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A Multidimensional Approach to Assessing Sustainability in Urban Green Open Spaces: An Integrative Review of Environmental, Social, and Economic Aspects

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***Abstract*—The sustainable development of cities has become essential, driving urban planners to design outdoor spaces that not only enhance the quality of life but also encourage meaningful interaction between residents and their surrounding environment. Urban green spaces play a vital role in this process, serving as a key element in fostering ecological balance, enhancing social quality, improving community well-being, and shaping a sustainable urban environment. Urban green open spaces offer benefits for the quality of life of citizens, including health, social interaction, and economic value. However, the existing reviews of sustainable concepts focus only on environmental aspects. In contrast, a comprehensive review of the implementation of sustainability strategies in open spaces and discussions of economic and social factors are not well presented. This paper aims to map the scientific literature on the sustainability of urban green open spaces, integrating environmental, social, and economic dimensions. Using a systematic literature review, it identifies critical sustainability indicators and clusters them into adaptive value categories. The results reveal twelve core indicators spanning three sustainability pillars, offering a comprehensive framework for enhancing the quality of urban green spaces. The findings can be utilized not only to evaluate existing urban green open spaces but also to offer valuable insights to planners, decision-makers, and other professionals involved in managing public open spaces. They can further serve as input for development plans or related initiatives.**

***Keywords*— Sustainability; social; economic; open space.**

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I. INTRODUCTION

Environmental conditions deteriorate due to climate change and urbanization, which endanger urban ecosystems [1], [2]. Hence, sustainable city development becomes a necessity [3]. Changes in urban ecosystems are prompting urban planners to design sustainable green spaces that allow city people to engage with their surroundings [4], [5]. Therefore, understanding and implementing adaptation techniques is vital to establishing pleasant circumstances for urban dwellers [6], [7]. Urban green open spaces (UGOS) are essential for creating sustainable cities [8]. Urban green open spaces are public areas where citizens can access freely. Everyone is free to engage in various activities within it. The importance of discussion about the City Green Open Space (GOS) from each aspect of sustainability, as well as a whole sustainability aspects discussion: Public open spaces act as a place to engage with the natural environment, to celebrate cultural diversity, and a place to meet various groups of people [9], [10].

Therefore, protecting natural resources sensitive to the environment and allowing for recreational use is the wisest course of action [11], [12]. Adding public open space to urban development also has significant economic benefits. The outdoor and recreational components add value to the property, and thus contribute to the city's tax income [13], [14]. UGOS planning is a method in urban planning that tries to promote the concepts of sustainable development, which are enhancing the condition of the natural world (environmental elements) and community welfare (economic and social aspects) [15], [16]. The following is a complete review of research conducted on indicators of sustainable development assessment.

Kaplan [17] made parameters about assessing the environment and its treatment. similarly, Bradley and Millwa

[18] established parameters for assessing social values within green open spaces. Burgess et al [19], in addition to highlighting the vital need for social services and natural environmental diversity in local communities, the study also demonstrated how accessible and connected urban green areas can be to enhancing the quality of life for all inhabitants.

Smith et al [20] conducted research to meet complex human needs. The quality of community life is a complex notion encompassing the physical environment that enables humans to fulfill their needs and desires. A structure to comprehend the connection between urban environmental quality and physical design, focusing on walkable communities, outdoor facilities, ample seating, barrier-free, and open space locations in residential neighborhoods [21]. Gobster [22] discussed how greening is one of the key components of sustainable urban planning. Enhancing parks and open spaces to provide a wider variety of green areas significantly affects the surrounding community and the parks' surroundings. Kotler et al [23] discusses the evaluation parameters from economic aspects and image branding that can be applied to assess an urban area. In the early 2000s, researchers started to think about the assessment of green open space not only from environmental aspects but also from social and economic aspects [24].

In research conducted by CABE [25], the standard of public space and built environment was considered to impact their lives and feelings directly. Access to public spaces is essential for the planning, design, comfort of cyclists, and management of these spaces. Research by Cabe Space [26] informed an understanding of the role of green open space with sustainability aspects. The same as previous research [27] discusses how to assess the quality of green open space services, including safety aspects for its users.

Kekere and Eja [28], and Selamat et al [29] discuss that parks and green areas are examples of public open spaces, which are the main environmental elements to encourage recreational facilities, because green spaces can have a significant and positive social impact on the environment. Lim and Zulkifli [30] conducted research that found that the use of public green open spaces was strongly associated with the presence of friendly facilities for pets. Not only that, but the open natural environment also requires a complete aspect in the form of economic, social, and environmental elements [4], [31], [32]. Turan et al [33], also has parameters for assessing green open environments by considering the suitability of use for people with disabilities. Not only thinking about this, but also focusing on comfort for migrants and refugees, air quality, and urban poverty must also be considered according to Geppert and Colini [34]. Sustainable development requires successfully collaborating on three dimensions of sustainability (economic, social, and environmental). Pitts' observation [35] indicates that some systems may not function properly without significant logical support mechanisms, given the interactions among stakeholders.

