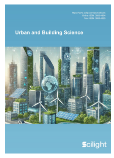
Scilight

Urban and Building Science
https://www.sciltp.com/journals/ubs



Article

Identifying the Design Indicators of Sustainable Urban Parks: Applying to Urban Parks in Tehran and Tabriz, Iran

Davood Vafadari Komarolya [1] and Kojiro Sho [2,*]

[1] Urban and Rural Planning Department, Faculty of Social Sciences, University of Mohaghegh Ardabili, Ardabil 56199-13131, Iran
[2] Department of Urban Engineering, School of Engineering, The University of Tokyo, Tokyo 113-8656, Japan
* Correspondence: shokojiro@g.ecc.u-tokyo.ac.jp

How To Cite: Vafadari Komarolya, D.; Sho, K. Identifying the Design Indicators of Sustainable Urban Parks: Applying to Urban Parks in Tehran and Tabriz, Iran. *Urban and Building Science* **2025**, *1*(1), 7. https://doi.org/10.53941/ubs.2025.100007

Received: 2 August 2025
Revised: 19 August 2025
Accepted: 13 October 2025
Published: 17 October 2025

Abstract: Sustainable urban parks (SUPs) are crucial for achieving sustainable urban communities. This research aimed to identify SUP design indicators through a literature review and semi-structured interviews with 31 experts. 17 key indicators were identified, encompassing the use of native plants, increasing vegetation, providing waste separation bins, involving the public in planning, considering local conditions, and incorporating local patterns. Less significant indicators included tree trunk protection for birds and open amphitheater design. Applying this framework to the case studies revealed a divergence in sustainability performance. The average number of indicators present in Tehran's parks was 28 out of a total of 50, exceeding the defined sustainability benchmark. Conversely, the average for Tabriz's parks was 24 out of 50, falling below the established threshold. This research helps address gaps in SUP design indicators and highlights the significance of involving specialists and city managers in planning and implementation to enhance sustainability.

Keywords: sustainable urban parks; design indicators; Teheran; Tabriz; Iran; MACTOR method

1. Introduction

The global urban population has grown from 30% in 1950 to 55% today, with predictions reaching 70% by 2050 [1]. Achieving city sustainability is critical to meeting the United Nations Sustainable Development Goals (SDGs) by 2030. While rapid urbanization has enhanced living conditions and spurred economic growth [2], it has also severely impacted global ecosystem health through habitat alteration and land conversion [3–7]. This growth, driven by population concentration, industrial modernization, and pollution, has transformed regional ecosystems and expanded urban footprints [8–10]. Forecasts suggest global resource consumption could escalate to 90 billion tons in coming decades [11,12].

In response to these challenges, sustainable development has become a key strategy for addressing social, economic, and environmental issues [13]. Urban green spaces and parks are vital in this endeavor, fostering sustainability and optimizing urban management [14–16]. Sustainable spaces create a sense of place through well-designed landscapes that promote well-being [17] and seek to eliminate negative environmental impacts by reflecting the connection between humans and nature [18]. A sustainable park must maintain its ability to serve the community at acceptable levels, which serves as a key criterion for evaluating success [19].

As crucial urban infrastructure, parks promote social interaction, physical and mental health, and reduce pollution [17,20–22]. Their quantity and quality are fundamental to sustainable cities [23]. Sustainable Urban Parks (SUPs), emerging in the late 1990s, are characterized by: (1) self-sufficiency in materials and maintenance, (2) addressing broader urban challenges, and (3) establishing new aesthetic standards [24]. They incorporate ecologically appropriate plants, support biodiversity, and are designed to reduce environmental impact while adapting to changing conditions, often providing co-benefits for health and well-being [25].

Despite their importance, previous research has not sufficiently focused on identifying the specific design indicators of SUPs [26–31], resulting in a significant planning and design gap. This study seeks to fill this gap by identifying the key planning and design indicators for Sustainable Urban Parks.

2. Literature Review

Urban parks are vital components of urban ecosystems, playing a crucial role in preserving ecological balance, enhancing community well-being, and promoting sustainable city development [31]. Extensive research affirms the strong correlation between urban green spaces and key sustainability outcomes, including public well-being [26], the promotion of urban agriculture [27], equitable distribution of resources [28], and the achievement of Sustainable Development Goals (SDGs) [29]. Furthermore, urban parks integrate the social, cultural, environmental, and economic dimensions of sustainability, forming a core element of urban infrastructure and design [32–34].

Internationally, several established frameworks provide benchmarks for evaluating urban sustainability. Standards such as ISO 37120 (Sustainable Cities and Communities), which offers indicators for city services and quality of life [35], the SITES rating system for sustainable land design [36], and LEED for Neighborhood Development [37] offer comprehensive guidelines for assessing ecological, social, and economic performance in urban landscapes. While these frameworks provide valuable foundational principles, their application often requires adaptation to local environmental conditions, cultural contexts, and specific urban challenges, particularly in developing countries [38].

The concept of Sustainable Urban Parks (SUPs) has evolved to address these needs, emphasizing self-sufficiency in materials and maintenance, solving broader urban problems, and establishing new aesthetic standards [24]. SUP design prioritizes native planting, habitat creation, and resource efficiency, contributing significantly to urban sustainability [39–41].

However, a critical gap remains in the literature. While prior studies have focused on sustainable management, community benefits, or environmental impacts of parks [16,42,43], there has been a notable lack of research dedicated to identifying and systematizing the specific design indicators that constitute a SUP. This gap is particularly evident in the context of developing countries, where localized indicators are essential for effective planning and design.

The present study addresses this gap by identifying, prioritizing, and modeling design indicators for SUPs through an urban sustainability lens. Our research aims to answer the following questions: What are the key design indicators for SUPs, and how can they be applied to evaluate and enhance existing urban parks?

3. Methodology

3.1. Data Collection

3.1.1. Semi-Structured Interview

This research gathered primary data through 31 semi-structured interviews with subject matter experts. The interviews began with broad, general questions designed to ease participants into the conversation, gradually progressing toward the core research aim. Participants were encouraged to express their views freely, sharing insights and perspectives on indicators related. Semi-structured interviews are recognized as a highly effective and versatile method for obtaining in-depth information on targeted research topics. While guided by predefined themes and questions, this approach retains flexibility, allowing the exploration of richer insights through follow-up inquiries shaped by the interviewee's responses [44–47]. This method has been effectively implemented in various urban planning research studies [47–49]. It proves highly suitable for collecting diverse perspectives, expertise, and experiences from professionals with different backgrounds pertinent to the study. A total of 31 interviews were conducted between 20 September 2024, and 20 October 2024. The face-to-face interviews lasted between 10 and 18 min, while email responses were completed within a timeframe of one to two days.

3.1.2. Participants and Sampling Method

The target demographic for this research, as detailed in Table 1, includes professionals whose expertise aligns with the research's focus and goals. Adherence to standardized protocols is crucial when undertaking semi-structured interviews to guarantee the acquisition of exhaustive data [47,50,51]. Research by [52] suggests that a minimum of 30 interviewees is necessary to gather dependable and comprehensive data. This research utilised the snowball sampling technique, a powerful method for investigating hard-to-reach or concealed demographics. Ref. [53] also highlights its usefulness in exploring sensitive topics and personal matters. The research employed this sampling approach, prioritizing convenience and expediting access to diverse expert opinions [47,54]. Interview participants were encouraged to suggest colleagues with similar expertise, aiding in the efficient recruitment of additional specialists [44,47]. In summary, the study involved a two-stage interview process with 31 participants from 6 specialized fields relevant to the research focus. Eligibility criteria required participants to be either university faculty members or authors of publications in international academic journals.

Table 1. Demographics of research samples.

