

# Developing A Sustainable Urban Planning Index: A Multi-Criteria Decision-Making Framework for Master Plan Evaluation in Developing Countries

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## ABSTRACT

Urban sustainability frameworks are increasingly being localized to reflect area-specific conditions, yet existing assessment tools remain inconsistent, relying on either conceptual models or physical evaluations that demand extensive datasets. This poses challenges, particularly in data-limited settings such as developing countries, where structured sustainability evaluations are lacking. A key gap exists in assessing and ranking development plans, including master plans and spatial strategies, due to the absence of a standardized ranking mechanism for sustainability indicators. "This study introduces the Sustainable Urban Planning Index (SUPI), a structured multi-criteria decision-making (MCDM) framework designed for prioritizing sustainability indicators through expert-driven validation and statistical ranking. Tailored for developing countries, SUPI integrates literature review, expert consultations, and quantitative ranking techniques. Two datasets were analyzed: (1) a broad assessment of 30 sustainability indicators evaluated by 64 experts using Relative Importance Index (RII), Fractional Ranking, and Analytical Hierarchy Process (AHP); and (2) a sector-specific weighting analysis conducted by 20 urban planning professionals employing AHP-based pairwise comparisons. These datasets were synthesized hierarchically through a structured normalization process, ensuring the convergence of sectoral priorities with individual indicator rankings. The final model integrates these rankings through normalized priority vectors, enhancing consistency and applicability in sustainable urban planning assessments. Findings reveal that land use efficiency, environmental resilience, and governance effectiveness are the most influential sustainability factors, whereas traditional indicators such as population density and zoning regulations exhibit weaker correlations with sustainability performance. The final SUPI model offers policymakers a quantifiable, adaptable evaluation framework for urban sustainability assessment. Future research will focus on real-world validation, refining predictive capabilities, and integrating geospatial analysis and real-time monitoring tools to enhance applicability in data-limited environments, making SUPI a practical decision-support tool for sustainable urban development.

**Keywords:** Sustainable Urban Planning Index (SUPI), Urban Sustainability, Multi-Criteria Decision-Making (MCDM), Relative Importance Index (RII), Urban Monitoring Systems

## INTRODUCTION

Urbanization is one of the most transformative global trends of the 21st century, with projections indicating that 68% of the world's population will reside in urban areas by 2050 (1). While urban expansion drives economic growth and social transformation, it also presents significant sustainability challenges, particularly in developing nations where governance inefficiencies, infrastructure deficits, environmental degradation, and resource constraints hinder effective urban planning (2). Unlike developed economies with structured regulatory frameworks and well-established sustainability assessment models, developing cities often lack

comprehensive evaluation mechanisms that allow them to prioritize sustainability efforts effectively. This results in fragmented policy implementation, uncoordinated infrastructure development, and misaligned urban growth, ultimately limiting their ability to achieve long-term sustainability goals (3);(4).

Over the years, urban sustainability assessments have evolved from basic environmental compliance models to multi-dimensional frameworks incorporating economic, social, and governance factors ((5). Global sustainability benchmarks, such as ISO 37120 and Sustainable Development Goal 11 (SDG 11), provide standardized indicators for assessing urban sustainability at an international level ((6);(7)). However, despite their broad applicability, these frameworks have not effectively enabled developing countries to implement, adapt, or excel in urban sustainability planning ((6); (8)). Governance complexities, infrastructural limitations, and socio-economic constraints within these regions often hinder the practical application of such frameworks, limiting their ability to drive context-specific urban planning interventions ((9); (5). While these models offer general sustainability guidelines, they often lack contextual adaptability, making their integration into localized urban planning frameworks challenging ((10); (11)).

Furthermore, existing sustainability assessment tools typically evaluate environmental, social, economic, and governance dimensions in isolation, without providing an integrated system that contextualizes sustainability priorities based on local governance capacities and resource availability (12). Research on urban sustainability in developing countries highlights key dimensions—including land use efficiency, infrastructure resilience, environmental sustainability, governance, and transportation—yet no standardized framework exists that systematically ranks these factors based on their significance in resource-constrained environments ((5); (2)). Existing models often rely on global benchmarks, which fail to capture localized governance inefficiencies, informal urbanization patterns, and infrastructure deficits (13). To address this gap, research must focus on developing a tailored evaluation model that is applicable in resource-constrained environments while also establishing pathways for advancing urban planning knowledge in developing nations.

This study introduces the Sustainable Urban Planning Index (SUPI)—a hybrid multi-criteria decision-making framework designed to provide a structured assessment and ranking model for urban sustainability evaluation. Unlike existing sustainability assessment models, which offer broad objectives without prioritization, SUPI integrates sectoral priorities with sub-indicator weightings, creating a structured decision-support tool for policymakers and urban planners. This study employs a systematic methodology, structured as follows:

1. Development of a structured sustainability indicator framework through literature review, international benchmarks, and expert validation, culminating in seven sectoral categories and thirty sustainability indicators.
2. Application of Relative Importance Index (RII) and Fractional Ranking to simplify pairwise comparisons among 30 sustainability indicators, enabling pre-normalization before applying the Analytical Hierarchy Process (AHP).
3. Ranking sectoral priorities using AHP, ensuring that sustainability efforts align with critical urban development challenges in developing countries.
4. Integration of AHP rankings at two levels, where the 30-indicator AHP assessment is merged with the 7-sector AHP output, ensuring that sectoral weightings serve as multipliers for the normalized indicator rankings. This hybrid ranking model ensures that sustainability priorities reflect both intra-sectoral importance and broader urban sustainability objectives.

By merging sectoral and sub-indicator weightings into a unified evaluation model, SUPI establishes a structured yet adaptable framework for assessing urban sustainability performance. To guide this research, the following questions are addressed:

1. What are the most relevant sustainability indicators for urban planning in developing countries?
2. How can sectoral sustainability priorities be ranked to reflect governance and resource constraints in developing cities?

3. What weighting mechanisms can effectively integrate sectoral and sub-indicator rankings into a comprehensive sustainability index?

This research contributes to the field of urban sustainability assessment by introducing a structured ranking methodology that enhances the evaluation and prioritization of sustainability indicators in resource-constrained environments. The SUPI framework provides a quantitative decision-making tool, ensuring that sustainability efforts are empirically validated, contextually relevant, and adaptable to local urban planning challenges.

## LITERATURE REVIEW

**Evolution of Urban Sustainability Assessment Models:** Urban sustainability assessment has progressed from single-dimensional environmental compliance models to multi-criteria frameworks that incorporate economic, social, and governance indicators(14, 15). Early models focused primarily on ecological concerns, such as air and water quality, with little consideration for their impact on broader urban planning strategies (4, 16). However, with the acceleration of urbanization, these models became inadequate, leading to the development of holistic sustainability assessment frameworks (12, 16).

Global sustainability frameworks, including ISO 37120 (Sustainable Cities and Communities), Sustainable Development Goal 11 (SDG 11), and LEED for Neighborhood Development (LEED-ND), aim to provide standardized sustainability indicators for urban areas (17-20). Despite their structured approach, these models have been critiqued for their limited applicability in developing countries, where institutional, financial, and infrastructural constraints hinder their effectiveness(13, 21). The reliance of these frameworks on comprehensive urban datasets and strong governance structures makes their application challenging in cities facing data inconsistencies and regulatory fragmentation(5, 21, 22).

Furthermore, many existing sustainability models analyse environmental, economic, and governance factors in isolation, failing to capture their interdependencies (12, 23, 24). This fragmented approach limits their effectiveness in developing cities, where sustainability challenges are inherently interconnected(25) (26). Thus, recent studies emphasize the need for context-sensitive sustainability indices that align with local governance structures and development priorities (24, 27-29).

**Challenges in Adapting Global Sustainability Models to Developing Nations:** Although international sustainability frameworks provide a standardized approach, their applicability in developing countries remains problematic due to governance limitations, inconsistent data availability, and financial constraints (29-31). A key challenge is the institutional gap, as many frameworks assume the presence of strong regulatory mechanisms, which are often weak or absent in resource-limited environments (32-34). Additionally, sustainability data in developing nations is often fragmented and unreliable(35), making it difficult to apply models that depend on quantitative assessments (36).

Another limitation is the economic feasibility of implementing sustainability policies, as many cities lack the financial resources to support large-scale sustainability interventions (37, 38). Moreover, global models often overlook informal urbanization patterns, which are a defining characteristic of many cities in the Global South, where unregulated settlements and infrastructure deficiencies pose unique sustainability challenges (25, 39). These challenges underscore the urgent need for adaptable sustainability assessment frameworks that consider local urban governance, financial constraints, and informal urbanization patterns (40, 41).

**A Novel Sustainable Urban Planning Index for Developing Countries:** While conventional sustainability assessment frameworks offer valuable benchmarks, they frequently fall short when applied to the dynamic urban contexts of developing nations.(42) These cities contend with challenges such as governance gaps, limited financial resources, and pervasive informal urbanization—factors that demand planning tools that are both adaptive and context-sensitive(43). Traditional models tend to evaluate sustainability indicators in isolation and in a static, retrospective manner, which does not fully capture the complex interdependencies inherent in urban systems(43, 44).

In response to these limitations, recent research has advocated for the development of a Sustainable Urban

Planning Index (SUPI)(45). SUPI is designed to serve dual functions: as a performance evaluation tool and as a master plan assessment instrument. the development of a Sustainable Urban Planning Index (SUPI), SUPI provides a holistic framework for assessing urban development(45). This integrated approach enables policy-implementing bodies to evaluate the effectiveness of current master plans while identifying gaps and inefficiencies that may hinder sustainable growth(46).

Moreover, SUPI supports periodic reassessment of urban plans, allowing decision-makers to refine planning and execution strategies proactively. In doing so, it bridges the gap between global benchmarks and local realities, ensuring that all critical indicators necessary for the sustainable development of cities in developing countries are systematically incorporated(43, 44). Ultimately, this adaptive framework empowers urban policymakers to make informed adjustments over time, fostering more sustainable and resilient urban environments (42).

**Multi-Criteria Decision-Making (MCDM) in Urban Sustainability Assessment:** Given the complex nature of sustainability assessment, scholars have increasingly turned to Multi-Criteria Decision-Making (MCDM) techniques to systematically rank and prioritize sustainability indicators (47). These methods facilitate data-driven decision-making by integrating expert opinions and structuring sustainability factors into hierarchical ranking frameworks (48).

**Analytical Hierarchy Process (AHP) in Sustainability Assessments:** The Analytical Hierarchy Process (AHP), introduced by Saaty (1990), is a widely used multi-criteria decision-making technique in urban planning, infrastructure evaluation, and governance. It allows for pairwise comparisons of sustainability indicators, ensuring a structured ranking based on relative importance. AHP also incorporates Consistency Ratio (CR) validation, which enhances the logical coherence of expert assessments. The method has been extensively applied across various urban sectors, including transport planning, energy efficiency, and environmental governance (49). However, despite its effectiveness, AHP becomes computationally intensive when dealing with large-scale indicator datasets, posing challenges for its application in urban planning within developing nations (50).