Green open spaces (GOS) are essential for sustainable urban development, requiring innovative approaches to integrate ecological, economic, and social aspects. Noguera and Riera [36] emphasize the importance of capacity calculations to enhance the sustainability of GOS. Additionally, Bruni and Porta [37] identify several critical aspects that contribute to the quality of these spaces, including environmental, cultural, aesthetic quality, and institutional efficiency in landscape planning. To achieve sustainability goals, effective management systems and programs are necessary.

Research by Liu et al [10] outlines three dimensions that significantly influence GOS: mobility, social interaction, and enjoyment of nature. Furthermore, Chiara Garau highlights that urban planners increasingly view quality of life as a strategic issue, with sustainable cities addressing various urban challenges to improve residents' living conditions. The benefits of GOS extend beyond aesthetics; they also provide psychological advantages by fostering emotional attachment and appreciation for green spaces, as noted by Malek and Nashar [38]. Proximity to urban green and blue spaces has been shown to enhance health and well-being [39], [40]. Moreover, two previous studies by [41], [42] advocate for equitable governance in urban greening initiatives that involve all stakeholders.

Jafari et al [43] and Karimi et al [44] stress the importance of prioritizing GOS in policymaking to enhance air quality, reduce noise pollution, and distribute budgets effectively. Research by Pedrosa et al [45] suggests that a sense of place can shape individual behaviors towards GOS, while Steiniger emphasizes the role of urban areas in ensuring access to green spaces and essential public services like sanitation [46]. In summary, the sustainable development of GOS requires integrated planning that balances ecological functions, cultural values, accessibility, and governance to improve urban living conditions.

TABLE I
REVIEW OF RESEARCH ON INDICATORS OF SUSTAINABLE DEVELOPMENT ASSESSMENT

No.	Ref/ Origin	Description
1.	[17] / USA	Natural setting, recreational activities, various shapes & trunk color trees, sense of being, involvement with nature, active participation, setting
2.	[18] / UK	Informal natural or countryside-like landscape, social mix of users, use & number of visitors, upgrade the standard of basic facilities, value by local people, diversity of activities
3.	[19] / UK	Natural setting, outdoor activities, children's recreational demands & a multiracial society, accessibility & connection, diverse topography & vegetation, safety, and proper upkeep
4.	[20] / Canada	Outdoor amenities, walkable community, accessibility & connection, characters & distinctiveness, barrier-free, lots of seating
5.	[22] / USA	Good overall & physical design, park management, well-established advisory council, social mix of users, and surrounding neighborhood
6.	[23] / USA	It must be valid, it must be appealing, it must be simple, it must be distinctive, it must be believable

