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Article

Sustainable Assessment Tools for Higher Education Institutions: Developing Two-Hierarchy Tools for China

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Abstract: Higher Education Institutions (HEIs) play an increasingly significant role in the practice of sustainability. For HEIs in their early stages of sustainability, they are still in need of sustainable assessment tools (SATs) that are suitable for their local context and also lead international sustainable development. The purpose of this paper is to develop a two-hierarchy sustainability assessment tool (THSus) for Chinese higher education institutions, including a quick analysis tool (QAT) and an in-depth benchmarking tool (IBT). The QAT provided a general overview of campus sustainability for HEIs to initiate initial actions and screen cases for the IBT. The IBT then provides more targeted analysis to plan long-term strategic changes. Based on the analysis of HEI cases, a 34-person Chinese research team was enlisted to discuss and select characteristics to formulate THSus. Indicators and weightings were developed according to the tool's purpose and applied to 15 cases to test its effectiveness. Results showed that THSus is suitable for systematically analyzing campus issues, particularly in research areas. It offers a regional solution for Chinese campuses that is adaptable and considers the comprehensive core of sustainability.

Keywords: campus sustainability; green campuses; higher education institution; sustainable assessment tools; two-hierarchy tools

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1. Introduction

The global commitment to sustainability is attracting increasing attention [1], and strong commitments are needed for countries to take action to create a shared sustainable future. In the context of education, sustainability in education refers to programs that aim to protect the environment and promote the responsible use of natural resources [2,3]. The 40th UNESCO World Conference outlines the framework to achieve the 17 Sustainable Development Goals (SDGs) by 2023 through sustainability education [4]. Therefore, HEIs play a crucial role in achieving a sustainable future [5].

HEIs are mini-cities [6] for promoting and practicing sustainable development (SD) strategies [7,8]. They also have a positive impact on students' knowledge and attitudes towards SDGs through sustainability-oriented education and activities [9]. A sustainable HEI campus not only represents the implementation of environmental science but also shows the interaction between the environmental, social, and economic factors [10,11], engaging a broad range of stakeholders [12].

Sustainable assessment is one of the initial steps for HEIs to take action toward sustainability [13]. A number of SATs have been developed for HEI campuses in regional and international contexts, but few regional tools exist for campuses in the early stages of sustainability [14]. On the one hand, it is of great importance for the proposal of the international SATs to explore the common guiding goals in the sustainability of HEIs. On the other hand, it is of practical importance to develop regional SATs to adapt to the local context and bridge the gaps between HEIs in different stages [15].

By May 2022, there were 2759 regular HEIs in China and 272 HEIs in Beijing–Tianjin–Hebei, accounting for about 10% of the total number. Chinese campuses have evolved from energy efficacy campuses in the 1990s to more comprehensive green campuses today [16]. The green campus is similar to the sustainable campus [17]. To encourage the construction of the green campus, the Ministry of Housing and Urban-Rural Development (MOHURD) and the Ministry of Education (MoE) have funded more than 300 HEIs [18] as demonstration campuses for the application of the Campus Energy Management Systems (CEMS) [19].

Previous studies have compared international SATs with Chinese campuses and have found that modifications are necessary to consider the actual status of campus sustainable development in China [17,20]. Additionally, regional case studies have been conducted to propose more appropriate SATs for Chinese HEIs [21,22]. In general, Chinese HEIs are still in their early stage of sustainability and in need of regional SATs. The MOHURD has supported to release the Evaluation Standards for Green Campus 2013 CSUS/GBC 04-2013 and the updated version of the Assessment Standard for Green Campus 2019 GBT 51356-2019 (ASGC) [23,24] to lead Chinese campus towards sustainability [25]. But no official campus assessment report has been published. It is challenging for campuses in their initial stages to adopt the ASGC because of the lack of data for assessment. Much effort is still needed for HEIs to enroll in assessments and take action toward more comprehensive green campuses [22].

This paper aims to propose a sustainable campus framework and two-hierarchy tool (THSus) for China, especially for the HEIs in Beijing–Tianjin–Hebei. The two-hierarchy tools included a quick analysis (30 indicators) tool and an in-depth (70 indicators) benchmarking tool. The quick SAT offered a general picture of the HEIs' sustainable performance and was developed for HEIs at all stages of sustainability, while the in-depth SAT aims to offer a systematic benchmarking and applies to the campuses with a certain basis for SD. To develop the two-hierarchy tools, 15 HEI cases in Beijing–Tianjin–Hebei were selected for analysis. And combined with the current situation of the HEIs and the characteristics of the existing SATs, with the assistance of a 34-person expert team, the framework, indicators, and weightings were proposed to formulate the tools. Then, the tools were applied to the 15 HEI cases to see their assessment results.

This research contributes to enrolling Chinese HEIs in sustainable assessment and could be helpful for HEIs at the early stage of SD to learn from the process of the assessment and potentially improve the sustainability by enrolling or developing more applicable regional SATs. The 15 cases and their assessment results also provided valuable empirical data to draw a more in-depth picture of HEI SD in Beijing–Tianjin and Hebei.

2. Research Area

2.1. The Beijing–Tianjin–Hebei

Beijing–Tianjin–Hebei, one of the most important city clusters in China, faced with common challenges towards sustainability, is selected as the research area. There were 272 regular HEIs in the research area, with 2.0943 million students and a total building area of 94.52 million square meters [26].

2.2. The HEI Cases

In order to select representative HEI cases in Beijing–Tianjin–Hebei, first a brief analysis of Chinese higher education was made to learn the basic characteristics of the campuses. Since the foundation of the People's Republic of China, higher education has experienced a development process of more than 70 years, and campuses have been exploring planning and designing methods for sustainability [27].

The SD periods of the HEI green campuses and basic characteristics of campuses (Table 1) were considered to select the cases of the HEIs [28,29]. And both green campus demonstration campuses that applied Campus Energy Management Systems (CEMS) and non-demonstration campuses have been included. Finally, based on the comprehensive consideration of the accessibility and adequacy of data, 15 cases were selected for further analysis (Table 2).

Table 1. Characteristics of the Chinese HEIs.

Characteristics	Types	Description
Sustainable development periods	The Exploration Period (campuses built before 1949)	Historical campuses faced with problems such as old infrastructure, disrepair of buildings, mismatch between original functions and current development, etc.
	The Enlightenment Period (campuses built between 1949 and 2006)	The concept of green development is not clearly defined, and campuses had been influenced by various planning ideas to explored the SD.
	The Developing Period (campuses built after 2006)	After the release of Evaluation Standards for Green Campus 2013 (CSUS/GBC 04-2013), some new built green campuses based on systematic planning and construction have emerged.
Campus area (hectares) [1]	XS	$0 < S \leq 25$
	S	$25 < S \leq 50$
	M	$50 < S \leq 100$
	L	$100 < S \leq 200$
	XL	$200 < S \leq 500$
	XXL	$S > 500$
Location	C	Central urban area
	S	Suburban area
Development mode	redevelopment (R)	On the basis of no obvious changes in the original site and boundary, the campuses have been transformed and renewed.
	Expansion (E)	On the basis of the original site, the surrounding land is absorbed to expand the campuses boundary.
	Multi-campus operation (M)	There are two or more campuses in different locations that share the daily teaching and research activities.

[1] A total of 189 out of 271 HEIs with accessible official data were considered according to the hectare. And the biggest campus has been included.

Table 2. Basic information of the selected HEIs cases in Beijing, Tianjin, and Hebei.

Period	Cases Abbreviation [1]	CEMS Demonstration	Discipline Type	Campus Area and Location	Development Mode
The Exploration Period	1THU	Y	Comprehensive	XL (C)	E
	2NKUU	Y	Comprehensive	L (C)	R and M
The Enlightenment Period	3TJUU	Y	Technology	L (C)	R and M
	4CUMT	Y	Technology	S (C)	R and M
	5MUC	Y	Nationalities	S (C)	R and M (In construction)
	6HEBUT	Y	Science and Technology	L (C)	R and M

Table 2. *Cont.*

Period	Cases Abbreviation [1]	CEMS Demonstration	Discipline Type	Campus Area and Location	Development Mode
	7BUA	N	Agriculture	M (C)	R
	8TFSU	N	Language	S (C)	R and M
	9TJCM	N	Art	S (C)	R
	10TJCM	Y	Finance	S (C)	R
	11HSU1	N	Sports	S (S)	R and M
	12CUGGW	N	Science and Technology	S (S)	R
	13LTU1	N	Normal	S (C)	M
The Development Period	14TJU2	Y	Science and Technology	XL (S)	M
	15NKU2	Y	Comprehensive	XL (S)	M

[1] The number after the HEIs abbreviations represent the branch campuses.

3. Methodology

The construction, transformation, application, and update of the SATs can be summarized in a systematic manner, considering the specific context [22,30,31]. Initially, it is crucial to review and compare existing SATs as a basis for either applying or constructing new SATs. Alternatively, if the existing SATs are only partially relevant, SATs could be modified or developed based on the characteristics of the existing SATs and the requirements of the local HEIs.

