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The Proposal of Integrated Actions in Transport as Part of a Climate Action Plan for UNICAMP

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Abstract. Since 2019, the State University of Campinas (UNICAMP) has been collecting data, preparing, and annually monitoring sustainability indicators submitted to the UI GreenMetric ranking, which guide improvement projects at the university in alignment with the Sustainable Development Goals (SDGs). This article aims to propose sustainable practices for managing urban mobility on its campuses, drawing inspiration from the experiences of national and international universities that ranked highest in the 2023 edition of the aforementioned ranking. The study employed both qualitative and quantitative research methods, using a descriptive approach combined with Deductive Content Analysis (DCA). This analysis was further validated by the Multi-Criteria Decision-Making (MCDM) method known as Fuzzy SWARA. Through this process, the study identified the most commonly adopted actions by universities: promoting the use of electric and/or conventional bicycles on campus (11.8%); projects in partnership with government, state, or municipal entities to develop express cycle paths and encourage bicycle use both on campus and in the city (9.2%); conventional bicycle rental on campus (9.2%); and electric car sharing on campus (9.2%). The proposals suggested for UNICAMP include encouraging carpooling, implementing a public transportation exemption or half-fare program for employees, promoting the use of bicycles while ensuring increased campus security, among other initiatives. This research is part of a proposal for a Climate Action Plan for the university, which aims to effectively integrate sustainability into the university's agenda and support the fight against the climate emergency through necessary adaptations.

Keywords:

Net Zero Plan, Sustainability indicators, Sustainable practices, Transport, Universities, UI GreenMetric, UNICAMP.

1. Introduction

The signing of the International Sustainable Campus Network (ISCN) charter [1] by the Sustainable University Management Group (GGUS) at the State University of Campinas (UNICAMP) marked a significant commitment. It provided administrative, technical, and academic support for the development of a Sustainable Campus model at the university. This model serves as a living laboratory for renewable energy minigeneration applications, energy consumption monitoring and management, and energy efficiency. Through these efforts, the university aims to align itself with the global sustainability agenda and is committed to achieving the United Nations (UN) Sustainable Development Goals (SDGs) [2].

Since then, UNICAMP has actively worked to promote and implement sustainability across its campuses through various initiatives led by internal bodies, including the Sustainable University Management Group (GGUS), the Executive Board for Integrated Planning (DEPI), the Coordination of Sustainability (CSUS), the Sustainable Campus Office, and the São Paulo Center for Energy Transition Studies (CPTEn). As part of this "living laboratory," the university prioritizes addressing the key challenges of the energy transition, focusing on developing solutions that can be applied beyond the academic environment, benefiting society. UNICAMP, with its total area of 4,979,434.58 m², including forests, planted vegetation, buildings, and parking lots [3], is home to around 50,000 people.

Regarding the university's CO2eq emissions, those from transport account for approximately 4% of indirect Scope 3 emissions. In 2023, UNICAMP emitted around 3,454,870.62 kg CO2eq from ethanol, diesel, and gasoline consumption [3]. The transport sector, following buildings, is one of the primary contributors to Greenhouse Gas (GHG) emissions, with an average annual growth rate of 1.7% between 1990 and 2022. This rate is higher than that of any other end-use sector, except for industry (which also grew by around 1.7%). To achieve the Net Zero Emissions (NZE) scenario by 2050, the transport sector's CO2 emissions must decrease by more than 3% annually until 2030. This reduction will require regulations, tax incentives, and substantial investment in infrastructure to support the operation of low- and zero-emission vehicles [4].

In this context, this article proposes sustainable practices for managing urban mobility on UNICAMP campuses, drawing inspiration from national and international universities' experiences. This is part of a broader research effort to propose a Net-Zero Plan aimed at neutralizing the university's GHG emissions and effectively integrating sustainability into the university's agenda to address the climate emergency through necessary adaptations.

2. Methodology

The research employs both qualitative and quantitative methods, using a descriptive approach, bibliographic research procedures, and Deductive Content Analysis (DCA). The analysis is validated through a combination of two Multi-Criteria Decision-Making (MCDM) methods: Fuzzy logic and the Step-wise Weight Assessment Ratio Analysis (SWARA), resulting in the Fuzzy SWARA method. In this case, a modified version of the Fuzzy SWARA method was proposed. Figure 1 details the adopted research methodology, which consists of sequential steps corresponding to the order of activities carried out.