7.	[25] / UK	Environmental & mental health, natural areas, tree & grass, air quality, wildlife, shade, specific needs, social inclusions, social events, community gardens, challenging play space, increased lighting, less traffic for cyclists, accessibility, secure spaces
8.	[26] / UK	Characters & distinctiveness, accessibility & connection, facilities, legibility, adaptability & robustness, inclusiveness, biodiversity, sustainability, enclosure
9.	[27]	Preserve natural environment, accessibility & connection, recreational activities for children, facilities, creative space, good maintenance, better lighting, track for joggers, service quality, safety
10.	[28] / Nigeria	Atmosphere, usage, accessibility & connection, signage & lighting, landscape, recreational facilities, amenity provision, good maintenance & services
11.	[30]	Increased green space, leisure, socializing, air quality, kids' play places, enhanced green space quality and quantity, additional amenities, equipment, bike lanes, sports facilities, dog walking areas, safety and security, improved management, and financing
12.	[29] / Indonesia	Pleasantness & safety, sense of community, social interaction, actual use, quality of path & facilities
13.	[4]	Environmental factors include groundwater, surface water, sediment, air, natural resources, waste, soil, and the physical impact on flora and fauna; social factors include local acceptance, equity, cultural heritage, health and safety, local involvement, and environmental quality and amenity. In a cost-benefit analysis, net present value (NPV) is used to quantify economic profitability
14.	[33] / Turkey	A park's feeling of security, lighting, upkeep, planting, accessibility for individuals with disabilities, degree of contentment with the range of activities, quality of the amenities, and the typical user profile
15.	[31] / Worldwide	Sociability, comfort & image, access & linkages, uses & activities
16.	[32] / Pakistan	Social function, gender equality, participatory, economic growth, urban mobility, territorial functions, disaster risk reduction, protecting ecosystems
17.	[34] / Europe	The issues of urban poverty, employment, and skill development within the local economy, jobs and skill development for refugees and migrants, housing, air quality, energy transition, circular economy, climate adaptation, sustainable land use, urban mobility, and public procurement are worth mentioning
18.	[35] / UK	Development focuses on inclusive and participatory methods, sustainable agriculture, and information. Self-sufficiency includes land and resource conservation (farmland, sensitive areas, soil, and water); waste management (construction and demolition); pollution control (construction and demolition, agriculture); food (local food production and agricultural diversification); health and well-being; water, housing, safety and security, energy, and economy
19.	[36] / Spain	Open space's inherent relationship to the city, as well as its numerous applications, upkeep, accessibility, security, sustainability of the environment, governance, design, and carrying capacity
20.	[37] / Italy	Biological quality includes a wide variety of species, richness of species, protection of species, and environmental areas; environmental quality: air transparency, cave protection, water body transparency, and forest fires; urban quality: rejuvenation of the historic regions, improvement of urban green, acoustic well-being; tangible culture: UNESCO site conservation, industrial site enhancement, cultural trail creation, and archeological legacy preservation; views, taste-related locations, heterotopic locations are examples of intangible culture. Aesthetic quality: the importance of the skyline landscape, damaged landscapes, protecting terraced landscapes, parking demand; institutional action: the effectiveness of the landscape planning-related measures
21.	[47] / Taiwan	Ecological: fragmentation, pollution, and air quality, level of protection, biodiversity, drainage; Economical: environmental, socio-economic, merit, financial; Social: recreation and sport, Wellness and health, education and life skills, and the level of living, security and social inclusion, support, community and local identity, management and finance; Planning: legislative and planning aspects, citizens participation, management and maintenance capacity, urban green as the outcome of an integrated process, cultural and esthetical aspects
22.	[10] / China	Mobility: legibility, interior-to-exterior connection, route pattern, barrier-free sidewalks, sufficient lighting; nature enjoyment: high-density vegetation, water features, high-quality vegetation, natural art design, waste arrangement; social interaction: seats on pathways, co-maintenance spaces, multifunctional space, access to life facilities, intimate seating, historical & cultural heritage
23.	[48] / Italy	Accessibility, emotional well-being, flexibility & functionality, minimum service provided, social well-being, risk of natural disaster, Life expectancy, environmental factors, soil pollution, architectural aspects, security systems, efficiency of primary services, and innovative crime prevention
24.	[6]	Technological and environmental modifications, behavioral adjustments, and psychological adaptations
25.	[38] / Malaysia	Distance, accessibility, location, facilities, natural surroundings, landscape elements, nature preferences, maintenance, ambiance, basic facilities, safety, design preferences, participation, satisfaction criteria
26.	[41] / Netherlands	Ecosystem vitality: water quantity, basin condition, water quality, biodiversity; Ecosystem services: regulation, cultural, provisioning; Governance & stakeholders: effectiveness, enabling environment, stakeholder engagement, vision & adaptive governance
27.	[42]	Integrity, equity, and justice (both intra- and intergenerational) in socio-ecological systems, good governance, resort maintenance, stable and meaningful livelihoods
28.	[39]	Urban & transport planning, green & blue infrastructure, urban food systems, urban health equity, built & indoor environment, sustainable and waste management
29.	[43]	Demography, urban spaces & tourism, housing, transport, safety, employment, water use, air quality & energy, waste management
30.	[44]	Accessibility, aesthetically appealing rural green, psychological, walkability, environmental aspects (air quality and noise reduction), social and cultural interactions, restorative, biophilia, physical, and social health and wellbeing
31.	[45]	Place involvement, sense of place, place-concerning behavior, place appreciation

In addition to several experts who have made sustainable parameters, organizations engaged in the sustainable field have made design criteria for sustainability areas, described in Table 2. Among these organizations, there are international scale organizations (BREEAM [49], UNECE [50], MEA [51]), American organizations (STAR [52] from the US, LEED [53], [54] from the US, LEED Canada-NC v1.0 [55] from Canada) European Organizations (UKGBC [56] from the UK, Regional Environmental Centre Slovakia [57] from Slovakia, SSI [58] from Poland & the Czech Republic, and Asian Organizations (ASGB [53], [54] from China, HK-BEAM [59] from Hong Kong, SGBC [60] from Singapore, and GBCI [61] from Indonesia. Several journals use indicators created by the organization to assess the study object, such as Shibani, who uses BREEAM [49], Jin and Wang use SSI [62], and Miao et. al use ASGB [63].

