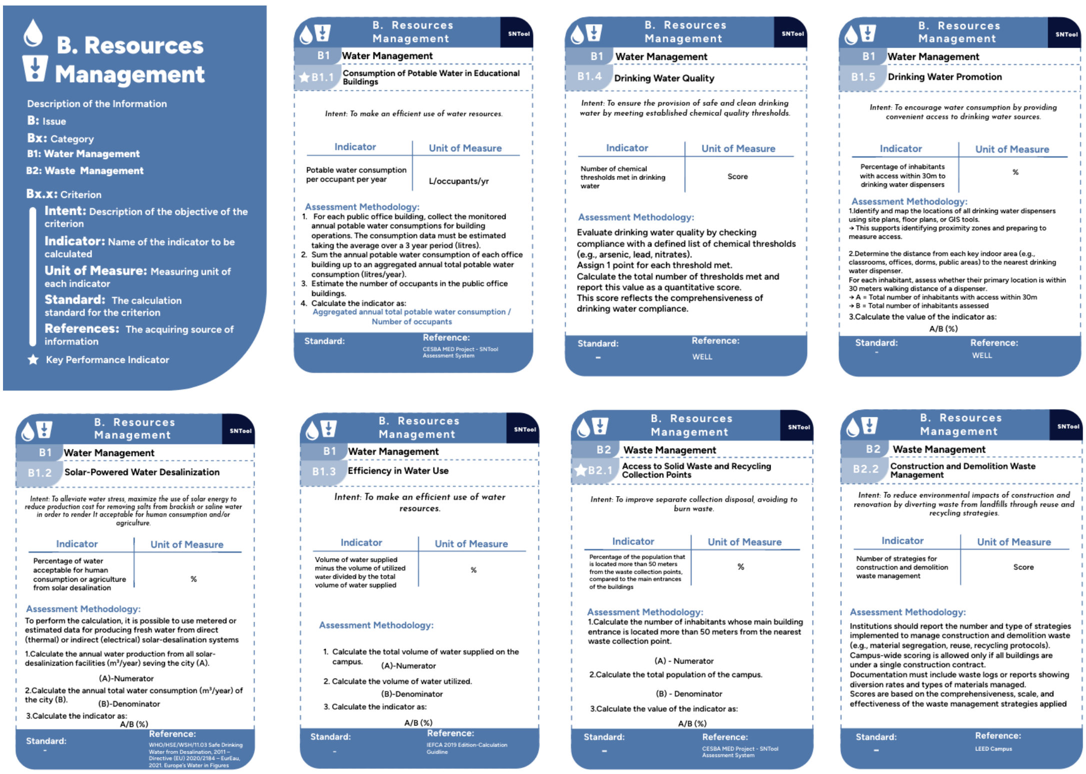


Figure 14.Thematic Profile – B. Resources Management (SNTool Campus – Urban Scale)

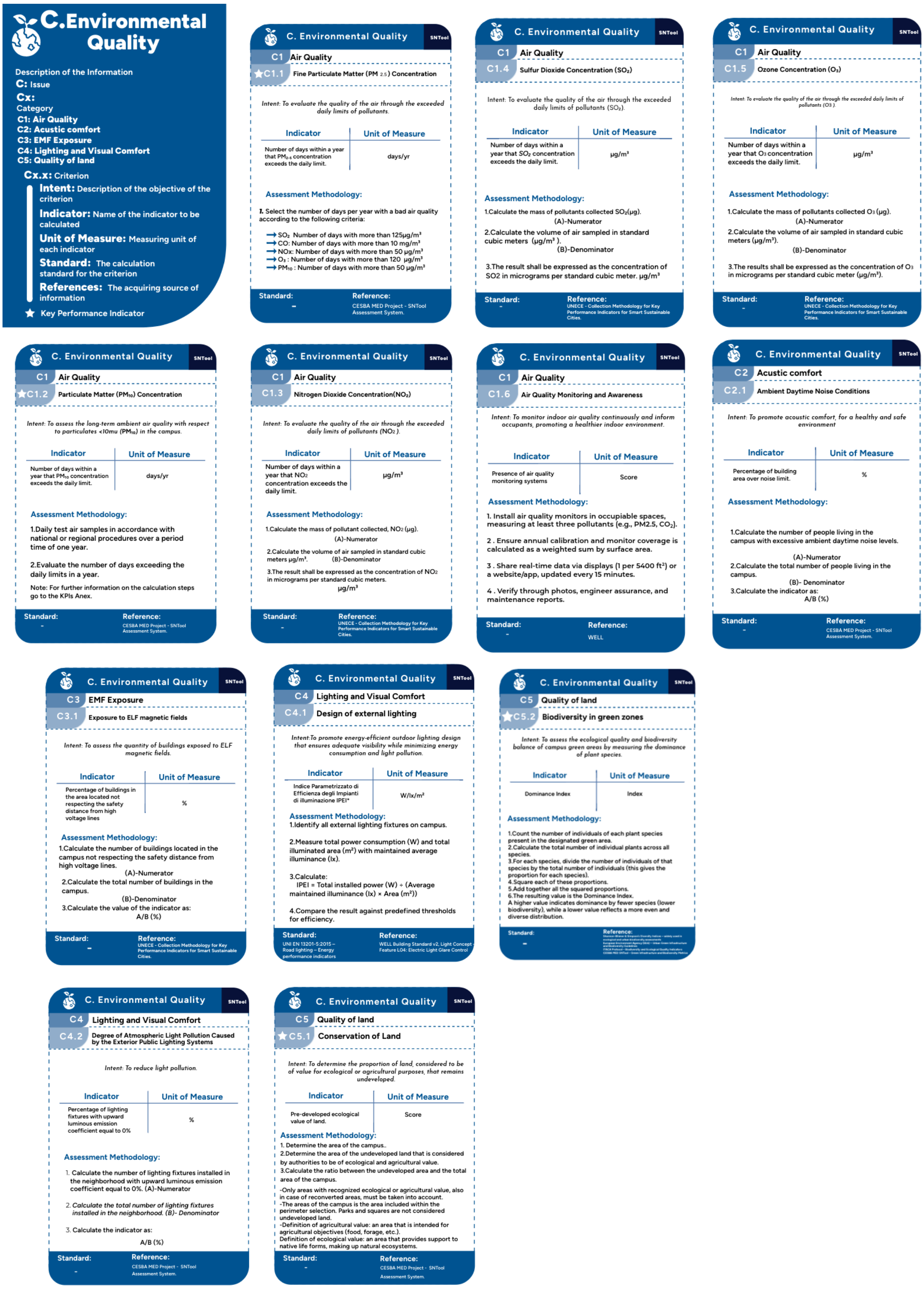


Figure 15.Thematic Profile – C. Environmental Quality (SNTool Campus – Urban Scale)

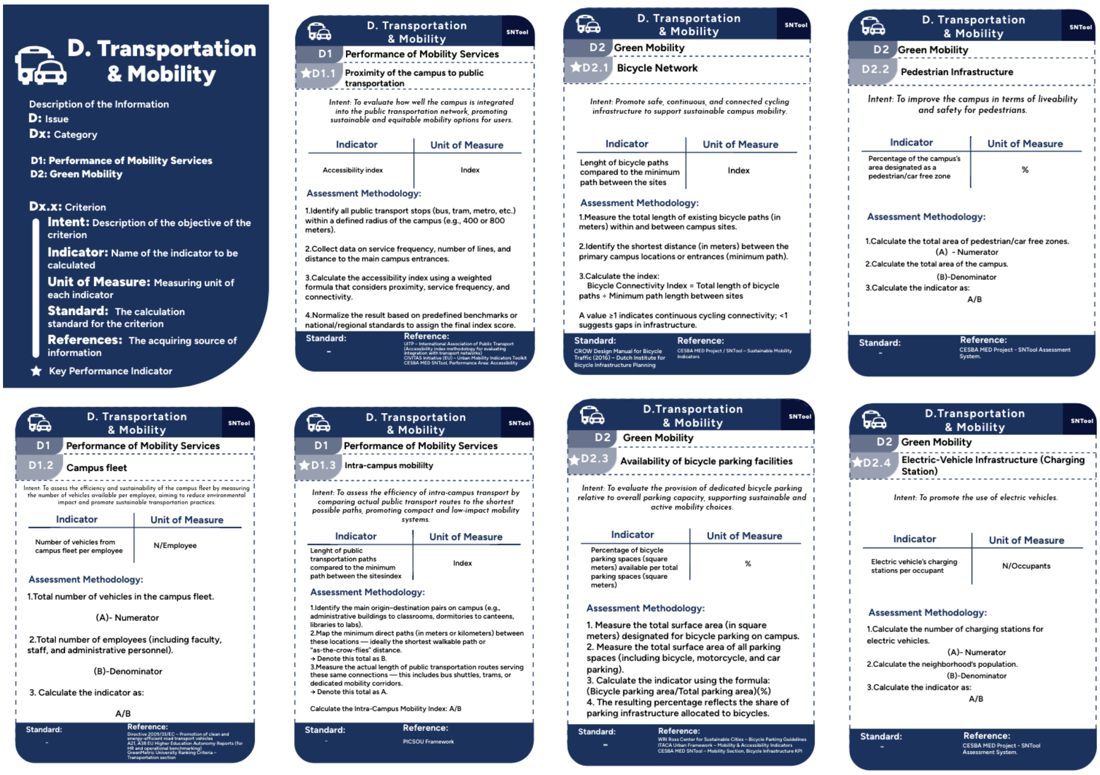


Figure 16.Thematic Profile – D. Transportation and Mobility (SNTool Campus – Urban Scale)