Row	Expertise	Gender	Race	Education	Number
1	Urban Planners	Male and female	Iranian	Master's and Phd	7
2	Urban Designers	Male	Iranian	Master's and Phd	4
3	Landscape Architects	Male and female	Iranian	Master's and Phd	6
4	Landscape Engineers	Male and female	Iranian	Master's	5
5	Sociologists	Male and female	Iranian	Master's and Phd	5
6	Psychologists	Male and female	Iranian	Master's and Phd	4
Total	-	Percentage: Male (0.6) Percentage: female (0.4)	-	Percentage: Master's (0.3) Percentage: Phd (0.7)	31

3.2. Data Analysis Method

3.2.1. Validity and Reliability of Interviews

A validation process was carried out with the interviewees to ensure the credibility of the interviews. After initially taking notes and coding the data, the findings were shared with participants for their confirmation [47,55]. To further evaluate the reliability of the interviews, the intra-subject agreement method was employed, involving two coders. During the analysis, both matching and differing codes were thoroughly examined. Altogether, 33 codes were identified, including 11 matching ones and 4 non-matching ones, resulting in a reliability percentage of 63%. As noted in prior research, a reliability score above 60% confirms the consistency of interviews [47,56,57] (Table 2).

$$ATC = \frac{(NSC) \times 2}{TNC} \times 100$$

ATC: Agreement of Two Coders
NSC: Number of Similar Codes
TNC: Total Number of Codes

Table 2. Calculation of the reliability percentage between two coders.

Interview Number	Total Number of Codes	Number of Similar Codes	Number of Non-Identical Codes	Inter-Coder Reliability
(1)	19	6	3	63%
(2)	16	5	1	62%
Total	35	11	4	63%

3.2.2. Reviewing Interviews and Identifying Indicators

Following the completion of the interviews, thematic analysis was employed to analyze the collected data. This method aims to uncover patterns and themes within qualitative datasets [47,58,59]. The process differentiates between semantic themes, which convey clear and explicit meanings, and latent themes, which delve into deeper, underlying concepts [47,58,59]. Following Braun and Clarke's six-step framework, the analysis process included gaining familiarity with the data, generating initial codes, identifying and examining themes, refining their definitions, and ultimately producing the final report [47,59,60]. By identifying these themes and through this method, the development of key indicators for designing sustainable urban parks can be facilitated.

3.2.3. Justification for MACTOR Method Selection

The MACTOR method was selected for this study due to its ability to analyze power relationships and strategic alliances among different actors (in this case, sustainability indicators) within a complex system. Unlike other Multi-Criteria Analysis (MCA) techniques such as AHP or TOPSIS, which focus primarily on ranking options based on static weights, MACTOR dynamically models interactions and dependencies between criteria, making it particularly suitable for capturing the multifaceted nature of urban sustainability indicators [47,61].

3.2.4. Rating Scale Rationale

The rating scale from −4 to +4 was adopted in accordance with the standard MACTOR methodology, allowing experts to express not only the intensity of an indicator's importance (positive values) but also its potential negative impacts or conflicts (negative values). This range provides a nuanced assessment that captures both facilitating and hindering roles of each indicator [47,61,62].

3.2.5. MACTOR Analysis Process

The next phase of the study employed MACTOR (Matrix of Tactics, Objectives, and Recommendations) to analyze alliances and conflicts among actors. Developed by Michel Godet in 1991, MACTOR is a specialized analytical tool that delves into power dynamics, focusing on the competitive stances and interactions between stakeholders relative to their objectives. The methodology places particular importance on the relational influences between actors, categorized as direct, indirect, or competitive [47,61,63]. Its versatility has been demonstrated across a wide array of sectors, such as fisheries and aquaculture [64], agriculture and food systems [65], sustainable development [66], higher education [67], renewable energy [68], government operations [69], creative industries [70], telecommunications [71], tourism [72], and other fields [47,61,73].

The experts were ultimately asked to rate each indicator on a scale from −4 to 4, where 0 represented no opinion, 4 indicated the highest score, and −4 represented the lowest score. Once the responses were collected, the assigned scores for each indicator were averaged by experts specialized in the relevant field and then incorporated into the actor-target matrix (expert-index and expert-sub-index) using MACTOR software [47,61,62]. This procedure was repeated for all participating specialties in the study until the completion of the final actor-target matrix (expert-indicators and expert-sub-indicators). Subsequently, the necessary analyses were conducted on the matrix within the MACTOR software, leading to the final results being generated (Figure 1) [47,74–76].

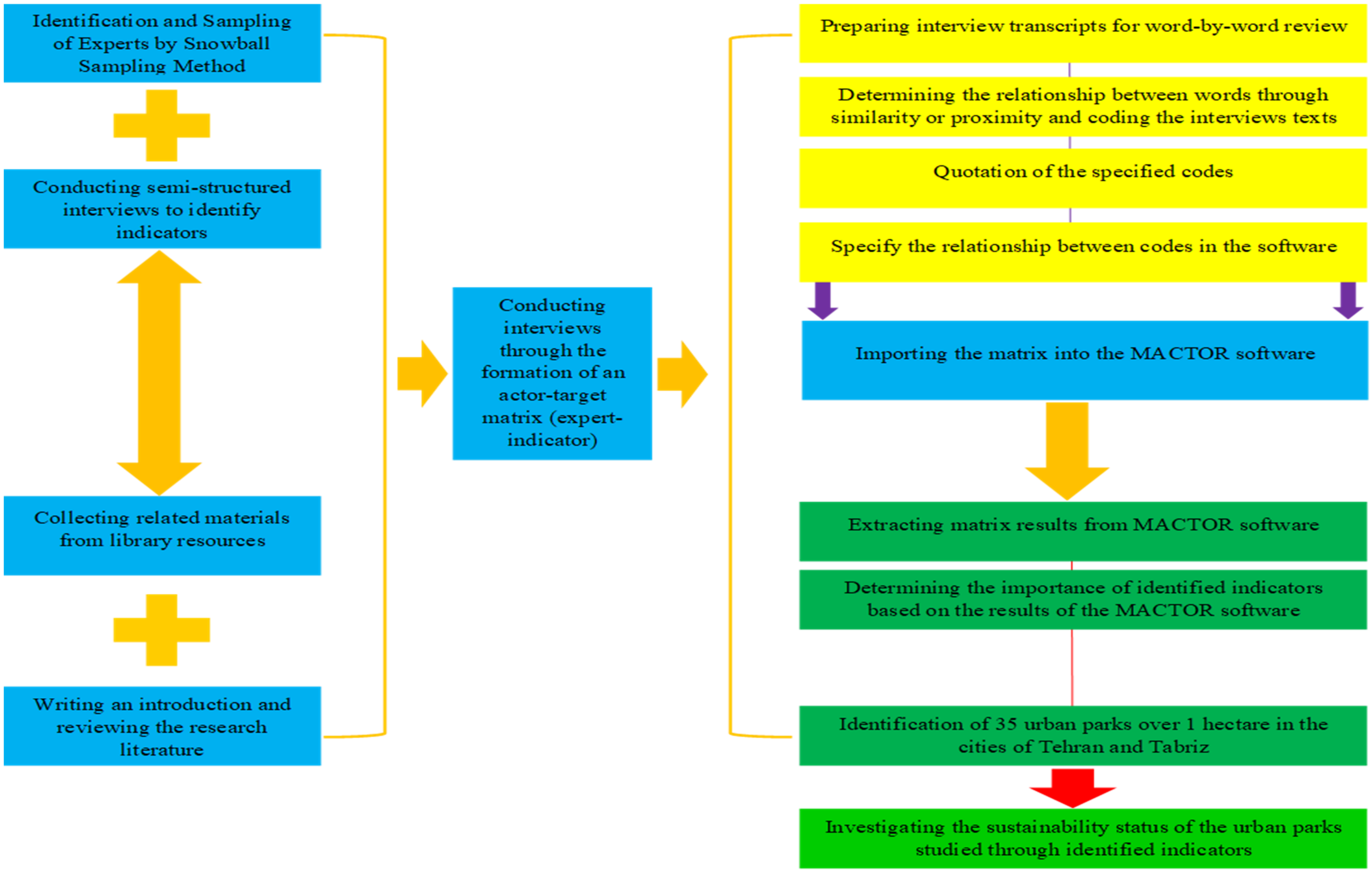


Figure 1. Research process.