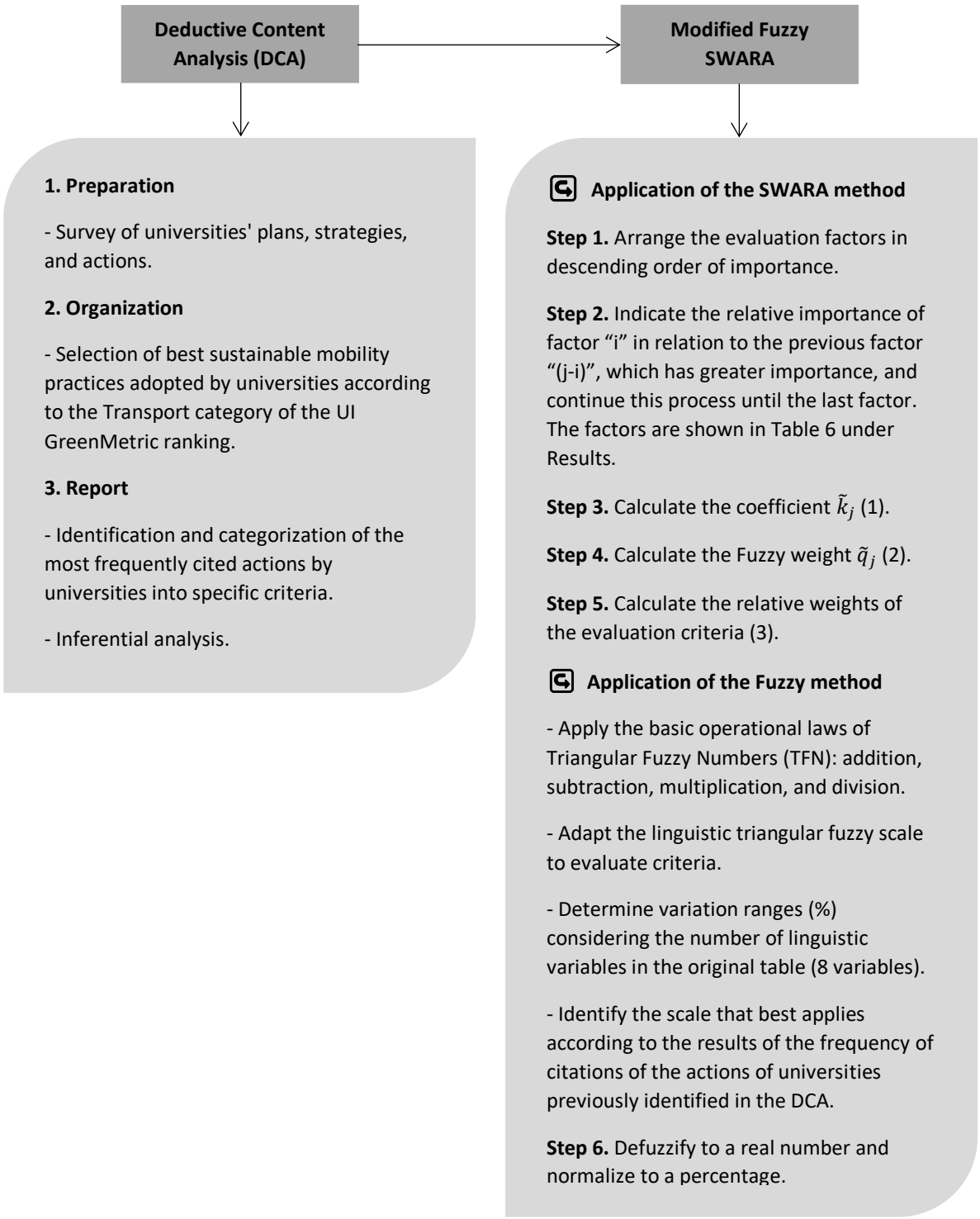

Figure 1. Stages of the Research Methodology

2.1. Analysis of UNICAMP's Good Sustainability Practices

At this stage, a situational analysis of UNICAMP was conducted regarding the indicators in the Transport category of the UI GreenMetric 2023 ranking. The analysis included a review of the university's completed projects and actions, those currently in progress, and planned future initiatives. The focus then shifted to the indicators where UNICAMP had the lowest scores, as detailed in Table 1.

Table 1. Indicators with Scores Below the Maximum

Indicators	Score
TR1 – The total number of vehicles (cars and motorcycles) divided by total campus' population	100 out of 200
TR5 – Ratio of ground parking area to total campus area	150 out of 200

Source: Compiled from information in [3].

2.2. Analysis of Good Sustainability Practices at Selected Universities

2.2.1 Deductive Content Analysis Method (DCA)

In this stage, good sustainability practices from national and international universities with high rankings in the UI GreenMetric 2023 were selected using a Content Analysis (CA) procedure, also known as document analysis.