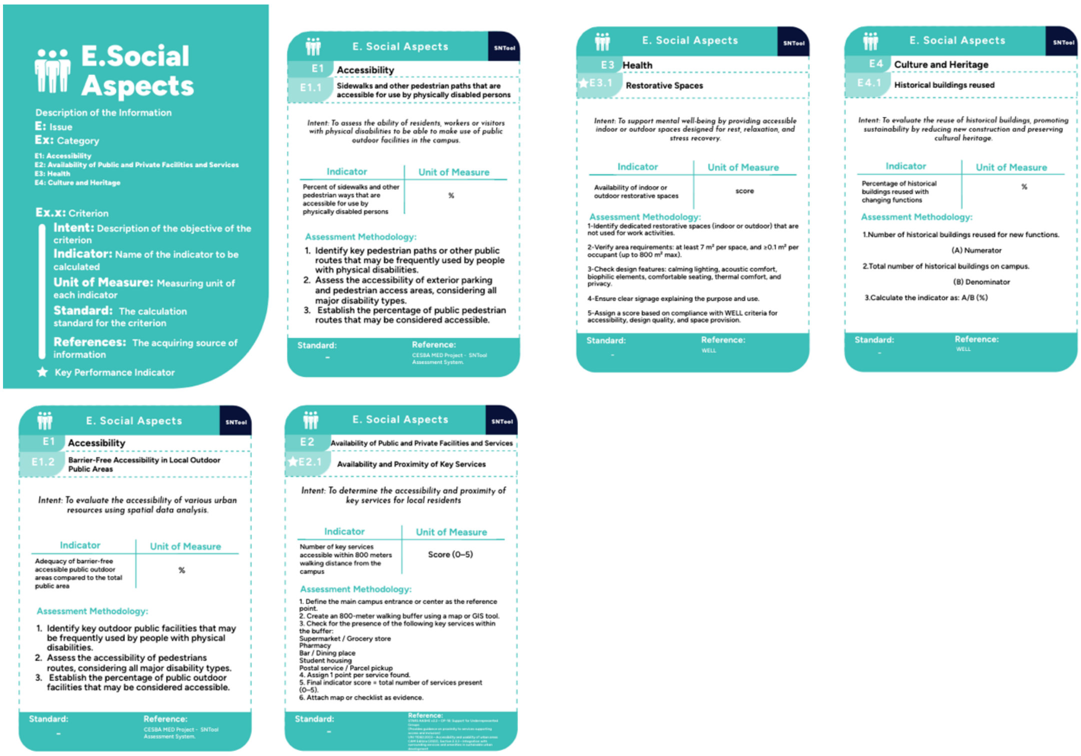
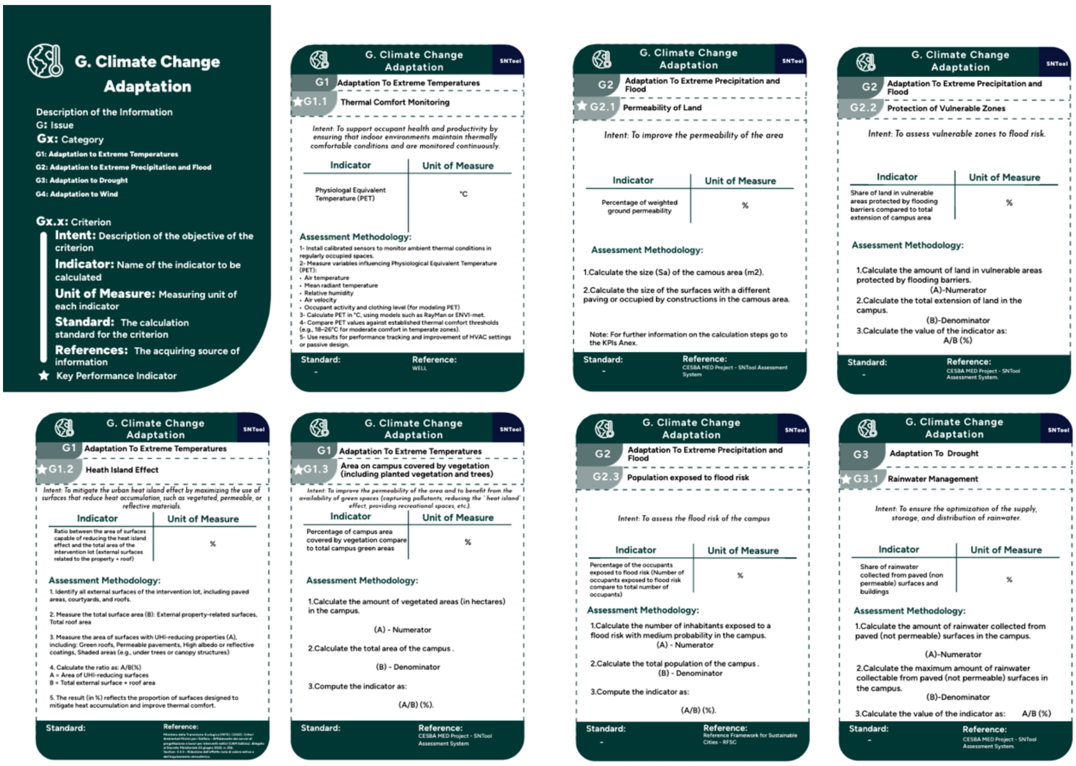


Figure 17.Thematic Profile – E. Social Aspects (SNTool Campus – Urban Scale)