In order to create a sustainable assessment framework that was both leading campuses toward sustainability and more adaptable to the Beijing–Tianjin–Hebei local context, a mixed method was used. The design process was developed based on the review of SATs and considering the local contexts. The process goes as follows (Figure 1).

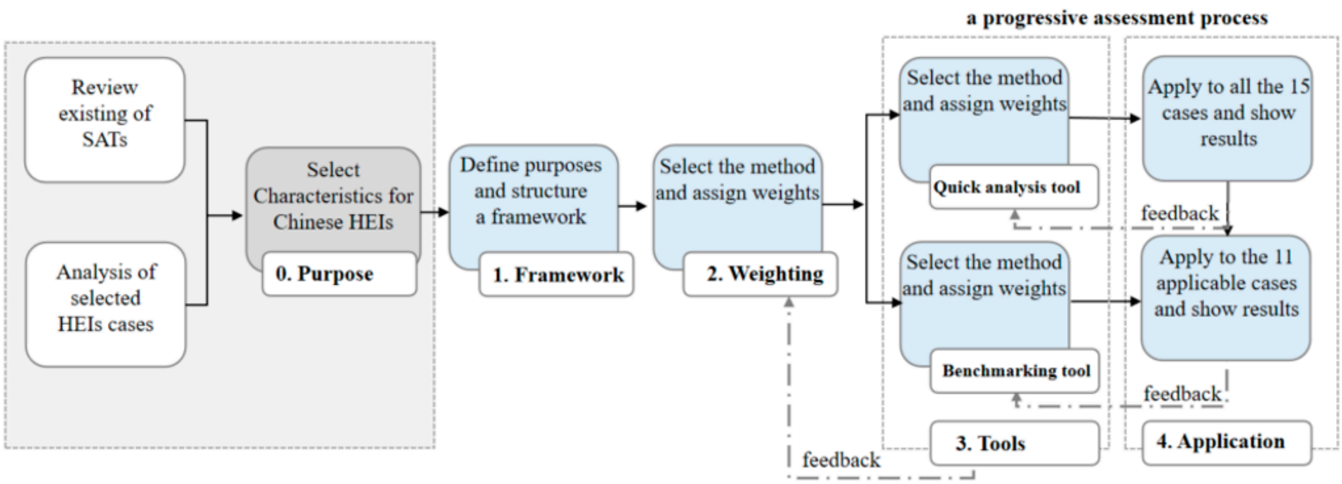

Figure 1. Process for developing the thus for the HEIs in Beijing, Tianjin, and Hebei.

In our previous study, 15 existing SATs have been selected and reviewed to make comparison of their purpose and stages, weightings, and assessment content in the level of indicators. This comparison helped us identify guidelines and assessment purposes that could be used to formulate the Chinese SATs [15].

Based on general guidelines and components of the Chinese SAT, according to the analysis of the HEIs cases, through the enrollment of a 34-person Chinese research team, this study developed the two-hierarchy tools in four steps: framework construction, weighting, tool development, and application. In each step, the main problems faced by HEIs in achieving sustainability have been identified and analyzed. Possible solutions were proposed, taking inspiration from existing SATs. These solutions were further improved by involving the research team or validating them through HEI cases. These solutions aim to find more practical and effective approaches for the assessment of the researched area.

The Chinese research team was involved in discussing and selecting characteristics to formulate the new framework and develop tools for the research area. The research team invited targeted experts from our network and those who have published papers related to campus sustainability between 2018 and 2020. A total of 34 experts were selected, including researchers, designers, engineers, senior managers, faculty leaders, and government officers from 14 institutes (eight HEIs, four research and design institutes, and two planning bureaus).

3.1. Framework

First, the proposed guidelines for Chinese SATs were studied in our previous analysis [15]. The study involved selecting 15 SATs out of 73 that were identified from 24 articles reviewing HEI SATs. The screening process was conducted using Scopus and Web of Science and was supported by the PRISMA statement. The selected SATs were then analyzed to identify important components for developing SATs. Based on these components, guidelines for the Chinese SAT were formulated through an online workshop. The guidelines for Chinese SATs were proposed as follows.

Chinese campuses are still in their early stage of SD and in need of a tool or toolkit for identifying the overall sustainability picture, benchmarking, and strategy making. And this paper aimed to develop two-hierarchy tools, in response to the first two purposes. The current ASGC has the highest emphasis on the environmental operations of the 15 SATs, which is recommended to move to a more balanced emphasis that aligns with the core of sustainability.

Second, the current situation of HEI cases was studied to better select the components for the SATs. These cases include HEIs of different basic characters and SD levels. And the general understanding of the main problems they faced towards sustainability was as follows.

- In terms of the environmental aspect, the CEMS demonstration campuses have adopted relatively more in-depth and extensive green design and renovation measures, but the SD of the non-demonstration campuses is at a relatively early stage.
- In terms of the social aspect, most of the campuses have carried out green education and related research, but the engagement of teachers and students was relatively insufficient. Sustainable campuses needed to be shared in order to be adopted and uniformly implemented across institutions [32].
- In terms of the economic aspect, in addition to funding from the CEMS project, some campuses are actively seeking support through energy management contracts, collaboration with government agencies, etc. In most cases, however, the long-term financing of SD remains a challenge.

Based on the review of existing SATs and the analysis of the Chinese campus cases, a new framework was proposed.

Campus sustainability has been defined in various studies [9,33,34]. The term 'sustainability in higher education' was first mentioned in the Stockholm Declaration of 1972. This declaration emphasized the connection between humanity and the environment [34]. As environmental issues become increasingly complex, campus sustainability focuses on the underlying principles of sustainability rather than just addressing the environmental issues. It bridges the Sustainable Development Goals (SDGs) with education, recognizing the interconnectedness between education and sustainability. It also addressed the importance of sustainability in education which refers to the education programs that aim to protect the environment and promote the responsible use of natural resources [3].

The framework started from the main functions of HEIs, engaging the main internal stakeholders of HEIs, adopted the core dimensions of sustainability, and responded to the solutions in the local context, with three core dimensions of (1) built environment, (2) operations, and (3) participation (Figure 2).

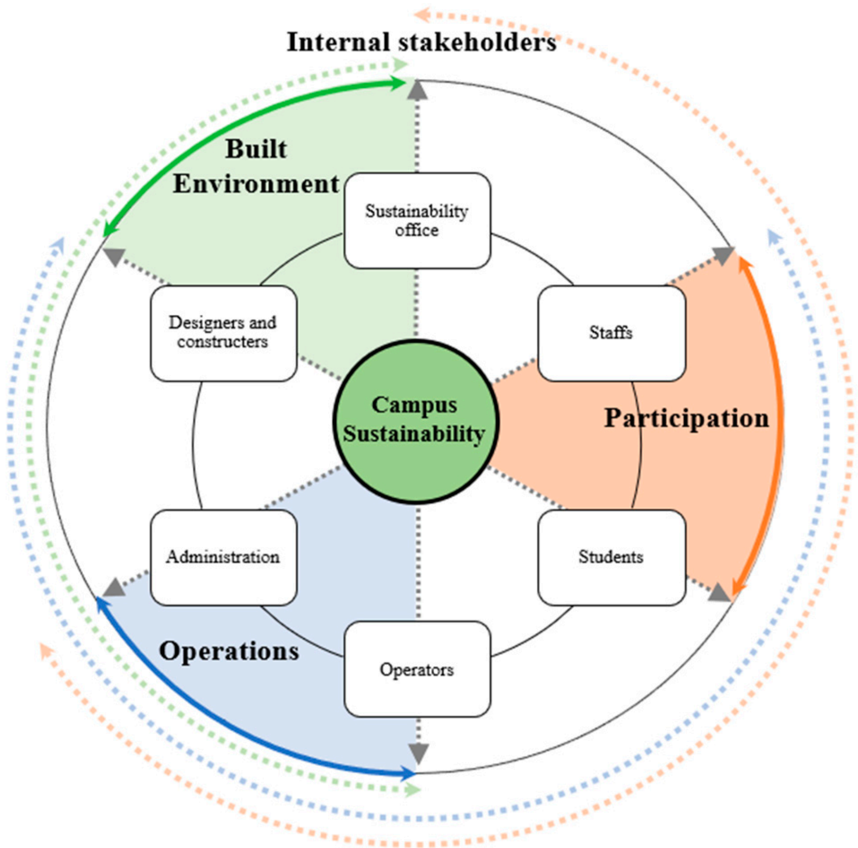

Figure 2. Sustainability dimensions and main internal stakeholders linked to the HEI system.

3.2. Indicators

The indicators of the tools were selected in two rounds. In the first round, 70 indicators were selected or modified to express the comprehensive core and leading roles of campus sustainability quantitively to develop the in-depth benchmarking tool. In the second round, 30 indicators were selected based on the 70 indicators and simplified to well express the core of campus sustainability and adaptability to campuses in all stages of SD to qualitatively develop the quick analysis tool.