For the analysis, two universities recognized as among the most sustainable in the world and two of the most sustainable universities in Latin America were selected. Among these, one is also considered the most sustainable in Brazil (University of São Paulo – USP). The selected universities and their respective scores in this category are shown in Table 2.

Table 2. Top-Ranked Universities in the UI GreenMetric Ranking

University	Classification in the Ranking	Score in the Transport Category
Wageningen University & Research (WUR)	1st	1750
Umwelt-campus Birkenfeld (Trier University of Applied Sciences)	3rd	1700
University of Sao Paulo (USP)	8th	1700
University of Rosario (UR)	32nd	1725

Source: Compiled from information in [5].

Content Analysis (CA) is a systematic and objective research method used to describe and quantify phenomena [6-8]. It allows researchers to test theoretical questions and enhance understanding of data. The objective is to obtain a concise yet comprehensive description of the phenomenon. The result of the analysis consists of concepts or categories that describe the phenomenon and facilitate the construction of a model, conceptual system, conceptual map, or categories [9]. This analysis can be either deductive or inductive.

The inductive and deductive analysis processes are typically represented in three main phases: preparation, organization, and reporting [10]. In this study, the deductive method was applied. During the research preparation phase, a survey of universities' plans, strategies, and actions related to the energy field was conducted, considering the teaching-research-extension triad. In the organization phase, the information extracted from each university was focused on the Transport category.

For data collection, a total of five institutional plans were reviewed, along with the respective websites featuring detailed sections on projects and actions developed by the institutions. Using the DCA method [10], relevant terms related to the selected category were defined as units of analysis, including “renewable energy,” “sustainable energy practices and/or actions,” “transport,” “sustainable mobility,” “sustainable transport practices,” and others.

In the reporting phase, the actions cited most frequently by universities were identified and categorized into criteria, followed by inferential analysis. These actions were used as a reference to evaluate practices that UNICAMP could adopt or adapt to enhance its performance according to the ranking requirements and promote genuine sustainability in urban mobility on its campuses.

The DCA approach was chosen because it facilitates the collection, selection, and organization of data. It presents numerous benefits, like offering a well-organized structure for data analysis, enabling researchers to validate current theories, and streamlining data management. Nevertheless, it also comes with drawbacks, such as the lack of adaptability to investigate unforeseen results, the possibility of bias from predefined categories, and the potential exclusion of pertinent data that does not align with the predetermined framework. In general, even though DCA assists in methodically arranging and deciphering data, its success relies on the strength of the original theoretical framework and could miss out on emerging insights or fresh viewpoints. One of the limitations of this approach was the constrained data available for the selected universities, which could have been overcome by expanding the sample size of the research.

2.2.2 SWARA Fuzzy Multicriteria Analysis Method

Based on the criteria categorized in the previous step, the Fuzzy SWARA method [11]—a combination of Fuzzy logic and the Step-wise Weight Assessment Ratio Analysis (SWARA) method—was applied. The SWARA method was originally proposed by [12].

Various factors, such as unquantifiable information, incomplete data, inaccessible information, and partial ignorance, can lead to inaccuracies in decision-making. Fuzzy multi-attribute decision-making methods have been developed to address the imprecision in assessing the relative importance of attributes and ranking the performance of alternatives with respect to those attributes [13]. This research extended the traditional SWARA method to Fuzzy SWARA, under the assumption of criteria independence.

The process of determining the relative weights of the criteria using the Fuzzy SWARA method follows the same steps as the traditional SWARA method. These steps are outlined below:

1. Arrange the assessment factors in descending order of importance.
2. Indicate the relative importance of factor "i" compared to the previous factor "(j-i)," which has greater importance, and continue this process until the last factor. The factors are shown in Table 6 under Results.
3. Calculate the coefficient $\tilde{k}_j$(1).

$$\tilde{k}_j = \begin{cases} \tilde{1} & j = 1 \\ \tilde{s}_j + \tilde{1} & j > 1 \end{cases} \quad (1)$$

4. Calculate the Fuzzy weight $\tilde{q}_j$(2).

$$\widetilde{q_j} = \begin{cases} \tilde{1} & j = 1 \\ \frac{\tilde{x}_j - 1}{\tilde{k}_j} & j > 1 \end{cases} \quad (2)$$

5. Calculate the relative weights of the evaluation criteria (3).

$$\widetilde{w_j} = \frac{\widetilde{q_j}}{\sum_{k=1}^{n} \tilde{q}_k} \quad (3)$$

Where $\widetilde{w}_j = \left(w_j^l, w_j^m, w_j^u\right)$ is the relative fuzzy weight of the j-th criterion, and n represents the number of evaluation criteria.