F.Economy
Description of the Information
F: Issue
Fx: Category
F1: Economic Performance
F2: Innovation and Digitalisation
F3: Costs
F4: Sustainable Purchase
Fx.x: Criterion
Intent: Description of the objective of the criterion
Indicator: Name of the indicator to be calculated
Unit of Measure: Measuring unit of each indicator
Standard: The calculation standard for the criterion
References: The acquiring source of information
Key Performance Indicator
F. Economy
F1 Economic Performance
F1.1 Financial implications and other risks and opportunities due to climate change
Intent: To assess and disclose the financial risks and opportunities related to climate change and their impact on the organization.
Indicator: Financial implications and other risks and opportunities due to climate change
Unit of Measure: €
Reference: GRI
F. Economy
F1 Economic Performance
F1.4 Significant indirect economic impacts
Intent: To evaluate the broader, often unquantified, economic effects resulting from institutional activities, particularly those that influence supply chains, job markets, or regional development.
Indicator: Indirect economic impacts (GRI)
Unit of Measure: Qualitative scale (0 - 5)
Reference: GRI
F. Economy
F2 Innovation and Digitalisation
F2.1 Sustainable Investment Program
Intent: To measure the institution's commitment to incorporating environmental, social, and governance (ESG) or sustainability criteria into its investment decisions.
Unit of Measure: Qualitative scale (-1 – 4)
Reference: STARS AASHE
F. Economy
F1 Economic Performance
F1.2 Financial assistance recieved by the government
Unit of Measure: %
Reference: GRI
G. Economy
F1 Economic Performance
F1.3 Infrastructure investments and services supported
Unit of Measure: Qualitative scale (0–1–3–5)
Reference: GRI
F. Economy
F2 Innovation and Digitalisation
F2.2 Sustainability Course Inventory
Unit of Measure: %
Reference: STARS AASHE
F. Economy
F2 Innovation and Digitalisation
F2.3 Support for open access publishing
Unit of Measure: Qualitative scale (0–3–5)
Reference: STARS AASHE
F. Economy
F2 Innovation and Digitalisation
F2.4 Sustainability Projects Fund
Unit of Measure: Qualitative scale (0–3–5)
Reference: STARS AASHE
F. Economy
F2 Innovation and Digitalisation
F2.5 Sustainability-Equity Coordination
Unit of Measure: Qualitative scale (0–3–5)
Reference: STARS AASHE
F. Economy
F2 Innovation and Digitalisation
F2.8 Fixed Broadband Subscriptions
Intent: To assess the access to information and technology connectivity.
Indicator: Percentage of classrooms equipped with fixed (wired) broadband.
Unit of Measure: %
Reference: UNECE-Collection Methodology for Key Performance Indicators for Smart Sustainable Cities
F. Economy
F2 Innovation and Digitalisation
F2.9 Wireless Broadband Coverage
Intent: To assess access to information and technology connectivity
Unit of Measure: %
Reference: UNECE-Collection Methodology for Key Performance Indicators for Smart Sustainable Cities
F. Economy
F2 Innovation and Digitalisation
F2.6 Student-Managed Sustainable Investment Fund
Indicator: Percentage of sustainability funds managed by students
Unit of Measure: %
Reference: STARS AASHE
F. Economy
F2 Innovation and Digitalisation
F2.7 Sustainable Retirement Plan
Unit of Measure: Qualitative scale (0–3–5)
Reference: STARS AASHE
F. Economy
F2 Innovation and Digitalisation
F2.10 Availability of WIFI in Public Areas
Intent: To increase access to internet at little or no cost.
Indicator: Number of public WIFI hotspots in the campus per 1.000 inhabitants.
Unit of Measure: N/1000 occupants
Reference: UNECE-Collection Methodology for Key Performance Indicators for Smart Sustainable Cities
F. Economy
F3 Costs
F3.1 Investment cost
Intent: To quantify capital investment made for the creation of the campus, enabling cost-benefit and sustainability analyses.
Indicator: Total amount of expenditure incurred for the construction and realization of the campus.
Unit of Measure: €
Assessment Methodology: Collect financial data related to construction and setup (e.g., infrastructure, facilities). Use invoices, contracts, and budgeting records. Report total gross amount in euros.

Figure 18.Thematic Profile – F. Economy (SNTool Campus – Urban Scale)



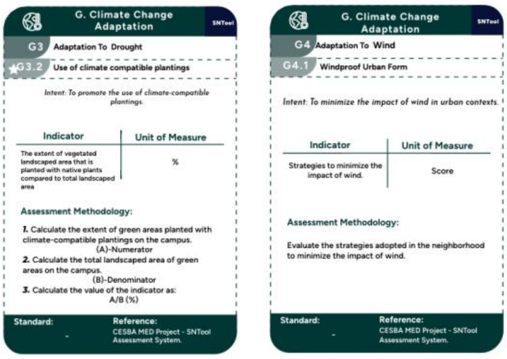


Figure 19.Thematic Profile – G. Climate Change Adaptation (SNTool Campus – Urban Scale)

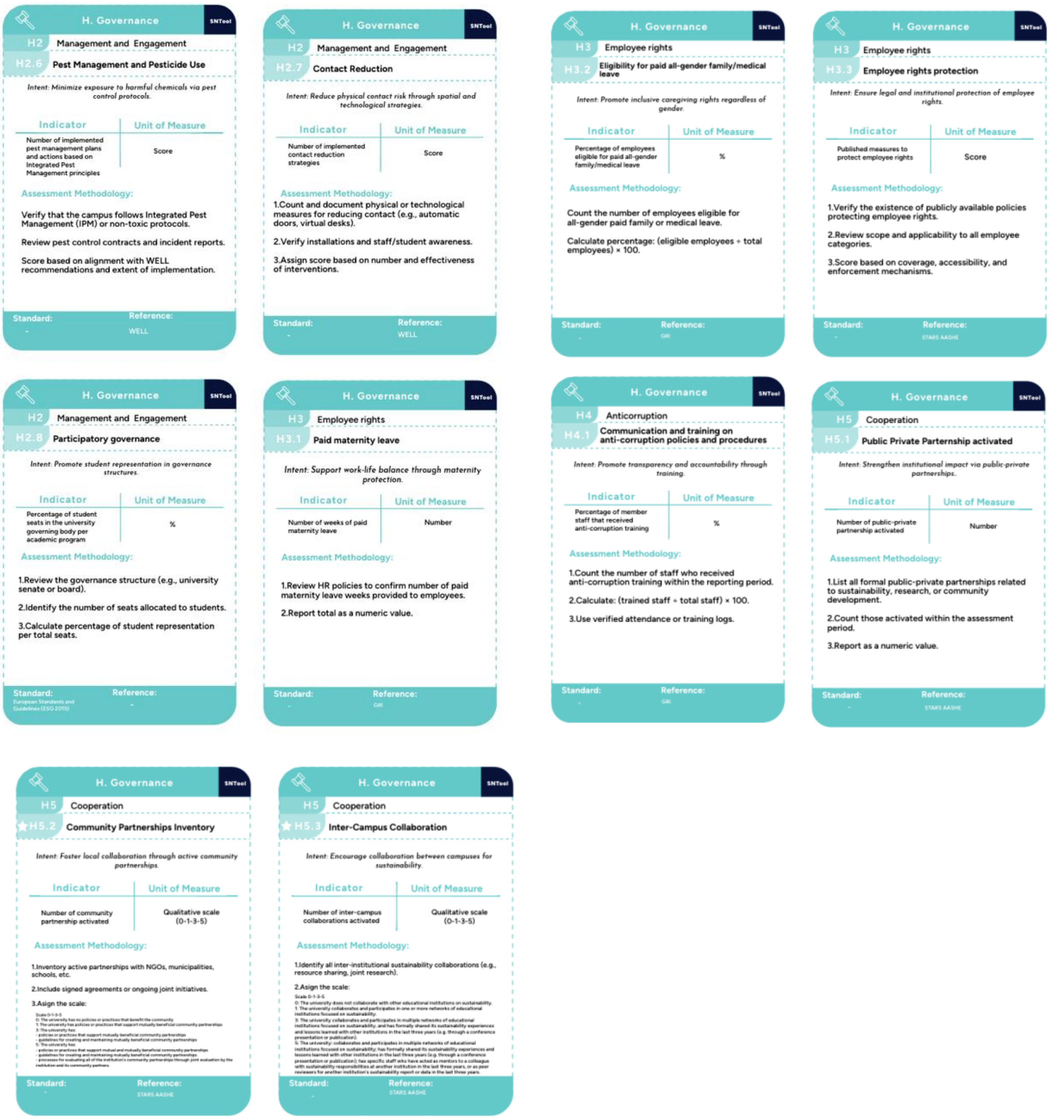


Figure 20.Thematic Profile – H. Governance (SNTool Campus – Urban Scale)

Chapter 4 – Implementation of the Assessment Tool on the Platform

4.1. Sustainable MED Cities (SMC)

The Sustainable MED Cities project operated as a research initiative which fell under the ENI CBC MED Programme (website).The initiative provided public administrations with resources to create sustainable urban policies and strategies and action plans. The project utilized outputs from CESBA MED: Sustainable Cities and GreenBuilding ENI CBC MED project to create sustainability-specific methodologies and digital tools which matched the Mediterranean region requirements (Sustainable MED Cities, 2024).

The United Nations Human Settlements Programme (UN-Habitat) predicts that the north will see 170 million more city residents while the southern and eastern subregions will experience a 300 million population surge by 2050. The rapid urban expansion creates three main challenges which include expanding informal settlements while failing to provide adequate fundamental services including water and sanitation and transport and increasing health and life safety risks. The present situation requires the implementation of integrated spatial planning approaches to achieve sustainable development across all areas throughout extended periods.

The Sustainable MED Cities project developed methodological instruments which enabled municipalities to develop sustainability plans. The model contained three essential components which consisted of participatory governance culture and multi-level institutional coordination and evidence-based policy-making. The project executed its strategy to fulfill the strategic goals of the Mediterranean Strategy for Sustainable Development 2016–2025 while maintaining policy alignment with international and Mediterranean regional sustainability initiatives (Sustainable MED Cities, 2024).

