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Exploring International Perspective on Factors Affecting Urban Socio-Ecological Sustainability by Green Space Planning

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Abstract: Urban green space (UGS) is one of the most important components of urban systems to create sustainable cities. This crucial urban element performs many social and ecological functions to facilitate a better quality of life for urban residents. The main aim of this study is to identify the most critical factors contributing to cities' social and ecological sustainability through UGS planning and development. To achieve this aim, an integrated socio-ecological approach was followed to collect and analyse the data, which comprised context analysis and an international experts survey. Therefore, firstly, the main influencing factors for urban social and ecological sustainability that can be achieved by UGS planning were extracted by reviewing the related literature. In the next step, to find the most critical factors, an online international survey of academicians and experts drawn from a number of countries was conducted. Based on the experts' opinions, twenty-two factors out of sixty-five, including twelve social factors and ten ecological factors, achieved the highest scores. According to the results, the key factors of accessibility from the social sustainability category and protection from the ecological sustainability category play the most important roles in maximising the social and ecological benefits of UGS.

Keywords: urban green space (UGS); socio-ecological approach; planning; affecting factors; sustainable cities

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1. Introduction

Over the last century, rapid urbanisation has been causing a range of environmental challenges, such as urban overheating and air pollution [1,2], as well as the diminishing of green areas in cities [3]. The environmental fragility of cities and advanced urbanisation have motivated extensive research and policy efforts on sustainable urban development [4,5]. More recently, planners have been applying sustainability principles to urban planning [1]. Sustainable development emerged from the ecological environment, natural ecosystems, and resource protection. It focuses on the compatibility of environment and development, society and nature, human life needs, and ecological integrity [6]. Nowadays, ecological sustainability aims to preserve natural and environmental resources for current and future generations [7,8]. On the other hand, for healthy and liveable communities, social sustainability has been considered a process that supports and enhances social interactions and cultural quality of life among all kinds of people within local environments [9,10]. Improving urban social and ecological sustainability depends on developing the interaction between people and nature in cities through natural public areas, such as green spaces [11,12]. Urban green space (UGS) has become a significant component of urban planning, as it is one of the most important components of urban systems that can help to alleviate social and environmental challenges and improve the quality of urban life [13,14]. According to the WHO report ([15], p. 3), "there is no universally accepted

definition of UGS. Generally, green spaces in urban areas are public parks". Based on this definition, UGSs with public access are considered in this study.

UGS plays a significant role in creating socio-environmental conditions that promote human well-being [16,17]. Hence, these two aspects of urban life, namely a city's ecological and social conditions, are tightly connected. UGS is an urban element that can improve this connection in the best possible way. The socio-ecological approach to UGS planning helps to create a sustainable society and provides an attractive and favourable living environment. Therefore, planning and designing UGS by emphasising its social and ecological aspects can benefit urban sustainability and promote people's quality of life.

A significant number of studies concerning the positive impacts of UGS on urban environments and people exist. They highlight how UGS contribute to the overall quality of urban life by addressing social, ecological, health, economic, and cultural aspects. Researchers and practitioners continue to explore and advocate for the integration and expansion of these spaces to create more sustainable, liveable, and resilient cities. Although there is a large body of literature on the socio-ecological benefits of UGS for urban life [18,19], little is known about the critical factors that influence UGS planning to promote urban social and ecological sustainability. Thus, studying the essential factors that can maximise the social and ecological benefits of UGS planning in cities is important.

This study aims to answer the following questions:

- How do UGSs' planning and design enhance urban social and ecological sustainability?
- Which factors impact the social and ecological sustainability of urban areas with the planning and design of UGS?
- Which factors have the most important role in the social and ecological sustainability of urban areas with UGS planning and design?

Therefore, the main goal of this study is to identify the most critical factors contributing to socioecological sustainability-oriented UGS planning in cities. To achieve the main aim of this research, exploring the role of UGS in urban socio-ecological sustainability and extracting effective factors are considered the objectives of this research. Thus, because the findings of this study are based on international expert surveys, the findings of this study can be generalised to most cities worldwide and are useful to urban planners involved in sustainable urban development.

2. Integrative Social–Ecological Approach and Urban Sustainability by UGS

Sustainable development is considered a universal and multidimensional issue globally. The sustainable development of social–ecological systems combines the ecological and social dimensions of sustainability [17,20–22]. As an integrated area, UGS comprises natural, semi-natural, and artificial green areas, ensuring multiple benefits to city dwellers [19]. Previous studies confirm that UGS can inject cities with vitality in terms of social and ecological advantages [17,18,23,24]. There are several key benefits to applying a socio-ecological approach to UGS planning and design. Firstly, this approach recognises that green spaces are not just physical places, but also social spaces that serve a variety of community needs. By taking into account the social and cultural context of UGS, planners and designers can ensure that green spaces are accessible and meet the needs of diverse communities [23]. Also, a socio-ecological approach recognises the ecological value of green spaces and their role in supporting biodiversity and ecosystem services [25].

One of the fundamental objectives of the social–ecological paradigm is to explore the interrelations between environmental conditions and human wellbeing [7]. This approach can reflect the close relationship between ecosystems' natural and social dimensions [8] and help to understand how planning elements can create enhanced built and social environments in urban areas [26].

Therefore, while investigating the affected factors for UGS planning to improve urban sustainability, a single factor only evaluates certain aspects of UGS, which is not suitable for comprehensively planning to enhance social and ecological benefits. Considering this limitation, this study offers an integrated approach to study and investigate the UGS

sustainability aspects from social and ecological perspectives. According to Figure 1, UGS planning based on social and ecological sustainability factors can create a better relationship between people and nature, consequently leading to sustainable cities.

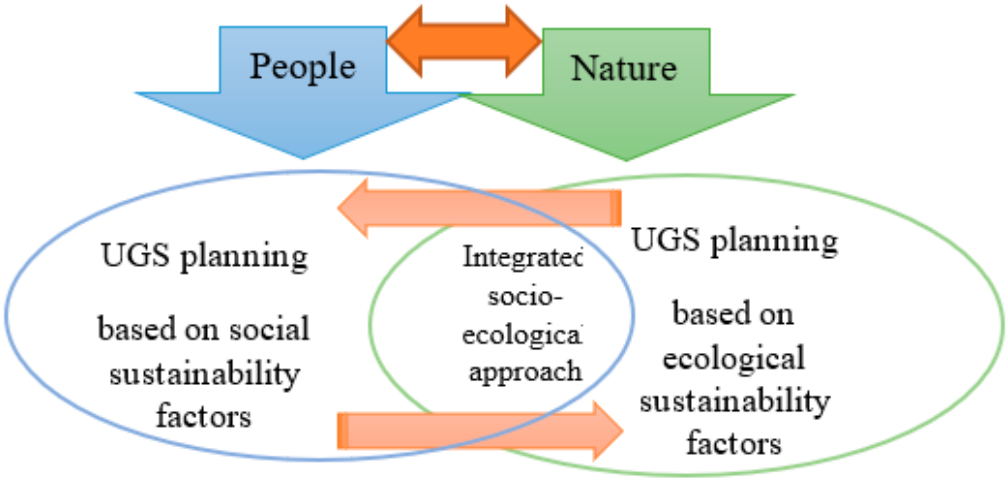

Figure 1. Integrated socio-ecological approach for UGS planning and design for social and ecological sustainability (Developed by the Authors, 2023).