TABLE III
RATING TOOLS ON THE CONCEPT OF SUSTAINABILITY BY ENVIRONMENTAL DEVELOPMENT ORGANIZATION

No.	Intuition-Organization / Scope	Description
1.	BREEAM [49] / Worldwide	Governance, social & economic wellbeing, land use & ecology, resources & energy, transport & movement, & innovation
2.	UNECE [50] / Worldwide	Economy: ICT, innovation, employment, trade, productivity, physical infrastructure; environment: air quality, environmental quality, water, noise, biodiversity, energy; society: education, safety, housing, health, culture, social inclusion
3.	MEA [51] / Worldwide	Providing ecosystem services, controlling and cultural aspects, safety, health, social interactions, and autonomy
4.	STAR [52] / US	Constructed environment, energy and climate, economics and employment, community, education and the arts, Accessibility and ability, safety and wellbeing, environmental systems, creative thinking, and technique
5.	LEED [53], [54] / US	Mobility and location, indoor air quality, water conservation, energy and atmosphere, sustainable locations, resources and materials, creativity, and regional priority
6.	LEED Canada-NC v1.0 [55] / Canada	Sustainable sites (SS), Energy and atmosphere (EA), Water efficiency (WE), Materials & resources (MR), Indoor environmental quality (EQ), Innovation in design (ID), Regional priorities (RP)
7.	ASGB [53], [54] / China	Land preservation and outdoor environment, materials saving and material resources utilization, energy saving and energy utilization, indoor environmental quality, water saving and water resources utilization, construction management, and operation management
8.	HK-BEAM [59] / Hong Kong	Site, indoor environmental quality, materials, resources, water resources, innovative design
9.	UKGBC [56] / UK	Mitigates and adapts to climate change, eliminates waste and maximizes resource efficiency, promotes the health and well-being of people, embraces and restores nature, promotes biodiversity, creates long-term value for society, and improves the quality of life
10.	Regional Environmental Centre Slovakia [57] / Slovakia	Transport, urban planning & construction, environmental burden & ecological footprint, environment-landscape-biodiversity, socio-economic situation of the city, management
11.	SSI [58] / Poland & The Czech Republic	Basic requirements include having enough food, water, sanitary conditions, and education. Well-being: a life free from illness, gender parity, social and personal development: population increase, equitable economic distribution, and sound government; natural resources include water resources that are renewable, consumable, and biological. Energy and the climate: energy consumption, energy conservation, greenhouse gas emissions, renewable energy; transition: GDP, organic farming, real savings; economy: debt to the public, employment
12.	SGBC [60] / Singapore	Energy efficiency, resource efficiency, water efficiency, health & environmental protection, and other green features
13.	GBCI [61] / Indonesia	The improvement of land ecology, mobility and connectivity, a plan for the welfare of the community, managing water and preservation, recycling and material processing, building and energy, creativity, and future growth

Theories on sustainable areas and insights from other fields provide valuable references for evaluating sustainable green open spaces. These theories have been grouped according to their main discussion. The following are the results of grouping theories according to each aspect of sustainability.

A. Economic Aspects

Economic factors are essential for developing sustainable green open spaces in cities. Theories of environmental economics and sustainable development stress integrating ecological values into economic decisions [64], [65], [66], Vivien emphasizes balancing economic, social, and ecological aspects for sustainable development [67]. Cities also use "Place Marketing" to enhance competitiveness by creating unique urban identities. This involves improving the "Image of the Place," which includes visitors' perceptions, emotional connections, and behaviors related to a space [23]. High-quality green spaces with a strong place image can improve residents' quality of life and drive urban development [45].

Green open space management has gained attention, with recent research focusing on governance, stakeholder engagement, and adaptive strategies [36], [41], [42]. Innovative concepts like Oosterom et al.'s 3D land-use model aim to optimize urban land use [50]. Green Open Space is expected to impact economic growth, both directly and indirectly, felt by the community, government, and the private sector [68], [69]. Research shows that the existence of Green Open Space can increase the value of surrounding properties, which is an essential indicator of the economic contribution of Green Open Space [70], [71]. Green spaces contribute to

economic growth by increasing property values, attracting investments, and providing ecosystem services such as air purification and flood mitigation [72].

Informal activities often emerge as a response to the community's need for accessibility and the existence of public spaces that can be used for selling. Street vending in these spaces also creates jobs and boosts local incomes [34]. Green open spaces offer direct and indirect economic benefits while supporting sustainable urban development.

B. Social Aspects

Social aspects play a key role in developing sustainable public spaces [9], [73]. This means involving the community in planning and meeting their needs, like providing play areas for kids [27], [30], [74]. By considering these social aspects, the development of public spaces can be more responsive to the needs and aspirations of the community [30].

Important things to consider about Green Open Space users include their behavior [45], social mix of users, use, and number of visitors, social inclusion, support, community, and local identity [25], [35], [47], [50], equality and social justice [52], personal & social development [58], and the level of satisfaction with the variety of activities and adequacy of facilities [33].

Community involvement in creating and caring for public spaces is essential for incorporating these social aspects [75], [76]. By participating, the community can shape spaces to fit local needs [77], [78]. More activities in Green Open Spaces lead to a more vibrant city, healthier residents, and a better quality of life [37].

Feeling safe is also very important for people to use these spaces [19], [35], [36], [47]. Standardized safety measures are needed to ensure comfort and encourage participation [35], [52]. Ultimately, community involvement is vital for creating sustainable public spaces [79], [80].

C. Environmental Aspects

Comprehending urban ecology necessitates analyzing the interactions between human and natural processes inside urban areas to create sustainable environments. The concept of urban ecosystems, highlighted by Richard T.T. Forman, amalgamates natural and artificial components, underscoring the dynamic relationship between humans and their environment [81]. Theories like Timothy Beatley's "Biophilic Cities" [82] and Bill Hillier's "The Social Logic of Space" stress the importance of connecting people with nature in urban planning [83].

Research on the urban environment has comprehensively examined several dimensions, including: Energy and Resource Efficiency: Studies emphasize improving energy and resource use in urban areas to enhance sustainability [50], [52], [53], [54], [55], [60], [61], Biodiversity and Natural Beauty: Studies emphasize the importance of species diversity, vegetation quality, and waste management in urban green spaces [25], [26], [37], [53], [54], [55], [4], [28], [38], [39], [40], [43], [44], [61], Historic Space Revitalization: Efforts focus on the maintenance and rejuvenation of historic urban spaces [37], Environmental Quality and Innovation: Topics include air and water quality, innovative design, sustainable materials, and effective land use [43], [50], [53], [54], [55], [43], [55], [61], [84], Ecological Challenges: Urban areas face issues like habitat fragmentation, pollution, and ecological footprints, which require mitigating techniques. [4], [19], [25], [35], [44], [47], [53], [54], [55], Climate Change Adaptation: Urban planning must integrate climate resilience by reducing emissions and restoring natural ecosystems [35], [56], [58].