3.2.6. Data Transparency Statement

The full set of semi-structured interview questions, detailed coding logic, scoring criteria, and weight assignment tables used in the MACTOR analysis are provided in Supplementary Materials (Supplementary S1 and S2).

3.3. Study Areas

Tehran, located at 35°41′ North and 51°26′ East, serves as the capital and largest city of Iran. Covering an area of approximately 730 km^2, its population density is estimated at 10,555 people per square kilometer, with a growth rate of 4.1%. The city's elevation ranges from 900 to 1800 m above sea level. The northern regions of Tehran experience a cold and dry climate, while the southern areas are comparatively warm and dry. Annual temperatures vary between 15 °C and 18 °C across the city, with localized fluctuations of around 3 degrees [77].

Tabriz, situated in northwestern Iran, serves as the political and economic hub of East Azerbaijan Province. It ranks as the fourth-largest city in Iran, with a population of approximately 2 million and an area close to 245 km^2. Renowned for its numerous industrial factories and rich cultural history, Tabriz plays a vital role in the national economy and attracts significant tourist activity. At an average elevation of 1321 m above sea level, the city features a semi-arid climate [78–81].

3.4. Park Selection and Field Observation Protocol

3.4.1. Park Selection Criteria

The selection of parks for evaluation was based on two primary criteria to ensure a focused and feasible study: (1) Size: Parks larger than 1 hectare were selected to ensure they had sufficient space to incorporate a variety of design indicators. (2) Accessibility and Prominence: Well-known urban parks in Tehran and Tabriz were chosen to represent vital green spaces that serve a significant portion of the urban population. A total of 21 parks in Tehran and 14 parks in Tabriz met these criteria.

3.4.2. Field Observation and Data Collection

Field observations were conducted to assess the presence or absence of the 50 identified indicators in each park. The assessment was carried out through a combination of:

- Direct Site Visits: The research team conducted structured site visits for accessible parks, using a checklist based on the 50 indicators.
- Verified Secondary Data: For parks that were not directly accessible, data were collected through consultations with local experts and municipal officials who had detailed knowledge of the parks. These experts were provided with the indicator checklist and their assessments were cross-verified for consistency where possible.

The scoring was binary (presence = 1 point, absence = 0 points) for each indicator, resulting in a total sustainability score out of 50 for each park.

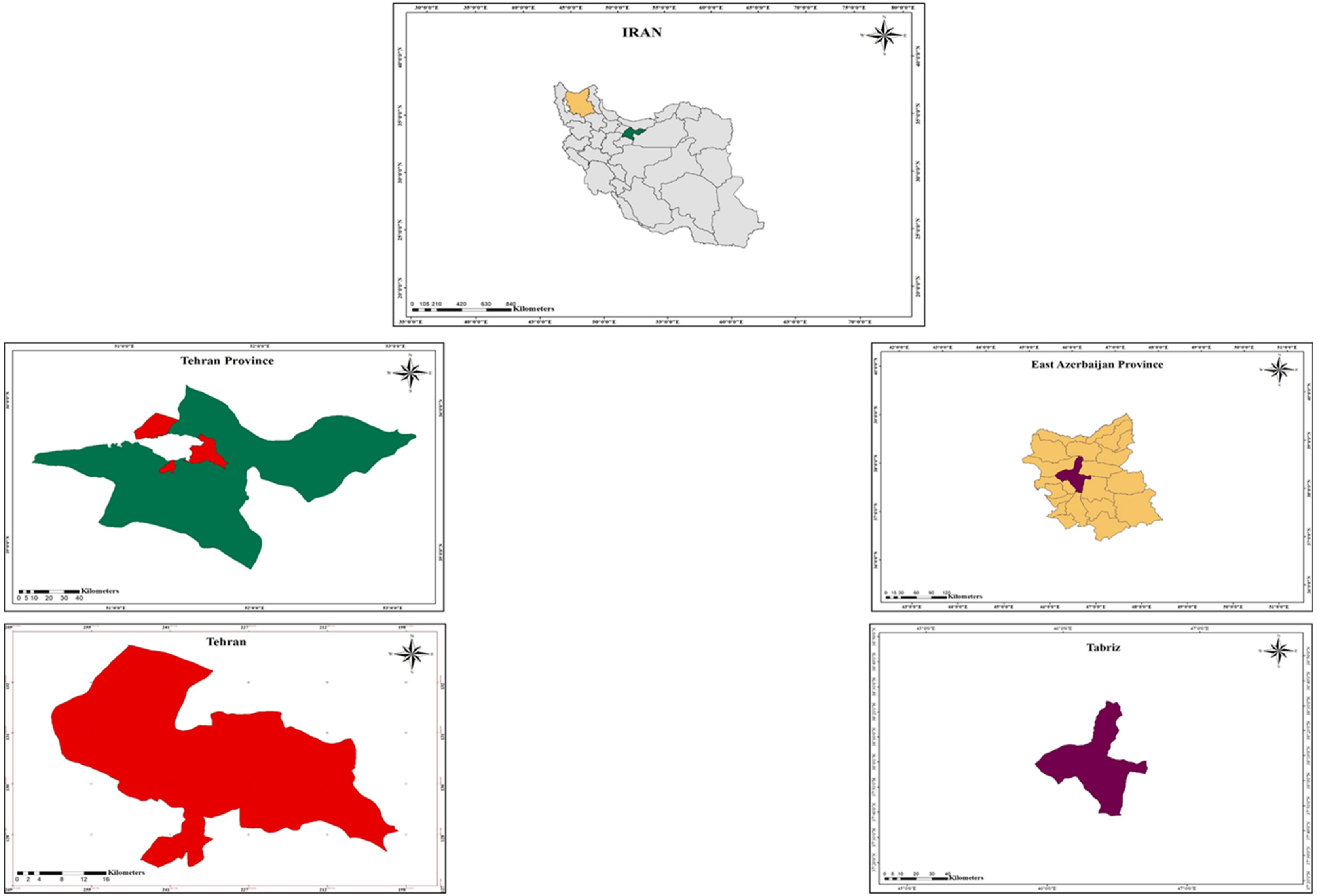


Figure 2. Study area location. The city boundary shapefile was sourced from publicly accessible GIS databases and refined by the authors to ensure spatial accuracy and alignment with official administrative borders (accessed in 2024).

4. Results

4.1. Thematic Clustering of Key Indicators

Analysis of expert interviews identified 50 key indicators for Sustainable Urban Parks (SUPs). These were grouped into five thematic clusters based on MACTOR analysis and repetition frequency: (1) Ecological Resilience, (2) Social Equity & Inclusivity, (3) Cultural & Aesthetic Quality, (4) Planning & Governance, and (5) Economic Viability. Indicators related to Ecological Resilience (e.g., native plants, waste separation) and Social Equity (e.g., public participation, accessibility) showed the highest repetition rates and expert consensus (Score: 24/24), while indicators in the Economic Viability cluster (e.g., attracting capital, local markets) showed greater divergence (Table 3 and Supplementary S3).

Table 3. Thematic Clusters of Key SUP Indicators (Top 5 per Cluster).