3. Social and Ecological Sustainability Factors through UGS Planning

This part provides a theoretical review regarding the affecting social and ecological factors for UGS planning to enhance urban sustainability.

3.1. Social Sustainability Factors through UGS Planning

- Accessibility

Accessibility, as the first criterion for enhancing social sustainability through UGS, was identified as one of the critical domains for gaining the social benefits of UGS at the neighbourhood level by several research outputs [27,28]. UGS accessibility and its balanced distribution throughout the city promote healthy behaviours, such as cycling and walking [29,30]. Also, exposure to public parks close to homes has been highly correlated with physical activity [31,32]. Access to UGS has contributed to improvements in public health and the socialization of urban residents [33–35], as they are essential to the liveability of cities [36]. Therefore, a positive correlation between the existence of UGS in the living atmosphere and people's welfare is shown by considerable scientific evidence [37], as it affects people's good feelings about their health and reduces mortality risks [34,38].

- Socialisation

The social dimensions of UGS include participating in healthy and active lifestyles in communities, providing social justice by engaging all age groups in green spaces, and providing opportunities to encourage people to develop social interactions [39]. Neighbour interactions usually happen locally in recreational parks and educational places [40]. Therefore, promoting cultural life for different societies living in a city is possible by creating a background to share ideas and feelings [7]. Another social effect of UGS due to the presence of natural landscapes is neighbourhood social capital [41]. Parks and green spaces create shared locations for social interaction [37], increase the levels of community support [42], and enhance engagement in socially oriented activities [43]. There is also a relationship between exposure to the natural environment and subjective well-being, such as happiness [44,45]. Therefore, the presence of vegetation in public spaces may push dwellers to outdoor spaces, leading to more contact with neighbours [46]. Nature can raise a sense of community by promoting feelings of emotional dependency on a neighbourhood and people's sense of place, which could reduce feelings of loneliness [47]. UGS also promotes a sense of place and place attachment [48], and enhances community satisfaction [49].

Therefore, UGS is the natural city element that can provide a background to reach urban social sustainability by gathering people and nature together.

- Recreation, Health, and Well-Being

Many health-related studies have demonstrated various positive health effects of UGS, including reducing stress and depression and improving mental health [50,51]. Continuously visiting green spaces can affect residents spiritually and physically by relaxing and reducing stress [34] and enhancing mood and self-esteem [52]. These spaces provide recreational opportunities, such as engaging in sports, visiting other people, and social interaction [12]. UGS also has an impact on crime and other incivilities. For instance, studies in Chicago suggest that green environments correlate with lower crime levels [53]. Therefore, UGS supports a broad spectrum of activities and interactions between people and nature, and is considered critical to sustaining environmental functions for the health of communities [54].

- Education and Management

One reason for people to value UGS is its potential contribution to education. Environmental perception and education are among the important factors for social sustainability [55]. UGS provides practical learning about natural ecology and its social benefits [56,57]. Green spaces produce rich laboratories as spaces that create opportunities for people of all ages to learn and explore cities' nature [58]. As people can directly impact green spaces through their participation, educating them regarding the preservation and development of green spaces is an essential criterion in UGS planning practice. According to Dennis and James (2016), educating people to participate in UGS development and planning promotes the value of ecosystem services [59]. In addition, planning facilities, like libraries, for outdoor study in public parks can be an effective factor to enhance green space visits [60].

In addition, creating jobs and employing local people for UGS development is recognised as another social factor that can be effective for UGS development and social sustainability [61]. Besides the educational factors, some managerial factors have been declared as affecting factors to help promote social sustainability. According to Smith, "stable institutions and local government structure should facilitate collaboration by allowing public managers to more credibly commit in a policy arena" ([62], p. 1). Therefore, institutional determinants and local community management for UGS development, regular supervision of UGS protection and development by local communities and authorities, and administrative measures for UGS development are among the management criteria that would be beneficial for UGS development programmes and consequently increasing social sustainability in residential areas. By considering the mentioned social sustainability domains and including factors in UGS planning and design, the city will promote more sustainable residential areas socially. Consequently, residents' quality of life will be improved by having a happy and healthy social life.

- Multifunctionality and Suitability

The benefits of public green spaces can be increased by managing multifunctionality through proper planning to make the best use of UGS [63]. Multifunctionality plays a pivotal role in cities developing the relationship between different benefits [64]. Therefore, to create the maximum number of services for the residents, considering multifunctionality criteria is one of the critical aspects of UGS planning [65]. UGSs' multifunctional performances include a combination of natural, semi-natural, and artificial services of UGS [64]. Through the development of various hierarchical green spaces in cities with different functions, such as pocket parks, neighbourhood parks, playgrounds, and urban and regional parks, most residents can gain the social and ecological benefits of UGS.

Furthermore, UGS should be available and suitable for different people and groups. Suitability for people depends on the services that users can receive from green spaces according to their preferences [66]. People of all ages should gain the positive effects of walkable neighbourhoods and green spaces for their welfare [67]. In particular, UGS

significantly impacts the health and well-being of the ageing population [68]. In addition, these public spaces should be suitable for women. Women perceive greater aesthetic value of green spaces and receive higher happiness and well-being in relation to UGS [69]. In addition, the mental health of children can be developed through regular access to green spaces [70]. Children can discover, be creative, master, and control green spaces, all of which are thought to influence various aspects of brain development [71]. Disability is another important item that needs to be considered in urban social infrastructure, such as UGS [63]. In most cases, the physical design of the infrastructure in public green spaces overlooks disabled people's needs, such as unique benches, footpaths, and toilets. This situation causes disabled people to prefer to stay indoors, as they feel separated from other green space users [63].

3.2. Ecological Sustainability Factors through UGS Planning

- Ecological Landscape Design

Green spaces are an important part of urban ecosystems [72] and provide essential ecosystem services with environmental, aesthetic, recreational, and economic advantages [73]. In recent decades, the Earth's landscape has significantly changed due to processes like agricultural expansion, deforestation, and urbanisation [74]. Some of the changes, mainly where natural land has been converted to constructed land, have impacted the ecology of cities and urban sustainability [75]. Therefore, in the current context, green spaces should be extensively regarded as a key component for promoting the quality of life in residential environments in urban areas through proper ecological design [76]. Cities that often experience urban heat islands can be affected by cooling the environment with UGS planning and design [77]. Urban heat and climate change pose major challenges to urban living. UGS can reduce exposure to excessive heat, air and noise pollution, as well as contribute to ecosystem services. There is evidence that green spaces can provide cooling effects and reduce temperatures by one to four degrees Celsius [78]. Green space also enhances human comfort and reduces high energy demand [79].

In addition, according to previous studies, the correct green space area [39,80], in regard to the population of neighbourhoods [10,81], should be considered while designing for UGS. A city's various kinds of nature should have the proper size, composition, and physical connection to each other [82]. Furthermore, the continuity of different green spaces throughout a city [83] with various structures, and designing green pathways, walkways, and cycle tracks, are among the essential factors [84,85] to create a UGS design aesthetic [86]. In addition, regarding the ecological approach in UGS landscape design, considering the natural form and shape of the land [87] and connections with neighbourhood homes [41] are essential items to enhance the ecological sustainability of residential areas by UGS environmental design.