The role of green spaces is particularly significant. They serve as pollutant absorbers, rainwater collecting sites to prevent flooding, and microclimate regulators. Access to these locations is critical for community participation and physical activity. Strategic location and integration with public transport enhance their utility [61], [85]. Furthermore, Green Open Space serves as a rainfall collecting area, lowering the risk of flooding and preserving groundwater quality [86], [87]. Green Open Space also regulates the temperature and humidity surrounding it, creating a more comfortable microclimate for the population [88], [89].

D. Research objectives

While previous studies primarily focus on the environmental dimension, a lack of research comprehensively integrates all three sustainability pillars [90], [91], [92]. This study aims to identify and assess the overall elements that influence the quality of sustainable green open spaces. A systematic literature review (SLR) was conducted to gain insight into sustainability factors and to determine the indicators that play a role in a comprehensive assessment of sustainable green open spaces [93], [94]. This study presents a comprehensive analysis of these characteristics, providing a new paradigm for urban planners and policymakers. The findings can be used by other public open space management professionals for further action or integration into development plans, in addition to evaluating existing urban green spaces.

II. MATERIALS AND METHOD

This exploratory study uses existing data and literature [95]. Instead of focusing on one specific case, it reviews documents about sustainability in Green Open Spaces and their indicators. The study examines several sources of information to assess current knowledge on sustainable urban Green Open Spaces.

The selection of research articles and reviews began with a systematic keyword search, as shown in Fig. 1. The sources were primarily journals and books from sciencedirect.com, using keywords such as: 'sustainability,' 'sustainable development,' 'sustainable city,' 'open space,' 'public space,' 'sustainable open space,' and 'public space quality.' Finding Indicators for Sustainable Development and Finding Indicators of Good Green Open Space were the two primary steps in the research process. Every article underwent two stages: Initial Review: Reading the title, abstract, and conclusion to determine their significance; Detailed Review: Examining the complete text to ensure its applicability. Finally, the indicators for assessment are prepared, particularly those suited to the Indonesian context. The formation of these indicators involved two key phases: (1) Open Coding Phase: Extracting keywords from articles, determining keywords based on how often similar words appeared in each article [96]; (2) Axial Coding Phase: Organizing these keywords into meaningful categories that

would become the final indicators [97]. For example, keywords found in the article, such as ‘place involvement’, ‘feelings towards place’, ‘behavior related to place’, and ‘appreciation of place’, can be grouped under the code "green open space image branding." Grouping the indicators according to the open and axial coding levels previously mentioned ensured a thorough method for evaluating sustainable growth in green open spaces.

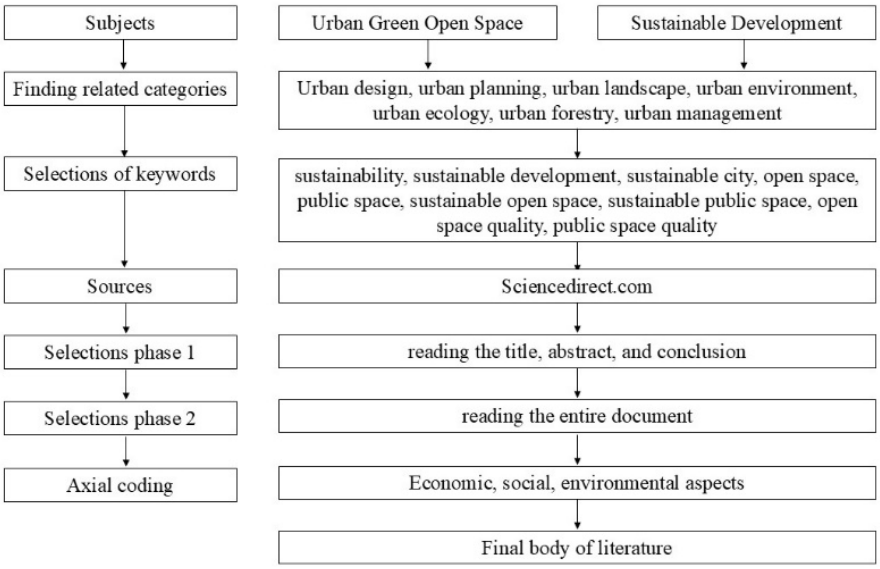

Fig. 1 Research methodology

III. RESULTS AND DISCUSSION

A. Results

To ensure a sustainable development path, appropriate indicators are needed. Finding the correct set of sustainable development indicators for a city requires knowledge of what is critical to the viability of the system in which it operates, and how it contributes to sustainable development [3], [98]. As presented in Fig.2, this study ultimately groups these indicators into three main pillars, according to the pillars of sustainable development: (1) economic, (2) social, and (3) environmental. Twelve indicators were produced from the three pillars.