According to the topics and issues selected by the expert's team, the indicators were selected or modified from the Chinese ASGC, Sustainability Tracking, Assessment and Rating System for Colleges and Universities (STARS) [35], Assessment System for Sustainable Campus (ASSC) [36], World University Rankings (GM) [37], Greening Universities Toolkit (Toolkit) [38], and Assessment Instrument for Sustainability in Higher Education (AISHE) [39].

The principles [40–42] of the selection of the indicators were as follows.

- The indicators demonstrate coverage of key campus sustainability themes and issues. They are relevant to users, decision-makers, and local and global sustainability challenges.
- They are linked to a clear objective and reflect the university's capacity to effect change.
- They are adaptable to the local context and based on accurate, available, and accessible data of known quality.

3.3. Weighting

The review of the SATs suggested that the weighting of the Chinese SAT should be more balanced compared to the overemphasis on environmental factors in ASGC. Then, the weights of the tool have been assigned to the dimensions and aspects with the analytic hierarchy process (AHP) weighting method. The weights should reflect the analysis and judgment of the value of the dimensions and aspects and reflect the scientific nature of the indicator system [43,44]. Therefore, the expert team was invited to integrate a wide range of stakeholders and practical experience related to campus sustainability in Beijing–Tianjin–Hebei, and 25 out of 34 experts were enrolled to assign weightings to aspects using the analytic hierarchy process (AHP). After two rounds of the interactive process, the AHP weightings were proposed.

3.4. Developing the Tools

Next, combined with the existing SATs and the characteristics of HEI campuses in this research area, the two-hierarchy SATs have been formulated.

The quick analysis tool

This tool offers a basic and quick analysis of the assessed campuses, aiming at giving a general and primary assessment including all key aspects of sustainability. This tool would be an entry-level sustainable assessment tool that is adaptable to almost all the HEIs in the research area.

The in-depth benchmarking tool

This tool offers an in-depth and comprehensive analysis of the assessed campuses, aimed at proposing benchmarking and complete results to foster campuses' future sustainable plans. This tool would be a more comprehensive tool adaptable to HEIs with basic quantitative data such as annual energy and water consumption.

3.5. Testing and Application of the Tools

This section shows the results of the assessments of the 15 cases by the two-hierarchy SATs. The adaptability and accuracy of the tools were tested. And a comparison of the results with the ASGC was presented.

4. The Two-Hierarchy Tools

The two-hierarchy tools for the HEIs in Beijing–Tianjin–Hebei were developed and presented. First, the conceptual framework and weightings were proposed to establish a comprehensive structure for the tools. Second, the purposes, indicators, weightings, and scoring of each tool were presented.

4.1. The Sustainable Campus Conceptual Framework

A four-level hierarchy of sustainable campus conceptual framework was proposed, with the overall goal of campus sustainability, followed by the three dimensions of (A) built environment, (B) operations, and (C) participation. The third level consists of nine aspects, followed by thirty-three topics in the fourth level (Figure 3).

4.2. The AHP Weighting

Next, the AHP weighting at the aspect level was proposed with the support of the experts' team. The weighting results are as follows (Table 3). The weighting placed significant importance on environmental factors, while also acknowledging the growing significance of social and economic factors.

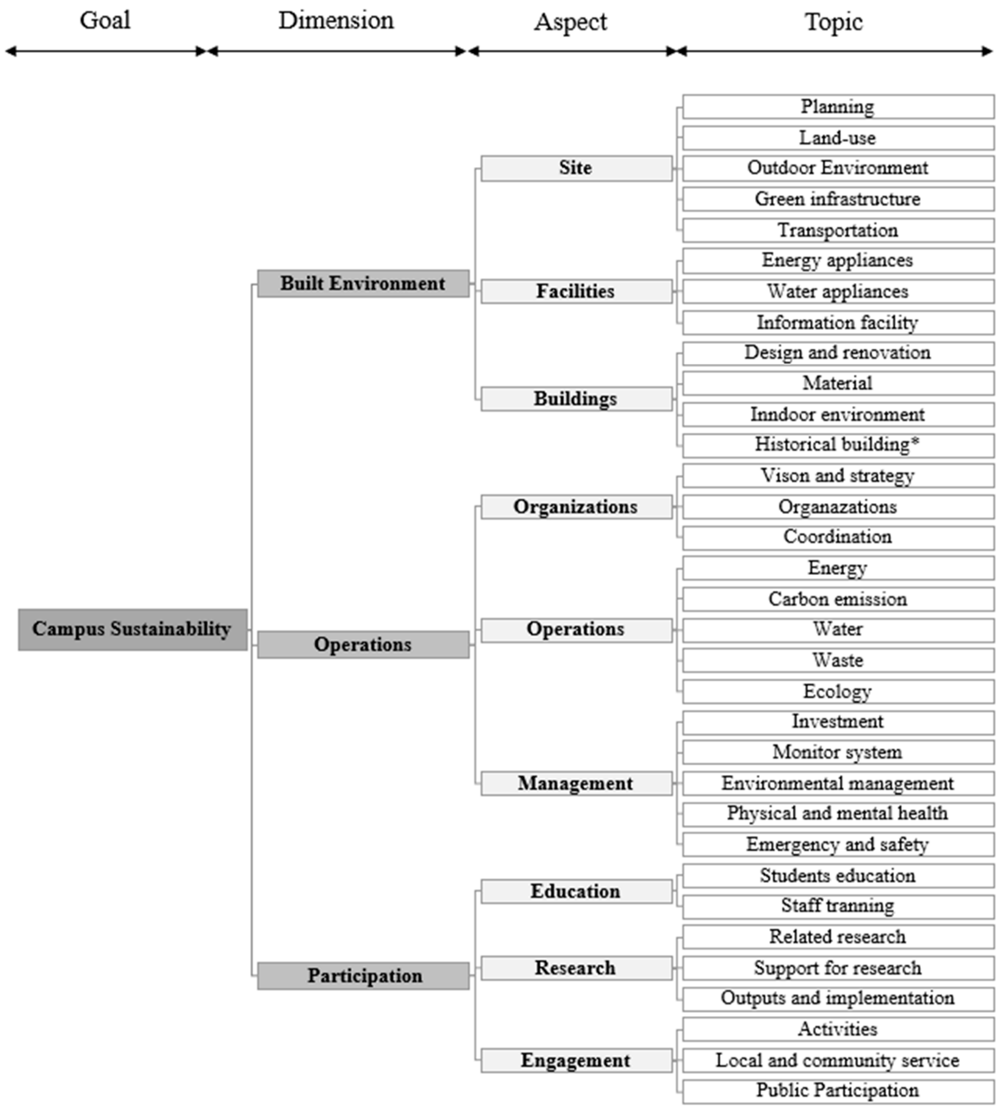

Figure 3. Four level hierarchy for sustainability assessment for the HEIs in Beijing, Tianjin, and Hebei. The * topic is optional for assessment.

Table 3. The weightings for the three-level hierarchy for sustainability assessment of HEIs.

Goal	Dimensions	Weight	Aspects	Weight
Campuses sustainability	Built environment	0.4452	Site	0.1331
			Facilities	0.1501
			Buildings	0.1620
	Operations	0.3537	Organizations	0.0721
			Operations	0.1614
			Management	0.1202
	Participation	0.2009	Education	0.0818
			Research	0.0513
			Engagement	0.0226

4.3. The Sustainable Campus Assessment Tools

The quick analysis and benchmarking tools form a progressive assessment process. Through the application of these tools, HEIs could first have a general and then an in-depth understanding of their status toward sustainability. The analysis results could help to control the short-, medium-, and long-term sustainable plans, formulating the path and steps for the implementation of the strategy (Figure 4).

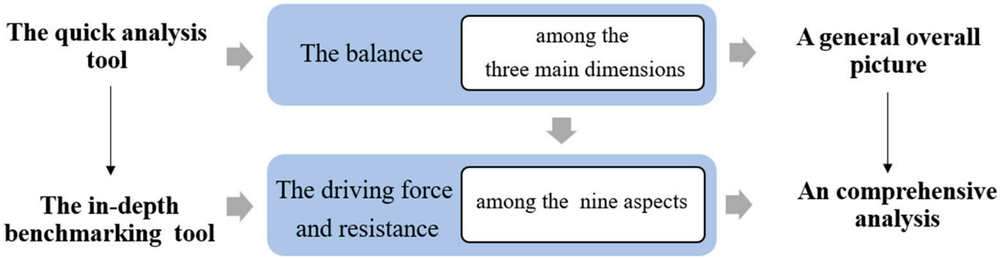

Figure 4. The progressive assessment process of the sustainable campus SATs.

4.3.1. The Quick Analysis Tool

Purpose and stage

The quick analysis tool offered a primary diagnosis of HEIs campuses at almost all the SD stages, to provide a quick, general assessment of the campuses, so as to draw an overall sustainable campus picture of the HEIs.

Indicators and weightings

The tool contains 30 key indicators and is a simplified version of the overall sustainable campus framework. The key indicators are selected based on the main dimensions and aspects of the framework and by considering the accessibility of data to be applied to various developments stage of the campus (Table 4). This tool uses an equal weight of the dimensions, aspects, and indicators.