- Biodiversity and Vegetation

Considering plant types regarding the climate and natural condition of a city, diversity and the density of green spaces and biodiversity are essential factors in the ecological structure of green spaces [81]. Furthermore, according to previous research, tree plantations in public green areas can decrease stormwater runoff and increase soil infiltration [88], which is crucial for resilient and sustainable cities.

UGS offers various services for natural wildlife and vegetation, including air and water purification by absorbing pollutants, increasing floodplain surfaces, stabilising soils, providing shade in the warm seasons and windbreak in the winter, decreasing levels of CO_2, and protecting wildlife by providing habitat [6].

Managing UGS is an increasing priority for ensuring that biodiversity resources are protected. Urbanisation and land-use change have resulted in UGS fragmentation and habitat loss, making it especially essential to design green spaces with conservation outcomes in mind. Most animals and plant species rely on green spaces in cities to survive, providing them with a habitat [89].

- Protection

Rapid urban and population growth and urban sprawl have sped up the loss of undeveloped green space [90]. Public green space preservation is a core issue for planners. The protection and preservation of UGS are significant for developing nature in cities [91]. Conserving existing green spaces also has economic benefits for the management of a city that should not be neglected. Decision-makers have identified UGS preservation's importance in preventing urban sprawl and improving urban life. According to Griffith (2010), "Smart growth concepts, new urbanism, and the current focus on sustainability all include the preservation of open space as necessary to realise their policy objectives" ([90], p. 267).) and Idris et al. (2022) identified that UGS conservation is an important action that provides a healthy local ecosystem and acts as a safeguard to maintain clean soil, water, and air [92].

Open space preservation and the conservation of other environmental resources, like biodiversity [93,94], help to achieve sustainability by air purification and providing habitats for biodiversity, which creates a valuable ecosystem service.

- Water Resources

Planning water-management systems for UGS according to a city's climate, soil types, and UGS development plans is another essential factor that should be established during UGS planning to enhance a city's ecological sustainability [95]. Restoring sustainable water resources is one of the fundamental measures for the environmental planning of UGS, which can be achieved by irrigation with a rain-harvesting system [96,97], wastewater management [98], and irrigation with reused recycled water [98,99]. The water-sensitive urban design (WSUD) approach is also considered a solution to preserving water quality and quantity for developing public green spaces [100].

- Ecological Network

The concept of ecological networks refers to the extended concept of UGS systems, greenways, and networking [101]. The planning of urban ecological networks to protect the environmental structure in the urban landscape is among the essential practices to achieve the environmental sustainability of UGS. Planning and designing various green spaces around natural linear elements, such as coastlines, rivers, cliffs, hills, dunes, and valley swamps, are vital to enhancing urban sustainability benefits [13]. Ecological green networks provide suitable accommodation for the survival of the various natural populations of animals and plant species [23,102]. Therefore, it would be better for all public gardens and parks, golf courses, urban woodlands, cemeteries, waterlines, railways, and motorways to focus on urban planners to organise ecological networks and green infrastructure at different scales [13]. According to Beatley ([103], p. 2), "urban ecological networks, from an urban planning perspective, establish physical, visual and ecological connectivity between built-up areas of the city and surrounding natural areas and greenspaces". Considering that the UGS network can improve the quality and quantity of the existing UGS system in cities [33], ecological networks can also aid in the survival of natural populations and threatened species, and solve the problem of fragmented land use [104]. The planning of a green ecological network generally includes green spot selection, the construction of environmental corridors, and ecological green network design [105,106]. Consequently, the development of UGS networks considerably provides an approach to enhancing the ecological value of UGS [106].

4. Methodology

Important socio-ecological factors need to be considered in UGS planning, as this will lead to the social and ecological sustainability of cities. The following stages were followed to achieve the aim and objectives of this study (Figure 2).

1. First, based on a socio-ecological approach, content analysis was undertaken to understand the role of UGS in urban sustainability and explore the main social and ecological affecting factors.
2. The identified factors were then divided into social and ecological categories to analyse their impacts separately.
3. All the factors in the two categories were further categorised into ten domains (five social and five ecological domains).
4. Second, an online survey was conducted with international experts involved in UGS development and sustainability to understand the importance of the influencing factors.

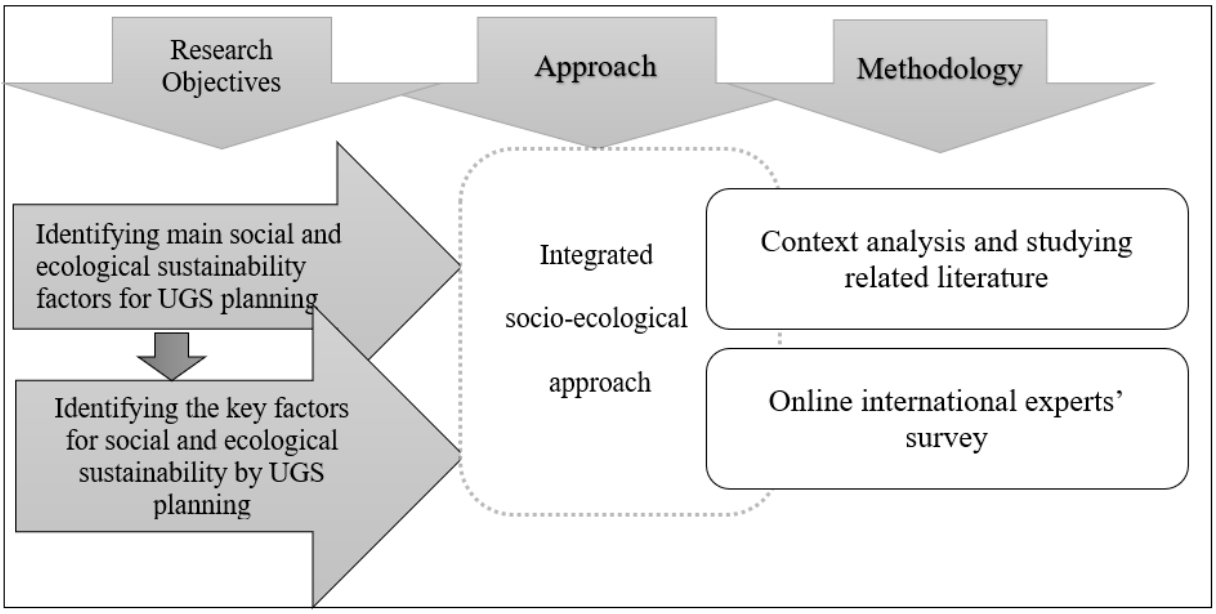

Figure 2. Methodology for this research based on the objectives and the considered approach.

4.1. Content Analysis

The content analysis component was undertaken to identify the importance of UGS in cities' sustainability and also to find the affecting social and ecological factors for UGS planning to enhance urban sustainability.

To identify social and ecological factors for urban sustainability that can be achieved by UGS planning, studying the relevant literature and exploring related studies is necessary to reach this objective. Therefore, according to the findings of Section 2 of this study, the main affecting factors were identified and are presented in Figures 3 and 4.

As a result of reviewing the related literature and context analysis, the main UGS social sustainability factors can be categorised into five domains (Figure 3).

According to Figure 4, the main ecological sustainability factors that UGS can provide for cities can be grouped into five domains.

Therefore, based on the context analysis, 65 factors that may influence urban social and ecological sustainability through UGS planning were initially identified (Figures 3 and 4).