The basic operational laws in Triangle Fuzzy Number (TFN) are $\mathrm{A1} = (l_1, m_1, u_1)$, where $l_1 \leq m_1 \leq u_1$, and $\mathrm{A2} = (l_2, m_2, u_2)$, where $l_2 \leq m_2 \leq u_2$, are defined as follows [11].

- Fuzzy Addition:

$$A1 + A2 = (l_1 + l_2,\ m_1 + m_2,\ u_1 + u_2) \quad (4)$$

- Fuzzy Subtraction:

$$A1 - A2 = (l_1 - U_2,\ m_1 - m_2,\ U_1 - l_2) \quad (5)$$

- Fuzzy Multiplication:

$$A1 \times A2 = (l_1 l_2,\ m_1 m_2,\ u_1 u_2) \quad (6)$$

- Fuzzy Division:

$$A1/A2 = (l_1/U_2,\ m_1/m_2,\ U_1/l_2) \quad (7)$$

The linguistic triangular Fuzzy scale for evaluating criteria was adapted based on Table 3 [14]. A variation range (%) was then determined, considering the number of linguistic variables from the original table (8 variables). This allowed for the identification of the scale that best applies according to the results of the frequency of citations of the actions previously identified in the DCA.

Table 3. Linguistic triangular fuzzy scale for modified fuzzy SWARA method

Linguistic Variable	Abbreviation	TFN Scale (l, m, n)	Var. of Citations [%]
Absolutely Less Significant	ALS	(1, 1, 1)	-100.00
Dominantly Less Significant	DLS	(1/2, 2/3, 1)	-85.71
Much Less Significant	MLS	(2/5, 1/2, 2/3)	-71.43
Really Less Significant	RLS	(1/3, 2/5, 1/2)	-57.14
Less Significant	LS	(2/7, 1/3, 2/5)	-42.86
Moderately Less	MDLS	(1/4, 2/7, 1/3)	-28.57

Linguistic Variable	Abbreviation	TFN Scale (l, m, n)	Var. of Citations [%]
Significant			
Weakly Less Significant	WLS	(2/9, 1/4, 2/7)	-14.29
Equally Significant	ES	(0, 0, 0)	0.00

Source: Adapted from Stevic *et al.* [14].

6. Defuzzify as follows (8):

$$Defuzzify = \frac{L + 2M + U}{4} \quad (8)$$

Finally, normalization was performed, expressed as a percentage.

The Fuzzy SWARA method was chosen to quantify and validate the data previously obtained using the DCA method, taking into account the frequency analysis based on the number of citations for each of the most commonly adopted sustainability practices. This method addresses uncertainties and subjective evaluations. Its benefits include the capacity to measure and confirm intricate data with varying levels of accuracy and the adaptability to include imprecise details. Nonetheless, it also presents drawbacks, such as reliance on the precision of the Fuzzy logic parameters and potential difficulties in interpreting outcomes due to the inherent intricacy of the approach. Furthermore, the efficiency of Fuzzy SWARA may be limited by the quality and extent of the data used, which could impact the dependability of the final evaluation.

It is important to note that the research faced some limitations related to this methodology. Specifically, it was not possible to assess how structural and management-level changes aimed at achieving sustainability at the university impact and are impacted by the behavior of individuals (teachers, students, and staff). The study primarily focused on gathering and analyzing information and cases, proposing improvements based on the current situation and experiences from other international and national examples. Variables requiring field research, interviews, or questionnaires were excluded. Additionally, the application of the MCDM Fuzzy SWARA method was constrained by a limited data set that relied solely on one criterion (citation frequency), which further restricted the analysis.

2.3. Proposals for the UNICAMP Climate Action Plan

Based on the experiences of the selected universities and the frequency of actions they undertook, as identified in the previous stage, proposals for UNICAMP were developed for each indicator where the university did not achieve the maximum score in the category, as shown in Table 1 of subtopic 2.1. These proposals can contribute to the creation of a Climate Action Plan for UNICAMP, structured and aimed at integrating university actions to achieve net-zero emissions.

3. Results

3.1. Analysis of UNICAMP's good sustainability practices

In the Transport category, a total of 8 indicators are analyzed. As shown in Table 4, UNICAMP scored below the total in two of these indicators: TR1 – The total number of vehicles (cars and motorcycles) divided by the total campus population, and TR5 – The ratio of ground parking area to total campus area. In all other indicators, the university

achieved the maximum score.