4.1.1. Objective

The main goal of this chapter is to display the digital application of the generic sustainability assessment frameworks which were developed for university campuses in Chapter 3. The two generic frameworks SBTool Campus and SNTool Campus underwent adaptation to represent the particular characteristics of university environments at building and campus levels. This chapter shows how the SMC platform implements these validated issues, categories, criteria and indicators into a functional sustainability evaluation tool. The implementation provides a flexible multi-scale system which enables universities to perform evidence-based sustainability performance assessments. The chapter implements these generic frameworks into the SMC platform which enhances their operational usability and institutional applicability (Sustainable MED Cities, 2024).

4.2. SMC Platform

The Sustainable MED Cities Platform (2024) defines that the platform serves as the main web interface developed in the Sustainable MED Cities - Integrated Tools and Methodologies for Sustainable Mediterranean Cities capitalization program. Through its interface public administrations can reach their project strategic goals by improving their sustainability policy development and implementation capabilities across built environment scales. Through the platform users can develop and implement sustainability measures and strategies for cities and districts and buildings (Sustainable MED Cities, 2024).

The SMC Platform functions as a decision-support tool which enables various stakeholders to develop sustainable urban transformation plans. The system provides users with data-driven planning and assessment capabilities to handle complex sustainability goals for all stakeholder groups.

The SMC Platform functions as a sustainability assessment and monitoring tool because it leads users through complete sustainability assessment and monitoring procedures. The platform provides three essential functions which allow users to:

- Users can establish sustainability targets through environment-specific definitions which align with municipal policy requirements using the platform;
- Users need to order interventions according to their projected effects at different levels of city, district and building;
- Users can evaluate current sustainability performance through established indicators.

The SMC platform allows users to create customized sustainability assessment tools based on internationally accepted frameworks. Users can customize core models such as SBTool for buildings and SNTool for neighbourhoods and SCTool for cities through the platform's modular system to suit their local requirements. The framework maintains methodological consistency while the tools achieve both flexibility and context sensitivity (Sustainable MED Cities, 2024).

The SMC Platform allows users to share results through its sophisticated data visualization features. The platform's visual tools support users in making data-driven decisions as they enhance transparency and accountability throughout urban governance activities. Public authorities together with experts use the platform as a strategic instrument to implement sustainability principles through quantifiable operational methods based on specific contexts.

The platform follows a structured user role hierarchy for security and access management purposes include the administrator, the owner, and the assessor. The system grants each role distinct duties with different permission levels for system access (Sustainable MED Cities, 2024).

The administrator role is designed for system-level operators and supervisory authorities. The platform's technical parameters and user profiles and assessment tool frameworks can be modified by administrators who control the platform architecture. The administrators are responsible for monitoring both operational stability and integrity of the platform (Sustainable MED Cities, 2024).

The framework generation from the generic toolset requires the owner role which public authorities and accredited private organisations assign to each other. Owners keep control of the generic frameworks while they can adjust parameters and criteria selection and weighting systems and benchmark definitions to match local needs. Owners have the responsibility to oversee project administration and select and assign assessors within their domain.

The assessor functions as the technical user who performs sustainability assessments. Assessors receive permission from owners to use customized frameworks for data entry and indicator scoring and result interpretation tasks but they cannot change the framework structure or methodological components. The framework structure together with methodological components remain fixed to maintain both consistent application and comparable results.

The platform uses role-based access to support workflow operations while ensuring assessment tools on the SMC Platform (Sustainable MED Cities, 2024) deliver consistent methodology.

4.2.1. Registration and Sign-In

The Sustainable MED Cities (SMC) internet platform provides access through an official registration and verification system which distinguishes user types to deliver appropriate functional capabilities. The platform requires this verification process to protect its evaluation tools and methodologies portfolio from unauthorized access by different user groups.

The platform directs users to its official portal at www.sustainablemedcities.tools where they can access project objectives and platform features together with supporting documents. Users must create their individual account on the registration platform by entering a valid email address and choosing a secure password. Users must state their future role between owner and assessor when they create their account. The platform requires users to provide essential account information during registration while defining their functional role within the system (see Figure 21).

Figure 21.User Registration Interface (Sustainable MED Cities Platform, 2024)

The site will send a verification email to activate the user account. If Users do not receive the confirmation email, can ask for a resend through the platform. The "Forgot your password?" feature enables password reset services to help users recover their credentials in accordance with standard data security protocols.

Users can access the login section after their account activation through their registered email and password combination. The platform provides customized dashboards to users after sign-in based on their assigned roles which enables each user to perform platform activities according to their permissions and responsibilities (see Figure 22).

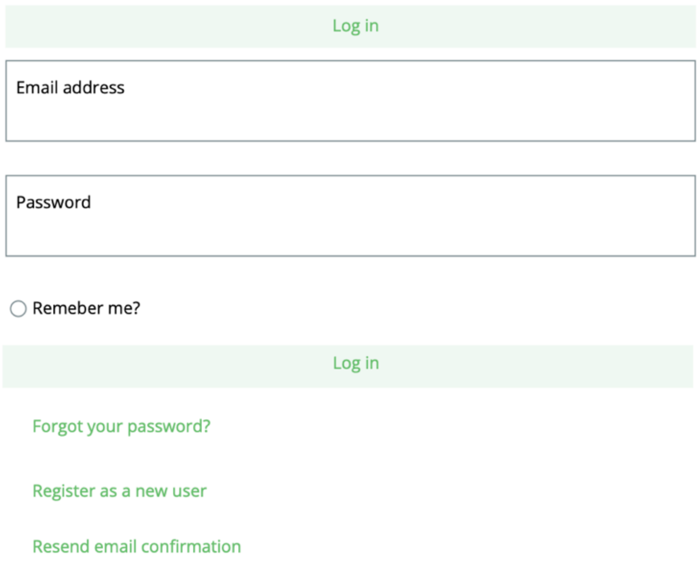


Figure 22. User Login Interface (Sustainable MED Cities Platform, 2024)

This regulated access mechanism allows for the integrity and responsibility of the SMC platform and a soundly organized and collaborative digital environment. By offering the appropriate differentiation of tool development and tool application functions, the platform guarantees the methodological soundness of its appraisal processes and promotes transparent, multi-actor-based governance of sustainable urban development in the Mediterranean area.

4.2.2. Generic Frameworks - Administrator Role

The Generic Framework section of the platform exists only for system administrators to access. The system administrator plays a crucial role in establishing and arranging sustainability assessment tools which operate at different spatial levels (Sustainable MED Cities Platform, 2024). Specifically:

- The SBTool MED operates at the building level.
- The SNTool MED operates at the neighbourhood or district level.
- SCTool MED exists to perform evaluations at urban or regional levels.

The four hierarchical components of each tool follow this structure:

1. Issues – broad thematic areas reflecting core sustainability topics.
2. Categories – subdivisions within each issue that bring more detail to the analysis.
3. Criteria – specific statements that define what aspects will be assessed.
4. Indicators – measurable or descriptive values that show how each criterion performs.

The administrator follows a specific order to develop or modify generic frameworks by designing element structures and contents and determining visibility and activity settings before making the framework available for owner and assessor use.

4.2.3. Assessment Tools - Owner Role

After the system administrator publishes the generic framework the designated owner can access the tool to customize it based on project-specific characteristics (Sustainable MED Cities Platform, 2024). The customization process aims to display local environmental conditions together with institutional priorities and planning scales.

The process involves four key stages:

1. Selection of Generic Framework

> The owner starts by choosing between the three available base frameworks which include SBTool, SNTool and SCTool. The owner can not change the core structure of framework but can modify the tool by giving it a name and adding context-based

information. Owner can enter data in five supported languages which include English and Italian and French and Spanish and Greek.

2.Defining Relevant Issues

The owner reviews the pre-defined issues to select those which are applicable to the project. The assessment tool evaluates the selected issues on a scale from 0 (not relevant) to 5 (highly relevant) to determine their level of importance. The weight of each issue will be calculated automatically by the platform based on the assigned priorities.

3.Prioritizing Categories

The activated issues show their corresponding categories to the owner. The same 0–5 rating system allows users to narrow down the assessment focus. The system generates automatic weight calculations which maintain consistency with the established priority framework.

4.Adjusting Criteria and Indicators

The owner determines which criteria and indicators should remain active during the most detailed assessment phase. The system assigns an impact factor between 0 and 225 to each criterion along with performance benchmarks that specify minimum (score 0) and optimal (score 5) performance levels. These modifications enable the assessment to match actual regulatory requirements and environmental requirements and infrastructure specifications.