Table 4. The indicators for the quick analysis tool.

Dimension and Weighting	No.	Indicator	Description (0–4) [1]
Built Environment (A) (0.33)	1	Land area per student	Per student area (m^2/person) = Core Teaching Area area/Total number of students (The value of indicator 1 is calculated by standardizing the value of 15 case samples in this study to a range of 0–4. Sa11 represents the index score; X1 represents the per capita land area; Xmax and Xmin, respectively, represent the maximum value and minimum value range. In the 15 cases of this study, Xmax = 170; Xmin = 11. The calculation method of Sa11 is Sa11 = {1 − (X1 − Xmin)/(Xmax − Xmin)} × 4)
	2	Outdoor environment	The overall quality of the outdoor environment (teacher and student/expert assessment)
	3	Green space	The ratio of green space to the core campus area (%)
	4	Rainwater infrastructure	Construction and distribution of rainwater infrastructure
	5	Landscape quality	The quality of the landscape (teacher and student/expert assessment)
	6	Slow traffic	Safety, convenience, and comfort of the slow traffic (teacher and student/expert assessment)
	7	Energy and water efficient appliances	The application of the appliances
	8	Information infrastructure	Wireless network, one card system, and other facilities
	9	Building design	The proportion of green campus building design standard area (one star or above) (%)
	10	Building renovation	The proportion of green campus building renovation standard area (one star or above) (%)

Table 4. *Cont.*

Dimension and Weighting	No.	Indicator	Description (0–4) [1]
Operations (B) (0.33)	11	Vision	The vision and mission
	12	Strategies and plans	Long-term and mid-term plans towards sustainability
	13	Communication	Problem feedback approaches
	14	Energy efficiency	Programs to reduce energy consumption
	15	Water efficiency	Programs to reduce water consumption
	16	Waste treatment	Programs that contribute to recycling and reducing waste
	17	Sustainable budget	The percentage of the university budget for sustainability efforts in a year (%)
	18	Sustainable management	Sustainable campus-related management system
	19	Energy and water monitor	The application of campus energy and a water monitoring system
	20	Smart campus	The application of a smart campus system
Participation (C) (0.33)	21	Curriculum	The ratio of sustainability curriculum to total (%)
	22	Participate in the curriculum	The ratio of green studens participation (%) (survey/expert assessments)
	23	Training	Sustainable training for staff
	24	Related research	Related research
	25	Research budget	Annual sustainability-related research budget
	26	Research application	Practice and application of green research in
	27	Green activity	Organization and participation in green activities
	28	Enterprise cooperation	Enterprises, HEIs, and governments collaborate on sustainable-related projects
	29	Implementation/Service	Enterprise and government cooperation projects. Service to local society

[1] Each indicator is graded using the following range [45]. 0—there is a total lack of information for the indicator. 1—the information presented is of poor performance, equivalent to around 25 per cent of the required full information. 2—the information presented is of regular performance, equivalent of around 50 percent of the full information required by the indicator. 3—the information presented is considered to be of good performance, equivalent of around 75 per cent. 4—The information has an excellent performance.

Scoring

The percentage of the scores in dimensions are calculated (Q_A for the standardized Built Environment score, Q_B for the Operations, and Q_C for the Participation), and finally Q_Z is the average of the three and is used as the final score.

$$Q_Z = (Q_A + Q_B + Q_C)/3 \quad (1)$$

According to the final score, campuses are divided into four categories: Preparatory Green, Light Green, Medium Green, and Deep Green (Table 5). Campuses that score less than 40% ($Q_Z < 0.4$) of the quick analysis will not be recommended for the benchmarking process, to ensure the quality and efficiency of the second process.

Table 5. The four categories of the quick analysis results.

Category	The Value Range of Q_Z	Categories
1	$0 \le Q_Z < 0.4$	Preparatory Green
2	$0.4 \le Q_Z < 0.6$	Light Green
3	$0.6 \le Q_Z < 0.8$	Medium Green
4	$0.8 \le Q_Z < 1.0$	Deep Green

4.3.2. The In-Depth Benchmarking Tool

Purpose and stage

The benchmarking tool is an integrity assessment based on the sustainable campus framework, considering the scientific nature and accuracy of the data. This tool is applied to the campus with a certain basis for development, offering a systematic and in-depth assessment of HEIs as a reference for future development strategies.

Indicators and weightings

This tool contains 70 indicators (Table 6). These indicators were selected and mortified mainly from the Chinese ASGC, STARS, ASSC, GM, Toolkit, and AISHE (Table A1). Indicators are divided into controlled and scoring ones. The controlled indicators state the basic requirements that HEIs must fulfill. The scoring indicators are recommended to be collected from the official website of the HEIs, from the relevant management and operation departments, and from surveys from the students and staff. The weightings of the indicators were as the results in Section 4.2.

Table 6. The indicators for the in-depth benchmarking tool.

Dimension and Weighting	No	Indicator
Built Environment (BE) (0.45)	1	Overall sustainable development planning
	2 *	Medium and long-term sustainable development planning
	3	Land or spatial use planning
	4	Underground space utilization
	5	Outdoor wind environment
	6 *	Outdoor noise environment
	7	Green Space and heat island effect
	8	Water absorption area
	9 *	Rain water management
	10	Landscape and biodiversity
	11	The surface water quality *
	12	Connection to public transportation
	13	Campus traffic environment
	14	Accessibility of facilities
	15 *	Energy efficiency facility
	16	Water conservation facility
	17	Information-based campus
	18	Green building certification
	19	Building shape coefficient
	20	Building materials
	21 *	Acoustic environment quality
	22 *	Indoor Air Quality
	23	Light environment
	24	Thermal comfort
	25	Historical buildings
Operations (OP) (0.35)	26	Strategy and plan
	27 *	Organizations
	28	Staff and expertise
	29	Enrollment of the stakeholders

Table 6. *Cont.*

Dimension and Weighting	No	Indicator
	30	Report and assessment
	31	Feedback
	32	Energy consumption reduction rate
	33	Renewable energy utilization
	34	Waste heat utilization
	35	Carbon emission
	36	Water consumption reduction rate
	37	Rainwater collection and reuse
	38	The proportion of recycled water
	39	Weight of waste per capita
	40	Waste reduction measures
	41 *	Hazardous waste treatment
	42	Ecological and landscape
	43	Pesticides
	44	Investment and budget
	45	Economical strategies
	46	Green purchase
	47	Ethnically and local investment
	48	Energy monitor system
	49	Smart campus tools
	50	Asset and facility
	51	Principles and rules
	52	Physical and mental health
	53	Healthy circumstances
	54	Prevention of infectious diseases
	55	Emergency and safety measures
Participation (PA) (0.20)	56 *	Medium and long-term education plan
	57	Curriculum
	58	Students enrolled in the curriculum
	59	Supports for curriculum
	60	Campus as a living lab
	61	Training
	62	Research integrating sustainability
	63	Supports for sustainable research
	64	Implementation and commercialization
	65	Green activity
	66	Students' engagement in sustainable operations
	67	Partnerships
	68	Volunteerism/disaster prevention and post-disaster education
	69	Public policy participation
	70	Information disclosure

The * indicators are the controlled ones.

Scoring

The percentage of the score in dimensions and aspects are calculated to make comparisons (MR for scores at the aspect level, MBE for standardized built environment score, MOP for Operations, and MPA for Participation), and finally Md is the sum of the scores.

$$Md = MBE \times 0.45 + MOP \times 0.35 + MPA \times 0.2 \quad (2)$$

The assessment results are divided into four categories, and the number of driving aspects is analyzed (Table 7). The Ma score of less than 40% is the resistance aspects, while the Ma score is greater than 80% is the driving aspects.

Table 7. The four categories of the benchmarking results.

Benchingmarking	Requirement at Overall Level (Md)	Minimum Proportion Requirement for each Aspect-Score (Ma) (Nine Aspects) *
Starter	$40\% \leq Md < 50\%$	None
Mover	$50\% \leq Md < 60\%$	The number of aspects below 40% does not exceed 3
Runner	$60\% \leq Md < 80\%$	The number of aspects below 40% does not exceed 2
Innovator	$80\% \leq Md < 100\%$	The number of aspects below 40% does not exceed 1

* If the total score is satisfied but the sub-score cannot be satisfied, the level will be lowered.

5. Result

The two-hierarchy tools were used to analyze 15 cases of Higher Education Institutions (HEIs) in the Beijing–Tianjin–Hebei region. The scoring results of the cases were presented and compared to evaluate the difference in applicability and scoring results of the tools with the current Chinese green campuses evaluation standard (ASGC).

5.1. Results of the Assessemnts

5.1.1. Results of Quick Analysis

In the quick assessment process, according to the average Q_Z score of each case, the assessment results of the above cases in detail are shown in Table A2. Of the fifteen cases selected in this study, four are Preparatory Green; five are Light Green; five are Medium Green; one is Deep Green (Table 8, Figure 5).