Table 4. Actions Carried Out by UNICAMP within the Scope of Transport

Indicator	UNICAMP performance
TR1 – The total number of vehicles (cars and motorcycles) divided by the total campus' population	100 out of 200
TR2 – Shuttle services	Total score (300)
TR3 – Zero Emission Vehicles (ZEV) policy on campus	Total score (200)
TR4 – The total number of Zero Emission Vehicles (ZEV) divided by total campus population	Total score (200)
TR5 – Ratio of ground parking area to total campus area	150 out of 200
TR6 – Program to limit or decrease the parking area on campus for the last 3 years (from 2020 to 2022)	Total score (200)
TR7 – Number of initiatives to decrease private vehicles on campus	Total score (200)
TR8 – Pedestrian paths on campus	Total score (300)

Source: Compiled by the author based on information from [3] and [15].

Figure 2 illustrates the actions taken by UNICAMP within the Transport category.

Figure 2. Actions Implemented by UNICAMP within the Transport Scope
Source: Compiled by the author based on information from [3] and [15].

Most vehicles use the campus as a gateway to the Barão Geraldo neighborhood, which borders the campus. This is why the number is so significant in TR1. In TR2, all buses are monitored by a system called 'Circulino', which provides real-time location information to users through an app. Figure 3 shows images of the electric bus that circulates on the Zeferino Vaz campus, as well as charging points for buses and cars.

(a) (b) (c)

Figure 3. (a) Electric bus, (b) Charging point for electric vehicles, (c) Charging point for electric buses
Source: Dalbelo [3].

In indicator TR6, the 'Shared Spaces and Tactical Urbanism' project is being implemented at the Zeferino Vaz Campus. This project aims to promote temporary and low-cost interventions to test and evaluate the effectiveness and community acceptance of shared spaces. As part of this initiative, some streets will no longer have parking spaces; instead, these areas will be shared with pedestrians and cyclists to reduce car circulation and parking, while ensuring user safety (as indicated on the map in Figure 4). A 10% reduction in the parking area has already been implemented.

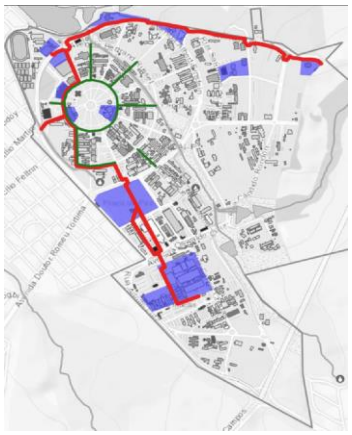

Figure 4. Shared Spaces and Tactical Urbanism Project
Source: Dalbelo [3].

Regarding indicator TR7, there are a total of 6 transport initiatives aimed at reducing the number of private vehicles on the Zeferino Vaz campus. These initiatives include: cycle paths; accessible sidewalks; a free public transport service within the campus and to the Student Housing Program (PME) outside the campus; a 'Smart Campus' app (for monitoring transportation services); a chartered bus service for employees; and public bus stops.

(a) (b) (c)

Figure 5. (a) Bike rack map on Zeferino Vaz Campus, (b) Bicycle pathways and accessible sidewalks, (c) Shuttle service monitoring app – Smart Campus App
Source: Dalbelo [3].

3.2. Analysis of good sustainability practices at selected universities

This section presents the best sustainability practices adopted by the selected universities. These actions were used as a reference to analyze which practices UNICAMP could adopt to enhance its performance according to the requirements of the aforementioned ranking. A summary of these practices is provided in Table 5.

Table 5. Actions Carried Out by HEIs within the Scope of Transport

University	Actions in Transport
Wageningen University & Research (WUR)	- Home office, online meetings, and travel only when necessary. - Electric car sharing for business trips. - Creation of shared electric bicycle centers on campus. - Replacement of outdated bicycle racks and expansion of space for special bicycles, such as cargo bikes and electric bicycles. - Encouragement of electric scooter and car adoption through the installation of charging points. - E-bike2WUR Project: Employees could try out an e-bike or speed pedelec (an e-bike capable of speeds up to 45 km/h) for two weeks. Approximately 150 employees participated, with some later purchasing an e-bike or speed pedelec. - Provision of a “Business Card” from the national railway company and implementation of a program for employees to purchase an electric bicycle with tax benefits. - Development of a network of express cycle paths leading to the campus, in partnership with the municipality and the province of Gelderland. - Participation in the “Bicycle Mission for Higher Education” by the Ministry of Infrastructure and Water Management, aiming to increase by 10% the number of employees commuting to the university by bicycle.
Umwelt-campus Birkenfeld	- Digital bicycle rental. - Acquisition of 10 bicycles and 1 cargo bike. - Increase in the number of participants in cycling in the city of