4.2.4. Assessments - Assessor Role

The assessment phase operates under the direction of the assessor who represents the last user group in the sustainability evaluation process of the platform. The owner selects assessors who perform three main duties: entering performance data while reviewing indicator definitions and creating sustainability evaluations through customized frameworks (Sustainable MED Cities Platform, 2024).

During the last evaluation stage the assessor plays an essential role in implementing the sustainability framework. The assessor starts their work by launching an assessment project through which they give the evaluation a name and choose a suitable tool from the available selection. The assessor activates the evaluation mode before advancing through the tool's hierarchical structure which starts with categories then moves to criteria and finally reaches indicators.

The assessor have to fill three important data fields for each active indicator which include observed value and expected target value and an optional override field for validation or adjustments. The platform automatically matches these new entries against benchmarks established by the owner which represent the minimum (score 0) and optimal (score 5) performance levels. The evaluation process produces standardized scores which convert various measurements into a single evaluation system.

The platform integrates all indicator data to generate results which display both tabular information and visual representations through radar charts. The visual displays enable users to easily monitor sustainability performance throughout various thematic domains. Through their input the assessor ensures the evaluation shows real project conditions while providing evidence-based analysis. The platform's collaborative framework between administrators owners and assessors creates transparent and accountable evaluation processes that maintain consistent application of the Sustainable MED Cities platform.

4.3. Implementation of Generic Framework SBTool Campus

The first step in configuration of the platform must build a basic generic framework named SBTool Campus by the platform administrator. By clicking on the the "Add" function in generic frameworks section, administrator is enable to create the generic frameworks. Inside the configuration window administrator able to write SBTool Campus as the framework name in the designated field. This step is the starting point which enables the organisation of future hierarchical categories and indicators (see Figure 23).

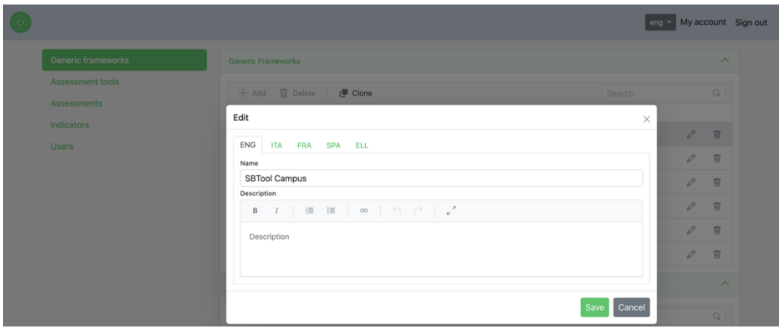


Figure 23. Initial Setup of the Generic Framework SBTool Campus (Sustainable MED Cities Platform, 2024)

The administrator can proceed with data entry after module activation by using the platform's sequential structure. The evaluation structure contains four levels which start with issues and continue to categories followed by criteria and then reletive indicators to create easily managed evaluation components (see Figure 24). The sustainability assessment framework depends on these four fundamental levels for its execution.

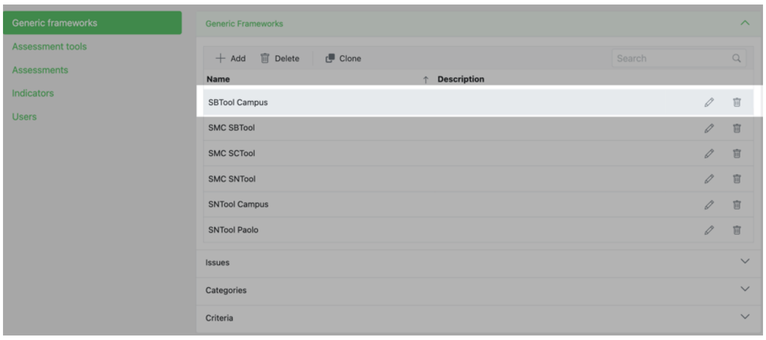


Figure 24. Hierarchical Structure of SBTool Campus Framework Interface (Sustainable MED Cities Platform, 2024)

4.3.1. Issues SBTool Campus

After enabling the SBTool Campus module the issues panel becomes accessible directly below the generic framework interface. At this point administrators need to start the framework configuration process through the "+Add" command that enables them to enter each issue that establishes the top assessment hierarchy level. The system generates alphabetical codes automatically in sequential order from A based on entry order. The first issue defined is Site Regeneration and Development which receives the code A (see figure

25).

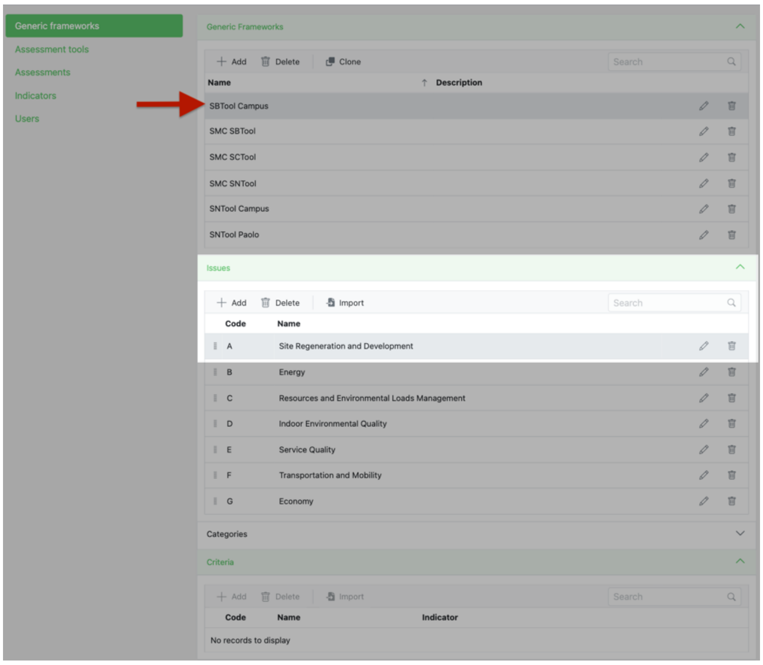


Figure 25. SBTool Campus Issues section Interface (Sustainable MED Cities Platform, 2024)

4.3.2. Categories SBTool Campus

The SBTool Campus framework requires administrators to establish thematic categories after defining the issues during its configuration process. When the platform user selects an Issue through its interface (e.g. A. Site Regeneration and Development) a new category input interface will automatically display below it.

The administrator can start adding content by clicking the “+Add” button in the categories section of the interface. The administrator can create new category titles which relate to the active issue at the moment. The system generates automatic category codes which represent their position under the main Issue (for example A1, A2). The issue A. Site Regeneration and Development has two categories which are A1. Site Selection and A2. Site Development as illustrated in the next figures (Figures 26,27,28).

These categories follow the thematic structure outlined in chapter 3 and form the foundation for adding relevant criteria and indicators.

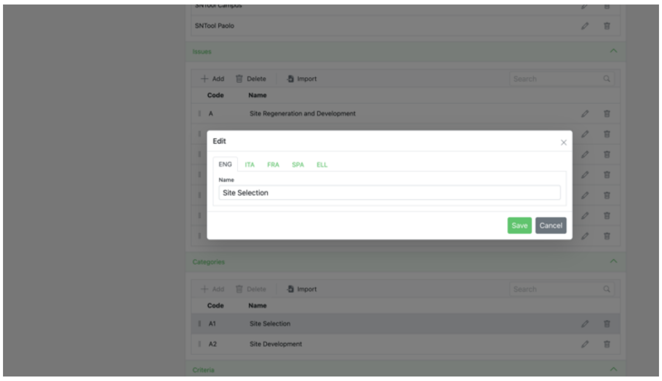


Figure 26. Interface view of category input for A1 under the SBTool Campus Issues panel (Sustainable MED Cities Platform, 2024).