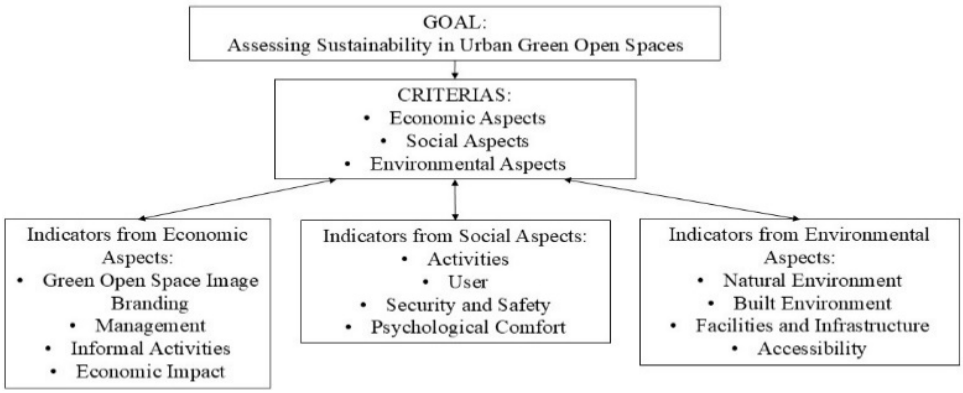

Fig. 2 3 pillars, 12 indicators of sustainable green open space.

Four indicators measure the economic aspect. First, image branding considers how well the green space reflects the city's identity. This includes ensuring the space's appearance aligns with the city's image, having a clear and distinctive theme that attracts visitors, and maintaining a simple and original theme. [45], [37]. Second, the management of natural open spaces examines how green spaces are maintained. This involves the involvement of the community, government, and private sectors, as well as commitments to eco-friendly maintenance practices (such as pest control and energy conservation), and regular maintenance of utilities. [47], [42], [41], [32], [36], [58], [51], [49]. The third indicator is about informal activities. In this indicator, there are three sub-indicators, namely providing a location for the development of the informal and commercial business sector in an area with boundaries both in the form of territory and in the form of selling time; quality of goods and services from informal activities; Cleaning the stall area from informal activities [34]. The fourth indicator is about the economic impact. It is measured by the availability of user facilities and infrastructure that support socio-economic activities. [41], [50], [58]. Table 3 details the relationships between these indicators and their sub-indicators.

TABLE IIIII
ECONOMIC PILLAR

Benchmark	Source
Green Open Space Image Branding	
1. The suitability of the physical appearance of the green open space with the city's slogan/identity.	[45], [37]
2. The public knows that the green open space has a specific theme.	[23], [45], [37]
3. The reality of green open space is by the theme of green open space that is trying to be formed.	
4. The green open space theme makes visitors want to come back.	
5. The green open space theme is made simple, not far-fetched, and not forced.	
6. Uniqueness (can be seen from the novelty/history/culture), the theme of green open space is unique in the form of novelty and has not been / rarely found in other green open spaces. And/or green open space has a visual symbol that is the main characteristic of the green open space. And/or green open space including cultural heritage seen from the historical value. And/or green open space, including cultural heritage, seen from cultural values.	
Management	
7. Community participation in managing green open space.	[47], [32], [36], [17]
8. The government's role in managing green open space.	[42],[41], [32], [36], [49], [51], [58]
9. The participation of the private sector in managing green open space	[41], [32]
10. A statement letter contains a commitment regarding maintenance of the built environment, integrated pest and weed management, and local habitat management using non-toxic materials. Definition of non-toxic: Effectively kills pests and/or weeds but has no harmful effects on humans and the environment. The proof can be seen in the Material Safety Data Sheet (MSDS).	[47], [36], [22], [19], [25], [27], [28]
11. The existence of a statement letter containing a commitment that includes: an energy audit, savings targets, and action plans for a certain period by the management.	
12. There is an operation and maintenance manual periodically for the entire utility system (clean and dirty water distribution system, pumps, and backup power plants).	
Informal Activities	
13. Provide a location for the development of the informal and commercial business sector in the area with boundaries both in the form of an area and in the form of time.	[34]
14. Quality of goods and services from informal activities.	
15. Clean the stall area from informal activities.	
Economic Impact	
16. It has facilities/infrastructure for users that can be used for socio-economic activities.	[41], [50], [49]

The social aspect has four indicators. The first indicator is about activities. This focuses on providing spaces and facilities that encourage movement and diverse activities for everyone. It considers factors like accessibility within a 400m radius, creating a comfortable environment for various users, and managing activity levels to avoid overcrowding. [10], [45], [51], [18], [19]. The second indicator is about the user. This considers the needs and satisfaction of the people using the space. It includes assessing carrying capacity for future use, promoting positive interactions between users, providing playgrounds for children, being pet-friendly, offering accessible parking and restrooms, gathering user feedback, creating communication channels for community input, and promoting sustainable lifestyles. [36], [58]. The third indicator is about security and safety. This focuses on ensuring a safe environment through adequate lighting based on energy conservation standards and implementing measures for disaster resilience. [33], [25], [27], [10]. The fourth indicator is about psychological comfort. This emphasizes creating a pleasant atmosphere by ensuring quality and privacy in green spaces and minimizing noise pollution according to established standards [44], [30], [52], [51]. Table 4 further details the relationship between these indicators and their sub-indicators.