University	Actions in Transport
Trier University of Applied Sciences	Birkenfeld. - Creation of an electric car sharing option for students and employees.
University of Rosario (UR)	- Encouragement of sustainable transport use, including the reactivation of the Shared Use Bicycle System (SIBUC) across the 5 campuses (653 bicycles, 54 scooters and electric bicycles), and 3 electric cars for shared use. - MoviUR (shared transport program), allowing users to upload routes for car sharing (via the "Carpooling – Try My Ride" app) and form cycling groups to various locations. - Free maintenance for SIBUC bicycles. - Insurance provision for electric bicycles and scooters. - Increased physical capacity for bicycle, scooter, and electric bicycle parking. - Comprehensive activities promoting sustainable mobility (e.g., theater, training actions).
University of São Paulo (USP)	- "Let's Go by Bike" project at the Pirassununga campus, featuring bicycle sharing points usable with the USP card, integrated with the Butantã Terminal and surrounding areas. - The Environmental Management Superintendency (SGA) is involved in a project by the Research Center for Gas Innovation, which aims to research sustainable mobility through a hydrogen-powered public transport line between São Paulo and São Bernardo do Campo. - A program set to operate 2 hydrogen fuel cell buses at the university in 2024, as a result of a partnership with EMTU (Metropolitan Urban Transport Company) and companies including Shell, Raízen, Hytron, SENAI, and Toyota. The initiative involves converting ethanol into hydrogen to fuel the buses.

Source: Compiled by the author based on information from [16-31].

The most frequently cited categories and their respective criteria are shown in Table 6.

Table 6. Grouping of Most Cited Action Criteria Categories by Universities

Category	Criteria / Factor	No. of Citations	Universities
Encouraging the Use of Bicycles (Cat_1)	C_1: Projects to encourage the use of electric and/or conventional bicycles on campus	4	WUR, Umwelt-campus Birkenfeld, UR, USP
	C_2: Projects in partnership with government, state, or municipality to develop express bike lanes and promote bicycle use on campus and in the city	3	WUR, USP

Category	Criteria / Factor	No. of Citations	Universities
	C_3: Conventional bicycle rental on campus	3	Umwelt-campus Birkenfeld, USP
	C_4: Implementation of a shared bicycle use system for students with free bicycle maintenance	1	UR
	C_5: Offering insurance for bicycles and electric scooters on campus	1	UR
	C_6: Increase in installed physical capacity for parking bicycles, scooters, and electric bicycles	1	UR
	C_7: Replacing outdated bike racks	1	WUR
Car Sharing (Cat_2)	C_8: Electric car sharing on campus	3	WUR, Umwelt-campus Birkenfeld , UR
	C_9: Car sharing program	1	UR
	C_{10}: Installation of charging points for electric scooters and cars	1	WUR
Education for Sustainable Mobility (Cat_3)	C_{11}: Education activities to promote sustainable mobility on campus	1	UR
	C_{12}: Projects in partnership with a research center to develop a hydrogen-powered public transport line between cities	1	USP
	C_{13}: Travel only when necessary, online meetings, and home office adoption	1	WUR

Source: Compiled by the author based on information from [16-31].

The weights of the criteria, as classified using the Fuzzy SWARA method, are shown in Table 7.

Table 7. Validation by the Fuzzy SWARA method

Criteria	No. of Citations	Var. [%]	Relative Importance (Sj)	Representation in fuzzy numbers Kj			kj			qj			wj			Defuzzification	normalized w
C1	4						1.00	1.00	1.00	1.00	1.00	1.00	0.11	0.12	0.13	0.1183831838	11.8%
C2	3	-25.00	MLS	1/4	2/7	1/3	1.25	1.29	1.33	0.75	0.78	0.80	0.08	0.09	0.10	0.09203072584	9.2%
C3	3	0.00	ES	0	0	0	1.00	1.00	1.00	0.75	0.78	0.80	0.08	0.09	0.10	0.09203072584	9.2%
C8	3	0.00	ES	0	0	0	1.00	1.00	1.00	0.75	0.78	0.80	0.08	0.09	0.10	0.09203072584	9.2%
C5	1	-66.67	MLS	2/5	1/2	2/3	1.40	1.50	1.67	0.45	0.52	0.57	0.05	0.06	0.07	0.06121122252	6.1%
C6	1	0.00	ES	0	0	0	1.00	1.00	1.00	0.45	0.52	0.57	0.05	0.06	0.07	0.06121122252	6.1%
C7	1	0.00	ES	0	0	0	1.00	1.00	1.00	0.45	0.52	0.57	0.05	0.06	0.07	0.06121122252	6.1%
C4	1	0.00	ES	0	0	0	1.00	1.00	1.00	0.45	0.52	0.57	0.05	0.06	0.07	0.06121122252	6.1%
C9	1	0.00	ES	0	0	0	1.00	1.00	1.00	0.45	0.52	0.57	0.05	0.06	0.07	0.06121122252	6.1%
C10	1	0.00	ES	0	0	0	1.00	1.00	1.00	0.45	0.52	0.57	0.05	0.06	0.07	0.06121122252	6.1%