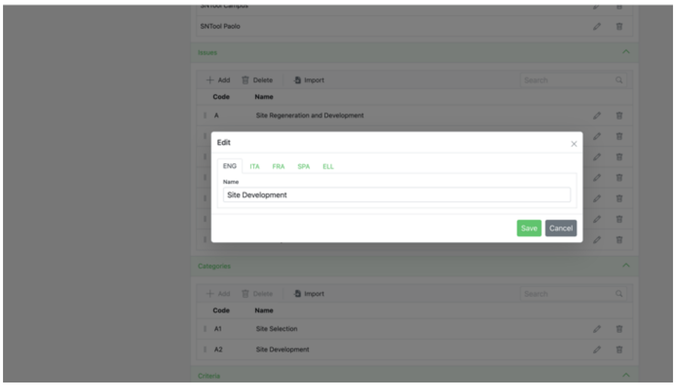


Figure 27. Interface view of category input for A2 under the SBTool Campus Issues panel (Sustainable MED Cities Platform, 2024)

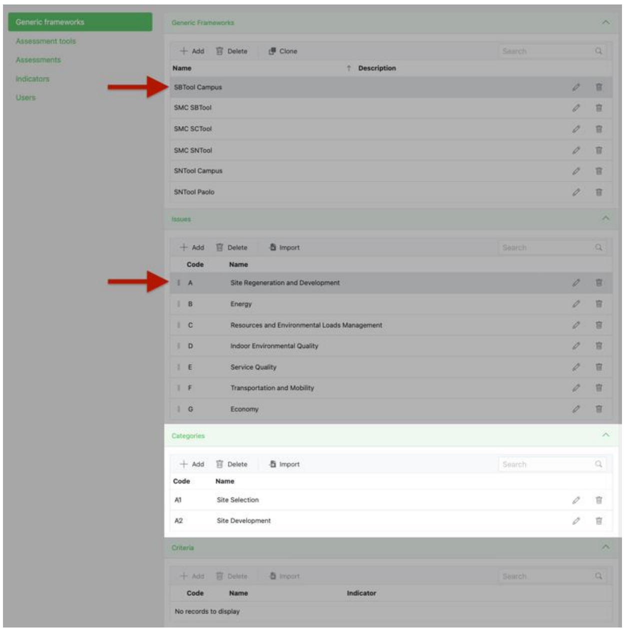


Figure 28.Interface for entering Categories under Issue A (Sustainable MED Cities Platform, 2024)

4.3.3. Criteria and Indicators SBTool Campus

The process of configuring criteria and indicators starts after selecting all the appropriate categories for each issue. A new interface labeled criteria becomes active after selecting a category (for example A1 – Site Selection) under the category panel.

The platform enables users to structure the evaluation element entry process through this interface. Users who have administrative roles need to fill out the data entry form that becomes available through the "+Add" command with these required fields: the criterion receives its name through this field. After that the purpose of the criterion appears as its intent. In the assessment methodology there is a brief outline of the calculation steps and procedures. The reference documents and standard (if applicable) should also write by admministrator. Indicator name, Unit of measure, and Benchmarks between 0 and 5 shuold also fill by administartor.

The SBTool Campus framework needs all these fields to create a complete criterion definition. The platform automatically sorts criteria and generates unique alphanumeric codes based on the issue-category hierarchy structure (A1.1, A1.2, etc.).

In the following screenshot the setup of criterion A1.1 that assesses the percentage of undeveloped land will be shown (See Figures 29). The assessment method includes of three distinct levels. The first level requires complete site surface area identification. The authorities establish which parts of land is ecological value. The assessment determines ecological site integrity by dividing the site's total value by its ecologically valuable land area.

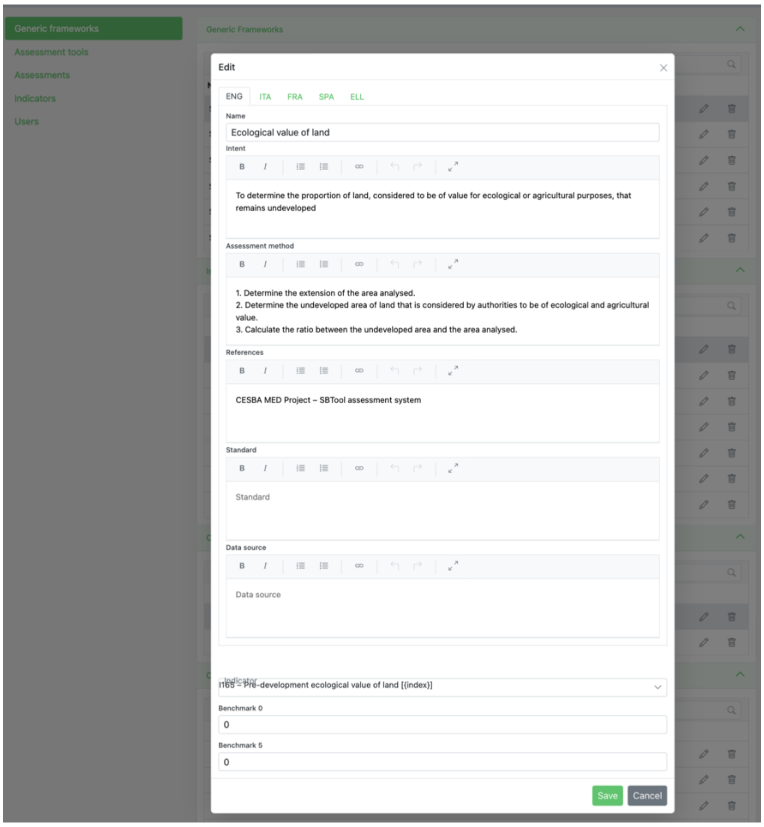


Figure 29.Configuration Interface for Criterion A1.1 in SBTool Campus (Sustainable MED Cities Platform, 2024)

The indicator Pre-development Ecological Value of Land serves as an index to assess this criterion. The methodological reference for this configuration comes from the CESBA MED Project together with the SBTool assessment system.

A1 – Site Selection contains an overview of its related criteria as shown in the following table. Under the issue A – Site Regeneration and Development the category A1 – Site Selection contains four specific criteria.

A1.1 – Ecological value of land

A1.2 – Proximity of site to public transportation

A1.3 – Adjacency to existing service infrastructure

A1.4 – Proximity to key services

The indicators match the criteria for each respective criterion (See Figures 30):

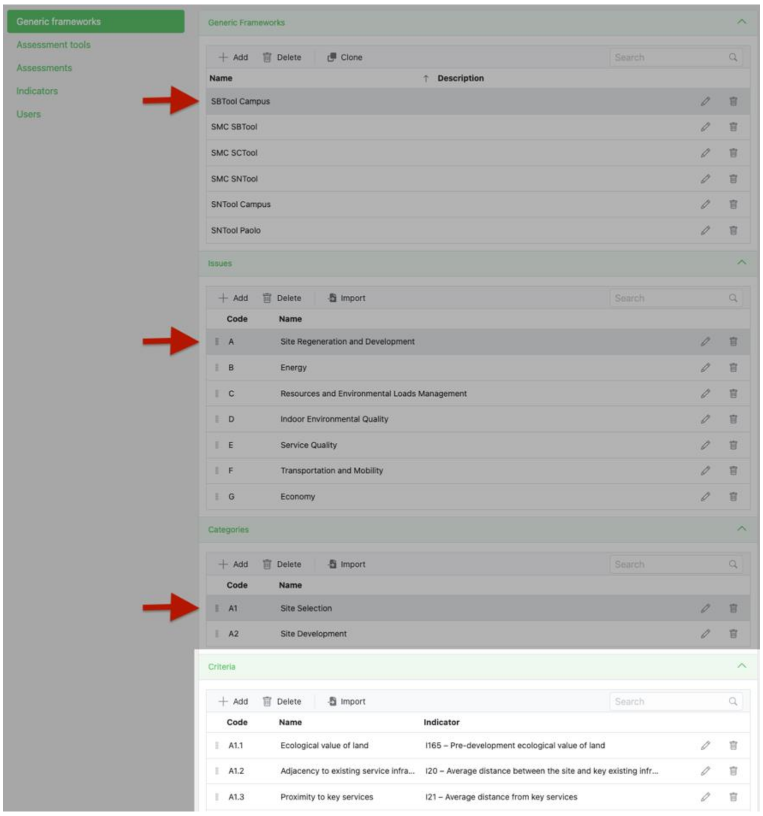


Figure 30.Overview Table of Criteria under Category A1(Sustainable MED Cities Platform, 2024)

4.4. Implementation of Generic Framework SNTool Campus

In configuration of the platform must build a basic generic framework named SNTool Campus by the platform administrator before any further action. To start the platform procedure the administrator needs to go to the Generic Frameworks section and click on Add command. Through the configuration interface the administrator enter SNTool Campus as the title in its designated field after execution. This fundamental structure activates the base framework which will later include issues along with categories and criteria and indicators.

