Stakeholder Engagement in Indicator Assessment

Hello,

My name is Leonardo Tomadon, and I am a doctoral student in the Postgraduate Program in Environmental Engineering and Technology (PPGETA) at the Federal University of Paraná (UFPR).

As part of my research, I am developing a Sustainability Index for Smart Cities in Paraná. To construct this index, I am applying a methodology that involves public consultation with stakeholders to understand their perception of the relevance of the indicators used. Your responses will contribute to defining the weights of each indicator, ensuring that the index accurately and fairly represents the various aspects of sustainable urban development.

Below, you will find a questionnaire designed to assess the dimensions that make up sustainable development, covering the following areas: environment, economy, circular economy, governance, mobility, resilience, social aspects, and technology. The estimated completion time is 35 to 40 minutes.

Your participation is essential for the advancement of this study, and I sincerely appreciate your time and contribution.

### **AHP-OS Tool**

In this consultation, we use the AHP-OS (Analytic Hierarchy Process – Online System) tool to determine the relevance of each indicator in constructing the Sustainability Index for Smart Cities.

AHP-OS Link → <https://bpmsg.com/ahp/>

The method works through pairwise comparisons, where you will be asked to indicate which of the two presented indicators is more important for measuring urban sustainability. This process will help establish a priority ranking, ensuring that the most essential indicators carry greater weight in the final index.

The AHP method follows a structured mathematical principle, where:

* If A is more important than B,
* And B is more important than C,
* Then A must be more important than C.

### **Instructions for Using the Tool**

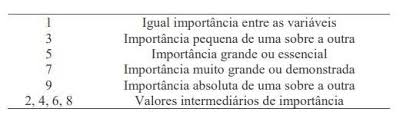
When you open the link, you will be directed to the homepage of the AHP questionnaire. First, enter your name to identify yourself, then click Check input to proceed.

On the next page, no modifications are needed; simply click Go to continue.

The following page contains a brief description of the objective of the dimension being assessed under Project description. In Decision Hierarchy, you will find the sustainable development dimension being evaluated at Level 0, while the indicators that compose this dimension and will be weighted are at Level 1. Next to the Level 0 dimension information, there is a red circle labeled AHP—click on it to proceed.

You will then be taken to the AHP questionnaire. The process is simple: you will choose between two options, A or B, and assign a weight from 1 to 9 to indicate how much more important the selected option is compared to the alternative (Figure 1).

Figure 1: Importance Scale for Weights



Inside the AHP questionnaire, the indicators appear in pairs (A and B) in a numbered sequence on the left side of the calculator. This sequence corresponds to each pairwise comparison to be made. To the right of the sequence numbers, you will see the A and B options, each representing an indicator. Your task is to determine which of the two options (A or B) holds greater importance for achieving the corresponding sustainable development dimension. After selecting either A or B, you must assign a value between 1 and 9, reflecting how much more important the chosen option is in achieving the objective.

Once you complete the evaluations, the data must be submitted for calculation. To do this, click the Calculate button. The AHP questionnaire will automatically calculate the Consistency Ratio (CR). If your evaluation results in a CR greater than 10%, it indicates that your assessments are inconsistent. In this case, the tool will suggest adjustments to improve consistency. Simply accept the suggestions and click Calculate again to generate a revised CR based on the adjustments made.

### **Reminder:** It is important to evaluate each option on a scale from 1 to 9 to ensure that the Consistency Ratio (CR) remains within the acceptable limit of 10%.

If your evaluation is correct (CR below 10%), simply click Submit to finalize the assessment. To save your information, click the red Save Judgments tab to ensure your evaluation is recorded. To complete the process, click the red Done tab.

Note: The tool may present a small access error, displaying the message: "Pairwise comparisons under Fulano completed." To work around this issue, simply close and reopen your browser, which will correct the error, and you will be able to access the questionnaire normally.

The instructions below aim to assist with the use of the AHP questionnaire. If the information in the instructions is insufficient, a support video has been created.

Note: The video was originally developed for individuals to answer multiple questionnaires, however, this approach has been changed to only one questionnaire per person, and the form has been removed.

### **Support and Tutorial Video**

We have prepared an explanatory video to guide you through using the AHP-OS tool. This video provides a step-by-step walkthrough of how to compare indicators and contribute effectively to the development of the Sustainability Index for Smart Cities.