**Relative Importance Index (RII) as a Simplification Tool:** The Relative Importance Index (RII) simplifies expert-based assessments into numerical rankings, reducing computational complexity (51). It is particularly useful in data-scarce environments, ensuring reliable decision-making (51). RII enables direct expert input integration, eliminating the need for complex calculations. This makes it an efficient tool for urban sustainability evaluations and planning.

Recent studies emphasize the effectiveness of hybrid methodologies that integrate AHP and RII, offering a structured yet flexible approach to sustainability assessment. AHP is utilized to establish sectoral sustainability priorities, ensuring that decision-making aligns with urban planning needs. Meanwhile, RII is applied for intra-sectoral indicator ranking, providing a more detailed evaluation of sustainability factors (52). These hybrid models enhance adaptability, making them particularly useful in data-scarce environments and cities with institutional constraints, where traditional assessment methods may be challenging to implement (53).

**The Need for a Context-Specific Sustainability Index:** Despite advancements in urban sustainability assessment models, existing frameworks often overlook governance structures, informal urbanization, and infrastructure limitations in developing nations. While some models attempt to contextualize global benchmarks, their adaptability and practical implementation remain limited (54). To address these challenges, scholars advocate for tailored sustainability indices that incorporate hybrid MCDM models (AHP + RII) for refined indicator ranking, adapt global benchmarks to local urban constraints, and provide structured decision-support tools for policymakers (40, 47, 54, 55). This study introduces the Sustainable Urban Planning Index (SUPI), a framework that integrates sectoral and sub-indicator weightings, creating a hierarchical sustainability ranking system that aligns with global benchmarks while addressing localized urban planning needs.

**Summary:** The literature highlights the challenges of adapting global sustainability models to developing nations, emphasizing governance gaps, unreliable data, and financial constraints as major obstacles. While MCDM techniques such as AHP and RII have been widely applied in sustainability ranking models, their

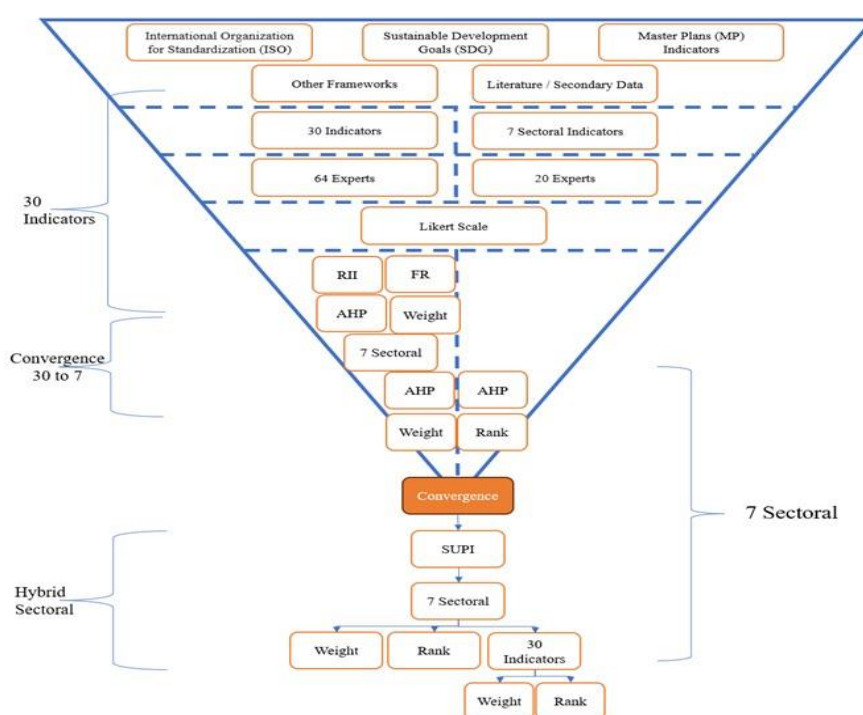


effectiveness in developing contexts requires further refinement through hybrid methodologies. This study builds on previous research by introducing SUPI, a sustainability index that integrates global benchmarks with localized urban planning considerations. By incorporating a hybrid AHP-RII framework, SUPI offers a flexible decision-making model that enhances sustainability assessment, policy implementation, and strategic urban planning in resource-constrained environments. Future research should focus on empirical validation of SUPI through case studies, ensuring its effectiveness in diverse urban settings.

## METHODOLOGY

A structured and sequential research design was adopted to develop the Sustainable Urban Planning Index (SUPI), integrating multiple analytical techniques to ensure a comprehensive evaluation framework. The methodology follows a multi-criteria decision-making approach (MCDM), combining Relative Importance Index (RII), Fractional Ranking, and Analytical Hierarchy Process (AHP) to systematically rank and weight sustainability indicators. A carefully selected panel of experts was engaged at different stages, ensuring both policy-level validation and sectoral prioritization through expert-driven evaluations.

To establish a robust foundation for SUPI, 64 urban planning and policy experts were consulted through structured surveys to determine the importance levels of 30 sustainability indicators, forming the basis for RII, fractional ranking, and AHP pairwise comparisons. Additionally, 20 high-level government officials—responsible for approving and implementing master plans at federal, provincial, and local levels—were engaged in sectoral and indicator selection, finalizing the most effective indicators through a long-term consultation process. The findings from these expert consultations were synthesized to derive sectoral weights and rankings, ultimately converging into a structured SUPI model. To ensure consistency and reliability, pairwise comparisons of seven sectors were conducted using AHP, followed by consistency ratio (CR) checks. The methodological steps employed, analytical processes undertaken, and the key outputs obtained are summarized in Figure 1. The structured questionnaire used for assessing indicator importance is annexed as Annexure A, while the expert panel survey for sectoral validation is annexed as Annexure B. This methodology ensures a comprehensive, expert-driven, and statistically validated framework for sustainable urban planning assessment. Figure 1 outlines the employed methods, processes, and outcomes that led to the final development of SUPI.



**Figure 1 Methodological Framework for the Development of the Sustainable Urban Planning Index (SUPI)**

The methodology consists of four key stages:

1. Indicator Identification and Categorization – Reviewing global sustainability frameworks, deriving relevant indicators, and categorizing them into sectoral domains.
2. Expert Validation and Prioritization – Engaging urban planning professionals to refine and validate the importance of sustainability indicators.
3. Ranking and Weighting of Indicators – Applying Relative Importance Index (RII), Analytical Hierarchy Process (AHP), and Fractional Ranking to establish a structured ranking system.
4. Hybrid Weighting and Final SUPI Computation – Integrating sectoral and sub-indicator weightings to develop a decision-support tool for master plan evaluation.

The development of the Sustainable Urban Planning Index (SUPI) bridges the gap between global sustainability frameworks and localized urban planning needs, ensuring that the index is structured with data-driven precision and strategic relevance. By integrating quantitative ranking techniques and expert-driven weighting methodologies, SUPI is designed as a context-sensitive framework, aligning international best practices with the unique governance, infrastructure, and sustainability challenges of developing countries.

### **Indicator Identification and Categorization**

This study is fundamentally guided by the question: What are the most relevant sustainability indicators for urban planning in developing countries? To address this, a structured methodology was employed that integrates an exhaustive literature review with targeted expert consultations, ensuring alignment with global sustainability benchmarks while incorporating context-specific insights from developing urban environments. An extensive review of internationally recognized sustainability assessment models, standards, and evaluation frameworks was conducted to extract key urban planning indicators. This analysis included widely adopted global benchmarks such as ISO 37120 (Sustainable Cities and Communities), Sustainable Development Goal 11 (SDG 11), and LEED for Neighborhood Development (LEED-ND), along with multiple master plan evaluation criteria. These frameworks provided essential insights into urban service delivery, sustainable urbanization, governance, housing, transportation, and environmental management, ensuring that the identified indicators captured the multidimensional aspects of urban sustainability.

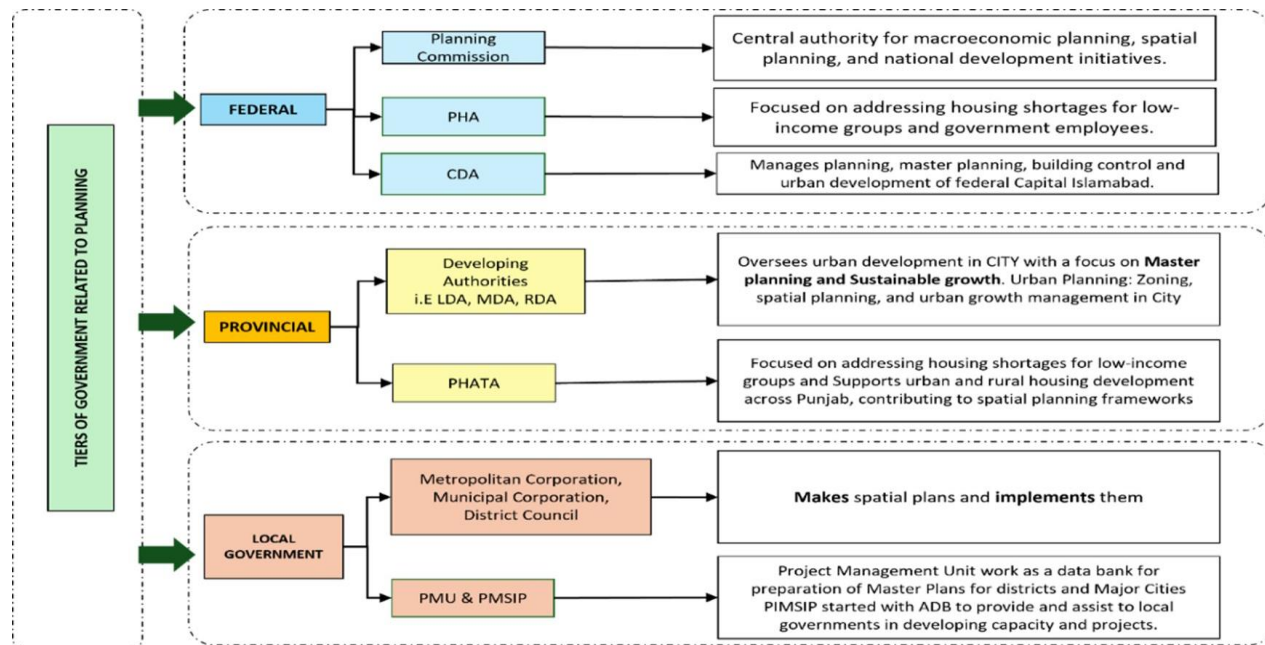
Following this detailed review, indicators were screened based on their relevance to sustainability challenges in developing countries, their measurability and feasibility for integration into policy evaluation models, and their alignment with global benchmarks while ensuring adaptability to local urban conditions. To further refine the indicator list and ensure its contextual relevance, a structured expert consultation process was implemented. Two sets of experts were engaged: a panel of 20 key government experts responsible for approving and validating development plans at federal, provincial, and local levels, who participated in an iterative process to finalize the most effective sustainability indicators, and a broader panel of 64 urban planning and policy experts selected through purposive sampling. The latter group assessed the importance of 30 sustainability indicators through structured surveys and focus group discussions, ensuring that the final selection was grounded in both theoretical rigor and practical relevance.