4.2. International Experts' Survey

Exploring and identifying the most critical factors for urban sustainability by UGS planning from the extracted social and ecological sustainability factors was the main goal of this research. To achieve this goal, an integrated socio-ecological approach was considered in the online survey of international experts in UGS development and sustainability. Therefore, an online questionnaire was designed based on all affecting factors to survey international experts to determine their ideas about the importance of each factor. The experts were chosen mainly from successful countries regarding UGS planning.

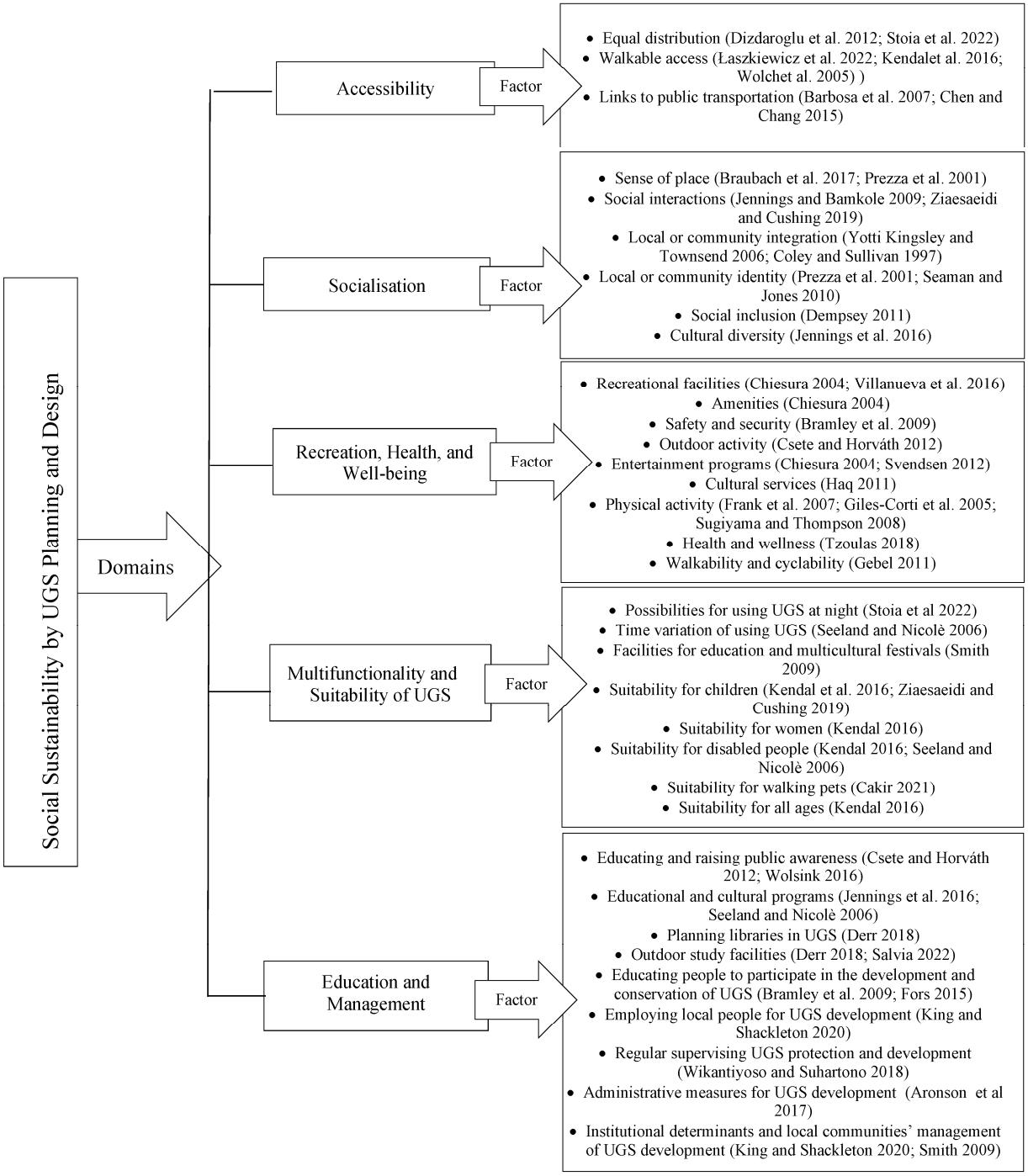

Figure 3. Affecting factors for social sustainability by UGS planning [6,7,9–12,19,27–29,31–33,35,36,39,42–44,46,47,54,55,58,60–63,66,68,81,107–111].