Cluster	Key Indicators	Repetition	Agreement
Ecological Resilience	Employing native plants	28	24/24
	Increasing vegetation	26	24/24
	Using waste separation bins	24	24/24
	Utilizing water innovatively	21	24/24
	Minimizing alterations to natural landforms	18	24/24
Social Equity & Inclusivity	Encouraging public participation	23	24/24
	Ensuring accessibility	18	24/24
	Designing safe spaces	19	24/24
	Attention to disabled needs	14	22/24
	Attention to children's needs	14	22/24
Cultural & Aesthetic Quality	Incorporating local patterns/symbols	22	24/24
	Using appealing colors	18	24/24
	Avoiding complexity in design	18	24/24
	Designing semi-public spaces with plants	17	23/24
	Avoiding uniformity	7	22/24
Planning & Governance	Designing for climate change adaptation	19	24/24
	Focusing on theme parks	19	24/24
	Considering local conditions	22	24/24
	Planning for clearing roads	5	22/24
	Designing multipurpose spaces	5	22/24
Economic Viability	Developing infrastructure to attract capital	19	24/24
	Using environmentally friendly materials	21	24/24
	Designing spaces for local markets	2	20/24
	Utilizing solar panels	15	22/24
	Using recycled materials	12	22/24

4.2. Net Distance between SUPs and Convergence between Experts

The MACTOR analysis revealed strong convergence among experts on the importance of core ecological and social indicators (Net Distance: <5). The highest expert consensus was observed among urban planners and designers (Convergence Score: 190/200), while psychologists and sociologists showed slightly lower agreement (178.5/200). Indicators such as tree trunk protection for birds and open amphitheater design showed the weakest convergence with other indicators, suggesting their perceived niche applicability (Figure 3, Supplementary S4–S6).

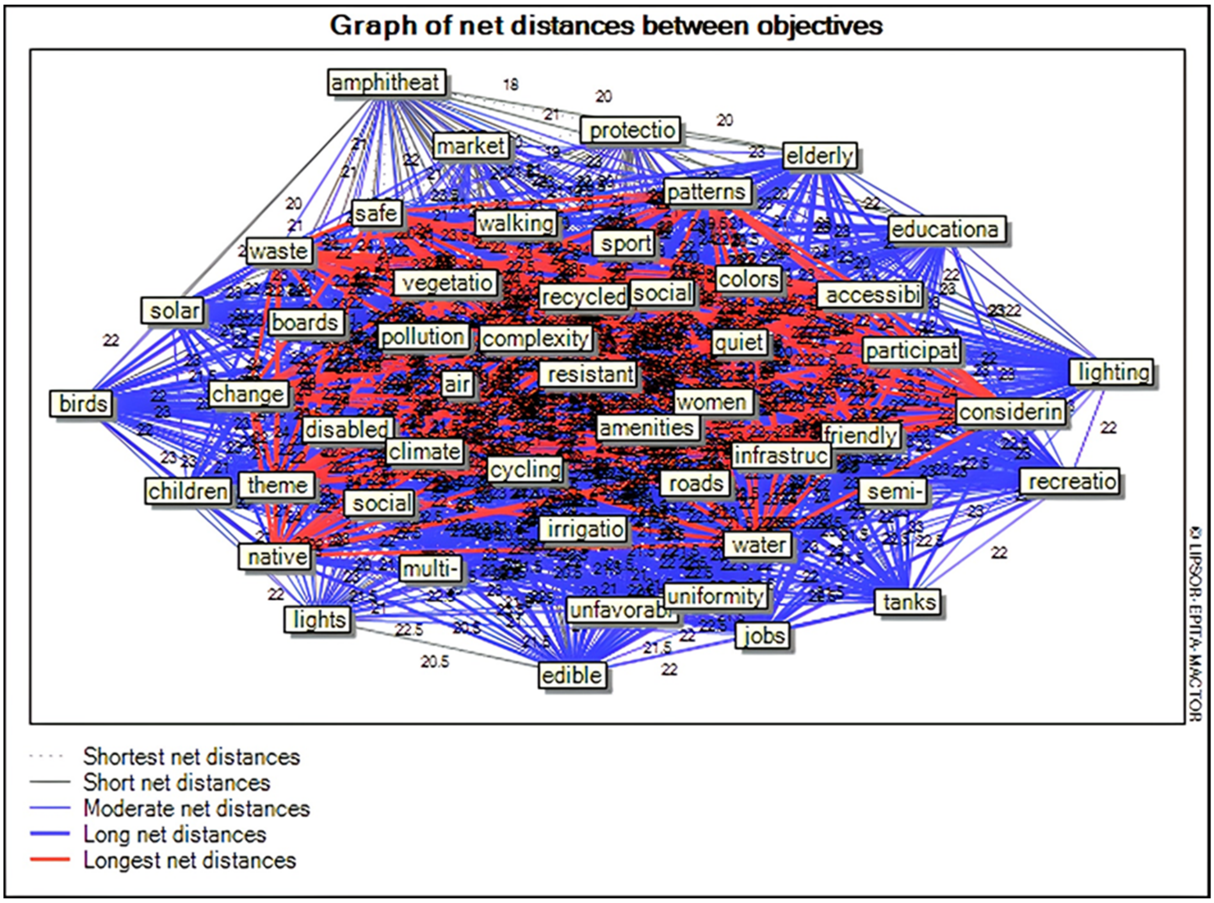


Figure 3. Net distance between SUPs.

4.3. Application of the Proposed Indicators to the Existing Parks

Evaluation of 35 parks in Tehran and Tabriz using the indicator framework revealed significant disparities. Parks in Tehran outperformed those in Tabriz, with an average score of 28/50 versus 24/50. Einali Mountain Park and Lavizan Forest Park scored highest (38/50), while Tabriz City Garden and Honarmandan Park scored lowest (20/50).

Critically, no park implemented key indicators like:

- Waste separation bins
- Public participation in planning
- Surface water collection tanks
- Recycled material usage
- Plant introduction boards (Supplementary S4 and S5, Table 4, Figures 4 and 5).

Table 4. Results of applying the indicators in the urban parks explored.

	Tehran	**Tabriz**	**Total**
Park number	21	14	35
Highest score	38	38	-
Lowest score	20	20	-
Frequent score	27 and 29	21	-
Average score	28	24	26
Number of high-frequency indicators	27	23	29
Number of low-frequency indicators	18	19	21
Average area (ha)	142	141	141/5

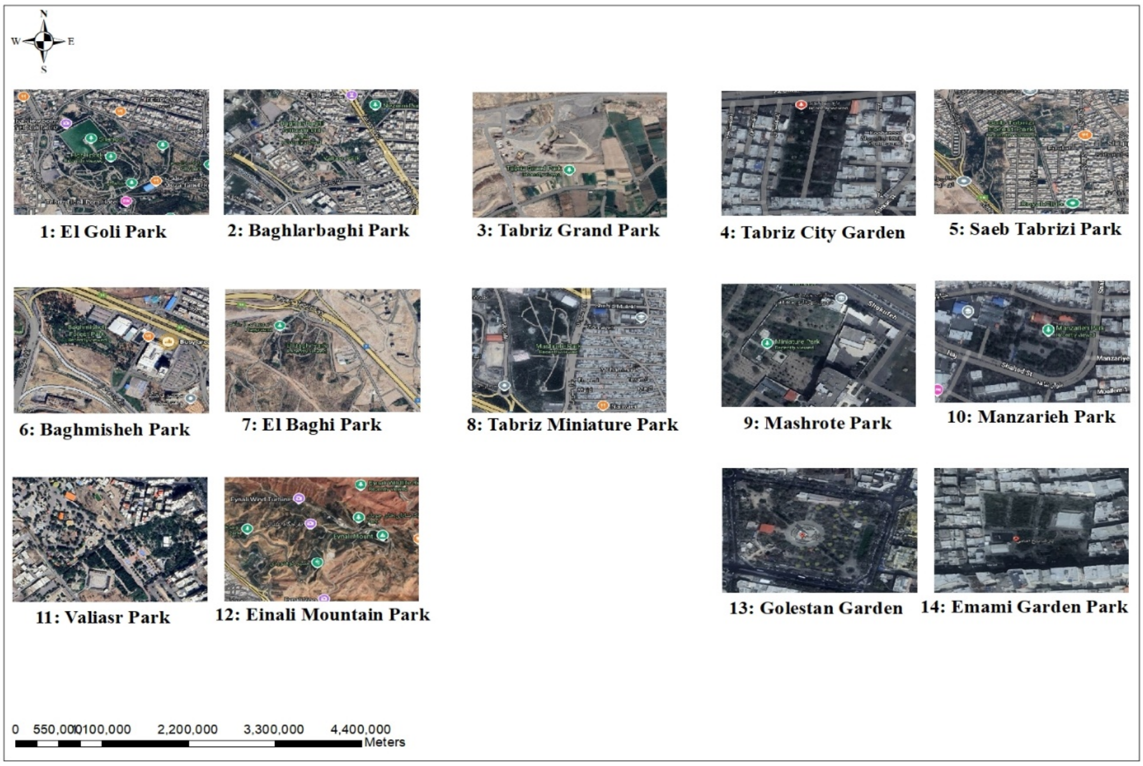


Figure 4. Plans of urban parks explored in Tabriz.