Through extensive deliberations and expert validation, a structured set of 30 sustainability indicators was finalized and categorized into seven sectoral domains, forming a hierarchical and comprehensive assessment framework. These sectors include Physical Characteristics, Socio-Economic Factors, Land Use & Urban Form, Housing, Transportation, Environmental & Infrastructure, and Governance & Institutional Efficiency. By integrating literature-driven insights with expert validation, this approach ensures that the selected indicators are both theoretically robust and practically applicable for evaluating urban sustainability, particularly in resource-constrained environments where conventional sustainability frameworks often fail to provide context-specific solutions.

## Expert Validation and Prioritization

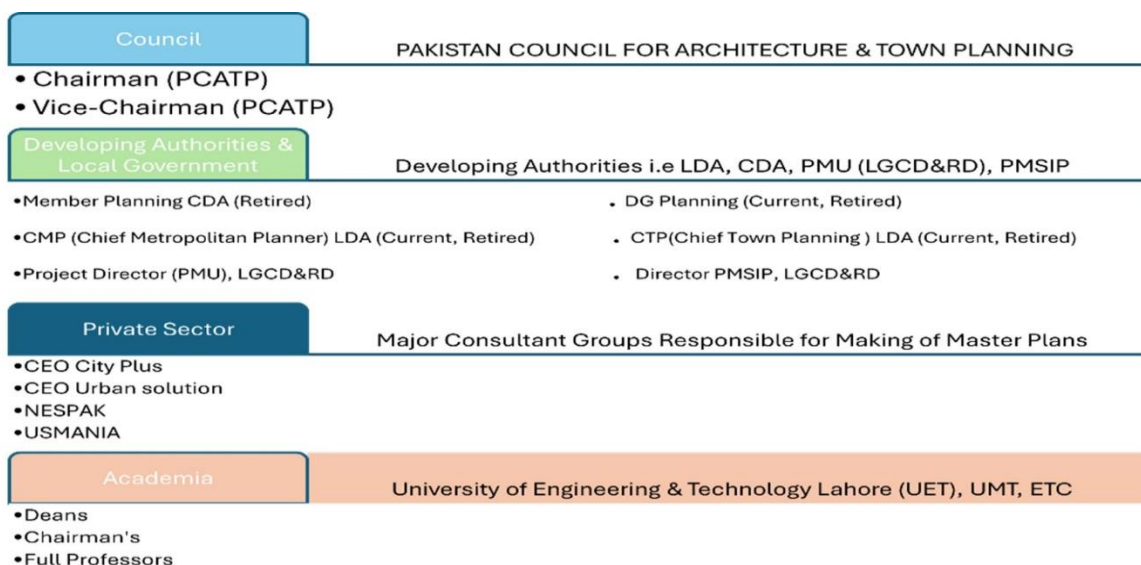
To ensure the credibility and applicability of sustainability indicators, a rigorous expert-driven validation process was conducted. This study engaged two distinct groups of experts to establish a robust and context-sensitive

selection of sustainability indicators.



**Figure 2 Key Experts Involved in Validating and Approving Development Plans**

The first group comprised 20 high-level government experts, selected using a purposive sampling approach from federal, provincial, and local authorities responsible for approving and validating development plans. These decision-makers provided critical insights into refining and validating sustainability indicators, ensuring their practical relevance for urban planning in developing countries. Through an extensive and iterative consultation process, they collaborated to develop and refine sectoral categories and identify the most effective indicators as supported by the literature. Additionally, they conducted pairwise comparisons of the seven identified sectors using the Analytical Hierarchy Process (AHP) to derive precise sectoral weights and rankings (Annexure B).



**Figure 3 Experts Responsible for Formulating and Executing Development Plans**

The second group comprised a broader panel of 64 experts, specializing in urban planning, policymaking, governance, and academic research. These experts, also selected through purposive sampling, contributed a diverse and multidisciplinary perspective, ensuring that the Sustainable Urban Planning Index (SUPI) accounted for both theoretical frameworks and real-world implementation challenges. The panel was tasked with completing the structured questionnaire annexed in Annexure A, which focused on assessing the importance level of 30 sustainability indicators. Their evaluations were employed in three key analytical processes:

1. Relative Importance Index (RII),
2. Fractional Ranking (FR),
3. Analytical Hierarchy Process (AHP) pairwise comparisons.

These methods facilitated the convergence of indicator weights into sectoral rankings, forming the multi-criteria decision-making foundation for the SUPI model. This systematic approach ensured that the developed index accurately reflects sectoral priorities, providing a structured and objective assessment framework for sustainable urban planning in developing countries.

**Methodological Framework for SUPI Development:** A structured multi-criteria decision-making approach was employed through a sequential and interlinked methodology to develop the Sustainable Urban Planning Index (SUPI) as an evaluation framework. As summarized in Figure X, this approach integrates global sustainability frameworks, expert validation, and statistical ranking techniques to ensure a systematic and data-driven assessment process.

Two distinct datasets were analyzed to establish a robust foundation for the SUPI model:

The first dataset focused on the importance ranking of 30 sustainability indicators, evaluated by 64 experts using Relative Importance Index (RII), Fractional Ranking (FR), and AHP.

The second dataset involved a more detailed AHP-based assessment of sectoral importance, conducted with 20 high-level government experts responsible for strategic urban planning decisions.

The findings from both datasets were systematically converged, ensuring a balanced integration of expert consensus and statistical rigor. This approach enabled the development of a structured SUPI model, which accurately ranks sustainability priorities and provides policymakers with a quantifiable, adaptable decision-support tool for urban sustainability assessment.

Through this rigorous expert validation and structured methodology, the SUPI framework ensures that sustainability efforts in developing countries are empirically validated, contextually relevant, and strategically aligned with both global benchmarks and local urban development realities.

### **Ranking and Weighting of Indicators**

A structured ranking system was developed using Relative Importance Index (RII), Analytical Hierarchy Process (AHP), and Fractional Ranking (FR) to ensure transparency and statistical rigor. The 64-expert dataset was analyzed through RII and FR to determine the relative importance of 30 sustainability indicators, while AHP was applied to both 30 indicators and 7 sectoral indicators for prioritization. The integration of these methods provided a robust weighting framework, balancing expert consensus with quantitative validation.

### **Relative Importance Index (RII) for Indicator Ranking**

The Relative Importance Index (RII) method was utilized to quantify expert evaluations and prioritize indicators based on their perceived significance. Experts provided their assessments using a four-point Likert scale, categorizing indicators as Very Unimportant (1), Unimportant (2), Important (3), and Very Important



(4). This structured approach ensured a systematic ranking of indicators, capturing expert consensus and enabling a data-driven prioritization process for sustainability evaluation.

The RII score for each indicator was calculated as:

$$RII = (\sum W)/(A \times N)$$

The Relative Importance Index (RII) calculation was based on a structured formula where W represented the weight assigned to each response category (ranging from 1 to 4), N denoted the number of responses in each category, A indicated the maximum scale value (4), and  $N_t$  referred to the total number of responses. This approach ensured a systematic quantification of expert opinions, facilitating the prioritization of sustainability indicators based on their assessed significance.

### Fractional ranking

Indicators with identical RII scores were fractionally ranked to ensure fair prioritization. Used to resolve tied RII values and ensure fair indicator prioritization.

$$Rank(X) = \sum (Count(X_i) \cdot I(X \leq X_i))$$

The Fractional Ranking (FR) method was applied to ensure a fair prioritization of indicators, particularly in cases where multiple indicators received identical scores. In this approach,  $\sum W$  represents the sum of weights assigned to each indicator by respondents, A denotes the maximum scale value (4 in a 1–4 Likert scale), and N corresponds to the total number of respondents. Fractional ranking was used to assign equal priority to indicators with the same scores, preventing ranking biases and ensuring a transparent and statistically balanced evaluation.

### Analytical Hierarchy Process (AHP) for Weighting

The Analytical Hierarchy Process (AHP) was employed to determine the relative weightings of each sustainability indicator. This process began with the construction of a reciprocal matrix through pairwise comparisons, where each indicator was systematically evaluated against every other in terms of its importance.

Table 3.1: Example of Pairwise Comparison Between Transportation and Other Sectoral Indicators

Indicator	Weighting Score																	Indicator
	More Importance than								Equal	Less Importance than								
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
Transportation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Land use & Urban Form
Transportation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Environmental and Infrastructure
Transportation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Governance and Institutional Efficiency
Transportation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Physical Characteristics
Transportation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Housing
Transportation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Socio Economic factors

Following this, eigenvalues were computed from the matrix to derive normalized weightings, providing a quantitative basis for the relative significance of each indicator.

Table 3.2: Saaty's 1–9 Scale for Relative Importance in AHP (1994)

Scale	Degree of importance	Reciprocal (decimal)
1	Equally important	1 (1.000)
2	Equally to moderately important	1/2 (0.500)
3	Moderately important	1/3 (0.333)
4	Moderately to strongly important	1/4 (0.250)

5	Strongly important	1/5 (0.200)
6	Strongly to very strongly important	1/6 (0.167)
7	Very strongly important	1/7 (0.143)
8	Very strongly to extremely important	1/8 (0.125)
9	Extremely important	1/9 (0.111)

Finally, the logical coherence of the experts' judgments was verified by calculating the Consistency Ratio (CR), ensuring that the pairwise comparisons were sufficiently consistent. This rigorous application of AHP ensured that the sustainability indicators were weighted accurately, thereby underpinning the robustness and reliability of the SUPI model in the context of urban planning for developing countries.

$$CR = CI/RI$$

Where CR is Consistency Ratio and CI is Consistency Index, calculated as:

$$CI = \lambda_{(\max - n)} / (n - 1)$$

Where  $\lambda_{\max}$  is Maximum eigenvalue of the pairwise comparison matrix, and n: Number of indicators while RI is Random Index, based on the size of the comparison matrix (Saaty provides standard RI values).