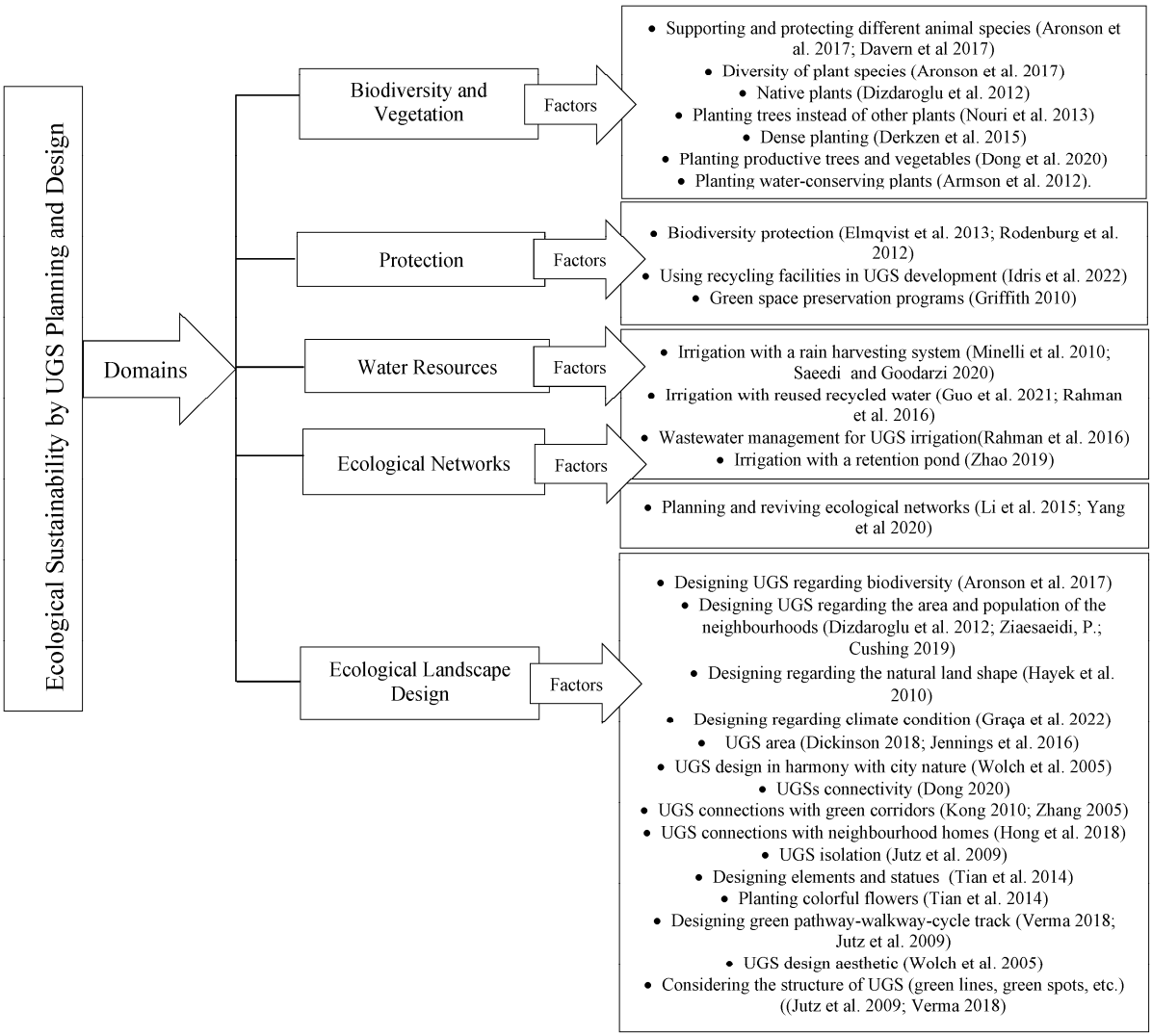

Figure 4. Affecting factors for ecological sustainability by UGS planning [2,10,16,36,39,41,72,78–81,83–85,87,88,90–94,96–99,105–107,112,113].

To conduct the survey, a human research ethics application was submitted and approved by the University of South Australia Human Ethics Committee (Ethics Protocol 202773). Also, participant information sheets and consent form indicating their willingness to participate in the survey were provided to the participants when sending the participation invitation emails. Therefore, the study aim and objectives were clarified to the participants and they were asked for their permission before starting the data collection.

In this research, 112 out of 300 experts who were contacted completed the survey. The sample size in this study was determined using the principle of saturation theory. Saturation theory is one of the well-known methods in qualitative research, which shows the data that have been collected and analysed so far are sufficient. Therefore, the collection of more data is not necessary and has no benefit for the research result, and the collection of additional data will not affect the research result. Purposive sampling was also considered to select the experts. This sampling method involves a researcher's conscious choice of participants with specific characteristics or rich information. Like other sampling methods, this sampling method may help to gain basic ideas about topics that have not been thoroughly explored before [114], and is used when an expert sample is required [115].

A structured online questionnaire survey was designed for this survey. To obtain the experts' reflections, an online survey was the preferred method. The survey included Likert scale questions divided into four parts: (i) general questions, which included five

questions about the experts' gender, age group, qualification, position, and experience in UGS planning and development; (ii) social factors, including five domains (accessibility, socialization, recreation health and well-being, suitability and multifunctionality, education, and management); (iii) ecological factors, including five domains (biodiversity and vegetation, ecological landscape design, ecological networks, water resources, and protection); and (iv) an open question.

The Likert scale (very important: 5; fairly important: 4; neutral: 3; less important: 2; not at all important: 1) was used for the expert survey. Finally, according to the weightings of the international experts, the key socio-ecological factors affecting UGS planning for sustainable cities were identified.

5. Results

5.1. Reliability of the Survey

To test the reliability/internal validity of the survey, Cronbach's Alpha method was used. This method enables researchers to measure any internal inconsistencies in surveys. The reliability value should be between 0 and 1 in this method [116]. After the online questionnaire was prepared, the survey link was sent to twenty experts. The completed forms were then tested for reliability/internal validity using Cronbach's Alpha in SPSS. As shown in Table 1, the reliability values for all social and ecological factors were between 0 and 1, showing a high degree of validation of the survey.

Table 1. Reliability of the social and ecological dimensions.

Domains	Number of Factors	Reliability (Cronbach's Alpha)
Factors in social domains		
Accessibility	3	0.078
Socialisation	5	0.583
Recreation, health, and wellbeing	9	0.643
Multi-functionality and suitability	8	0.692
Education and management	10	0.722
All social factors' reliability	35	0.841
Factors in ecological domains		
Ecological landscape design	15	0.720
Ecological network	1	-
Protection	3	0.422
Biodiversity and vegetation	7	0.504
Water resources	4	0.498
All ecological factors' reliability	30	0.825
Reliability of all social and ecological factors	65	0.898

In this research, two analytical techniques were used to analyse the online survey data. First, to describe the general questions, including the participants' scientific characteristics, and to obtain the summary statistics, namely the mean and standard deviation and the scores of each factor, descriptive statistics analysis was used. Second, to evaluate the values of social and ecological domains, a one-sample T-test was considered. It was also used to rank domains to calculate the average value of sub-domains, including factors in each domain, and to analyse the average of the domains.

Therefore, to investigate the ranks of factors within the social and ecological domains, a one-sample T-test in SPSS was conducted. This test is a widely used statistical method to

compare group means and examine whether the data mean is statistically different from the mean value [117]. As the Likert scale values were between 1 and 5, the mean value was 3. In the one-sample T-test, the average value of sub-domains (factors) was calculated, analysed, and compared with the mean value to determine their ranks.

5.2. Findings of International Experts' Survey

As mentioned in the methodology, sixty-five social and ecological factors affecting UGS planning and development for sustainable cities were extracted from the literature review (Figures 3 and 4). To find the most critical factors, an international experts survey was conducted.

5.2.1. Participants' General Characteristics

Among the 112 experts who responded, 66 were male and 43 were female. Eleven respondents did not prefer to answer the question on gender. Most respondents were in the 41–50 age group. In terms of qualifications and experience, most respondents had a PhD or other higher education, while 34% had 1–5 years of research experience in UGS planning and development (Figure 5).

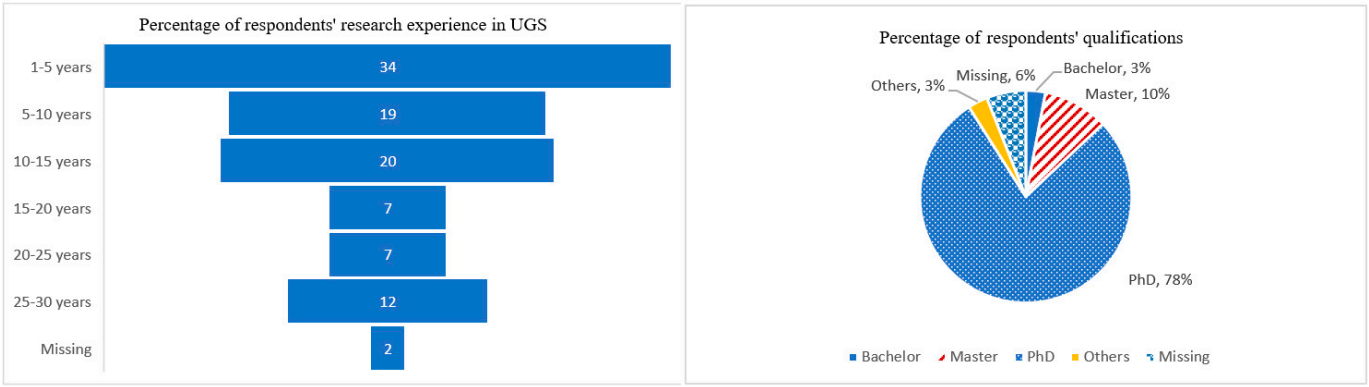

Figure 5. Respondents' qualifications and experiences.