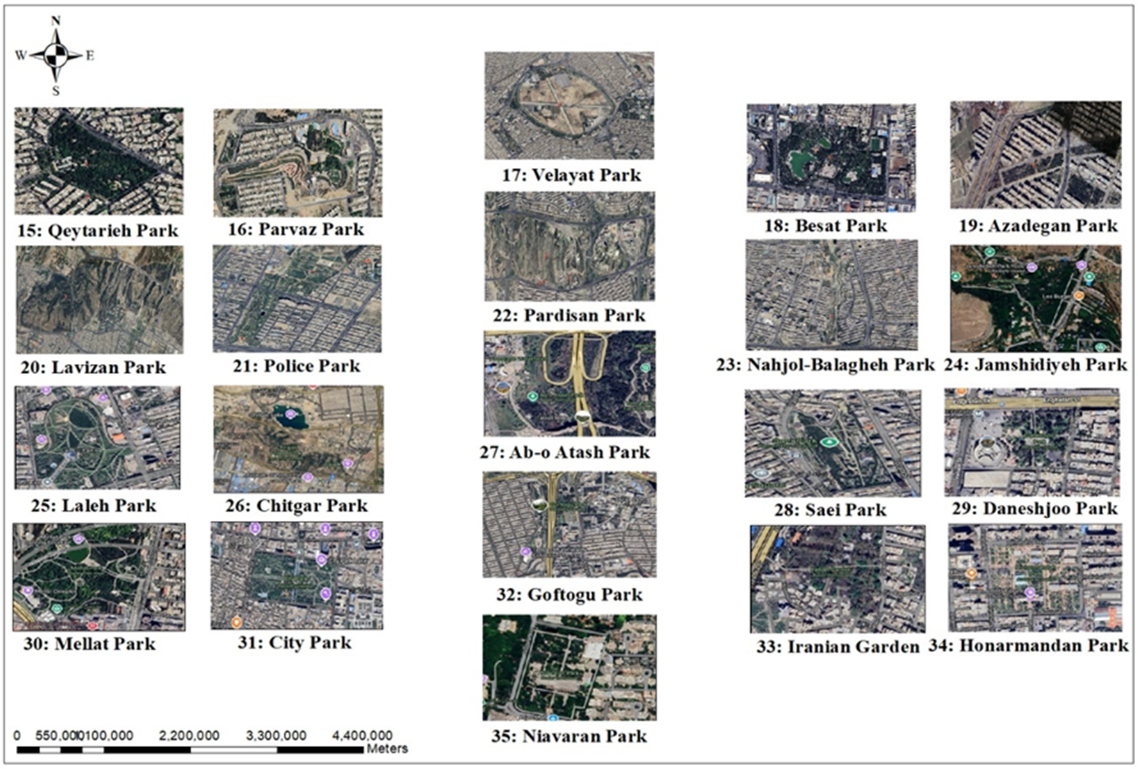


Figure 5. Plans of urban parks assessed in Tehran.

4.4. Key Implementation Gaps

The largest implementation gaps were observed in:

1. Participatory Planning: No park involved citizens in design/planning.
2. Resource Management: Absence of water/energy innovation (e.g., solar panels, water tanks).
3. Inclusive Design: Limited attention to needs of disabled, elderly, and children.

4. Economic Sustainability: Minimal use of recycled materials or capital-attraction infrastructure.

Tehran parks prioritized ecological and planning indicators, while Tabriz parks lagged particularly in social and economic dimensions.

5. Discussion

5.1. Thematic Interpretation of Key Findings

This study identified 50 design indicators for Sustainable Urban Parks (SUPs), with 17 emerging as the most critical based on expert consensus, repetition frequency, and convergence in MACTOR analysis. The findings reveal that experts prioritize ecological resilience and social inclusivity indicators (e.g., native plants, public participation, accessibility) over purely aesthetic or economic ones. This aligns with global trends emphasizing nature-based solutions and community-centric design in urban sustainability [82,83]. The strong convergence among urban planners and designers (Score: 190/200) underscores the professional emphasis on functional and ecological aspects, while slightly lower consensus among sociologists may reflect divergent priorities in social equity implementation.

5.2. Comparative Analysis with Literature and Global Frameworks

Our results demonstrate significant alignment with international SUP research while highlighting context-specific priorities for Iranian cities:

- Ecological indicators (e.g., native plants, waste separation) consistently emerge as priorities across global studies [43,84] and frameworks like SITES [36], though their implementation in Iranian parks remains limited.
- Social participation—absent in all studied parks—is increasingly recognized as critical for sustainable park management globally [42,85], suggesting a key gap in Iranian practice.
- Cultural integration (e.g., local symbols) resonates with place-making theories [30] but remains underutilized compared to ecological features.

5.3. Contextualizing Implementation Gaps

The evaluation of 35 parks revealed critical implementation gaps:

- No park employed participatory planning, water recycling, or recycled materials. This starkly contrasts with the emphasis placed on such practices in international sustainability frameworks like LEED-ND [37] and ISO 37120 [35], highlighting a significant area for improvement in local practice.
- Tehran parks outperformed Tabriz in ecological and planning indicators, possibly due to greater resources and technical capacity.
- The absence of design features for marginalized groups (e.g., disabled, elderly) observed in this study points to a common prioritization challenge in urban development, where resources may be focused on basic infrastructure before addressing nuanced social equity needs.

5.4. Limitations and Research Implications

This study has several limitations:

1. Geographical focus on two Iranian cities limits generalizability.
2. Expert-centric approach may overlook citizen perspectives (particularly marginalized groups).
3. Methodological constraints: The 63% inter-coder reliability, while acceptable, suggests interpretive variability in qualitative analysis.

Future research should:

- Validate these indicators through citizen surveys and multi-city comparisons.
- Develop quantitative metrics for each indicator (e.g., specific thresholds for “sufficient vegetation”).
- Explore integration pathways with municipal regulations and certification systems (e.g., local adaptations of SITES).

5.5. Practical Applications and Policy Recommendations

To bridge the implementation gap, we recommend:

1. Prioritizing high-impact, low-cost indicators (e.g., waste separation bins, native plant zones) in municipal park guidelines.
2. Mandating participatory design processes for new park projects.
3. Developing a SUP certification system for Iranian cities, integrating global standards with local priorities identified here.

6. Conclusions

This study developed a comprehensive framework of 50 design indicators for Sustainable Urban Parks (SUPs) through expert interviews and MACTOR analysis. The findings highlight that ecological resilience and social inclusivity are the foremost priorities for experts, providing a validated, context-aware toolkit for urban planners and landscape architects in Iran.

The primary contribution of this work is the localization of global sustainability principles into actionable indicators tailored to the environmental and cultural context of Iranian cities. The application of this framework revealed critical implementation gaps, particularly in participatory planning and resource management, offering clear directions for municipal policy and park design practice.

Ultimately, this research provides a foundational step toward creating urban parks that are not only ecologically functional but also socially vibrant, contributing to more sustainable and livable urban environments.