Tutorial Video Link: <https://youtu.be/iePT1LxcQRo>

### **Evaluation**

Below, you will find the dimensions to be assessed, with a brief explanation of each one, along with a link to the AHP-OS tool.

Since some indicators may be difficult to interpret based on their names alone, a detailed spreadsheet has been created, available in an online repository.

For further clarification, access the provided link. The Metadados-indicadores repository contains three files:

* **PUBLIC CONSULTATION GUIDELINES:** Explaining the public consultation process.
* INDICATORS METADATA – Detailing the meaning of each column in the indicator table.
* INDICATORS - Excel Spreadsheet, listing all indicators.

Repository Link: <https://github.com/LeonardoTomadon/Metadados-indicadores>

Dimensions  
The dimensions of the Sustainability Index represent different aspects of sustainable and smart urban development. Each one assesses a specific set of essential factors to ensure quality of life, public management efficiency, and environmental balance.

**Link** **to** **dimensões** → https://bpmsg.com/ahp/ahp-hiergini.php?sc=ewAHyP

Environmental  
The environmental dimension focuses on the preservation of natural resources and the resilience of urban ecosystems. Effective environmental management contributes to mitigating climate change, air and water quality, biodiversity conservation, and the sustainable use of resources. Additionally, it promotes higher quality of life for the population and reduces risks associated with extreme events.

**Link to environmental** → <https://bpmsg.com/ahp/ahp-hiergini.php?sc=HeTa8E>

Circular Economy

Circular economy assesses the efficiency of resource use, promoting the reduction, reuse, and recycling of materials to minimize waste and environmental impacts. Its goal is to measure the transition of cities to more sustainable and resilient models, reducing dependence on virgin raw materials and encouraging innovations in reverse logistics and sustainable design.

**Link to circular economy** → https://bpmsg.com/ahp/ahp-hiergini.php?sc=uSyGAk

Economy  
The economic dimension measures the development and resilience of the urban economy, evaluating wealth generation, employment opportunities, and income distribution. Additionally, metrics such as average income help identify inequalities and promote economic equity policies, which are essential for smart and sustainable urban development.

**Link to economy** → https://bpmsg.com/ahp/ahp-hiergini.php?sc=evYtyM

Governance  
The governance dimension is crucial to ensure transparency, social participation, and efficiency in the public management of smart and sustainable cities. A good governance model promotes data-driven decision-making, public involvement in urban planning, and the implementation of policies that balance economic, social, and environmental development.

**Link to governance** → <https://bpmsg.com/ahp/ahp-hiergini.php?sc=gYvUky>

Mobility  
Urban mobility is a central element in building smart and sustainable cities, directly influencing quality of life, economic efficiency, and environmental impact. Well-planned transportation infrastructure reduces congestion, improves access to essential services, and contributes to lowering pollutant emissions.

**Link to mobility** → https://bpmsg.com/ahp/ahp-hiergini.php?sc=9EKAry

Resilience  
Urban resilience is essential for smart and sustainable cities to anticipate, absorb, and recover from shocks and crises, such as natural disasters, climate change, and socio-economic instabilities. A resilient city adopts effective risk management strategies, territorial planning, and adaptive infrastructure, ensuring greater safety and quality of life.

**Link to resilience** → <https://bpmsg.com/ahp/ahp-hiergini.php?sc=avA8UB>

Social  
The social dimension is fundamental to assess the well-being of the population and equity in access to essential services such as education, healthcare, security, and culture. A smart and sustainable city must guarantee dignified living conditions for all citizens, promoting social inclusion, reducing inequalities, and strengthening community cohesion.

**Link to social** → https://bpmsg.com/ahp/ahp-hiergini.php?sc=u9ArY7

Technology  
The technological dimension is an essential pillar for the development of smart and sustainable cities, driving innovation, service digitalization, and urban connectivity. The use of advanced technologies such as the Internet of Things (IoT), artificial intelligence, and big data improves the efficiency of public services, optimizes urban mobility, and strengthens natural resource management.

**Link to technology** → https://bpmsg.com/ahp/ahp-hiergini.php?sc=YPumYq

Conclusion  
We thank you for participating in this process! Your contribution is essential to ensure that the Sustainability Index for Smart Cities is built accurately and representatively. The information gathered will help establish a ranking of indicators aligned with the real needs and urban challenges.  
If you have any questions, feel free to contact us via email at leonardotomadon@hotmail.com. Thank you for your participation!

Thank you very much for your time and collaboration!