According to the diagnosis results, the four cases of 9TJCM, 13LTU1, 11HSU1, and 12CUGGW are at the Preparatory Green stage ($Q_Z < 0.4$), and the implementation measures and accessible information of a green campus still need to be improved. These cases were in the very initial level of SD and have a relatively obvious gap with other cases and were not recommended for benchmarking. The 11 cases above the Preparatory Green level can be further assessed.

By enrolling in the quick assessment, these cases were generally provided the necessary guidance for its green campus goals to gradually form the preliminary plans so as to enter the track of SD.

Table 8. The result of the 15 cases in category of the quick analysis tool.

Assessment Category	Cases
Preparatory Green ($0 < Q_Z < 0.4$)	9TJCM, 13LTU1, 11HSU1, 12CUGGW
Light Green ($0.4 \leq Q_Z < 0.6$)	4CUMT, 6HEBUT, 10TJCM, 5MUC, 8TFSU
Medium Green ($0.6 \leq Q_Z < 0.8$)	15NKU2, 14TJU2, 7BUA, 3TJU, 2NKU
Deep Green ($0.8 \leq Q_Z < 1.0$)	1THU

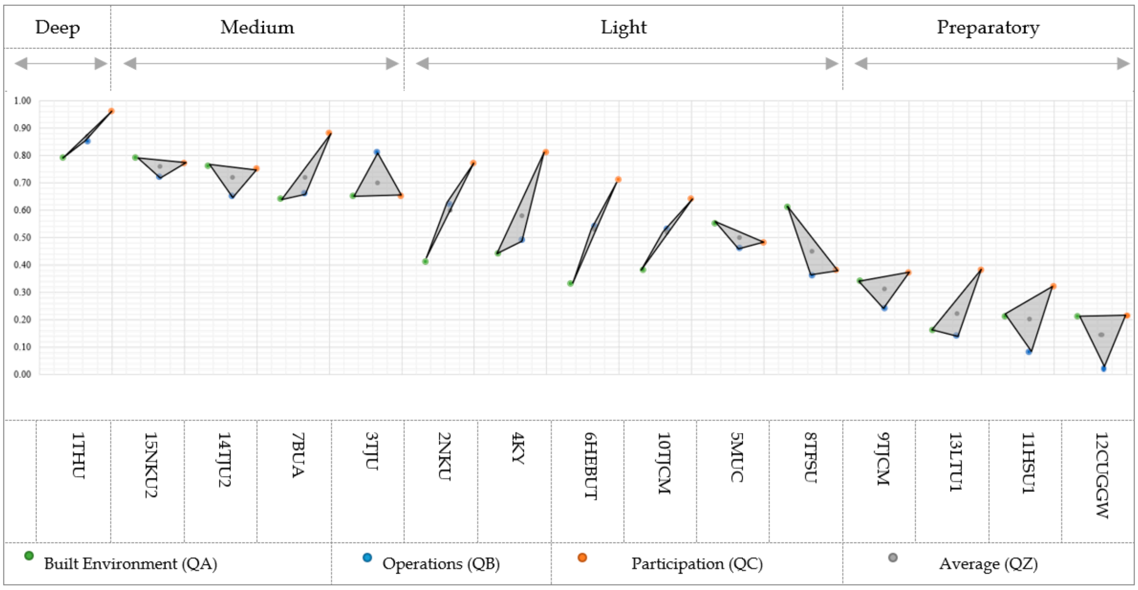

Figure 5. The graphic quick assessment results of the 15 cases.

5.1.2. Results of Benchmarking

Based on the quick assessment, this section further assessed the 11 cases above the Preparatory Green level, analyzed the multi-source data of the campus cases in depth, and simulated, calculated, and described the benchmarking process and results in detail (Table A3).

In the in-depth benchmarking step, the eleven cases are divided into three categories. Four cases were the Movers; five cases were the Runners; two cases were the Innovators; and no case is at the initial level of the Starter (Table 9).

Table 9. The result of the 11 cases in category of the benchmarking tool with the number of the driving aspects (D) and resistance aspects (R).

Benchmarking	Types	Cases
Mover (50% ≤ Md < 60%)	Driver and Resitance	5MUC (D = 1, P = 1)
	Single driver	10TJCM, 8TFSU
	Mutiple drivers	6HEBUT (D = 3)
Runner (60% ≤ Md < 80%)	Single driver	7BUA
	Double drivers	15NKU2, 4KY
	Mutiple drivers	2NKU (D = 3), 3TJU (D = 3)
Innovator (80% ≤ Md < 100%)	Mutiple drivers	1THU (D = 8), 14TJU2 (D = 5)

The Ma score of less than 40% is the resistance aspects, while the Ma score is greater than 80% is the driving aspects.

The Movers, such as 6HEBUT and 10TJCM (50% ≤ Md < 60%, with no more than three aspects scoring less than 40%), have already made some progress in the three main dimensions of green campus and have even made deeper progress in some aspects. However, the foundation of green campus construction is relatively weak or limited by financial resources, lack of organizational experience, etc. The overall scale and depth of construction still need to be improved.

The Runners, such as 15NKU2 and 4KY (60% ≤ Md < 80%, with no more than two aspects less than 40%), have made good progress in each major dimension and achieved obvious results in some aspects; the comprehensiveness of sustainable campus construction can still be improved. The campuses have laid the SD foundations in all dimensions for current and future continuous improvement. The Innovators, such as 1THU and 14TJU2 (60% ≤ Md < 80%, with no aspect score lower than 40%), with multiple drivers, have achieved a high level of progress in most aspects. The two cases showed a relatively balanced state in the nine aspects, but the scores in the building aspects were relatively in the middle (the proportion of scores did not reach 80%).

Then, the 11 cases were compared in the three dimensions and in the overall benchmarking.

From the Built Environment dimension, the score of 11 cases in the three aspects showed a fluctuating trend with the increase of the overall benchmarking category (Figure 6). The aspect of Site (BE1) fluctuates greatly (40–85%) with the increase of the benchmarking category and is followed by the aspect of Buildings (BE3) with the range of 40–70%. The scores in the aspect of Facilities (BE2) were relatively high with little fluctuation between 80 and 100%.

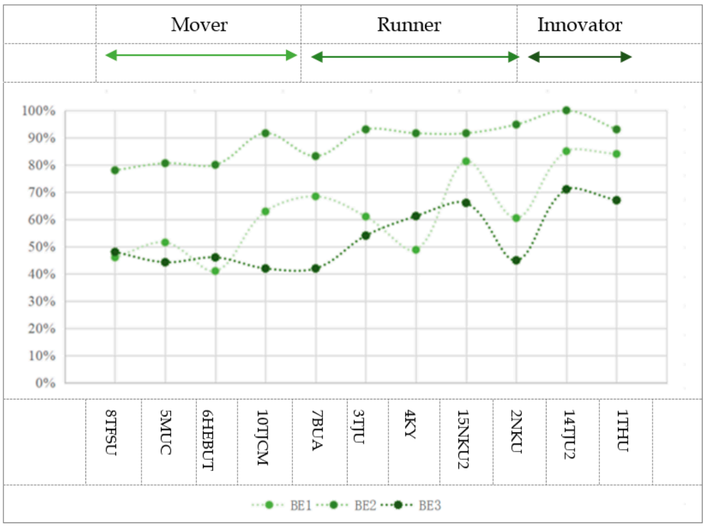

Figure 6. The scores of the Built Environment dimension of the 11 cases in the order of the total score from lowest to highest.

From the Operations dimension, the aspect of Operations (OM2) fluctuates greatly (30–90%) with the increase of the benchmarking category, followed by the aspect of Management (OM3) and Organizations (OM1) with the range of 60–90% (Figure 7).

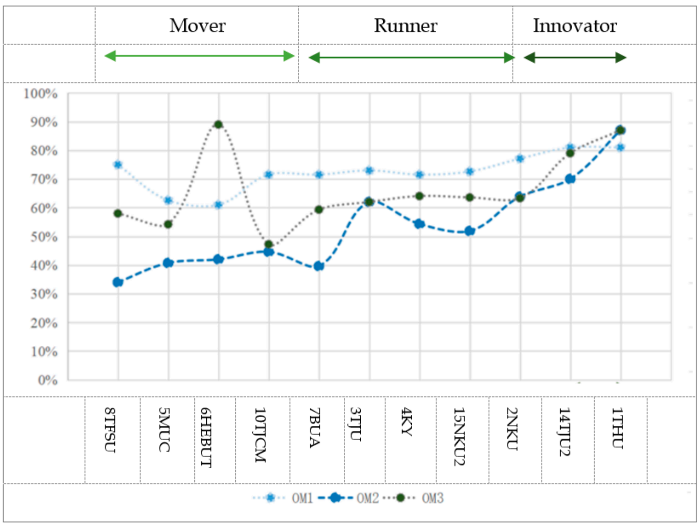

Figure 7. The scores of the Operations dimension of the 11 cases in the order of the total score from lowest to highest.