Supplementary Materials

The additional data and information can be downloaded at: https://media.sciltp.com/articles/others/2510171604484431/UBS-2508000255-SI-1016.pdf. Supplementary S1: Semi-structured Interview Questions. Supplementary S2: Coding Logic and Themes. Supplementary S3: Total repetition and importance of SUP indicators. Supplementary S4: The degree of convergence between actors (experts). Supplementary S5: Net distance between actors (experts). Supplementary S6: The convergence of an actor with other actors. Supplementary S7: The final model of SUP planning and design indicators extracted from ATLAS.ti software. Supplementary S8: Status of SUP indicators.

Author Contributions

All authors contributed to the conception, design, data collection, analysis, and interpretation of the research. Manuscript drafting and critical revisions were performed collaboratively.

Funding

This research was funded by JSPS (Grant No. 22K14390).

Institutional Review Board Statement

All interviews were conducted with adult experts who participated voluntarily and anonymously. No personal or sensitive information was collected, and participants provided informed consent prior to the interviews. According to local guidelines, formal ethics approval was not required for expert interviews with minimal risk. The study fully adhered to ethical standards for research involving human participants.

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Data Availability Statement

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Conflicts of Interest

The authors declare no conflict of interest.

Use of AI and AI-Assisted Technologies

No AI tools were used to generate ideas, collect or analyze data. All the scientific content and evidence-based conclusions are the original work of the authors. Artificial intelligence tools were used solely for language editing and clarity improvement.

References

1. Chen, S.; Shao, C.; Yu, H.; et al. Navigating urban human settlement sustainability: A multi-indicator assessment based on sustainable development goal 11. *J. Clean. Prod.* **2024**, *472*, 143509. https://doi.org/10.1016/j.jclepro.2024.143509.
2. Liu, Y.; Dong, K.; Wang, K.; et al. Moving towards sustainable city: Can China's green finance policy lead to sustainable development of cities? *Sustain. Cities Soc.* **2024**, *102*, 105242. https://doi.org/10.1016/j.scs.2024.105242.
3. Li, D.; Yang, Y.; Xia, F.; et al. Exploring the influences of different processes of habitat fragmentation on ecosystem services. *Landsc. Urban Plan.* **2022**, *227*, 104544. https://doi.org/10.1016/j.landurbplan.2022.104544.
4. Rafael, S.; Rodrigues, V.; Fernandes, A.P.; et al. Evaluation of urban surface parameterizations in WRF model using energy fluxes measurements in Portugal. *Urban Clim.* **2019**, *28*, 100465. https://doi.org/10.1016/j.uclim.2019.100465.
5. Han, D.; An, H.; Cai, H.; et al. How do 2D/3D urban landscapes impact diurnal land surface temperature: Insights from block scale and machine learning algorithms. *Sustain. Cities Soc.* **2023**, *99*, 104933. https://doi.org/10.1016/j.scs.2023.104933.
6. McKinney, M.L. Urbanization, biodiversity, and conservation. *BioScience* **2002**, *52*, 883–890. https://doi.org/10.1641/0006-3568(2002)052[0883:UBAC]2.0.CO;2.
7. McKinney, M.L. Urbanization as a major cause of biotic homogenization. *Biol. Conserv.* **2006**, *127*, 247–260. https://doi.org/10.1016/j.biocon.2005.09.005.
8. Dadashpoor, H.; Azizi, P.; Moghadasi, M. Land use change, urbanization, and change in landscape pattern in a metropolitan area. *Sci. Total Environ.* **2019**, *655*, 707–719. https://doi.org/10.1016/j.scitotenv.2018.11.267.
9. He, B.J.; Wang, J.; Zhu, J.; et al. Beating the urban heat: Situation, background, impacts and the way forward in China. *Renew. Sustain. Energy Rev.* **2022**, *161*, 112350. https://doi.org/10.1016/j.rser.2022.112350.
10. Ettinger, A.K.; Buhle, E.R.; Feist, B.E.; et al. Prioritizing conservation actions in urbanizing landscapes. *Sci. Rep.* **2021**, *11*, 818. https://doi.org/10.1038/s41598-020-79258-2.
11. U.N. Environmental Program I. *The Weight of Cities–Resource Requirements of Future Urbanization*; International Resource Panel Secretariat: Paris, France, 2018.
12. Orchi, H.; Diallo, A.B.; Elbiaze, H.; et al. A contemporary survey on multisource information fusion for smart sustainable cities: Emerging trends and persistent challenges. *Inf. Fusion* **2025**, *114*, 102667. https://doi.org/10.1016/j.inffus.2024.102667.
13. Liu, J.; Cheng, Z.; Yi, P.; et al. Predictive evaluation of city sustainability based on benchmarking method–A case study of 34 cities in northeastern China. *Sustain. Cities Soc.* **2024**, *112*, 105627. https://doi.org/10.1016/j.scs.2024.105627.
14. Garcia, C.; López-Jiménez, P.A.; Pérez-Sánchez, M.; et al. Methodology for assessing progress in sustainable development goals indicators in urban water systems. How far are we from the 2030 targets? Sustain. *Cities Soc.* **2024**, *112*, 105616. https://doi.org/10.1016/j.scs.2024.105616.
15. Engström, G.; Gren, A. Capturing the value of green space in urban parks in a sustainable urban planning and design context: Pros and cons of hedonic pricing. *Ecol. Soc.* **2017**, *22*, 21. https://doi.org/10.5751/ES-09365-220221.
16. Hosseinpour, N.; Kazemi, F.; Mahdizadeh, H. A cost-benefit analysis of applying urban agriculture in sustainable park design. *Land Use Policy* **2022**, *112*, 105834. https://doi.org/10.1016/j.landusepol.2021.105834.
17. Moubarak, L.M.; Nour El-Dine, A.; Morghany, E.A.M. Sustainable international parks in Egypt: Suggested criteria for design. *J. Urban Res.* **2022**, *44*, 82–102. https://doi.org/10.21608/jur.2022.77038.1066.
18. Kim, S.; Kwon, H. Urban sustainability through public architecture. *Sustainability* **2018**, *10*, 1249. https://doi.org/10.339 0/su10041249.
19. Sarhan, A.A.; Farghaly, Y.; Elsayed, R. Measures and attributes for sustainability of parks. *Procedia Environ. Sci.* **2016**, *34*, 453–460. https://doi.org/10.1016/j.proenv.2016.04.040.
20. Kazemi, F.; Mahdizadeh, H. Sustainable low-input urban park design based on some decision-making methods. *Land Use Policy* **2022**, *117*, 106092. https://doi.org/10.1016/j.landusepol.2022.106092.
21. Vafadari Komarolya, D.; Kafi, M.; Khansefid, M. Investigating the Preventive Factors of People in the Society from Attending Urban Parks during the COVID-19 Pandemic. *J. Hortic. Sci.* **2023**, *37*, 231–243. https://doi.org/10.22067/jhs.2022.75378.1143.
22. Vafadari Komarolya, D.; Kafi, M.; Khansefid, M.; et al. Criteria for Designing Urban Parks in a Pandemic of Infectious Diseases: A survey based on experts' opinions. *IJAUP* **2024**, *34*.
23. Jim, C.Y.; Chen, W.Y. External effects of neighbourhood parks and landscape elements on high-rise residential value. *Land Use Policy* **2010**, *27*, 662–670. https://doi.org/10.1016/j.landusepol.2009.08.027.
24. Cranz, G.; Boland, M. Defining the sustainable park: A fifth model for urban parks. *Landsc. J.* **2004**, *23*, 102–120. https://doi.org/10.3368/lj.23.2.102.