### Hybrid Weighting and Final SUPI Computation

To integrate sectoral and sub-indicator rankings, a hybrid weighting model was applied. The final Hybrid Weight (HW) for each sustainability indicator was derived by integrating the Relative Importance Index (RII) and Analytical Hierarchy Process (AHP) sectoral weights to ensure a balanced and statistically validated ranking system. The formula used for computing HW is:

$$HW_i = (RII_i / (\sum RII_{sector})) \times AHP_{sector}$$

Where:

The final hybrid weight (HW<sub>i</sub>) for each indicator is calculated by normalizing its Relative Importance Index (RII<sub>i</sub>) within its sector ( $\sum RII_{sector}$ ) and adjusting it using the sectoral weight from the Analytical Hierarchy Process (AHP<sub>sector</sub>). This approach ensures a balanced weighting system that maintains intra-sector comparability while reflecting the overall priority of each sector in urban sustainability assessment.

This methodological approach ensured that sectors identified as high priority received proportionally greater weights in the final ranking, preserving the integrity of sectoral significance in the evaluation process. To establish a balanced and statistically robust ranking of urban planning criteria, a hybrid Analytical Hierarchy Process (AHP) weighting approach was employed, integrating two independently derived AHP-based priority weight tables while maintaining sectoral consistency.

The process commenced with the normalization of AHP weights from both datasets to ensure comparability. Given that pairwise comparisons in AHP can introduce variations due to subjective expert judgments, normalizing each weight set to sum to one mitigated discrepancy arising from differences in expert evaluations. This step was critical in enhancing methodological rigor and ensuring a standardized ranking framework.

To align both rankings, a hybrid weighted averaging approach was implemented using an equal 0.5:0.5 weighting ratio, assigning equal influence to both datasets. This approach balanced sectoral priorities while preventing the overemphasis of any single criterion, ensuring a structured multi-criteria decision-making (MCDM) framework that integrates expert-driven insights with statistical validation. The final hybrid weights

were ranked according to their relative importance, providing a comprehensive and methodologically sound foundation for sustainable urban planning assessment.

## RESULT AND DISCUSSION

The results of the data analysis are presented through structured ranking and weighting methodologies, including Relative Importance Index (RII), Analytical Hierarchy Process (AHP), and Fractional Ranking (FR). A comparative assessment was conducted to evaluate the significance of sectoral indicators in urban sustainability, measuring their relative contributions to sustainable master planning. The expert-based analysis utilized AHP to establish indicator weights, ensuring logical consistency through consistency ratio (CR) validation. Additionally, inter-rater reliability assessments were performed to verify expert consensus on indicator rankings. The findings provide a structured evaluation framework, offering insights into the effectiveness of urban master plans in developing countries.

### Indicator Identification and Categorization

The study successfully identified and categorized sustainability indicators, ensuring their alignment with both global sustainability benchmarks and local planning requirements. The results confirm that the selected indicators comprehensively address key aspects of urban sustainability, including land use efficiency, governance, infrastructure resilience, and environmental management. This structured categorization provides a clear framework for evaluating and ranking sustainability priorities, forming the basis for assessing master plan execution and sustainable urban development strategies.

The table presents 30 sustainability indicators classified under seven sectoral domains, each contributing to the assessment of urban sustainability and master plan efficiency. These indicators were rigorously selected through expert consultation and sectoral analysis, ensuring their relevance to sustainable urban development, governance efficiency, environmental resilience, and infrastructure performance.

The Physical Characteristics sector includes key indicators such as land development, climate resilience, and groundwater management, emphasizing the importance of planned urban expansion and ecological sustainability. Socio-Economic indicators highlight employment opportunities, urban growth, and income equity, underlining their role in economic stability and inclusive urbanization. The Land Use and Urban Form category prioritizes mixed-use development, land conservation, and transport accessibility, reinforcing efficient spatial planning and land utilization.

In the Housing sector, the focus is on affordability, density regulations, and informal settlement management, which are critical to urban housing accessibility and population distribution. Transportation indicators emphasize mobility integration, congestion reduction, and accessibility, reinforcing the need for well-connected and sustainable transport networks. Environmental indicators such as carbon reduction, waste management, and flood resilience stress the significance of climate adaptation and resource efficiency. Lastly, Governance & Institutional Efficiency covers public participation, transparency, and digital governance, which are fundamental to effective urban management and service delivery.

This table forms the core structure of the Sustainable Urban Planning Index (SUPI) framework, providing a structured reference for evaluating and ranking sustainability priorities. These indicators serve as a practical tool for urban master plan assessment, framework development, and sustainability evaluation models, ensuring that planning strategies align with both global sustainability goals and localized urban challenges.

Table 4.1: Sectoral Indicators Forming the Basis of the Sustainable Urban Planning Index (SUPI)

Sectoral Indicator	Indicator	Indicator Description	Label	Reference
Physical Characteristics	Land Development & Slope Stabilization	Land Development Percentage & Stabilize Slopes	PSS	(56)

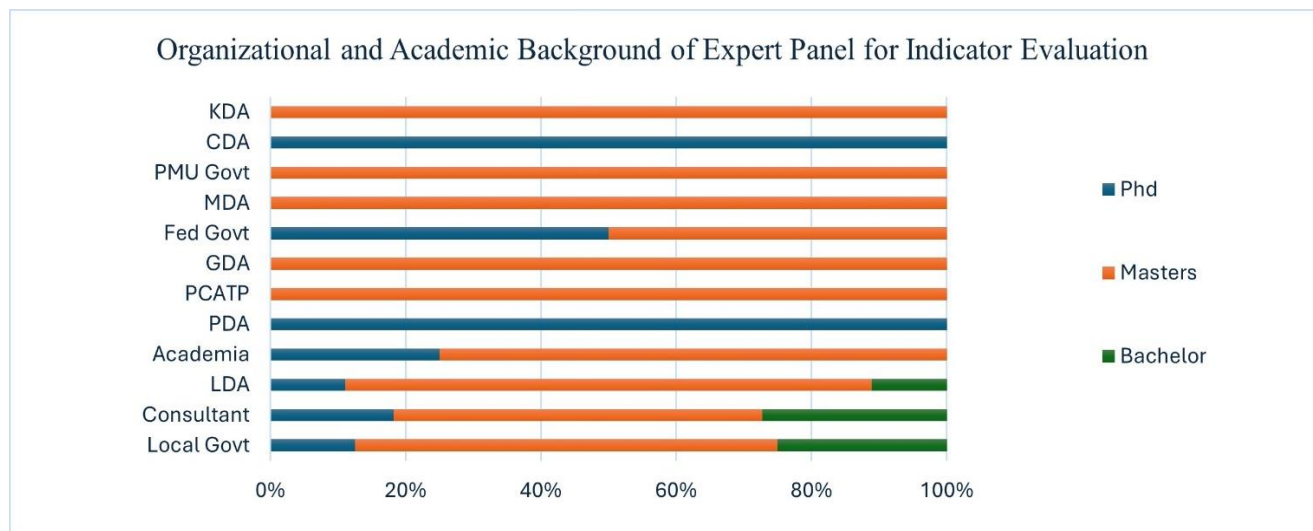
	Urban Climate Resilience	Urban Heat Island reduction, stormwater management	UHIR	(57)
	Groundwater and Water Quality Management	Groundwater recharge, quality compliance, water balance	GWB	(58)
	Green Infrastructure and Biodiversity	Green cover, Accessibility, Biodiversity, Air quality impact	GCA	(59)
Socio-Economic	Urban Growth and Demographics	Growth rate, Urban density, Urbanization rate	GRUD	(60)
	Employment and Economic Opportunity	Employment rate, Job creation, Sectoral distribution	ERJC	(61)
	Socioeconomic Equity	Income / Wealth Difference, Median income, Poverty rate	IWDMI	(62)
Land Use and Urban Form	Land Use and Efficiency	Land use efficiency, Employment density, Revenue generation	LUED	(63)
	Environmental Compliance and Transport Accessibility	Land utilization, Environmental compliance, Transport proximity	LUEC	(63)
	Land Conservation and Agricultural Preservation	Vacant land reduction, Agricultural land preservation	VLDALP	(63)
	Mixed-Use Development and Density	FAR, Mixed-use ratio	FARM	(64)
Housing	Housing Affordability and Ownership	Housing affordability index, Supply, Ownership rate	HAISOR	(65)
	Housing Density and Accessibility	Housing density, Affordability ratio, Access to services	HRAR	(66)
	Compact Development and Residential Accessibility	Residential/population density, Compact development ratio, Transport access	PDCD	(67)
	Informal Settlement and Resettlement	Informal settlement regularization, Access to services, Resettlement success	ISRA	(68)
	Vertical Housing Compliance	Proportion of high-rises, Compliance with zoning, Vertical housing ratio	PHCZ	(69)
	Housing Utilization and Overcrowding	Housing unit density, Overcrowding rate, Land use efficiency for housing	HUDOR	(70)
Transportation	Transportation Accessibility	Accessibility coverage, Service frequency, Ridership growth	ACSFF	(71)
	Traffic and Safety Management	Traffic flow efficiency, Congestion index, Accident rate	TFECI	(71)
	Active and Sustainable Mobility	Path coverage, Usage rate, Bicycle parking, Connectivity index	PCUB	(72)



	Integrated and Sustainable Transportation	Integration, sustainability, investment, emissions reduction	ISIELL	(73)
Environment	Carbon Reduction and Tree Canopy	Emissions reduction, Tree canopy cover	SWAG	(74)
	Water Resource Management	Safe water access, Groundwater compliance, Reuse rate, Loss rate	SWAGC	(75)
	Waste Management	Waste collection, Recycling rate, Landfill compliance, Composting	WCRL	(76)
	Renewable Energy and Energy Efficiency	Outages/year, Renewable energy share, Energy efficiency	RES	(77)
	Flood Resilience and Stormwater Management	Coverage, Flood-prone reduction, Stormwater capture rate	CFR	(78)
Governance & institutional efficiency	Governance and Public Participation	Consultation coverage, Participation rate, Inclusivity index	CC	(77)
	Transparency and Anti-Corruption	Public plan access, Budget transparency, Corruption perception	PPABT	(79)
	Service Efficiency and Resource Management	Service delivery time, Revenue collection, HR capacity	SDTRC	(80)
	Digital Governance and User Experience	Digital service coverage, User satisfaction, System uptime	DSC	(81)

### Expert Representation in Sustainability Indicator Evaluation

The Figure presents the organizational and academic background of the 64 experts involved in the evaluation and ranking of sustainability indicators. These experts were selected from local government bodies, urban development authorities, private consultancy firms, academia, and professional institutions, ensuring a diverse and multidisciplinary approach to urban sustainability assessment. Their qualifications range from bachelor's and master's degrees to PhDs, reflecting a high level of expertise in urban planning, governance, and environmental management.