From the Participation dimension, the aspect of Research (EN2) fluctuates greatly (30–90%) with the increase of the benchmarking category, followed by the aspect of Engagement (EN2) with the range of 40–80%. The scores in the aspect of Education (EN1) were relatively high with relatively little fluctuation between 60 and 90% (Figure 8).

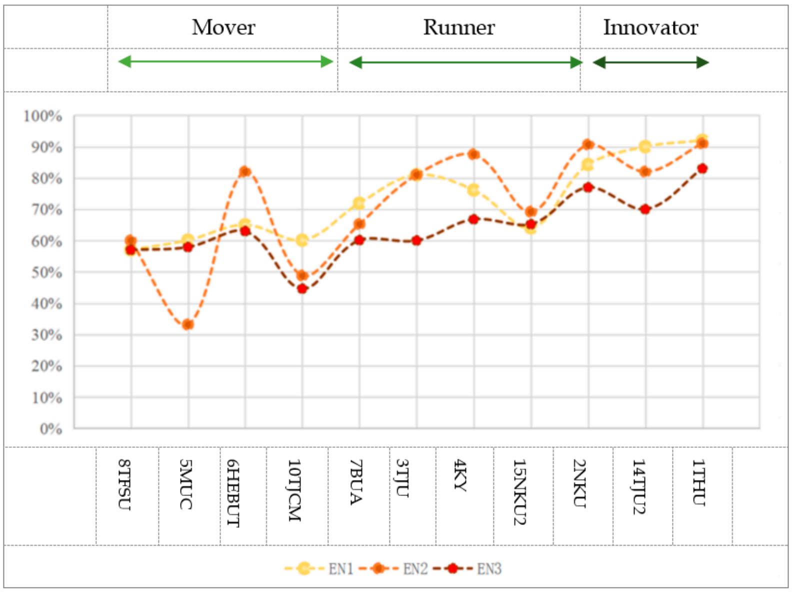

Figure 8. The scores of the Participation dimension of the 11 cases in the order of the total score from lowest to highest.

Combined with the current situation of the cases, it can be seen that the aspects such as Site (BE1) and Facilities (BE2) included the key factors of energy efficiency campuses that have been funded for renovation. Some energy efficiency demonstration campuses had relatively good performance in these aspects. Some aspects such as Organizations (OM1) and Education (EN1) contain the basic indicators in the initial stages of SD and have been adopted by most campuses. Some aspects such as Buildings (BE3) and Engagement (EN2) include indicators that are time or resources consuming and were relatively challenging to score at a high level.

It can be seen that when the development of sustainable campuses reaches a certain level, the promotion of a single dimension and aspects will face the bottleneck, and multi-dimensional coordination and complementarity are needed to jointly promote the improvement of the comprehensive level of the sustainable campus. And it needs continuous SD strategy and plans to reach the higher level, but it is still challenging for most campuses to integrate SD in campuses' strategic planning to strive for optimum added value in the long term [46].

5.2. Comparison of the Assessments Result

5.2.1. The Quick Analysis Tool (QAT) and ASGC

First, the 15 cases were analyzed for the data accessibility of the QAT and ASGC indicators, with the four categories [47] of Formal, Not Formal, Some Evidence, and No Evidence. The analysis showed that the three cases of 9TJCM, 13LTU1, and 12CUGGW have over 60%, and 11HSU1 has around the 60% of the ASGC indicators with No Evidence. Because there is no relevant evidence or accessible evident data, it is not recommended that these four cases use the ASGC for assessment (Table 10).

After comparing the cases, we found that the QAT indicators were able to find evidence for all 15 cases, indicating strong overall applicability. However, the ASGC indicators showed that there were four cases that lack evidence. It is important to note that insufficient information may affect the accuracy of the results of ASGC.

Table 10. The ratio of No Evidence data of the 15 cases of the quick analysis tool (QAT) and ASGC.

The Ratio of No Evidence (NE)	**Cases**														
	1THU	**2NKU**	**3TJU**	**4CUMT**	**5MUC**	**6HEBUT**	**7BUA**	**8TFSU**	**9TJCM**	**10TJCM**	**11HSU1**	**12CUGGW**	**13LTU1**	**14TJU2**	**15NKU2**
QAT	0%	0%	0%	5%	5%	5%	3%	6%	5%	3%	6%	6%	10%	0%	8%
ASGC	12%	9%	12%	26%	27%	21%	13%	38%	62%	25%	60%	63%	67%	5%	20%

5.2.2. The In-Depth Benchmarking Tool (IBT) and ASGC

To better analyze the characteristics of the two-hierarchal tools, the assessment results of the benchmarking tool of the HEIs cases were compared with the ASGC (Table 11). Besides the four cases, five cases at different SD levels were assessed and normalized to percentages to compare their results. It can be seen that the assessment results of the proposed benchmarking tool and ASGC were as follows (Figure 9).

Table 11. The results of the five cases of the in-depth benchmarking tool (IBT) and ASGC.

Assessment Category (M)	**The Bencnmarking Tool**	**The ASGC**
M ≥ 80%	1THU (84%) 14TJU2 (80%)	1THU (85%) 14TJU2 (87%)
60% ≤ M < 80%	3TJU (66%)	3TJU (76%)
40% ≤ M < 60%	6HEBUT (55%) 8TFSU (54%)	6HEBUT (56%) 8TFSU (58%)

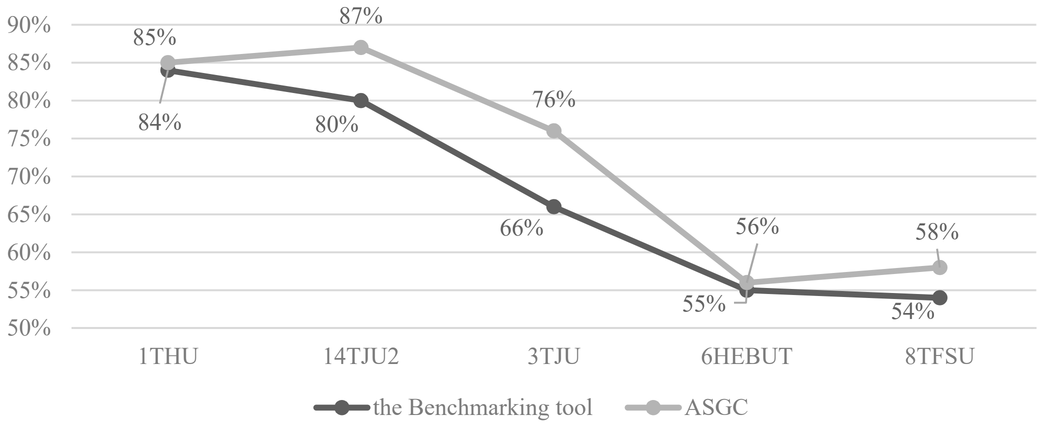

Figure 9. The comparison of the results of the five cases of the benchmarking tool and ASGC.

- Both tools have categorized the five cases into three levels. And the results of the IBT are in some cases relatively low compared to ASGC.
- In the case with the highest score, both tools showed consistent results and identified the best case (1THU). This case had high scores in all dimensions, indicating strong comprehensiveness in sustainability. In the cases of 14TJU2 and 3TJU, there was a gap between the BKT and ASGC, with the BKT score being about 10% lower than ASGC. This suggests that the BKT score has higher comprehensive requirements, and only cases with good performance in the environmental, social, and economic dimensions will have a higher score in the BKT. For the last two cases (6HEBUT and 8TFSU), the difference between the two tools was not significant, indicating that the comparison

was mostly focused on the score of the environment, with other aspects not being dominant and therefore not contributing to a large gap in scores.

- The benchmarking tool showed a more balanced emphasis on the core dimensions of sustainability and paid more attention to the state of campus operations. This was the main reason for the difference in the results.

Compared to the existing SATs, THSus showed its distinguished character in leading HEI cases toward more comprehensive sustainability in the flowing aspects. First, it showed better overall applicability to the HEIs in Beijing, Tianjin, and Hebei. and cases with insufficient data can be assessed for primary diagnosis by the quick analysis tool. All 15 cases were able to use the quick analysis tool for assessment rather, and at least four cases were not able to use ASGC (with less than 60% of the indicators with some evidence for assessment). Second, it showed the pursuit of the core of sustainability by a more balanced weighting on environmental operations compared to ASGC and enrolled both important and applicable indicators in the benchmarking tool. Consequently, the 11 cases obtained scores that were 1% to 10% lower than those of ASGC. Additionally, it is evident that the highest-scoring cases in both tools were influenced by multiple contributing drivers.

6. Discussion

In the context of Chinese campuses, the international SATs and the Chinese ASGC may not be entirely suitable and require modifications to fit the local practices. This is because, on the one hand, the amount and accuracy of campus data are insufficient to participate in the assessment in some cases. On the other hand, some SATs, especially the ASGC, prioritize the assessment of the environment. Therefore, for the Beijing–Tianjin–Hebei campuses, it is necessary to develop an SAT that is more adaptable and emphasizes the comprehensive core of a sustainable campus.