25. Anderson, J.; Benton, J.S.; Ye, J.; et al. Large walking and wellbeing behaviour benefits of co-designed sustainable park improvements: A natural experimental study in a UK deprived urban area. *Environ. Int.* **2024**, *187*, 108669. https://doi.org/10.1016/j.envint.2024.108669.
26. Bressane, A.; Galvão, A.L.S.; Loureiro, A.I.S.; et al. Valuing urban green spaces for enhanced public health and sustainability: A study on public willingness-to-pay in an emerging economy. Urban For. *Urban Green.* **2024**, *98*, 128386. https://doi.org/10.1016/j.ufug.2024.128386.
27. Opoku, A.; Duff, A.; Wasim Yahia, M.; et al. Utilisation of green urban space for food sufficiency and the realisation of the sustainable development goals–UK stakeholders perspective. *Geogr. Sustain.* **2024**, *5*, 13–18.
28. Lu, W.; Jiang, W.; Qiao, D.; et al. Embracing green spaces: Exploring spatiotemporal changes in urban green space accessibility and its equity in Guangzhou, China for sustainable urban greening. *Environ. Sustain. Indic.* **2023**, *19*, 100290.
29. Wey, Y.E.; Sarma, V.; Lechner, A.M.; et al. Malaysians' perception on the contribution of urban green spaces to the UN sustainable development goals. Urban For. *Urban Green.* **2022**, *78*, 127792. https://doi.org/10.1016/j.ufug.2022.127792.
30. Wang, Y.; Su, T. The Impacts of Friendly Designs on the Long-Term Sustainability of Modern Urban Parks. *Sustainability* **2025**, *17*, 830. https://doi.org/10.3390/su17030830.
31. He, B.; Wang, S.; Xiong, Q.; et al. Urban Park Planning for Sustainability: Resident Insights from China's Major Cities. *Land* **2025**, *14*, 128. https://doi.org/10.3390/land14010128.
32. Faragallah, R.N. The impact of productive open spaces on urban sustainability: The case of el Mansheya Square–Alexandria, Alexandria. *Alex. Eng. J.* **2018**, *57*, 3969–3976. https://doi.org/10.1016/j.aej.2018.02.008.
33. Badiu, D.L.; Iojă, C.I.; Pătroescu, M.; et al. Is urban green space per capita a valuable target to achieve cities' sustainability goals? Romania as a case study. *Ecol. Indic.* **2016**, *70*, 53–66. https://doi.org/10.1016/j.ecolind.2016.05.044.
34. Lalbakhsh, E. The impact of recycling urban space in sustainable development in developing countries. *APCBEE Procedia* **2012**, *1*, 331–334. https://doi.org/10.1016/j.apcbee.2012.03.054.
35. Couto, E.; Gregorio, L.; Valle, G. SITIUS method: A new approach for sustainable urban development indexes based on the ISO 37120 standard. Environ. *Dev. Sustain.* **2025**, *27*, 1619–1642.
36. Ma, F. Evaluating the implementation of the Sustainable Sites Initiative (SITES) and its adaptation potential in China. *Environ. Sustain. Indic.* **2024**, *24*, 100532.
37. Hamdy, A. Quality of life: Quantitative analysis in New Urbanism and LEED-ND certified neighbourhoods. *Proc. Inst. Civ. Eng. Urban Des. Plan.* **2024**, *177*, 195–231.
38. Zhao, Q.; Zhang, L.; Hou, J. Developing a cultural sustainability assessment framework for environmental facilities in urban communities. *NPJ Herit. Sci.* **2025**, *13*, 107.
39. Kim, G.; Coseo, P. Urban park systems to support sustainability: The role of urban park systems in hot arid urban climates. *Forests* **2018**, *9*, 439. https://doi.org/10.3390/f9070439.
40. Seymour, M. Just sustainability in urban parks. *Local Environ.* **2012**, *17*, 167–185. https://doi.org/10.1080/13549839.2011.646968.
41. Aly, D.; Dimitrijevic, B. Systems approach to the sustainable management of urban public parks. *Urban For. Urban Green.* **2022**, *68*, 127482. https://doi.org/10.1016/j.ufug.2022.127482.
42. Kreutz, A. Student and senior views on sustainable park design and intergenerational connection: A case study of an urban nature park. *Landsc. Urban Plan.* **2024**, *241*, 104290. https://doi.org/10.1016/j.landurbplan.2023.104920.
43. Ibrahim, R.; Clayden, A.; Cameron, R. Tropical urban parks in Kuala Lumpur, Malaysia: Challenging the attitudes of park management teams towards a more environmentally sustainable approach. Urban For. *Urban Green.* **2020**, *49*, 126605. https://doi.org/10.1016/j.ufug.2020.126605.
44. Megyesi, B.; Gholipour, A.; Cuomo, F.; et al. Perceptions of stakeholders on nature-based solutions in urban planning: A thematic analysis in six European cities. *Urban For. Urban Green.* **2024**, *96*, 128344. https://doi.org/10.1016/j.ufug.2024.128344.
45. Zhong, W.; Schröder, T.; Bekkering, J. Implementing biophilic design in architecture through three-dimensional green spaces: Guidelines for building technologies, plant selection, and maintenance. *J. Build. Eng.* **2024**, *92*, 109648. https://doi.org/10.1016/j.jobe.2024.109648.
46. Ruslin, R.; Mashuri, S.; Sarib, M.; et al. Semi-structured interview: A methodological reflection on the development of a qualitative research instrument in educational studies. *J. Res. Method Educ.* **2022**, *12*, 22–29. https://doi.org/10.9790/7388-1201052229.
47. Vafadari Komarolya, D.; Nazmfar, H.; Hami, A.; et al. Identifying indicators for planning and designing lively urban landscape. *Landsc. Archit. Sustain.* **2025**, *1*, 100002. https://doi.org/10.1016/j.las.2025.100002.
48. Vafadari Komarolya, D.; Yousefpour Dokhaniyeh, A.; Heidari, A.; et al. Future research of factors affecting the acceptability of urban parks with an emphasis on women's parks. *Geogr. Eng. Territ.* **2024**. https://doi.org/10.22034/jget.2024.459213.1559.
49. Vafadari Komarolya, D.; Nazmfar, H.; Hami, A.; et al. Analyzing and Identifying the indicators of planning and designing a happy urban landscape. *J. Sustain. Urban Reg. Dev. Stud.* **2024**, *5*, 69–86.