TABLE IVV
SOCIAL PILLAR

Benchmark	Source
Activities	
1. Provide facilities where people can do activities, within a minimum radius of 400 m.	[10], [45], [51], [18]
2. A flexible area where diverse groups of people can engage in a range of activities	[45], [33], [18], [19]
3. Organizing events, controlling activities by the carrying capacity of open spaces	[36]
User	
4. Bring in capacity studies as part of planning, considering future usage scenarios.	[36], [58]
5. Quality and continuity of interaction between users.	[44], [42]
6. There is play equipment and facilities for children. Assess the situation of the playground area in the city. Measure through the number, type, and size of the playground area in the city.	[19], [25]
7. Pet friendly.	[30]
8. Public parking spaces for wheelchairs.	[31], [32], [33], [4], [58], [52], [50]
9. Public toilets for wheelchairs.	

10. Conduct a satisfaction survey of users/workers regarding the quality of the environment and area facilities and an effective response mechanism.	[47], [61], [52]
11. Have a means of communication with representatives of citizens or community associations, as a place to express opinions for regional development plans.	
12. Organizing the promotion of sustainable lifestyles to communities in the region.	[4]
Security and Safety	
13. Using lamps with room illuminance (lighting level) by SNI 03-6197-2011 concerning Energy Conservation in Lighting Systems.	[33], [25], [27], [10]
14. Make efforts to guarantee security and resilience in the face of disasters.	[35], [36], [47], [4], [30], [26], [52], [51], [50], [19], [27]
Psychological Comfort	
15. Quality atmosphere and privacy in green open space.	[52], [30] [52], [51]
16. The noise level at 90% of the net lettable area (NLA) is not more than or by SNI 03-6386-2000.	[44], [36], [37], [50]

The environmental aspects of an area or project are evaluated using four key indicators, each containing a set of sub-indicators. The first indicator concentrates on the natural environment, emphasizing preserving and enhancing ecological elements. Sub-indicators within this category include specific efforts to improve the quality of the microclimate in public spaces, increasing the environmental value of the land based on expert recommendations, promoting diversity in plant species through the use of local flora and management plans, implementing plans for fauna protection and increased diversity, and managing surface water and stormwater runoff effectively [36], [47], [30] [60], [52], [50], [49], [25], [28], [10] [57], [56], [19], [10], [37].

The second indicator addresses the built environment, focusing on the materials, infrastructure, and systems that make up the constructed aspects of the area. Key sub-indicators include utilizing materials with locally sourced raw components and environmentally friendly attributes, ensuring the availability of waste treatment units for all waste generated, employing energy-efficient lighting and alternative energy sources, developing water management plans to meet clean water needs, and meeting strategic targets for lamp shielding, light trespass, glare, and sky-glow limitation [36], [59], [55], [47], [61], [43], [52], [49].

The third indicator pertains to facilities and infrastructure, highlighting amenities that support sustainable and healthy lifestyles. The sub-indicators under this category include the provision of bicycle lanes, safe bicycle parking spaces, pedestrian paths, jogging tracks, children's play areas, sports facilities, essential infrastructure, and accessible public furniture [26], [20], [44], [10].

The fourth and final indicator emphasizes accessibility, focusing on connectivity to transportation networks and the availability of essential amenities. The sub-indicators include connections to public transportation networks, access to mass public transportation within a reasonable distance, the ability to reach the area using intermodal transportation, and the availability of public amenities within a specified radius. [36], [44], [26], [61], [49], [27], [74], [28]. The relationship between indicators and sub-indicators from the social aspect is described in Table 5.

TABLE V
ENVIRONMENTAL PILLAR

Benchmark	Source
Natural Environment	
1. Demonstrate efforts to improve microclimate quality for regional public spaces.	[36], [47], [60], [52], [50], [49], [25], [28]
2. Increasing the ecological value of the area's land on the recommendation of a competent landscaper or biologist.	[10], [47], [37], [29], [26], [60], [49], [27], [74] , [28]
3. Diversity of plant species, use of provincial local plants in the form of trees and/or shrubs in the area, and has a management plan.	[10], [47] [57], [56], [19]
4. Fauna protection plan.	[47] [37], [26], [49], [25]
5. Plans to increase the diversity of local fauna.	[47], [37], [56]
6. Presence of water surface.	[10], [37]
7. Reducing the volume of regional rainwater runoff to city drainage.	
Built Environment	
8. Using materials primary main raw material origin and manufacturing locations are within a radius of 1000 km from the project site, according to a percentage of the total cost of road infrastructure materials.	[36], [59], [49], [55], [53], [54]
9. Using environmentally friendly materials. List of Environmentally Friendly Materials, namely: a. 80% Regional production based on total overall material spending b. 30% SNI/ISO/ecolabel certified based on total material expenditure c. 5% Recycled materials based on total material spend d. 10% of used materials (reuse) based on the total material spent e. 2% Renewable Materials based on total material spending f. 30% Modular or Prefabricated materials based on total overall material spend.	
10. Treatment units for all waste generated in the area are available.	[47], [61]
11. Identification of waste types and estimated volume/weight.	
12. There are installations or facilities for sorting and collecting waste for the operational period of the area, resulting in at least 3 (three) types of waste consisting of:	