The conceptual framework was inspired by the review of the 15 SATs [11] and summarized as five dimensions of governance, operations, education, research, and engagement and considers the core of campus sustainability and stakeholder engagement in the local HEIs to be reorganized as three dimensions of the Built Environment, Operations, and Participation. The environmental issues were addressed, and other important issues were added, as have been explored in other Chinese regional SATs [20,22].

Comparisons have been made regarding the weightings of SATs, and there have been calls for a decrease in the environmental operations of the Chinese SAT. The weighting of the benchmarking tool highlights the importance of environmental performance, which consists of 36 indicators and carries an overall weight of 61%, which showed around a 10% decrease compared to the current Chinese standard ASGC. This weighting approach could contribute to a more comprehensive and balanced assessment.

Considering the different SD levels and comprehensive goals of sustainable campuses, a two-hierarchy tool would be one of the solutions. In comparison to ASGC, the quick analysis tool can be utilized in these 15 cases, and cases with insufficient information are filtered out by scoring (less than 40%) before further assessment. The QAT can efficiently identify campus problems and improve the efficiency of in-depth assessment. This tool was inspired by AISHE [39] and GM [37]. The assessment results of benchmarking tool showed a difference between it and ASGC. Campuses that prioritize the environment over social and economic aspects experienced a comprehensive score drop of nearly 10% compared to ASGC. The assessment results also indicated that campuses that scored highest in both the QAT and ASGC were influenced by multiple drivers. The two-hierarchy SATs have some limitations that could be explored in future research. To begin with, this research takes the 15 HEIs cases in the Beijing–Tianjin–Hebei as an example, and more cases could be included in future research to fully analyze the characteristics of the Chinese HEIs. Second, although the framework and indicators were proposed based on the characteristics of the HEIs, it still needs more empirical case studies to make indicators better reflect the capacity to effect change.

Compared to the number and diversity of Chinese HEI campuses, future research should further explore the common and unique characteristics of the current situation and SD strategies of the HEIs. With the development of digital and smart campuses, it would need more accessible data to better characterize the campuses. And it would be of practical importance to conduct an annually continuous assessment to track the SD of HEIs and analyze the SD strategies and their payoff for campuses' decision-making.

7. Conclusions

Chinese HEIs are still in their early stage of sustainability and in need of regional sustainable assessment tools (SATs) that address the international SDGs and are more adaptable to local contexts. Based on the analysis of existing SATs and characteristics of the 15 HEIs cases, with the engagement of a 34-person expert team, this research proposed the sustainable assessment framework and the more adaptable two-hierarchy SATs for the HEIs in Beijing–Tianjin–Hebei.

The proposed two-hierarchy SATs included a quick and in-depth assessment tool that could be adapted to HEIs cases at different stages of sustainable development. The quick analysis tool offers an overall picture of the campuses. The in-depth benchmarking tool offers a comprehensive analysis that leads the SD. Compared to the ASGC, the two-hierarchy SATs showed better applicability and efficiency to the HEIs in the researched area and address the comprehensive core of sustainable campuses.

The benchmarking assessment results showed that a single driver could be leading SD in the early stage. However, to achieve a higher level of sustainability, it is necessary for multiple drivers to work together. For the cases that could play the active leading roles, their overall sustainable development is relatively balanced, fully exploiting the advantages of the campuses in a state of multiple cooperation and mutual promotion.

This two-hierarchy SAT offered a solution for regional campuses in different stages of SD to adopt sustainable assessment and also provided key indicators for campuses to be on the track of SD, which shed light on strategic planning for future development.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. The 15 SATs reviewed and inspired this study.

No.	SATs	Abbreviation	Context	Selected and/or Modified Indicators from the SATs (Y for YES.)
1.	Assessment Instrument for Sustainability in Higher Education	AISHE	Global	Y
2.	Adaptable Model for Assessing Sustainability in Higher Education	AMAS	Regional (Chile)	
3.	Assessment System for Sustainable Campus	ASSC	Regional (Japan)	Y
4.	Campus Sustainability Assessment Framework Core	CSAF Core	Regional (Canada)	
5.	Graphical Assessment of Sustainability in University	CASU	Global	
6.	GreenMetric World University Rankings	GM	Global	Y
7.	People & Planet Green League	P&P	Regional (UK)	
8.	Pacific Sustainability Index	PSI	Regional (US)	
9.	Sustainability Assessment Questionnaire	SAQ	Global	
10.	Sustainability Tracking, Assessment and Rating System for Colleges and Universities	STARS	Global	Y
11.	Sustainable University Model	SUM	Global	
12.	Sustainability in Higher Education Institutions	SusHEI	Regional (Portugal)	
13.	Greening Universities Toolkit	Toolkit	Global	Y
14.	Unit-based Sustainability Assessment Tool	USAT	Regional (Africa)	
15.	Assessment Standard for Green Campus	ASGC	Regional (China)	Y

Table A2. The results of the 15 cases from the quick analysis tool.

Score	Cases														
	1THU	2NKUU	3TJUU	4CUMT	5MUC	6HEBUT	7BUA	8TFSU	9TJCM	10TJCM	11HSU1	12CUGGW	13LTU1	14TJU2	15NKU2
Built Environment (Q_A)	0.79	0.41	0.65	0.44	0.55	0.33	0.64	0.61	0.34	0.38	0.21	0.21	0.16	0.76	0.79
Operations ($Q_{B)}$)	0.85	0.62	0.81	0.49	0.46	0.54	0.66	0.36	0.24	0.53	0.08	0.00	0.14	0.65	0.72
Participation (Q_C)	0.96	0.77	0.65	0.81	0.48	0.71	0.88	0.38	0.37	0.64	0.32	0.21	0.38	0.75	0.77
Average (Q_Z)	0.87	0.60	0.70	0.58	0.50	0.53	0.72	0.45	0.31	0.52	0.20	0.14	0.22	0.72	0.76

Table A3. The results of 11 cases from the benchmarking tool.

Scores	Cases										
	1THU	14TJU2	2NKU	15NKU2	4KY	3TJU	7BUA	10TJCM	6HEBUT	5MUC	8TFSU
M_{BE1}	84%	85%	60%	81%	49%	61%	68%	63%	41%	52%	46%
M_{BE2}	93%	100%	95%	92%	92%	93%	83%	92%	80%	81%	78%
M_{BE3}	67%	71%	45%	66%	61%	54%	42%	42%	46%	44%	48%
M_{OM1}	81%	81%	77%	73%	72%	73%	72%	72%	61%	63%	75%
M_{OM2}	87%	70%	64%	52%	54%	62%	40%	45%	42%	41%	34%
M_{OM3}	87%	79%	63%	64%	64%	62%	59%	47%	89%	54%	58%
M_{EN1}	92%	90%	84%	64%	76%	81%	72%	60%	65%	60%	57%
M_{EN2}	91%	82%	91%	69%	88%	81%	65%	49%	82%	33%	60%
M_{EN2}	83%	70%	77%	65%	67%	60%	60%	45%	63%	58%	57%
Md	84%	80%	70%	69%	67%	66%	60%	57%	55%	54%	54%