**Figure 4 : Organizational and Academic Background of Expert Panel for Indicator Evaluation**

The largest representation comes from Local Government (24 experts), emphasizing the importance of practitioners involved in policy implementation and municipal governance in shaping sustainability frameworks. Consultants (11 experts) and urban development authorities such as LDA (9 experts) and PDA, PCATP, GDA, and CDA (smaller groups) contribute specialized knowledge in planning, infrastructure, and regulatory frameworks. The inclusion of academia (8 experts) ensures that the indicator selection and ranking process is grounded in research-based methodologies. The results reflect a balanced mix of policymakers, practitioners, researchers, and private-sector consultants, providing a comprehensive assessment of sustainability indicators. The diversity of qualifications and organizational backgrounds enhances the credibility of the indicator ranking and weighting methodology, ensuring that both theoretical and practical insights were incorporated.

These findings demonstrate that the expert selection process was rigorous and inclusive, reinforcing the robustness of the Sustainable Urban Planning Index (SUPI) framework. The participation of various institutional stakeholders ensures that the indicators used for the development of the SUPI Index will serve as an evaluation model for urban sustainability in developing countries, helping cities assess, compare, and improve their sustainability performance based on data-driven insights.

### Ranking of 30 Indicators Based on Expert Evaluation Using RII and AHP by Level of Importance

This table 4.2 presents the ranking of 30 sustainability indicators based on expert evaluations using the Relative Importance Index (RII). Experts rated each indicator across four importance levels, and the RII scores determined their ranking and priority weight. The highest-ranked indicator, Urban Growth and Demographics (GRUD, RII = 0.8633, Rank 1), highlights its critical role in urban sustainability. Other top indicators include Digital Service Coverage (DSC, Rank 2) and Groundwater Management (GWB, Rank 3), emphasizing the importance of technological advancement and water security. Lower-ranked indicators, such as Housing Overcrowding (HUDOR, Rank 16) and Land Development & Slope Stabilization (PSS, Rank 15), indicate less immediate influence compared to governance, environmental, and infrastructure priorities. The ranking provides a structured framework for urban sustainability assessment, ensuring that high-impact indicators are prioritized in evaluation models for developing countries.

### Pairwise Comparison of Sustainability Indicators

The pairwise comparison of 30 sustainability indicators was conducted to evaluate their relative importance in urban sustainability assessment. Each value in the matrix represents the comparative weight assigned to one indicator over another, based on expert evaluations. This structured comparison ensures a systematic ranking approach, forming the basis for final weight assignment. Please refer to Table [4.3] below for detailed pairwise comparisons.

Table 4.2: Ranking of 30 Sustainability Indicators Based on Relative Importance Index (RII) and Expert Evaluation

Variable	Description	VUNIMP	UNIMP	IMP	VIMP	TOTAL	Weight	RII	Rank	Priority Weight
PSS	Percentage for Land Development & Stabilize Slopes	1	6	44	13	64	197	0.7695	15	0.031799
UHIR	Urban Heat Island reduction, stormwater management	1	11	28	24	64	203	0.7930	11	0.03277
GWB	Groundwater recharge, quality compliance, water balance	0	5	30	29	64	216	0.8438	3	0.034869
GCA	Green cover, Accessibility, Biodiversity, Air quality	1	3	35	25	64	212	0.8281	5	0.03422

	impact									
GRUD	Growth rate, Urban density, Urbanization rate	1	1	30	32	64	221	0.8633	1	0.035675
ERJC	Employment rate, Job creation, Sectoral distribution	0	6	42	16	64	202	0.7891	12	0.032609
IWDMI	Income / Wealth Difference, Median income, Poverty rate	1	12	31	20	64	198	0.7734	14	0.03196
LUED	Land use efficiency, Employment density, Revenue generation	1	7	30	26	64	209	0.8164	7	0.033737
LUEC	Land utilization, Environmental compliance, Transport proximity	2	4	35	23	64	207	0.8086	8	0.033414
VLDALP	Vacant land reduction, Agricultural land preservation	3	4	28	29	64	211	0.8242	6	0.034059
FARM	FAR, Mixed-use ratio	1	10	41	12	64	192	0.7500	17	0.030993
HAISOR	Housing affordability index, Supply, Ownership rate	0	9	34	21	64	204	0.7969	10	0.032931
HRAR	Housing density, Affordability ratio, Access to services	1	8	31	24	64	206	0.8047	9	0.033253
PDCD	Residential/population density, Compact development ratio, Transport access	1	6	35	22	64	206	0.8047	9	0.033253
ISRA	Informal settlement regularization, Access to services, Resettlement success	2	2	32	28	64	214	0.8359	4	0.034542
PHCZ	Proportion of high-rises, Compliance with zoning, Vertical housing ratio	3	8	34	19	64	197	0.7695	15	0.031799
HUDOR	Housing unit density, Overcrowding rate, Land use efficiency for housing	1	13	33	17	64	194	0.7578	16	0.031315
ACSFF	Accessibility coverage, Service frequency, Ridership growth	2	5	31	26	64	209	0.8164	7	0.033737
TFECI	Traffic flow efficiency, Congestion index, Accident rate	2	4	35	23	64	207	0.8086	8	0.033414
PCUB	Path coverage, Usage rate, Bicycle parking, Connectivity	2	1	34	27	64	214	0.8359	4	0.034542

	index									
ISIELL	Integration, sustainability, investment, emissions reduction	2	5	40	17	64	200	0.7813	13	0.032286
SWAG	Emissions reduction, Tree canopy cover	1	10	30	23	64	203	0.7930	11	0.03277
SWAGC	Safe water access, Groundwater compliance, Reuse rate, Loss rate	1	7	33	23	64	206	0.8047	9	0.033253
WCRL	Waste collection, Recycling rate, Landfill compliance, Composting	0	3	38	23	64	212	0.8281	5	0.03422
RES	Outages/year, Renewable energy share, Energy efficiency	1	3	33	27	64	214	0.8359	4	0.034542
CFR	Coverage, Flood-prone reduction, Stormwater capture rate	1	8	43	12	64	194	0.7578	16	0.031315
CC	Consultation coverage, Participation rate, Inclusivity index	1	10	27	26	64	206	0.8047	9	0.033253
PPABT	Public plan access, Budget transparency, Corruption perception	1	7	30	26	64	209	0.8164	7	0.033737
SDTRC	Service delivery time, revenue collection, HR capacity	1	3	33	27	64	214	0.8359	4	0.034542
DSC	Digital service coverage, User satisfaction, System uptime	1	2	31	30	64	218	0.8516	2	0.035191

Table 4.3: Pairwise Comparison of 30 Sustainability Indicators Based on Importance

	PSS	UHIR	GWB	GCA	GRUD	ERJC	IWDMI	LUED	LUED	VLDALP	FARM	HAISOR	HRAR	PDCD	ISRA	PHCZ	HUDOR	ACSF	TFECI	PCUB	ISIELL	SWAG	SWAGC	WCRL	RES	CFR	CC	PPABT	SDTRC	DSC
PSS	1.00	0.97	0.91	0.93	0.89	0.98	1.00	0.94	0.95	0.93	1.03	0.97	0.96	0.96	0.92	1.00	1.02	0.94	0.95	0.92	0.99	0.97	0.96	0.93	0.92	1.00	0.96	0.94	0.92	0.90
UHIR	1.03	1.00	0.94	0.96	0.92	1.01	1.03	0.97	0.98	0.96	1.06	1.00	0.99	0.99	0.95	1.03	1.05	0.97	0.98	0.95	1.00	1.00	0.99	0.96	0.95	1.00	0.99	0.97	0.95	0.93
GWB	1.10	1.06	1.00	1.02	0.98	1.07	1.09	1.03	1.04	1.02	1.13	1.06	1.05	1.05	1.01	1.10	1.11	1.03	1.04	1.01	1.08	1.06	1.05	1.02	1.01	1.10	1.05	1.03	1.01	0.99



GCA	1.08	1.04	0.98	1.00	0.96	1.05	1.07	1.01	1.02	1.01	1.10	1.04	1.03	1.03	0.99	1.08	1.09	1.01	1.02	0.99	1.06	1.04	1.03	1.00	0.99	1.09	1.09	1.03	1.01	0.99	0.97
GRUD	1.12	1.09	1.02	1.04	1.00	1.09	1.12	1.06	1.07	1.05	1.15	1.08	1.07	1.07	1.03	1.12	1.14	1.06	1.07	1.03	1.11	1.09	1.07	1.04	1.03	1.14	1.11	1.07	1.06	1.03	1.01
ERJC	1.03	1.00	0.94	0.95	0.91	1.00	1.02	0.97	0.98	0.96	1.05	0.99	0.98	0.98	0.94	1.03	1.04	0.97	0.98	0.94	1.01	1.00	0.98	0.95	0.94	0.94	1.04	0.98	0.97	0.94	0.93
IWDMI	1.01	0.98	0.92	0.93	0.90	0.98	1.00	0.95	0.96	0.94	1.03	0.97	0.96	0.96	0.93	1.01	1.02	0.95	0.96	0.93	0.99	0.98	0.96	0.93	0.93	1.02	0.96	0.95	0.93	0.91	
LUED	1.06	1.03	0.97	0.99	0.95	1.04	1.06	1.00	1.01	0.99	1.09	1.02	1.02	1.02	0.98	1.06	1.08	1.00	1.01	0.98	1.05	1.03	1.02	0.99	0.98	1.08	1.08	1.02	1.00	0.98	0.96
LUEC	1.05	1.02	0.96	0.98	0.94	1.03	1.05	0.99	1.00	0.98	1.08	1.02	1.01	1.01	0.97	1.05	1.07	0.99	1.00	0.97	1.04	1.02	1.01	0.98	0.97	1.07	1.07	1.01	0.99	0.97	0.95
VLDALP	1.07	1.04	0.98	1.00	0.96	1.04	1.07	1.01	1.02	1.00	1.10	1.03	1.02	1.02	0.99	1.07	1.09	1.01	1.02	0.99	1.06	1.04	1.02	1.00	0.99	1.09	1.09	1.02	1.01	0.99	0.97
FARM	0.98	0.95	0.89	0.91	0.87	0.95	0.97	0.92	0.93	0.91	1.00	0.94	0.93	0.93	0.90	0.98	0.99	0.92	0.93	0.90	0.96	0.95	0.93	0.91	0.90	0.99	0.99	0.93	0.92	0.90	0.88
HAISOR	1.04	1.01	0.94	0.96	0.92	1.01	1.03	0.98	0.99	0.97	1.06	1.00	0.99	0.99	0.95	1.04	1.05	0.98	0.99	0.95	1.02	1.01	0.99	0.96	0.95	0.95	1.05	0.99	0.98	0.95	0.94
HRAR	1.05	1.02	0.95	0.97	0.93	1.02	1.04	0.99	1.00	0.98	1.07	1.01	1.00	1.00	0.96	1.05	1.06	0.99	1.00	0.96	1.03	1.02	1.00	0.97	0.96	1.06	1.06	1.00	0.99	0.96	0.95
PDCD	1.05	1.02	0.95	0.97	0.93	1.02	1.04	0.99	1.00	0.98	1.07	1.01	1.00	1.00	0.96	1.05	1.06	0.99	1.00	0.96	1.03	1.02	1.00	0.97	0.96	1.06	1.06	1.00	0.99	0.96	0.95
ISRA	1.09	1.05	0.99	1.01	0.97	1.06	1.08	1.02	1.03	1.01	1.12	1.05	1.04	1.04	1.00	1.09	1.10	1.02	1.03	1.00	1.07	1.05	1.04	1.01	1.00	1.10	1.10	1.04	1.02	1.00	0.98
PHCZ	1.00	0.97	0.91	0.93	0.89	0.98	1.00	0.94	0.95	0.93	1.03	0.97	0.96	0.96	0.92	1.00	1.02	0.94	0.95	0.92	0.99	0.97	0.96	0.93	0.92	0.92	1.02	0.96	0.94	0.92	0.90
HUDOR	0.99	0.96	0.90	0.92	0.88	0.96	0.98	0.93	0.94	0.92	1.01	0.95	0.94	0.94	0.91	0.99	1.00	0.93	0.94	0.91	0.97	0.96	0.94	0.92	0.91	1.00	0.94	0.93	0.91	0.99	0.89
ACSF	1.06	1.03	0.97	0.99	0.95	1.04	1.06	1.00	1.01	0.99	1.09	1.02	1.02	1.02	0.98	1.06	1.08	1.00	1.01	0.98	1.05	1.03	1.02	0.99	0.98	1.08	1.08	1.02	1.00	0.98	0.96
TFECI	1.05	1.02	0.96	0.98	0.94	1.03	1.05	0.99	1.00	0.98	1.08	1.02	1.01	1.01	0.97	1.05	1.07	0.99	1.00	0.97	1.04	1.02	1.01	0.98	0.97	1.07	1.07	1.01	0.99	0.97	0.95
PCUB	1.09	1.05	0.99	1.01	0.97	1.06	1.08	1.02	1.03	1.01	1.12	1.05	1.04	1.04	1.00	1.09	1.10	1.02	1.03	1.00	1.07	1.05	1.04	1.01	1.00	1.10	1.10	1.04	1.02	1.00	0.98
ISIEL	1.02	0.99	0.93	0.94	0.91	0.99	1.01	0.96	0.97	0.95	1.04	0.98	0.97	0.97	0.94	1.02	1.03	0.96	0.97	0.94	1.00	0.99	0.97	0.94	0.94	1.03	0.97	0.96	0.94	0.92	
SWAG	1.03	1.00	0.94	0.96	0.92	1.01	1.03	0.97	0.98	0.96	1.06	1.00	0.99	0.99	0.95	1.03	1.05	0.97	0.98	0.95	1.02	1.00	0.99	0.96	0.95	1.05	0.99	0.97	0.95	0.93	
SWAGC	1.05	1.02	0.95	0.97	0.93	1.02	1.04	0.99	1.00	0.98	1.07	1.01	1.00	1.00	0.96	1.05	1.06	0.99	1.00	0.96	1.03	1.02	1.00	0.97	0.96	1.06	1.06	1.00	0.99	0.96	0.95