Criteria	No. of Citations	Var. [%]	Relative Importance (Sj)	Representation in fuzzy numbers Kj			kj			qj			wj			Defuzzification	normalized w
C11	1	0.00	ES	0	0	0	1.00	1.00	1.00	0.45	0.52	0.57	0.05	0.06	0.07	0.06121122252	6.1%
C12	1	0.00	ES	0	0	0	1.00	1.00	1.00	0.45	0.52	0.57	0.05	0.06	0.07	0.06121122252	6.1%
C13	1	0.00	ES	0	0	0	1.00	1.00	1.00	0.45	0.52	0.57	0.05	0.06	0.07	0.06121122252	6.1%
C13	1	0.00	ES	0	0	0	1.00	1.00	1.00	0.45	0.52	0.57	0.05	0.06	0.07	0.06121122252	6.1%

It is noted that the most frequently cited urban mobility actions, and therefore the ones most commonly adopted by the universities analyzed, are related to: (i) C_1 Projects to encourage the use of electric and/or conventional bicycles on campus (11.8%); (ii) C_2 Projects in partnership with government, state, or municipal entities to develop express cycle paths and promote bicycle use on campus and in the city (9.2%); (iii) C_3 Rental of conventional bicycles on campus (9.2%); and (iv) C_8 Sharing of electric cars on campus (9.2%).

3.3. Proposals for the UNICAMP Climate Action Plan

In the Transport category, where UNICAMP achieved nearly 100% performance (1600 out of 1800 points), some improvement proposals are suggested based on the indicators that did not reach the maximum score: TR1 (the total number of vehicles—cars and motorcycles—divided by the total campus population) and TR5 (ratio of ground parking area to total campus area). Therefore, the university could consider actions such as encouraging the use of public transport, implementing a car-sharing program (creating a university car pool), promoting bicycle use on campus, and adopting remote work practices.

Regarding the promotion of sustainable mobility alternatives, such as bicycles, encouraging their use also involves promoting sharing systems. For instance, WUR plans to establish shared e-bike centers on the Wageningen campus [18]. UR has a Shared Use Bicycle System (SIBUC) across its five campuses, with 53% of dedicated parking spaces allocated for bicycles [26-29]. USP implemented the “Let’s Go by Bike” project, which includes bicycle sharing points that can be accessed with a USP card and integrates with the Butantã Terminal and its surroundings [23]. Currently, UNICAMP lacks a similar bicycle promotion program. Although there are bicycle parking areas on campus, there have been reports of bicycle theft, which highlights the need for improved surveillance and security from the UNICAMP City Hall.

Additionally, improving public transport quality and safety is crucial. In developed countries, such services are often well-provided, but in Brazil, partnerships with local authorities, public transport providers, and municipal security are necessary to ensure quality service. This would help in two main areas: (i) enhancing the quality of public transport, increasing the number of lines, improving access roads, and overall infrastructure to encourage public use, and (ii) reducing the number of private vehicles in the Campinas region, thereby lowering pollutant emissions.

Campinas has a total of 975,402 vehicles for its 1,139,047 inhabitants [32, 33], which averages nearly one vehicle per person. If the 2% annual growth rate continues, the city may exceed one million vehicles by 2025 [34]. At this stage, a collaboration between the

university, public authorities, and private companies could introduce a more environmentally sustainable bus fleet, including vehicles powered by biodiesel, electricity, or hydrogen, which can cut pollutant emissions by up to 90% and reduce fuel consumption by about 35% [35]. Initially, UNICAMP could provide transport passes for locations close to the university and later expand this service based on the results.

Another cost-effective measure could be instituting remote work, online meetings, and limiting travel to when absolutely necessary. During the pandemic, many universities adopted these practices, and some continue to encourage them. For example, WUR implemented a subsidy for remote work [16]. UNICAMP could consider starting with one remote work day per week and assess the impact on service quality over time.