5.2.2. The Weighting of Influencing Factors

The importance of social and ecological factors affecting UGS planning was weighted by international experts using the Likert scale. As can be seen in Figure 6, factors of proper distribution, walkable access, suitability for disabled people, suitability for all ages, women and children, education of people to protect and develop UGS, safety and security, walkability and cyclability, and physical activity and recreational facilities were identified as the most important social factors influencing UGS planning to promote urban social sustainability.

On the other hand, design in harmony with nature, reservation, design regarding the area and population of neighbourhoods, plant species, biodiversity protection, designing according to climatic condition, and irrigation with recycled water were identified as the most important ecological factors influencing UGS planning to enhance urban ecological sustainability (Figure 7).

5.2.3. Analysing the Importance of the Domains

To determine the significance level of the domains and to determine if the mean of a single variable differed from the test value (assumed average), a one-sample T-test in SPSS was performed. The significance level of variables showed the significance of the difference between the means of a group. A significant value indicates whether the results occurred randomly or not. If the value is less than 0.05, it indicates equal variances between variables in a group.

The test value or the mean value of the variables was 3 in this study (as the survey was based on the Likert scale).

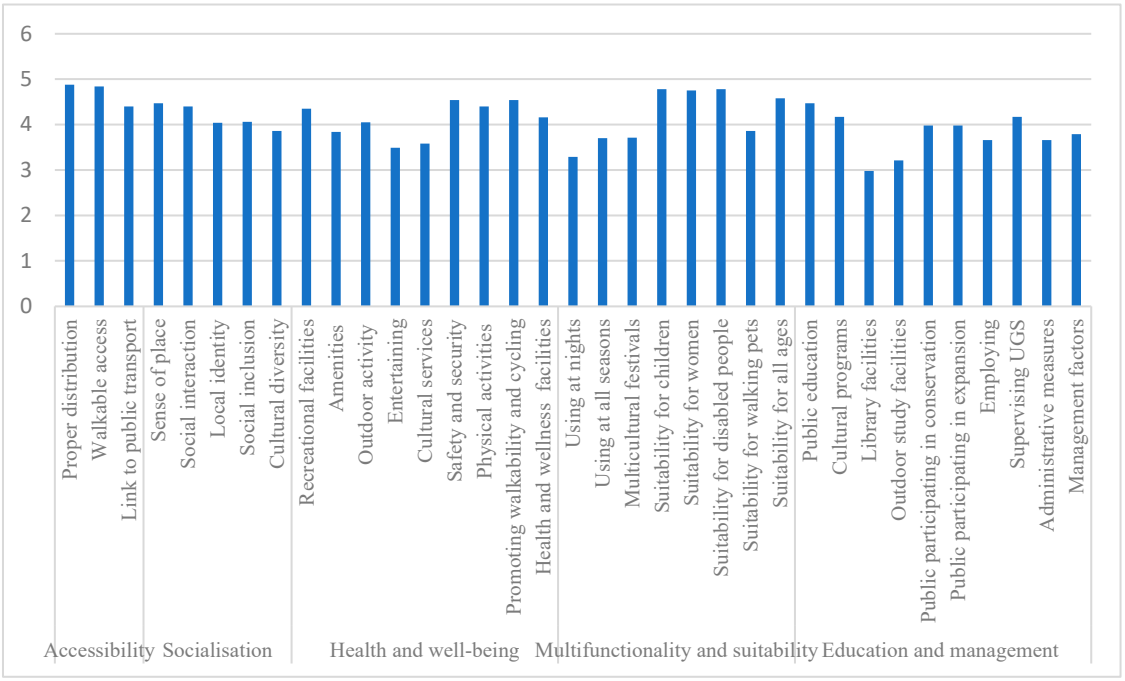

Figure 6. The importance of affecting social factors.

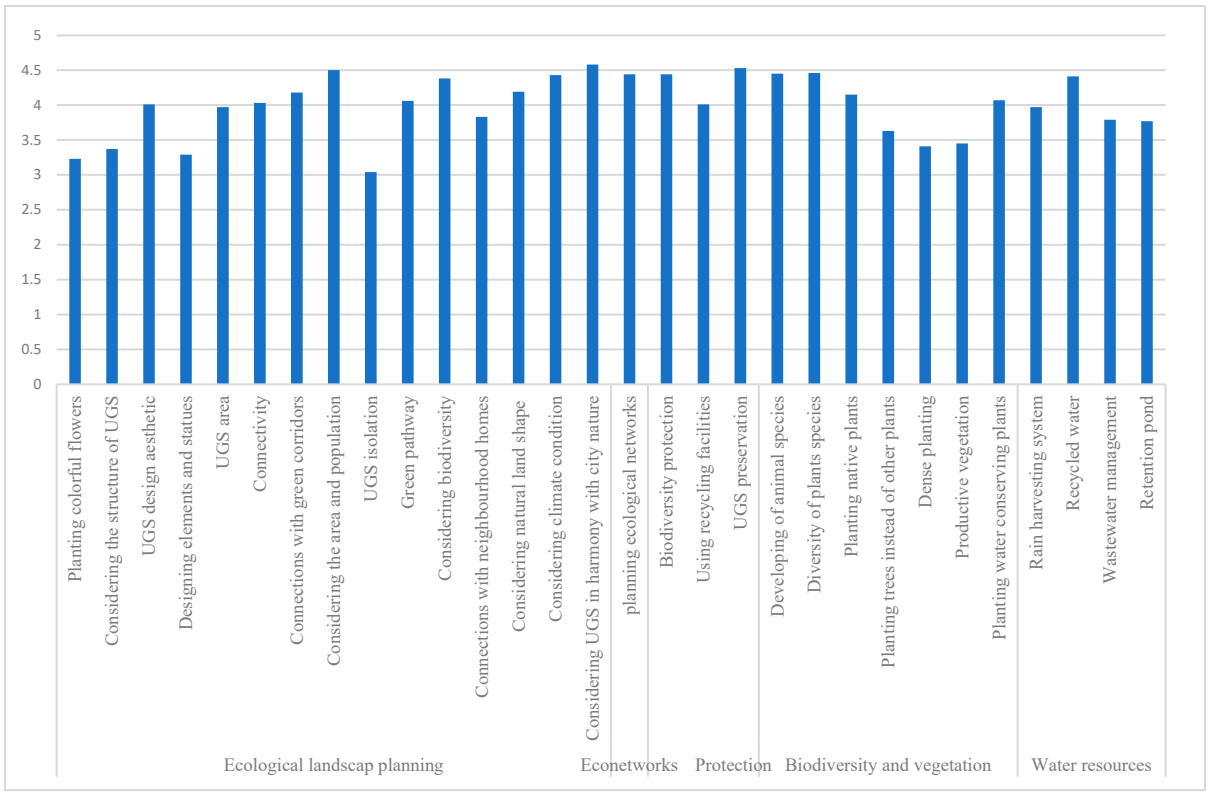

Figure 7. The importance of affecting ecological factors.

Social Domains

The mean, standard deviation, and standard error mean of the variables in each domain were calculated by a one-sample T-test (Table 2).

Table 2. One-sample T-test statistics for social domains.

	Number of the Variables	Mean [a]	Std. Deviation [b]	Std. Error Mean
Accessibility	3	4.6867	0.29195	0.16856
Socialisation	5	4.1620	0.25616	0.11456
Recreation, health, and wellbeing	9	4.1111	0.40170	0.13390
Multi-functionality and suitability	8	4.1762	0.60863	0.21518
Education and management	10	3.8150	0.46810	0.14803

[a] Mean: average value of the variables in each group (domain); [b] Std. Deviation: standard deviation of the variables.