WCR	1.0	1.0	0.9	1.0	0.9	1.0	1.0	1.0	1.0	1.0	1.1	1.0	1.0	1.0	0.9	1.0	1.0	1.0	1.0	0.9	1.0	1.0	1.0	0.9	1.0	1.0	0.9	0.9		
L	8	4	8	0	6	5	7	1	2	1	0	4	3	3	9	8	9	1	2	9	6	4	3	0	9	9	3	1	9	7
RES	1.0	1.0	0.9	1.0	0.9	1.0	1.0	1.0	1.0	1.0	1.1	1.0	1.0	1.0	1.0	1.0	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.0	1.0	1.0	0.9	
	9	5	9	1	7	6	8	2	3	1	2	5	4	4	0	9	0	2	3	0	7	5	4	1	0	0	4	2	0	8
CFR	0.9	0.9	0.9	0.9	0.8	0.9	0.9	0.9	0.9	0.9	1.0	0.9	0.9	0.9	0.9	0.9	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	0.9	0.9	0.9	0.8	
	9	6	0	2	8	6	8	3	4	2	1	5	4	4	1	9	0	3	4	1	7	6	4	2	1	0	4	3	1	9
CC	1.0	1.0	0.9	0.9	0.9	1.0	1.0	0.9	1.0	0.9	1.0	1.0	1.0	1.0	0.9	1.0	1.0	0.9	1.0	0.9	1.0	1.0	1.0	0.9	0.9	1.0	1.0	0.9	0.9	0.9
	5	2	5	7	3	2	4	9	0	8	7	1	0	0	6	5	6	9	0	6	3	2	0	7	6	6	0	9	6	5
PPAB	1.0	1.0	0.9	0.9	0.9	1.0	1.0	1.0	1.0	0.9	1.0	1.0	1.0	1.0	0.9	1.0	1.0	1.0	1.0	0.9	1.0	1.0	1.0	0.9	0.9	1.0	1.0	1.0	0.9	0.9
T	6	3	7	9	5	4	6	0	1	9	9	2	2	2	8	6	8	0	1	8	5	3	2	9	8	8	2	0	8	6
SDT	1.0	1.0	0.9	1.0	0.9	1.0	1.0	1.0	1.0	1.0	1.1	1.0	1.0	1.0	1.0	1.0	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.0	1.0	1.0	0.9	
RC	9	5	9	1	7	6	8	2	3	1	2	5	4	4	0	9	0	2	3	0	7	5	4	1	0	0	4	2	0	8
DSC	1.1	1.0	1.0	1.0	0.9	1.0	1.1	1.0	1.0	1.0	1.1	1.0	1.0	1.0	1.0	1.1	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.0	1.0	1.0	1.0	
	1	7	1	3	9	8	0	4	5	3	4	7	6	6	2	1	2	4	5	2	9	7	6	3	2	2	6	4	2	0

## Sectoral Consolidation of Sustainability Indicators

The pairwise comparison of 30 sustainability indicators was consolidated into 7 sectoral categories, ensuring a structured evaluation of urban sustainability priorities.

Table 4.4: Pairwise Comparison of 30 Sustainability Indicators Consolidated into 7 Sectoral Categories

	E&I	G&IE	H	LU&UF	PC	SE	T
E&I	1.000	1.215	1.269	0.837	1.243	1.657	1.240
G&IE	0.823	1.000	1.044	0.689	1.023	1.364	1.020
H	0.788	0.957	1.000	0.660	0.979	1.306	0.977
LU&UF	1.194	1.451	1.515	1.000	1.484	1.979	1.481
PC	0.805	0.978	1.021	0.674	1.000	1.333	0.998
SE	0.604	0.733	0.766	0.505	0.750	1.000	0.748
T	0.807	0.980	1.023	0.675	1.002	1.337	1.000

Table 4.4 presents the sectoral-level pairwise comparisons, where Land Use & Urban Form (LU&UF) holds the highest comparative importance, reinforcing its role in shaping sustainable urban environments. Environmental & Infrastructure (E&I) and Governance & Institutional Efficiency (G&IE) also rank highly, emphasizing their significance in climate resilience, resource management, and policy implementation.

Table 4.5: Priority Weights and Rankings of 30 Sustainability Indicators Consolidated into 7 Sectoral Categories

Sector	Priority Weight (Normalized)	Rank
Land use & Urban Form	0.198	1
Environmental and Infrastructure	0.166	2

Governance and Institutional Efficiency	0.137	3
Transportation	0.134	4
Physical Characteristics	0.134	5
Housing	0.131	6
Socio Economic factors	0.100	7

Table 4.5 further refines these comparisons into normalized priority weights, ranking LU&UF (0.198) as the most influential sector, followed by E&I (0.166) and G&IE (0.137). Transportation (0.134), Physical Characteristics (0.134), and Housing (0.131) hold moderate influence, while Socio-Economic factors (0.100) rank lowest, indicating their dependence on governance and infrastructure support. These rankings form the foundation for further integration with AHP analysis, ensuring a data-driven approach to sustainability assessment in developing urban frameworks.

### AHP-Based Evaluation of Sectoral Indicators

The Analytical Hierarchy Process (AHP) was applied to determine the relative importance of sectoral indicators using Saaty's 1–9 scale. This scale facilitates pairwise comparisons, allowing experts to assign weights based on the influence of one sector over another in urban sustainability. The AHP method ensures logical consistency in rankings, forming the basis for prioritizing sectoral contributions to the Sustainable Urban Planning Index (SUPI).

Table 4.6: Sectoral Weights and Rankings of Sustainability Indicators Based on AHP

#### AHP Analytic Hierarchy Process (EVM multiple inputs)

K. D. Goepel Version 04.05.2016 | Free web based AHP software on: <http://bpmsq.com>

Only input data in the light green fields and worksheets!

n= 7 Number of criteria (2 to 10) Scale: 1 AHP 1-9  
N= 20 Number of Participants (1 to 20)  $\alpha$ : 0.1 Consensus: 78.7%  
p= 0 selected Participant (0=consol.) 2 7 Consolidated

Objective To rank and weight Visual Pollution Objects through AHP method

Author Ramine Ch

Date 14-Feb-25

Thresh: 1E-07

Iterations: 4

EVM check: 5.9E-09

Table	Criterion	VPO Group	Weights	Rank
1	PC	Physical Characteristics	24.9%	2
2	SE	Socio Economic	14.3%	3
3	LU&UF	Land Use & Urban Form	25.7%	1
4	H	Housing	12.0%	4
5	T	Transport	7.8%	6
6	E&I	Environment & infrastructure	4.0%	7
7	G&IP	Governance & Institutional Performance	11.3%	5

Result

Eigenvalue

lambda: 7.060

Consistency Ratio

GCI: 0.03

CR: 0.7%

This table 4.6 presents the AHP-derived priority weights and rankings for seven sectoral categories in urban sustainability. Land Use & Urban Form (25.7%) emerged as the most influential criterion, followed by Physical Characteristics (24.9%) and Socio-Economic Factors (14.3%). Housing (12.0%) and Governance & Institutional Performance (11.3%) held moderate influence, while Transportation (7.8%) and Environment &

Infrastructure (4.0%) ranked lower. The consistency ratio (CR = 0.7%) confirms the logical coherence of expert evaluations, ensuring a reliable weighting system for sustainability assessment.