References

1. Wang, C.; Geng, L.; Rodríguez-Casallas, J.D. How and When Higher Climate Change Risk Perception Promotes Less Climate Change Inaction. *J. Clean. Prod.* **2021**, *321*, 128952. [CrossRef]
2. Dale, A.; Newman, L. Sustainable Development, Education and Literacy. *Int. J. Sustain. High. Educ.* **2005**, *6*, 351–362. [CrossRef]
3. Alam, G.M. Sustainable Education and Sustainability in Education: The Reality in the Era of Internationalisation and Commodification in Education—Is Higher Education Different? *Sustainability* **2023**, *15*, 1315. [CrossRef]
4. UNESCO. *Education for Sustainable Development: A Roadmap*; United Nations Educational, Scientific and Cultural Organization: Paris, France, 2020.
5. Flores-Aguilar, G.; Prat-Grau, M.; Fernández-Gavira, J.; Muñoz-Llerena, A. "I Learned More Because I Became More Involved": Teacher's and Students' Voice on Gamification in Physical Education Teacher Education. *Int. J. Environ. Res. Public Health* **2023**, *20*, 3038. [CrossRef]
6. den Heijer, A.C.; Magdaniel, F.T.J.C. The University Campus as a Knowledge City: Exploring Models and Strategic Choices. *Int. J. Knowl. Based Dev.* **2012**, *3*, 283. [CrossRef]
7. Cottafava, D.; Ascione, G.S.; Corazza, L.; Dhir, A. Sustainable Development Goals Research in Higher Education Institutions: An Interdisciplinarity Assessment through an Entropy-Based Indicator. *J. Bus. Res.* **2022**, *151*, 138–155. [CrossRef]
8. Priyadarshini, P.; Abhilash, P.C. Rethinking of Higher Education Institutions as Complex Adaptive Systems for Enabling Sustainability Governance. *J. Clean. Prod.* **2022**, *359*, 132083. [CrossRef]
9. Mohammadi, Y.; Monavvarifard, F.; Salehi, L.; Movahedi, R.; Karimi, S.; Liobikienė, G. Explaining the Sustainability of Universities through the Contribution of Students' Pro-Environmental Behavior and the Management System. *Sustainability* **2023**, *15*, 1562. [CrossRef]
10. Klein, L.L.; Alves, A.C.; Abreu, M.F.; Feltrin, T.S. Lean Management and Sustainable Practices in Higher Education Institutions of Brazil and Portugal: A Cross Country Perspective. *J. Clean. Prod.* **2022**, *342*, 130868. [CrossRef]
11. Chen, Y.; Liu, G.; Zhuang, T. Evaluating the Comprehensive Benefit of Urban Renewal Projects on the Area Scale: An Integrated Method. *Int. J. Environ. Res. Public Health* **2022**, *20*, 606. [CrossRef]
12. Giovanelli, L.; Rotondo, F.; Ezza, A. Business Models for Integration of Sustainability in Universities: An Explorative Analysis of Italian State Universities. *J. Clean. Prod.* **2021**, *324*, 129227. [CrossRef]
13. Larrán Jorge, M.; Herrera Madueño, J.; Calzado, Y.; Andrades, J. A Proposal for Measuring Sustainability in Universities: A Case Study of Spain. *Int. J. Sustain. High. Educ.* **2016**, *17*, 671–697. [CrossRef]
14. Gómez, F.U.; Sáez-Navarrete, C.; Lioi, S.R.; Marzuca, V.I. Adaptable Model for Assessing Sustainability in Higher Education. *J. Clean. Prod.* **2015**, *107*, 475–485. [CrossRef]
15. Du, Y.; Arkesteijn, M.H.; den Heijer, A.C.; Song, K. Sustainable Assessment Tools for Higher Education Institutions: Guidelines for Developing a Tool for China. *Sustainability* **2020**, *12*, 6501. [CrossRef]
16. Tan, H.; Chen, S.; Shi, Q.; Wang, L. Development of Green Campus in China. *J. Clean. Prod.* **2014**, *64*, 646–653. [CrossRef]
17. MoE Action Plan for Green Campus. Available online: https://www.ndrc.gov.cn/xwdt/ztzl/qgjnxcz/bmjncx/202006/t20200626_1232117.html (accessed on 24 January 2023).
18. Hongbo, L.; Xia, Z.; Yunfeng, L. A Summary of the Research on Green Campus Construction in China. *Tianjin Sci. Technol.* **2017**, *44*, 96–98. [CrossRef]
19. MOHURD. MoE The Construction and Management Guidelines of Energy and Resource Efficient Campus in Colleges and Universities (Trial Implementation). Available online: http://www.moe.gov.cn/jyb_xxgk/moe_1777/moe_1779/201409/t20140917_175035.html (accessed on 24 January 2023).
20. Zhu, B.; Dewancker, B. A Case Study on the Suitability of STARS for Green Campus in China. *Eval. Program Plan.* **2021**, *84*, 101893. [CrossRef]
21. Du, Y.; Zou, Z.; He, Y.; Zhou, Y.; Luo, S. Beyond Blue and Green Spaces: Identifying and Characterizing Restorative Environments on Sichuan Technology and Business University Campus. *Int. J. Environ. Res. Public Health* **2022**, *19*, 13500. [CrossRef]
22. Shuqin, C.; Minyan, L.; Hongwei, T.; Xiaoyu, L.; Jian, G. Assessing Sustainability on Chinese University Campuses: Development of a Campus Sustainability Evaluation System and Its Application with a Case Study. *J. Build. Eng.* **2019**, *24*, 100747. [CrossRef]
23. *CSUS-GBC 04-2013*; Evaluation Standards for Green Campus. China Green Building Council of Chinese Society for Urban Studies: Beijing, China, 2013.
24. *GB/T51356-2019*; Assessment Standard for Green Campus. Ministry of Housing and Urban-Rural Development of the PRC: Beijing, China, 2019.
25. MHURD Announcement of the Ministry of Housing and Urban-Rural Development on the Issuance of the National Standard "Assessment Standard for Green Campus". Available online: https://www.mohurd.gov.cn/gongkai/fdzdgknr/tzgg/201909/20190911_241758.html (accessed on 24 January 2023).
26. MoE Bulletin of National Education Statistics. 2022. Available online: http://www.moe.gov.cn/jyb_sjzl/moe_560/2021/ (accessed on 24 January 2023).
27. China Education Daily Taking Root in China, Forging Ahead and Strengthening the Country: 70 Years of Higher Education Reform and Development in New China. Available online: https://www.chsi.com.cn/jyzx/201909/20190927/1829961780.html (accessed on 24 January 2023).
28. den Heijer, A.C.; Curvelo Magdaniel, F.T.J. Campus–City Relations: Past, Present, and Future. *Geogr. Univ.* **2018**, *12*, 439–459.

29. Chen, J. *University Campus Beijing*; Tsinghua University Press: Beijing, China, 2014.
30. Lindsay Cole, B. Assessing Sustainability on Canadian University Campuses: Development of a Campus Sustainability Assessment Framework. Master's Thesis, Royal Roads University, Victoria, BC, Canada, 2003.
31. Shi, H.; Lai, E. An Alternative University Sustainability Rating Framework with a Structured Criteria Tree. *J. Clean. Prod.* **2013**, *61*, 59–69. [CrossRef]
32. Gutu, I.; Agheorghiesei, D.T.; Tugui, A. Assessment of a Workforce Sustainability Tool through Leadership and Digitalization. *Int. J. Environ. Res. Public Health* **2023**, *20*, 1360. [CrossRef] [PubMed]
33. Dawodu, A.; Dai, H.; Zou, T.; Zhou, H.; Lian, W.; Oladejo, J.; Osebor, F. Campus Sustainability Research: Indicators and Dimensions to Consider for the Design and Assessment of a Sustainable Campus. *Heliyon* **2022**, *8*, e11864. [CrossRef] [PubMed]
34. Alshuwaikhat, H.M.; Abubakar, I. An Integrated Approach to Achieving Campus Sustainability: Assessment of the Current Campus Environmental Management Practices. *J. Clean. Prod.* **2008**, *16*, 1777–1785. [CrossRef]
35. AASHE STARS Technical Manual 2.2. Available online: https://stars.aashe.org/resources-support/technical-manual/ (accessed on 1 July 2023).
36. Sustainable Campus Management Office of Hokkaido, University Assessment System for Sustainable Campus 2013. Available online: https://www.osc.hokudai.ac.jp/en/action/assc. (accessed on 1 July 2023).
37. University of Indonesia, UI GreenMetric Guideline 2019 English 1.2. Available online: https://greenmetric.ui.ac.id/about/methodology. (accessed on 1 July 2023).
38. UN Environment Programme Greening Universities Toolkit. Available online: https://www.unenvironment.org/resources/toolkits (accessed on 24 January 2021).
39. Roorda, N.; Waara, S.; Urbano Fra Paleo, S. AISHE 2.0 Manual Assessment Instrument for Sustainability in Higher Education Edition 2.0 Second Draft AISHE 2.0. Available online: https://www.eauc.org.uk/theplatform/aishe (accessed on 1 July 2023).
40. Fadzil, Z.F.; Hashim, H.S.; Che-Ani, A.; Aziz, S. Developing a Campus Sustainability Assessment Framework for the National University of Malaysia. *Int. J. Environ. Ecol. Eng.* **2012**, *6*, 333–334.
41. Waheed, B.; Khan, F.I.; Veitch, B.; Hawboldt, K. Uncertainty-Based Quantitative Assessment of Sustainability for Higher Education Institutions. *J. Clean. Prod.* **2011**, *19*, 720–732. [CrossRef]
42. Alghamdi, N.; den Heijer, A.; de Jonge, H. Assessment Tools' Indicators for Sustainability in Universities: An Analytical Overview. *Int. J. Sustain. High. Educ.* **2017**, *18*, 84–115. [CrossRef]
43. Xiao, O. Simulation and Optimal Regulation of Urban Land Use Expansion in Changzhutan Urban Agglomeration Based on Symbiosis Concept. Ph.D. Thesis, Hunan Normal University, Changsha, China, 2020.
44. Du, Y.; Zheng, Y.; Wu, G.; Tang, Y. Decision-Making Method of Heavy-Duty Machine Tool Remanufacturing Based on AHP-Entropy Weight and Extension Theory. *J. Clean. Prod.* **2020**, *252*, 119607. [CrossRef]
45. Lozano, R. The State of Sustainability Reporting in Universities. *Int. J. Sustain. High. Educ.* **2011**, *12*, 67–78. [CrossRef]
46. Arkesteijn, M.H. *Corporate Real Estate Alignment: A Preference-Based Design and Decision Approach*; Delft University of Technology: Delft, The Netherlands, 2019.
47. Parvez, N.; Agrawal, A. Assessment of Sustainable Development in Technical Higher Education Institutes of India. *J. Clean. Prod.* **2019**, *214*, 975–994. [CrossRef]