As shown in Table 3, the significance of all domains was less than 0.5, indicating a high significance level between variables or factors in a group or domain. Furthermore, the mean differences indicate a slight variation between the test value (=3) in this study and the mean of the factors in each domain. These results imply that all domains were in an optimal situation regarding factors (in each domain) and each domain was in relation to other domains.

Table 3. One-sample T-test results for social domains.

	Test Value = 3					
	t [a]	df [b]	Significance (2-Tailed)	Mean Difference [c]	95% Confidence Interval of the Difference	
					Lower	Upper
Accessibility	10.007	2	0.001	1.68667	0.9614	2.4119
Socialisation	10.143	4	0.001	1.16200	0.8439	1.4801
Recreation, health, and wellbeing	8.298	8	0.000	1.11111	0.8023	1.4199
Multi-functionality and suitability	5.466	7	0.001	1.17625	0.6674	1.6851
Education and management	5.506	9	0.000	0.81500	0.4801	1.1499

[a] t: calculated by dividing the mean difference by the standard error of the mean; [b] df: degrees of freedom for the test. For a one-sample T-test, df = n − 1; [c] Mean difference: indicates the variation between the test value and the values of the variables.

Ecological Domains

A one-sample T-test analysis was also performed on ecological domains (Table 4). Since there was only one factor in the domain of ecological networks, no standard deviation was calculated.

The significance of the ecological domains was also less than 0.5, indicating a high significance level between variables in each domain. The mean differences among the domain of ecological landscape design factors were less than those of other domains, indicating very slight variation between them and the test value. Therefore, all domains were in the optimal situation regarding factors (in each domain) and each domain in relation to other domains (Table 5).

The domains with social and ecological sustainability factors for UGS planning were scored with a slight difference (Figure 8). According to the analysis, accessibility in the social sustainability domain and protection in the ecological sustainability domain achieved the highest scores. This suggests that accessibility is an important indicator of people's use of UGS. On the other hand, the protection and preservation of the natural environment in cities can support favourable urban ecology for urban residents, biodiversity, and liveable cities.

Table 4. One-sample T-test statistics for ecological domains.

	N	Mean [a]	Std. Deviation [b]	Std. Error Mean
Ecological landscape design	15	3.9393	0.49138	0.12687
Protection	3	4.4400	0.27221	0.15716
Ecological networks	1 [c]	4.3300	.	.
Biodiversity and vegetation	7	3.9443	0.44996	0.17007
Water resources	3	4.0533	0.31342	0.18095

[a] Mean: average value of the variables in each group (domain); [b] Std. Deviation: standard deviation of the variables; [c]. t cannot be computed because the sum of the case weights is less than or equal to 1.

Table 5. One-sample T-test results for ecological domains.

	Test Value = 3					
	t [a]	df [b]	Significance (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Ecological landscape design	7.404	14	0.000	0.93933	0.6672	1.2114
Protection	8.463	2	0.014	1.33000	0.6538	2.0062
Biodiversity and vegetation	5.552	6	0.001	0.94429	0.5281	1.3604
Water resources	5.821	2	0.028	1.05333	0.2747	1.8319

[a] t: calculated by dividing the mean difference by the standard error of the mean; [b] df: degrees of freedom for the test. For a one-sample T-test, df = n − 1; Mean difference: variation between the test value and the values of the variables.

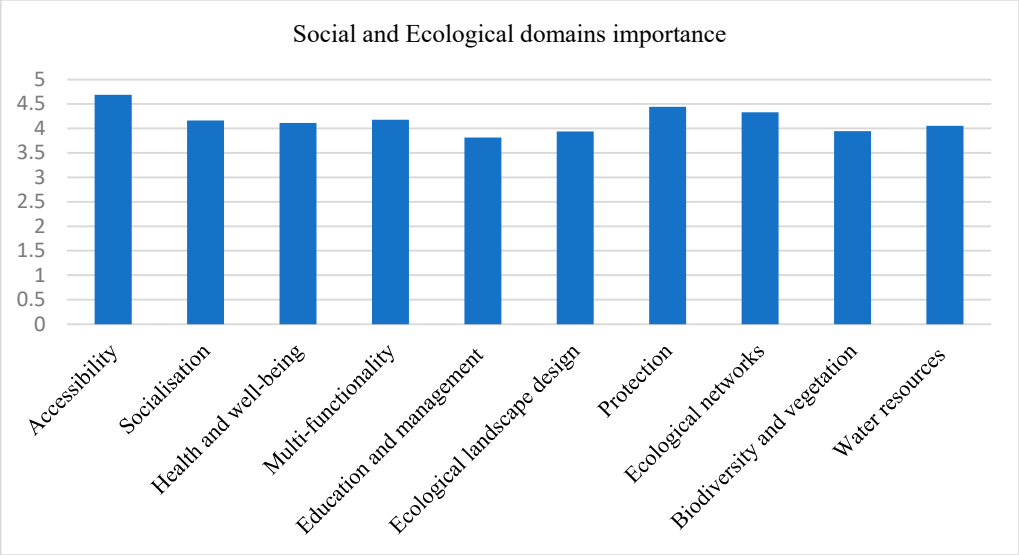

Figure 8. The importance of social and ecological domains.

To understand the mean value of the key factors, descriptive analysis in SPSS was used. As is clear from Figure 9, the factors of proper distribution, walkable access to UGS, and suitability for disabled people had the highest ranks among the key factors.

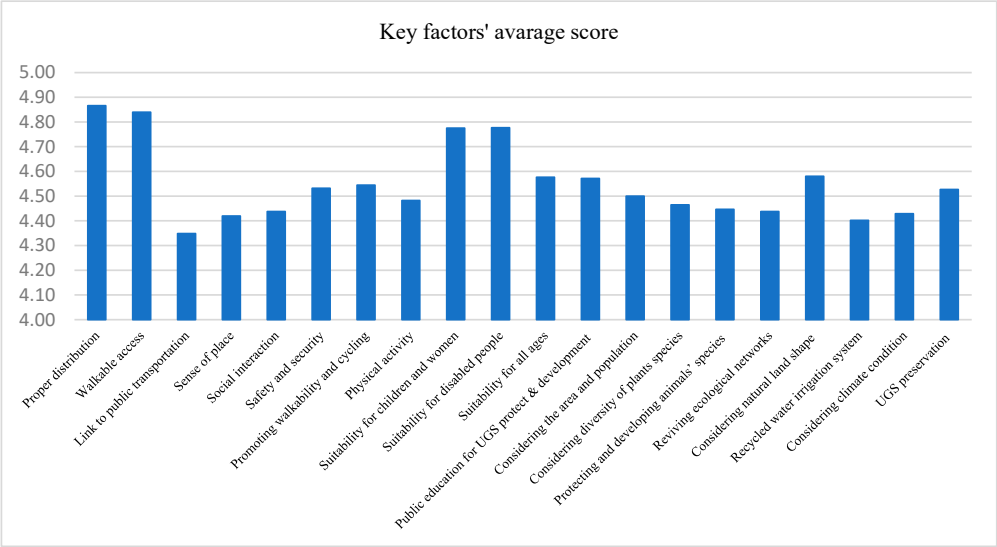

Figure 9. Key affecting factors scores for social and ecological sustainability.