Table 4.7: Pairwise Comparison Matrix and Normalized Weights for Sectoral Criteria Using AHP

Matrix											normalized principal Eigenvector	
	PC	SE	LU&UF	H	T	E&I	G&IP	0	0	#N/A		
	1	2	3	4	5	6	7	8	9	10		
PC	1	-	2	1	2	3 5/8	5	2	-	-	-	24.87%
SE	2	1/2	-	1/2	1 1/8	2 3/8	3 5/8	1 2/5	-	-	-	14.31%
LU&UF	3	1	2 1/9	-	2	3 2/3	5 1/4	2 1/2	-	-	-	25.70%
H	4	1/2	8/9	1/2	-	1 2/5	3 2/5	1	-	-	-	12.04%
T	5	2/7	3/7	1/4	5/7	-	2 3/5	3/4	-	-	-	7.80%
E&I	6	1/5	2/7	1/5	2/7	2/5	-	1/3	-	-	-	3.98%
G&IP	7	1/2	5/7	2/5	1	1 1/3	3	-	-	-	-	11.30%

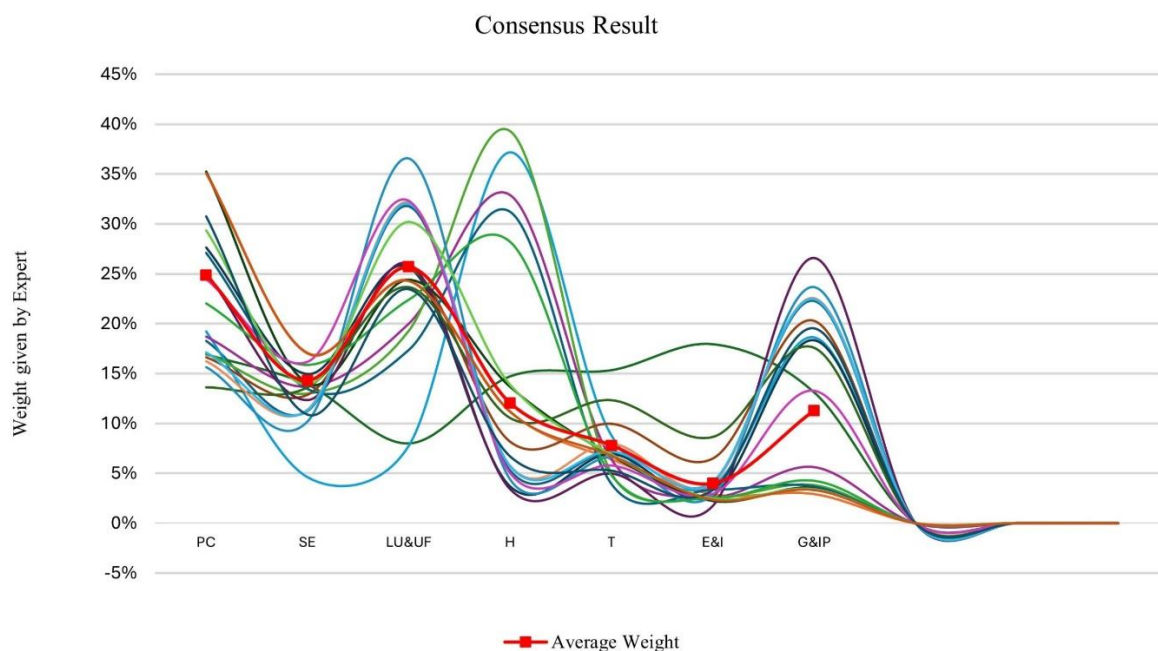
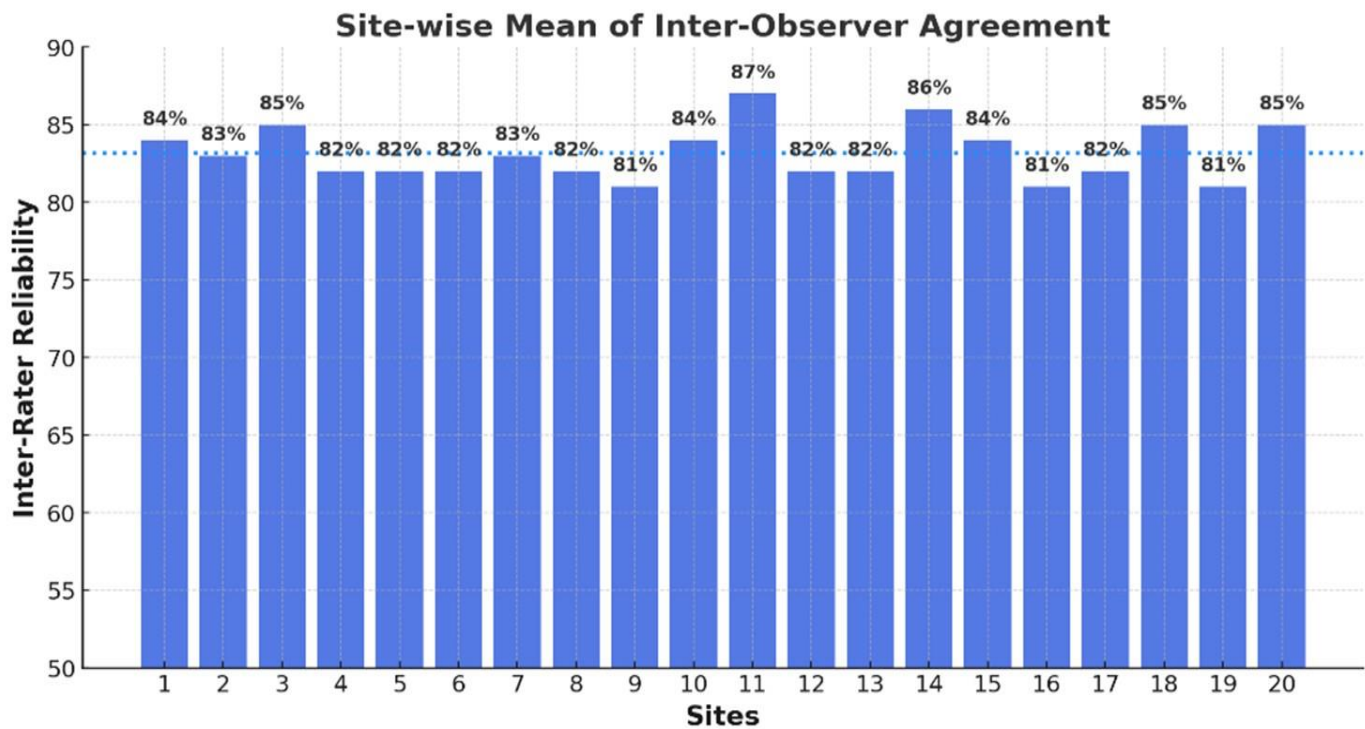


Figure 5 Expert Consensus on Sectoral Weights for Sustainability Indicators Using AHP

This figure 5 illustrates the consensus results of expert evaluations for the relative importance of sustainability sectors using the Analytic Hierarchy Process (AHP). Each curve represents an expert's assigned weight to different sectoral indicators, namely Physical Characteristics (PC), Socio-Economic Factors (SE), Land Use & Urban Form (LU&UF), Housing (H), Transportation (T), Environment & Infrastructure (E&I), and Governance & Institutional Performance (G&IP).

The red line with markers represents the average weight assigned to each sector across all experts, capturing the overall trend of expert consensus. The fluctuations in individual curves indicate variability in expert opinions, while the red trend line smooths out these variations to depict a final consensus ranking. The highest peaks reflect sectors with greater perceived importance, while the lower points indicate less prioritized sectors in the sustainability assessment framework.





**Figure 6 Site-wise Mean of Inter-Observer Agreement for Inter-Rater Reliability (IRR) Test**

This figure 6 presents the Inter-Rater Reliability (IRR) test results, depicting the site-wise mean of inter-observer agreement across 20 different sites. The IRR test assesses the consistency and reliability of expert judgments in evaluating sustainability indicators. The y-axis represents the inter-rater reliability percentage, while the x-axis represents the sites where assessments were conducted. The blue bars indicate the agreement level at each site, with values ranging between 81% and 87%, showing strong consistency in expert evaluations. The dotted blue line represents the average agreement across all sites, serving as a benchmark for assessing overall reliability. A higher IRR percentage signifies greater consistency among experts, ensuring that the indicator rankings and evaluations used in this study are statistically valid and reliable for sustainability assessments.

### Final Normalization and Weighted Hybrid Scoring of RII and AHP Pairwise Comparison

The final normalization and weighted hybrid scoring integrated the Relative Importance Index (RII) and Analytical Hierarchy Process (AHP) pairwise comparisons to ensure a balanced assessment of sustainability indicators. This hybrid approach mitigated potential biases from individual methodologies, creating a structured ranking system that aligns sectoral priorities with expert-driven weighting. The normalized weights provided a comprehensive evaluation framework, enhancing the adaptability of the Sustainable Urban Planning Index (SUPI) for application in data-limited environments. The results highlight a refined prioritization of sustainability indicators, ensuring their contextual relevance and practical applicability in urban planning assessment models.

**Table 4.8: Final Hybrid Weighting and Ranking of Sectoral Criteria**

Criteria	Hybrid Weight (%)	Rank
Physical Characteristics	0.191157	2
Socio Economic Factors	0.121655	5
Land Use & Urban Form	0.22771	1

Housing	0.125657	3
Transportation	0.106007	6
Environmental and Infrastructure	0.102958	7
Governance and Institutional Efficiency	0.124857	4

The table 4.8 presents the final hybrid weight distribution for sectoral criteria after the normalization of Relative Importance Index (RII) and Analytical Hierarchy Process (AHP) results. This ensures a balanced hybrid weighting approach, preventing dominance by either AHP's structured hierarchy or RII's expert consensus. Land Use & Urban Form (22.77%) ranked highest, indicating its critical role in sustainable urban planning, followed by Physical Characteristics (19.12%) and Housing (12.57%). Governance and Institutional Efficiency (12.48%) also held significance, reflecting its role in implementation effectiveness. Environmental and Infrastructure (10.29%) and Transportation (10.60%) ranked lowest, signifying their relative weight in the evaluation framework. These weights will be utilized for further model convergence in sustainable urban planning assessment.

The table presents the final hybrid priority weights for sustainability indicators after normalizing the RII and AHP results. VLDALP (0.05866) ranks highest, followed closely by LUED (0.05811) and LUEC (0.05755), underscoring their critical importance. In contrast, indicators like CFR (0.01625), ISIELL (0.01676), and HUDOR (0.01996) rank lowest. These weights form the basis for further refinement of the SUPI framework.