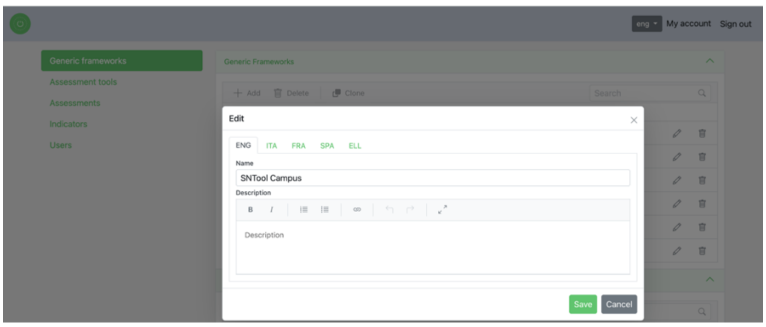


Figure 31. Initial Configuration of the SNTool Campus Generic Framework (Sustainable MED Cities Platform, 2024)

The SNTool Campus module of the Sustainable MED Cities (SMC) platform must first be activated to begin campus-scale sustainability assessment configuration. Through this activation users gain access to the generic evaluation framework presented in Chapter 3 that features thematic organization based on issues and iategories developed through a discipline-based methodology for university campuses.

The administrator will start building the generic framework through SNTool Campus module activation by inputting content across the four hierarchical levels of issues, categories, criteria, and indicators. The backbone of SNTool Campus framework consists of these four levels which provide organizational structure for university campus sustainability evaluations (see Figure 32).

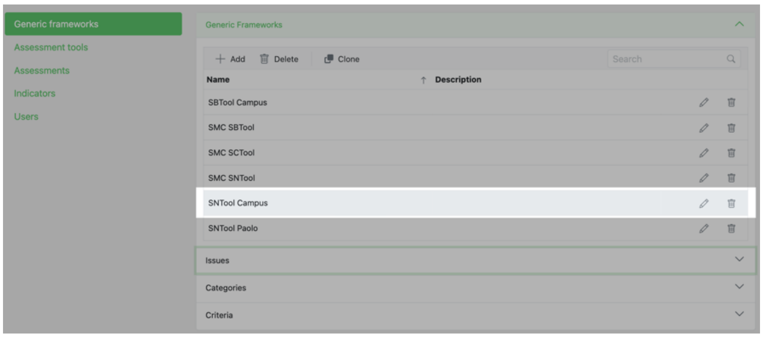


Figure 32. Hierarchical Structure of SNTool Campus Framework Interface (Sustainable MED Cities Platform, 2024)

4.4.1. Issues SNTool Campus

The issues section becomes accessible through the generic framework interface when the SNTool Campus module gets activated. The administrator continues the structured assessment tool configuration by using the +Add function to start entering sustainability issues which represent the top hierarchical level in the tool.

The first issue entry in the generic framework will automatically be assigned the label “A”. In this example, the first "Energy" issue is registered as issue A in the system (see Figure 33).

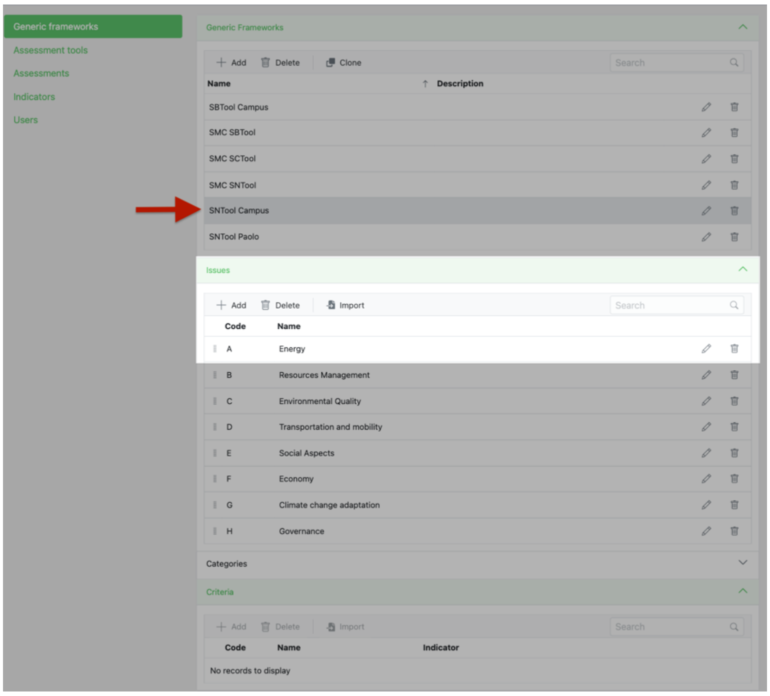


Figure 33. Interface for Defining issues in SNTool Campus (Sustainable MED Cities Platform, 2024)

4.4.2. Categories SNTool Campus

After defining the issues in the SNTool Campus framework the platform requires administrators to specify related thematic categories for further configuration. The platform interface shows an issue selection option followed by a secondary interface that leads to category input section below it.

The administrator must use the “+Add” button in the categories panel to proceed with the operation. The administrator can directly enter category names in a structured field which is activated when selecting an issue. The system generates automatic alphanumeric codes which maintain consistent tracking capabilities through sequential assignment (e.g., A1, A2, A3 for issue A) (see Figure 34):

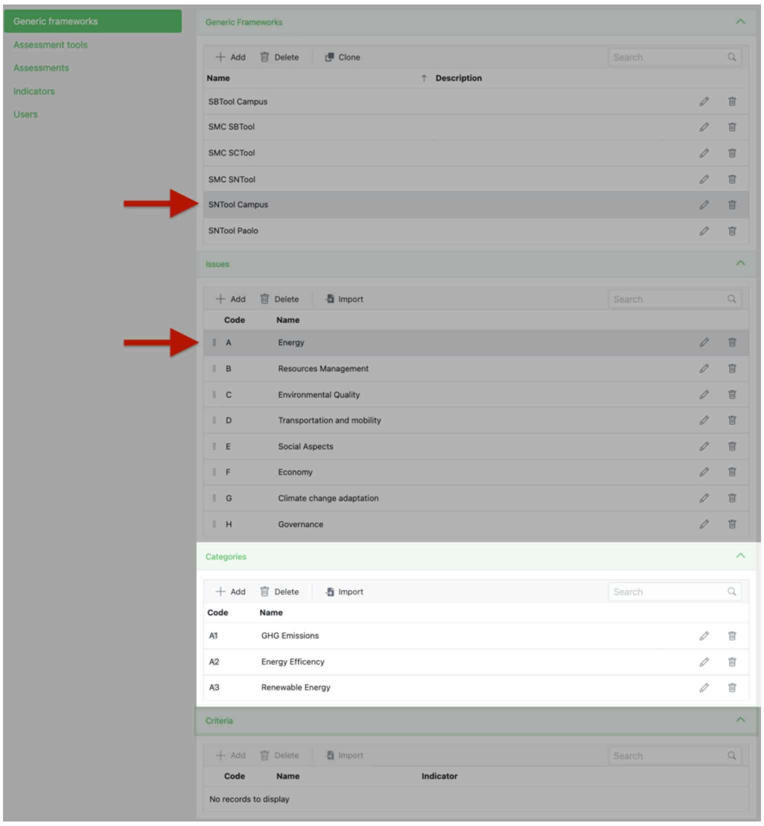


Figure 34. Category Configuration under issue A in SNTool Campus (Sustainable MED Cities Platform, 2024)

4.4.3. Criteria and indicators SNTool Campus

The next step for SNTool Campus framework configuration requires administrators to establish evaluation criteria alongside their corresponding indicators after categories are defined for each thematic issue. The system enables administrators to select categories starting with A1: GHG Emissions to access the "criteria" interface which appears directly below the category panel.

During this platform setup phase administrators use the “+Add” function to input each evaluation component. Users must provide essential information through this form by specifying the criterion name and sustainability goal together with assessment methods. The technical standards and reference documents such as CESBA MED Project and UNI standards should be recorded at this time.

Each criterion requires the selection of an indicator together with its measurement unit (percentage, index or $kgCO_2e$). Both minimum (score 0) and optimal (score 5) performance levels are established through benchmark values. The system generates a unique alphanumeric code for each criterion which reflects its position within the structural hierarchy (e.g., A1.1, A1.2).

Example: Criterion A1.1 – Greenhouse Gas Emissions (Figure 35)

The intent is to determine the extent to which the campus generates greenhouse gas emissions that cause climate change.

The assessment methodology contains calculating campus operational greenhouse gas emissions in tonnes of CO_2 equivalent which should be divided by the total campus population.