50. Vafadari Komarolya, D.; Nazmfar, H.; Hami, A.; et al. Analyzing and Recognition indicators of 24-h urban landscape planning and design. *Geogr. Hum. Relatsh.* **2024**. https://doi.org/10.22034/gahr.2024.453164.2100.
51. Yousefpour Dokhaniyeh, A.; Vafadari Komarolya, D. Analysis and recognition of design indicators for planting ornamental plants in urban green spaces. *J. Nat. Environ.* **2024**, *77*, 537–549. https://doi.org/10.22059/jne.2024.379080.2693.
52. McIntosh, M.; Morse, J. Situating and Constructing Diversity in Semi-Structured Interviews. *Glob. Qual. Nurs. Res.* **2015**, *2*, 2333393615597674. https://doi.org/10.1177/2333393615597674.
53. Waters, J. Snowball sampling: A cautionary tale involving a study of older drug users. *Int. J. Soc. Res. Methodol.* **2015**, *18*, 367–380. https://doi.org/10.1080/13645579.2014.953316.
54. Kubiciel-Lodzińska, S. Snowball sampling vs. respondent driven sampling in regional research. Comparing the use of the methods to study migrants working in elderly care. *Stud. Migr. Przegląd Pol.* **2021**, *47*, 149–180. https://doi.org/10.4467/25444972SMPP.21.007.13319.
55. Zarie, H.; Sepehri, B.; Anvar Adibhesami, M.; et al. A strategy for giving urban public green spaces a third dimension: A case study of Qasrodasht, Shiraz. *Nature-Based Solutions.* **2024**, *5*, 100102. https://doi.org/10.1016/j.nbsj.2023.100102.
56. Sajedi, S.; Vafadari Komarolya, D. Investigating factors affecting the role of historical buildings in urban tourism with a future research approach. *J. Sustain. Urban Reg. Dev. Stud.* **2025**, *6*, 219–235.
57. Vafadari Komarolya, D.; Nazmfar, H.; Hami, A.; et al. Identifying of the aesthetic indicators of the urban landscape. *Geography* **2024**, *22*, 149–164. https://doi.org/10.22034/iga.2024.2036141.1318.
58. Maguire, M.; Delahunt, B. Doing a thematic analysis: A practical, step-by-step guide for learning and teaching scholars. *All Irel. J. High. Educ.* **2017**, *9*, 3. https://doi.org/10.62707/aishej.v9i3.335.
59. Kamjou, E.; Scott, M.; Lennon, M. A bottom-up perspective on green infrastructure in informal settlements: Understanding nature's benefits through lived experiences. *Urban For. Urban Green.* **2024**, *94*, 128231. https://doi.org/10.1016/j.ufug.2024.128231.
60. Braun, V.; Clarke, V. Using thematic analysis in psychology. *Qual. Res. Psychol.* **2006**, *3*, 77–101. https://doi.org/10.1191/1478088706qp063oa.
61. Darmastuti, L.; Rustiadi, E.; Fauzi, A.; et al. Stakeholder Analysis of Sustainable Wastewater Management: A Case Study of Bogor, Indonesia. *Sustainability* **2023**, *15*, 11826. https://doi.org/10.3390/su151511826.
62. Rees, G.H.; MacDonell, S. Data gathering for actor analyses: A research note on the collection and aggregation of individual respondent data for MACTOR. *Future Stud. Res. J. Trends Strateg.* **2017**, *9*, 115–137. https://doi.org/10.24023/FutureJournal/2175-5825/2017.v9i1.256.
63. Elmsalmi, M.; Hachicha, W. Risk mitigation strategies according to the supply actors' objectives through MACTOR method. In Proceedings of the 2014 International Conference on Advanced Logistics and Transport (ICALT), Hammamet, Tunisia, 1–3 May 2014; pp. 362–367. https://doi.org/10.1109/ICAdLT.2014.6866339.
64. Vivanco-Aranda, M.; Mojica, F.J.; Martínez-Cordero, F.J. Foresight analysis of tilapia supply chains (Sistema Producto) in four states in Mexico: Scenarios and strategies for 2018. Technol. *Forecast. Soc. Chang.* **2011**, *78*, 481–497. https://doi.org/10.1016/j.techfore.2010.05.005.
65. Lafourcade, B.; Chapuy, P. Scenarios and actors' strategies. *Technol. forecast. Soc. Chang.* **2000**, *65*, 67–80.
66. Elmsalmi, M.; Khlifi, H.; Hachicha, W. Elaboration of Risk Mitigation Strategies based on Sustainable Development Practices. In Proceedings of the 2017 6th IEEE International Conference on Advanced Logistics and Transport (ICALT), Bali, Indonesia, 24–27 July 2017; pp. 53–58. https://doi.org/10.1109/ICAdLT.2017.8547014.
67. Lakner, Z. Main actors and their strategies in Hungarian higher education. *Acta Oeconomica* **2013**, *63*, 201–224. https://doi.org/10.1556/aoecon.63.2013.2.4.
68. Lo, C.C.; Wang, C.H.; Huang, C.C. The national innovation system in the Taiwanese photovoltaic industry: A multiple stakeholder perspective. *Technol. Forecast. Soc. Chang.* **2013**, *80*, 893–906. https://doi.org/10.1016/j.techfore.2012.08.016.
69. Bettencourt, R. Strategic prospective for the implementation of employment policies in the Azores. *Technol. Forecast. Soc. Chang.* **2010**, *77*, 1566–1574.
70. Mangifera, L.; Isa, M. Development model of creative industries: An application of MACTOR. *KnE Soc. Sci.* **2019**, *3*, 360. https://doi.org/10.18502/kss.v3i14.4322.
71. Heger, T.; Rohrbeck, R. Strategic foresight for collaborative exploration of new business fields. *Technol. Forecast. Soc. Chang.* **2012**, *79*, 819–831.
72. Made-Sutrisna, I.B.; Nyoman-Saskara, I.A.; Suyana-Utama, M.; et al. Prospective analysis of sustainable tourism development in penglipuran village as a tourist village role model in Bali. *Tech. Soc. Sci. J.* **2020**, *13*, 184–198.
73. Cerezo-Narváez, A.; Pastor-Fernández, A.; Otero-Mateo, M.; et al. The relationship between building agents in the context of integrated project management: A prospective analysis. *Buildings* **2021**, *11*, 184. https://doi.org/10.3390/buildings11050184.
74. Yousefpour Dokhaniyeh, A.; Vafadari Komarolya, D. Analyzing and Identifying the Effects of Using Native Plants in Urban Green Spaces. *Environ. Interdiscip. Dev.* **2024**, *9*, 55–68. https://doi.org/0.22034/envj.2024.455518.1373.

75. Vafadari Komarolya, D.; Pourbeirami Hir, Y.; Vafadari Komarolya, M. Futuristic Design of Urban Parks with the Biophilic Urban Approach. *Environ. Interdiscip. Dev.* **2024**, *9*, 65–87.
76. Makmun, M.; Fahmid, I.; Ali, M.; et al. Power relations among actors in laying hen business in Indonesia: A MACTOR analysis. *Open Agric.* **2024**, *9*, 20220334. https://doi.org/10.1515/opag-2022-0334.
77. Kaviani Rad, A.; Razmi, S.O.; Nematollahi, M.J.; et al. Machine learning models for predicting interactions between air pollutants in Tehran Megacity, Iran. *Alex. Eng. J.* **2024**, *104*, 464–479. https://doi.org/10.1016/j.aej.2024.08.023.
78. Behboudi, D.; Mohamadzade, P.; Feizizadeh, B.; et al. Multi-criteria based readiness assessment for developing spatial data infrastructures in East Azerbaijan Province, Iran. *GI_Forum* **2018**, *1*, 322–333. https://doi.org/10.1553/giscience2018_02_s322.
79. Feizizadeh, B.; Blaschke, T. Land suitability analysis for Tabriz County, Iran: A multi-criteria evaluation approach using GIS. *J. Environ. Plan. Manag.* **2013**, *56*, 1–23. https://doi.org/10.1080/09640568.2011.646964.
80. Feizizadeh, B.; Omarzadeh, D.; Ronagh, Z.; et al. A scenario-based approach for urban water management in the context of the COVID-19 pandemic and a case study for the Tabriz metropolitan area, Iran. *Sci. Total Environ.* **2021**, *790*, 148272. https://doi.org/10.1016/j.scitotenv.2021.148272.
81. Saemian, P.; Elmi, O.; Vishwakarma, B.D.; et al. Analyzing the Lake Urmia restoration progress using ground-based and spaceborne observations. *Sci. Total Environ.* **2020**, *739*, 139857. https://doi.org/10.1016/j.scitotenv.2020.139857.
82. Lemes de Oliveira, F. Nature in nature-based solutions in urban planning. *Landsc. Urban Plan.* **2025**, *256*, 105282.
83. Combary, Y.; Atchrimi, B.; Zemo, A. Graph-Based Approaches Modeling to Assess Ecological Connectivity, Create Natural Habitats and Strengthen Ecological Networks in Ouagadougou, Burkina Faso. *Int . J. Sustain. Dev. Plan.* **2025**, *20*.
84. Chan, C.S.; Si, F.H.; Marafa, L.M. Indicator development for sustainable urban park management in Hong Kong. *Urban For. Urban Green.* **2018**, *31*, 1–14. https://doi.org/10.1016/j.ufug.2018.01.025.
85. Firmansyah Soeriaatmadja, A.R.; Wulanningsih, R. A Set of Sustainable Urban Landscape Indicators and Parameters to Evaluate Urban Green Open Space in Bandung City. *IOP Conf. Ser. Earth Environ. Sci.* **2018**, *179*, 012016.