Table 4.9: Hybrid Priority Weights and Ranking of Sustainability Indicators

Variable	Hybrid Priority Weight	Rank
PSS	0.04547877	8
UHIR	0.046867489	7
GWB	0.049869469	5
GCA	0.048941272	6
GRUD	0.043294782	9
ERJC	0.039573919	10
IWDMI	0.038786299	11
LUED	0.058109515	2
LUEC	0.057553172	3
VLDALP	0.058664137	1
FARM	0.053383176	4
HAISOR	0.020995219	22
HRAR	0.021200511	20
PDCD	0.021200511	20
ISRA	0.022022315	19

PHCZ	0.02027351	23
HUDOR	0.019964935	24
ACSFF	0.035168184	13
TFECI	0.034831482	14
PCUB	0.036007334	12
ISIELL	0.016755729	29
SWAG	0.017006914	28
SWAGC	0.017257581	27
WCRL	0.017759432	26
RES	0.017926543	25
CFR	0.016251801	30
CC	0.030367018	18
PPABT	0.030809012	17
SDTRC	0.031544148	16
DSC	0.032136822	15

The SUPI framework is a comprehensive multi-criteria decision-support tool that integrates both expert consensus (via the Relative Importance Index) and structured pairwise comparisons (using the Analytical Hierarchy Process) to evaluate urban sustainability. By combining these methodologies, it produces a balanced model that systematically identifies and prioritizes key indicators—for example, sectors such as Land Use & Urban Form may contribute around 22.77% while Physical Characteristics and Housing also hold significant weights. This balanced approach ensures that the most critical aspects of urban planning are highlighted, providing policymakers with a robust tool to guide sustainable master plan assessments and informed decision-making.



**Figure 7: Proposed framework of SUPI for developing countries**

## CONCLUSIONS AND FUTURE WORK

This study developed a Sustainable Urban Planning Index (SUPI) by integrating AHP, RII, and hybrid weighting methods to systematically evaluate sectoral indicators critical for urban sustainability. The findings highlight Land Use & Urban Form, Environmental & Infrastructure, Governance, and Transportation as key determinants in assessing urban development effectiveness. The hybrid approach ensured balanced indicator ranking, minimizing biases and enhancing applicability in developing countries. The SUPI framework provides a structured evaluation tool for policymakers and urban planners to assess master plans and guide sustainable urban development.

Future work should focus on refining the framework through expanded datasets, GIS-based monitoring, and scenario-based modelling to enhance predictive capabilities. Institutional adoption of the SUPI framework, particularly in urban planning policies, will strengthen decision-making and transparency. Further research is needed to analyse sectoral interdependencies, integrate digital governance tools, and assess applicability in diverse urban settings. By advancing these areas, the SUPI framework can evolve into a scalable and adaptive tool for evaluating sustainability across different urban environments.

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## APPENDIX A

Please indicate the level of impact each indicator has on Sustainable Urban Planning by selecting one of the following options: 1 for Very Unimportant (V-UNIMP), 2 for Unimportant (UNIMP), 3 for Important (IMP), and 4 for Very Important (V-IMP).

### A. How strongly does Physical Character impact Sustainable Urban Planning?

- |   |   |
|---|---|
| 1. Land Development & Slope Stabilization   | <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 |
| 2. Urban Climate Resilience                 | <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 |
| 3. Groundwater and Water Quality Management | <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 |
| 4. Green Infrastructure and Biodiversity    | <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 |

### B. How strongly does Socio-Economic Development impact Sustainable Urban Planning?

- |  |   |
|--|---|
| 1. Urban Growth and Demographics       | <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 |
| 2. Employment and Economic Opportunity | <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 |
| 3. Socioeconomic Equity                | <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 |

### C. How strongly does Land Use & Urban Form impact Sustainable Urban Planning?

- |   |   |
|---|---|
| 1. Land Use and Efficiency                              | <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 |
| 2. Environmental Compliance and Transport Accessibility | <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 |
| 3. Land Conservation and Agricultural Preservation      | <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 |
| 4. Mixed-Use Development and Density                    | <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 |

### D. How strongly does Housing impact Sustainable Urban Planning?

- |  |   |
|--|---|
| 1. Housing Affordability and Ownership               | <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 |
| 2. Housing Density and Accessibility                 | <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 |
| 3. Compact Development and Residential Accessibility | <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 |
| 4. Informal Settlement and Resettlement              | <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 |
| 5. Vertical Housing Compliance                       | <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 |
| 6. Housing Utilization and Overcrowding              | <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 |

### E. How strongly does Transportation impact Sustainable Urban Planning?

- |  |   |
|--|---|
| 1. Transportation Accessibility              | <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 |
| 2. Traffic and Safety Management             | <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 |
| 3. Active and Sustainable Mobility           | <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 |
| 4. Integrated and Sustainable Transportation | <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 |

### F. How strongly does Environmental & Infrastructure impact Sustainable Urban Planning?

- |   |   |
|---|---|
| 1. Carbon Reduction and Tree Canopy           | <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 |
| 2. Water Resource Management                  | <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 |
| 3. Waste Management                           | <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 |
| 4. Renewable Energy and Energy Efficiency     | <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 |
| 5. Flood Resilience and Stormwater Management | <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 |

### G. How strongly does Governance & Institutional Performance impact Sustainable Urban Planning?



- |   |   |
|---|---|
| 1. Governance and Public Participation        | <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 |
| 2. Transparency and Anti-Corruption           | <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 |
| 3. Service Efficiency and Resource Management | <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 |
| 4. Digital Governance and User Experience     | <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 |

## APPENDIX B

This questionnaire aims to gather expert opinions on prioritizing sectoral indicators for sustainable urban planning using the Analytic Hierarchy Process (AHP). You will compare two indicators at a time and assign a score based on Saaty's 1-9 scale: 1 (equal importance), 3 (moderate), 5 (strong), 7 (very strong), and 9 (extreme), with 2, 4, 6, 8 as intermediate values. For each pair, select the more important criterion and assign a score reflecting its significance. If both are equally important, assign 1. Please complete all 21 pairwise comparisons to ensure statistical consistency. Your expertise is highly valued. Thank you for your participation.

Name: \_\_\_\_\_ Affiliation: \_\_\_\_\_ Position: \_\_\_\_\_ Years of Experience in Urban Planning: \_\_\_\_\_

Physical Characteristics vs. Socio-Economic Factors	<input type="checkbox"/> Physical Characteristics (PC)	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7
	<input type="checkbox"/> Socio-Economic Factors (SE)	<input type="checkbox"/> 8 <input type="checkbox"/> 9
Physical Characteristics vs. Land Use & Urban Form	<input type="checkbox"/> Physical Characteristics (PC)	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7
	<input type="checkbox"/> Land Use & Urban Form (LU&UF)	<input type="checkbox"/> 8 <input type="checkbox"/> 9
Physical Characteristics vs. Housing	<input type="checkbox"/> Physical Characteristics (PC)	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7
	<input type="checkbox"/> Housing (H)	<input type="checkbox"/> 8 <input type="checkbox"/> 9
Physical Characteristics vs. Transportation	<input type="checkbox"/> Physical Characteristics (PC)	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7
	<input type="checkbox"/> Transportation (T)	<input type="checkbox"/> 8 <input type="checkbox"/> 9
Physical Characteristics vs. Environment & Infrastructure	<input type="checkbox"/> Physical Characteristics (PC)	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7
	<input type="checkbox"/> Environment & Infrastructure (E&I)	<input type="checkbox"/> 8 <input type="checkbox"/> 9
Physical Characteristics vs. Governance & Institutional Performance	<input type="checkbox"/> Physical Characteristics (PC)	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7
	<input type="checkbox"/> Governance & Institutional Performance	<input type="checkbox"/> 8 <input type="checkbox"/> 9
Socio-Economic Factors vs. Land Use & Urban Form	<input type="checkbox"/> Socio-Economic Factors (SE)	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7
	<input type="checkbox"/> Land Use & Urban Form (LU&UF)	<input type="checkbox"/> 8 <input type="checkbox"/> 9
Socio-Economic Factors vs. Housing	<input type="checkbox"/> Socio-Economic Factors (SE)	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7
	<input type="checkbox"/> Housing (H)	<input type="checkbox"/> 8 <input type="checkbox"/> 9
Socio-Economic Factors vs. Transportation	<input type="checkbox"/> Socio-Economic Factors (SE)	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7
	<input type="checkbox"/> Transportation (T)	<input type="checkbox"/> 8 <input type="checkbox"/> 9

Socio-Economic Factors vs. Environment & Infrastructure	<input type="checkbox"/> Socio-Economic Factors (SE)	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7
	<input type="checkbox"/> Environment & Infrastructure (E&I)	<input type="checkbox"/> 8 <input type="checkbox"/> 9
Socio-Economic Factors vs. Governance & Institutional Performance	<input type="checkbox"/> Socio-Economic Factors (SE)	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7
	<input type="checkbox"/> Governance & Institutional Performance	<input type="checkbox"/> 8 <input type="checkbox"/> 9
Land Use & Urban Form vs. Housing	<input type="checkbox"/> Land Use & Urban Form (LU&UF)	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7
	<input type="checkbox"/> Housing (H)	<input type="checkbox"/> 8 <input type="checkbox"/> 9
Land Use & Urban Form vs. Transportation	<input type="checkbox"/> Land Use & Urban Form (LU&UF)	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7
	<input type="checkbox"/> Transportation (T)	<input type="checkbox"/> 8 <input type="checkbox"/> 9
Land Use & Urban Form vs. Environment & Infrastructure	<input type="checkbox"/> Land Use & Urban Form (LU&UF)	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7
	<input type="checkbox"/> Environment & Infrastructure (E&I)	<input type="checkbox"/> 8 <input type="checkbox"/> 9
Land Use & Urban Form vs. Governance & Institutional Performance	<input type="checkbox"/> Land Use & Urban Form (LU&UF)	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7
	<input type="checkbox"/> Governance & Institutional Performance	<input type="checkbox"/> 8 <input type="checkbox"/> 9
Housing vs. Transportation	<input type="checkbox"/> Housing (H)	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7
	<input type="checkbox"/> Transportation (T)	<input type="checkbox"/> 8 <input type="checkbox"/> 9
Housing vs. Environment & Infrastructure	<input type="checkbox"/> Housing (H)	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7
	<input type="checkbox"/> Transportation (T)	<input type="checkbox"/> 8 <input type="checkbox"/> 9
Housing vs. Governance & Institutional Performance	<input type="checkbox"/> Housing (H)	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7
	<input type="checkbox"/> Governance & Institutional Performance	<input type="checkbox"/> 8 <input type="checkbox"/> 9
Transportation vs. Environment & Infrastructure	<input type="checkbox"/> Transportation (T)	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7
	<input type="checkbox"/> Environment & Infrastructure (E&I)	<input type="checkbox"/> 8 <input type="checkbox"/> 9
Transportation vs. Governance & Institutional Performance	<input type="checkbox"/> Transportation (T)	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7
	<input type="checkbox"/> Governance & Institutional Performance	<input type="checkbox"/> 8 <input type="checkbox"/> 9
Environment & Infrastructure vs. Governance & Institutional Performance	<input type="checkbox"/> Environment & Infrastructure (E&I)	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7
	<input type="checkbox"/> Governance & Institutional Performance	<input type="checkbox"/> 8 <input type="checkbox"/> 9