A. Degradable waste (organic); B. Inorganic waste; C. Waste contains hazardous and toxic materials, and hazardous and toxic waste (B3). 13. The plan includes a system of separation, collection, transportation, processing, and final processing of waste.	
14. Use lamps (streetlamps, garden lamps, parking lamps) with a maximum lighting consumption of 2.5 W/m2* without compromising lighting quality.	[35], [36], [58], [60], [61], [49], [55], [53], [54], [52], [49], [27], [74]
15. Using alternative energy sources within the area.	
16. Create a schematic diagram of regional water (clean water from PDAM, land, alternative water such as lake water, rainwater, and recycled water).	[35], [36], [58], [60], [61], [59], [49], [55], [53], [54], [50]
17. Use alternative water to meet the area's clean water needs.	
18. Performing regional rain runoff analysis calculations.	
19. Fulfil strategies: Lamp Shielding, Light Trespass, Glare, and Sky-Glow Limitation.	[61]
Facilities and Infastructure	
20. Provide bicycle lanes within the area.	[26]
21. Provide a safe bicycle parking space at (at least one) entry area and a place to change public transportation modes.	
22. Provide pedestrian paths within the area.	[20], [44], [10]
23. 100% unbroken pedestrian path.	
24. Pedestrian paths must be shaded by at least 60% of the pedestrian path.	
25. Creating an attractive environment for pedestrians.	
26. The existence of a jogging track.	[10], [27], [74]
27. The presence of a children's play area.	[10], [29], [27], [74]
28. Presence of sports facilities.	[38], [47]
29. Fulfils 7 (seven) basic infrastructure.	[61]
30. There are at least 6 (six) types of facilities within a range of 400 m.	[61]
31. The presence of public furniture, the rest area is mainly used as a relaxing seat on the edge.	[20], [10]
Accessibility	
32. The area is connected to the public transportation network and provides adequate interconnection space (as well as shelter for public transport users).	[36], [44], [26], [61], [53], [54], [49], [27], [74] [28]
33. The area has access to mass public transportation within a radius of 400 m from the outermost side of the area.	[48] [61], [53], [54], [49] , [27], [74], [28]
34. The existence of the area can be reached by using all intermodal transportation with no more than 20 minutes from and to other public functions.	
35. Alternative transportation options.	
36. There are at least seven types of public facilities within the reach of the main road as far as 1500 m from the site.	[10], [29], [61], [53], [54], [49]

B. Discussion

1) Economic aspect of sustainable development: The economic dimension of sustainable development centers on enhancing profitability and governance within various sustainable sectors. This dimension is evaluated using four key indicators. First, the Image indicator, which aims to strengthen the identity of green open spaces in the city by improving their quality and suitability. Second, the Management indicator emphasizes community empowerment, government participation, and private sector involvement to ensure the physical sustainability of these spaces. Third, the Informal Activities indicator aims to preserve the quality of informal uses within green open spaces. Lastly, the Economic Impact indicator strives to generate benefits for all parties involved. These objectives aim to create jobs, save operational costs, and encourage sustainable profit growth.

2) Social aspect of sustainable development: The social aspect of sustainable development emphasizes equality and respect for individual rights. This aspect is evaluated through four main indicators. The Activity Indicator focuses on facilitating community engagement and events. The User Indicator has several objectives, including encouraging human interaction, promoting social equity, ensuring accessibility for individuals with special needs, integrating the community into the area, and raising awareness about sustainability. The Security and Safety Indicator aims to prevent disturbances from inadequate lighting and create a secure environment free from crime and natural disasters. Ultimately, the Economic Impact indicator aims to deliver benefits to all stakeholders involved. This goal is in line with efforts to combat discrimination, promote solidarity and improve the overall quality of life of the population.

3) Environmental aspect of sustainable development: The environmental aspect of sustainable development addresses the need to minimize environmental degradation. This aspect is measured through four indicators. The Natural Environment Indicator focuses on improving the microclimate, increasing biodiversity, and effectively managing stormwater runoff. The Building Environment indicator aims to reduce the carbon footprint of transportation and construction processes while promoting waste management and energy conservation. In addition, it encourages the use of alternative energy sources and independent water solutions to reduce environmental impacts. The Facilities and Infrastructure indicator promotes cycling and walking while ensuring pedestrian areas are safe and

accessible. Finally, the Accessibility indicator ensures that everyone can do activities and facilitates easy access to public facilities. These efforts aim to create a sustainable environment that benefits both people and nature.

IV. Conclusion

The presence of urban green open space is critical in establishing a sustainable urban environment. The provision of urban green open spaces creates a balance between development and the environment. However, it is important to standardize the design and implementation policies of urban green open spaces, which requires the development of indicators that affect their quality. The findings of this study can be the basis for planning regulations or for creating urban design guidelines. In addition, these indicators can be used to conduct sustainability assessments of existing green open spaces. Future research can investigate how these indicators can be applied in various urban environments and attempt to build a set of sustainability guidelines tailored to specific regions.

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