The indicator tracks greenhouse gas emissions that each user produces.

The measurement unit is tCO_2eq/user/year.

The CESBA MED Project implements the SNTool as its reference for this measurement.

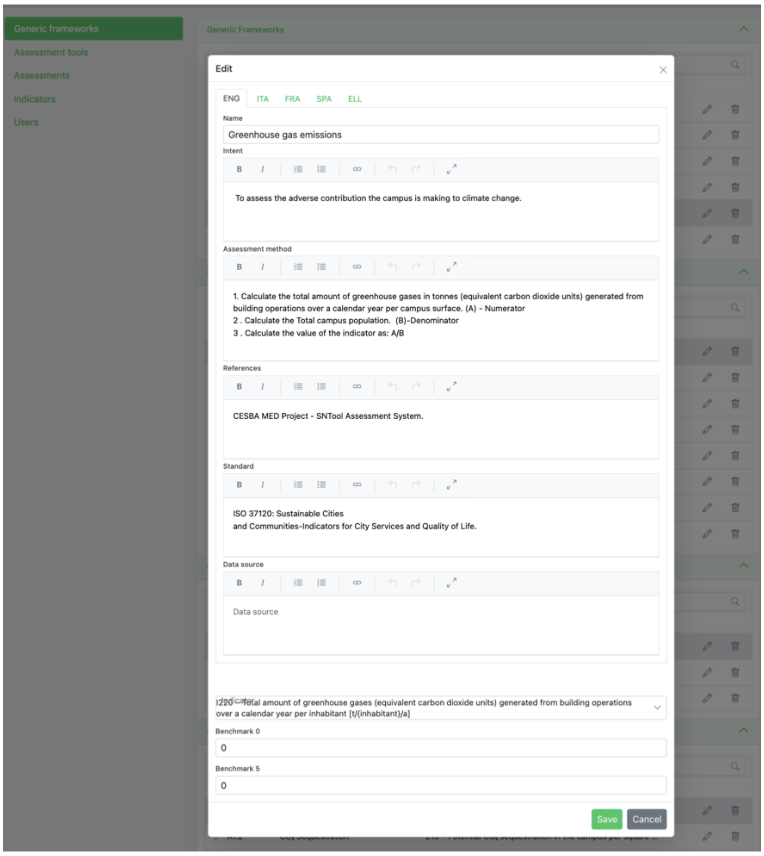


Figure 35. Configuration of Criterion A1.1 (Sustainable MED Cities Platform, 2024)

The criteria from A1 for GHG Emissions need an overview update

The new added criteria will appear in a tabular format after user select the designated category. The issue A – Energy category under A1 – GHG Emissions includes five criteria in the example provided:

A1.1 – Greenhouse gas emissions

A1.2 – CO_2 Sequestration

A1.3 – Campus carbon footprint

A1.4 – CO_2 compensation

A1.5 – Life cycle global warming potential

The SNTool Campus assessment system enables performance evaluations through quantitative and qualitative assessments by linking each criterion to its corresponding indicator (see Figure 36).

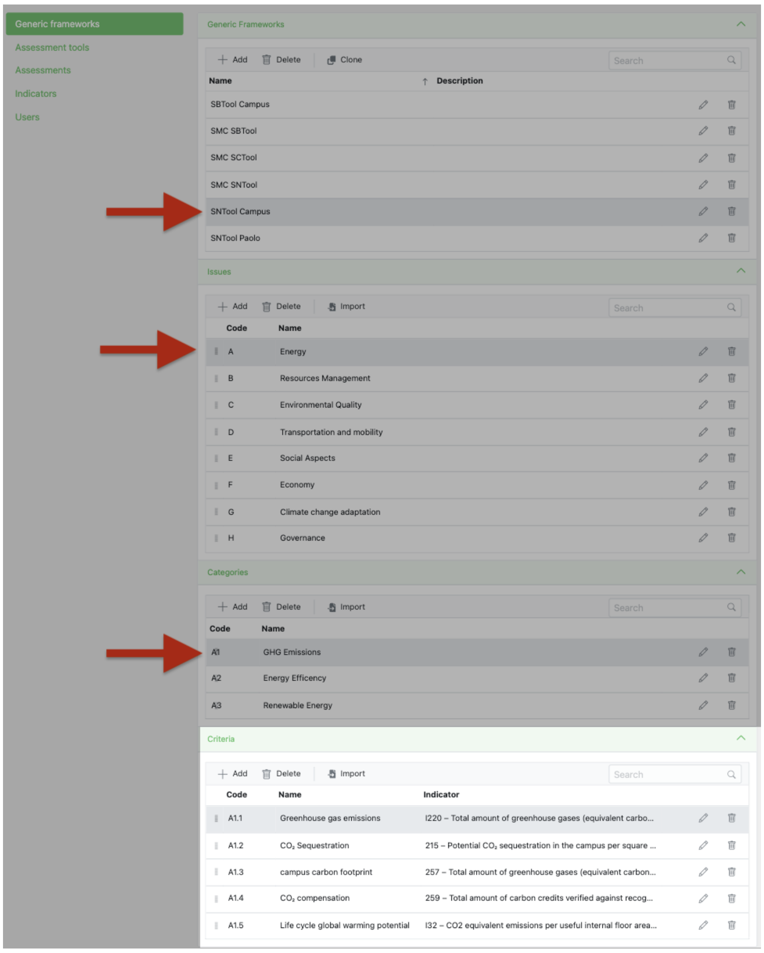


Figure 36. Overview Table of Criteria under Category A1 (Sustainable MED Cities Platform, 2024).

Chapter 5 – Conclusion

5.1 General Overview of the Key Findings and Main Considerations

The research examined the urgent need for sustainability assessment tools to adapt to university campus operational characteristics and spatial layouts and governance frameworks. The research used the Sustainable Built Environment Method (SBE Method) hierarchical framework and multi-criteria assessment approach to develop customized versions of the SNTool and SBTool generic frameworks which operate at building and campus levels.

The research began by performing an extensive review of sustainability assessment tools used in higher education institutions. The assessment revealed that STARS and UI GreenMetric are widely used but have specific limitations regarding their ability to adapt to regional regulations and multiple campus purposes and complex governance arrangements. The identified gaps confirmed that sustainability assessment needed adaptable tools which fit institutional contexts and local requirements.

The research developed solutions by combining literature reviews with professional consulting and platform testing methods. The extension work on SNTool and SBTool structures resulted in a generic sustainability framework for university campuses. The Sustainable MED Cities (SMC) platform functioned as a digital testing platform to implement and validate the system developed by the research team.

The system includes role-based modularity as its primary benefit. The administrator, owner and assessor roles operate independently through the platform yet maintain integrated functionality for users to customize tools and adapt context and evaluate data independently. Users can monitor assessment methods while multiple stakeholders can participate at various stages of sustainability assessment through this design structure.

The assessment tools developed through this research utilize a structured hierarchical system starting from issues before moving through categories and criteria and indicators with adaptable features for diverse university settings and regional contexts. Several expert workshops and collaborative sessions with semantic cards were conducted to assess the framework that improved both understanding and consistency. The input data shows that the criteria and indicators will be remained scientific validity with implementation feasibility. The system included digital functions which established benchmarks and automatic visualization of results and indicator scoring to make evaluation simpler between different scales.

This study contributes to higher education sustainability by developing and testing a broad adaptable assessment protocol method which works at different scales and locations. The research combines theoretical knowledge with expert guidance along with digital implementation to develop an operational framework which helps institutions make strategic decisions and achieve enduring transformations.

5.2. Future Direction

The research developed SBTool Campus and SNTool Campus generic frameworks to advance sustainability assessment practices for university facilities. The future of this research involves transforming these generic frameworks into two official assessment tools known as Protocollo ITACA Campus – Building Scale and Protocollo ITACA Campus – Urban Scale.

The transformation process demands systematic contextualization methods that include picking relevant issues and categories and criteria and indicators and benchmark value definition and weight assignment. The assessment tool development process will validate the tools' functionality in the environmental and functional and regulatory settings of higher education institutions.

The assessment tools will undergo testing at the Politecnico di Torino campus to evaluate their usefulness for institutional applications. The tools will be transferred under iiSBE Italia coordination to ITACA for potential national regional implementation throughout Italy.

The assessment tools demonstrate their ability to fulfill two functions which include building campus sustainability practices and establishing standardized assessment protocols for institutions and regions. The research methodology established in this thesis offers enduring direction for campus sustainability governance through ongoing innovation.

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