Regarding vehicle sharing, universities vary in their approach. Some promote conventional vehicle sharing, while others extend it to electric vehicles. Sharing can also include electric scooters and bicycles for short-distance travel, as seen at WUR [18]. If these actions are institutionalized and coordinated, they could form an integrated UNICAMP net-zero emissions plan. Therefore, it is proposed that the university develop and implement a comprehensive Climate Action Plan, focused on integrated actions to align with the global sustainability commitments established by the UN.

This approach is already being adopted by many European universities. For example, WUR aims to be emissions-neutral by 2050 as part of its “WUR Outline Energy Transition 2050” plan [36]. Umwelt-campus Birkenfeld in Germany is already a carbon-neutral campus and follows a coordinated set of actions to maintain this status [37]. Some USP campuses, such as those in Piracicaba, Pirassununga, and Ribeirão Preto, have developed Participatory Socio-Environmental Master Plans or Environmental Master Plans aligned with the university's Environmental Policy [38]. However, like UNICAMP, USP has not yet adopted a Net Zero Plan.

Table 8 provides a summary of the proposed improvements concerning the indicators previously mentioned in the Transport category.

Table 8. Actions Proposed for Improvement in Transport

Indicator	Action Proposal
TR1	- Encourage car sharing by creating a university carpooling program. - Implement a public transport subsidy or half-fare program to promote the use of public transport over private vehicles. Provide passes for transport in locations close to the university, with the possibility of expanding to more distant areas based on results. - Institute remote work, initially one day a week, with an assessment of service quality over time. - Promote online meetings and limit travel to essential trips.
TR5	- Promote the use of sustainable mobility alternatives, such as bicycles, with increased surveillance on campus to address issues like theft. - Implement measures to reduce individual vehicle use, such as introducing parking fees. Gradually reduce some parking areas. - Increase the number of bicycle racks on campus. - Establish a loan program for conventional bicycles for internal campus use, with monitoring of the return process.

4. Conclusions

Regarding the implementation of sustainability at UNICAMP, selecting the UI GreenMetric 2023 ranking as a parameter for analyzing the university's sustainable actions and practices, along with analyzing the cases of the top-ranked international and national higher education institutions (HEIs) within the Transport category, leads to the conclusion that improving the university's performance in this category involves forming partnerships with the government, state, municipality, and private companies in the region. These partnerships should focus on improving the university's score across a set of indicators that, when integrated, can enhance not only the university's position in the ranking but also the impact of its actions and proposals in contributing to a solid journey towards sustainability.

The main actions currently developed by the university, as identified in the research, include: using 5 internal circular buses powered by biodiesel and 1 electric bus; implementing a campus sidewalk policy; establishing cycle paths and pedestrian crossings connecting to the Barão Geraldo neighborhood; installing charging points for electric vehicles; ongoing projects to promote shared spaces on campus; a “Smart Campus” app for transportation service monitoring; and a chartered bus service for employees.

To further enhance sustainability practices within this category, the following actions are suggested for UNICAMP: encourage car sharing; implement a public mobility exemption or half-pass program for employees; promote the use of more sustainable mobility alternatives, such as bicycles, with increased campus surveillance; increase the number of bicycle racks on campus; and create a loan program for conventional bicycles for internal campus use, including monitoring the return of the bicycles.

To overcome the limitations of this study and to enhance future research, several avenues can be pursued. Incorporating field research methods like interviews and surveys will provide a deeper understanding of how structural and management changes influence individual behaviors. Expanding the MCDM Fuzzy SWARA method's data set with additional criteria and diverse case studies will lead to a more comprehensive analysis. Longitudinal studies and interdisciplinary collaborations can illuminate the long-term impacts and interplay between sustainability measures and behaviors. Finally, employing mixed methods, establishing feedback mechanisms, and benchmarking with similar institutions will bolster the robustness and applicability of the findings.

Future research perspectives include focusing on the development of public policies and the establishment of partnerships between HEIs and public authorities, municipalities, and states. The aim is to integrate universities with their surrounding regions, particularly concerning transportation, to facilitate the implementation of more sustainable mobility solutions both on campuses and in cities. This area/category currently shows limited sustainability actions among universities, suggesting inherent challenges that extend beyond the actions of HEIs alone. A detailed analysis of the policies, partnerships, and actions of other HEIs that have made progress in sustainable mobility could be valuable. Future research could explore how benchmarking between these institutions and UNICAMP could pave the way for similar advancements at the university.

Sharing best practices among universities has significant potential to guide the development and implementation of climate neutrality or action plans. Such collaboration

can contribute to the sustainable and integrated development of greenhouse gas (GHG) emissions mitigation actions and necessary adaptations on campuses. This area also presents a promising avenue for future research.

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