6. Discussion

The challenges of urbanisation need to be addressed through sustainability principles. Nature-based solutions, such as UGS planning, can provide innovative approaches to modify the quantity and quality of public spaces [15] and enhance quality of life in urban areas [26]. However, it is important to understand how UGS can promote urban sustainability and what key factors can help to maximise the ecological and social value of UGS [118]. Such an understanding will help policymakers and planners to implement useful and efficient green spaces in urban areas and promote overall sustainability in the built environment. This study, with a socio-ecological approach, explored how the advantages of UGS can be maximised by identifying the most effective planning factors through an international expert survey. More specifically, it identified the most critical factors that contribute to social and ecological sustainability-oriented UGS planning in cities.

Therefore, due to the impact of UGS on the environmental quality of residential areas, as Zambrano et al. [119] and Mofrad and Ignatieva [120] stated, a socio-ecological approach must be considered to provide new strategies and guidelines to improve UGS quality to attract people. Studying and identifying these variables and incorporating them into UGS planning is vital to promote residential areas' social and ecological sustainability. However, UGS social or ecological sustainability factors and criteria are not exclusive, and they affect each other too.

The findings of this study show that the key UGS planning indicators that can lead to social sustainability in urban areas are (a) accessibility (proper distribution, links to public transportation, and walkable access); (b) socialisation (sense of place and social interactions); (c) education (education of people to protect and develop UGS); (d) health and well-being (safety and security, walkability and cyclability, physical activity, and recreational facilities); and (e) multi-functionality (suitability for all ages, women, children, and disabled people). On the other hand, the most significant UGS indicators that can enhance ecological sustainability in urban areas are: (a) biodiversity and vegetation (diversity of plant species and protecting animal species); (b) ecological networks (organising ecological networks through planning); (c) ecological landscape and design (form and shape in harmony with nature, designing for population and the area of the neighbourhoods or suburbs, and climatic condition); (d) water resources (irrigation with recycled water); and (e) protection (UGS preservation) (Figure 10).

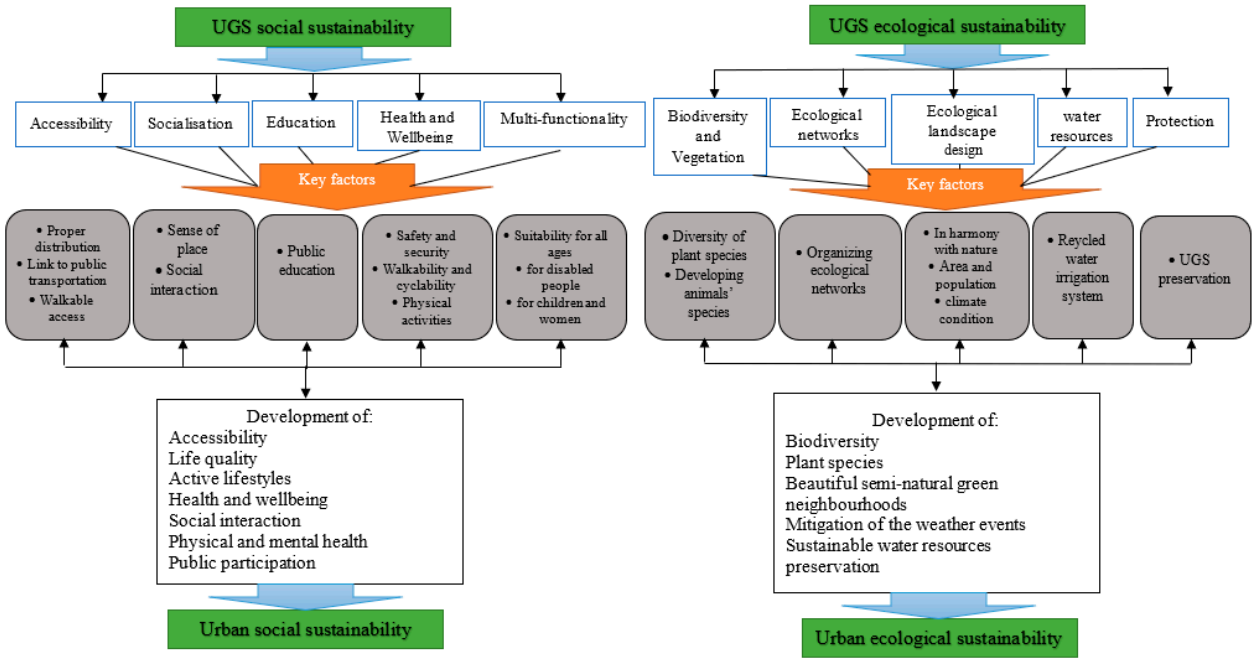

Figure 10. Key affecting factors for social and ecological sustainability.

Considering the above-identified key indicators in urban development and green space planning programs can be useful in many ways. For example, the social value indicators of UGS—including providing easy accessibility and exposure to nature, promoting active lifestyles, social interaction, physical and mental health and well-being, and increasing public participation in urban green space development—can lead to overall social sustainability in cities. Similarly, the ecological value indicators of UGS—including developing and protecting biodiversity and plant species, designing semi-natural green neighbourhoods, mitigating extreme climate effects, sustainable water resource use, and protection and preservation programs—can contribute to overall environmental and ecological sustainability in urban areas.

UGS planning can be a long-term investment. However, creating a successful UGS depends on a multidisciplinary approach and cross-sectoral stakeholder collaborations at all stages, including the planning, designing, and implementation of UGS [2,121]. UGS should be considered as part of the urban planning process and would be most effective when combined with social engagement. The green space action cycle, proposed by the WHO [15], is a good example of the engagement of residents and local communities in the building, promotion, protection, assessment, and management of UGS. Furthermore, it is essential to integrate UGS within local development strategies, such as urban sustainability, biodiversity strategies, climate adaptation, and masterplans to promote the socio-ecological benefits of green areas.

This research faced some limitations when conducting the international experts' survey. The first challenge was the low response rates. Although the authors sent invitation emails to 300 experts, after several follow-ups, only 120 experts responded to the survey. In addition, identifying experts who had practical experience in UGS planning and design in governmental and private organisations and finding their email addresses was impossible. Therefore, the authors decided to identify the academicians in the green space development and sustainability area by studying the relevant publications. Another limitation during surveying international experts was the experiences of the participants regarding UGS development. A proportion of 30% of the respondents had only 1–5 years of experience in UGS research, and over 47% had up to 10 years of experience. While most of the participants had more than 10 years of experience, it can be stated that receiving the younger researchers' ideas did not affect the reliability of the output.

In addition, most of the selected participants were from developed countries and from successful countries regarding UGS planning and development. Therefore, planning UGS based on the key factors identified from the developed countries' academicians' perspective may be better for developing countries. However, the results of this study can be useful for UGS planning in most cities worldwide.

7. Conclusions

Urban green spaces are pivotal in supporting urban ecological and social systems [11]. Proper planning of UGS is one of the urban planning challenges due to its significant role in increasing the health and wellbeing of city dwellers [16], which depends on essential indicators that influence the functions of UGS [122]. This research investigated all influential social and ecological sustainability factors for UGS planning and addressed the most important of them to consider in UGS planning programs to enhance social and environmental sustainability of the urban areas.

The findings indicated that the factors in the domain of accessibility had the highest importance, which indicates the pivotal role of accessibility for people to receive the benefits of UGS. On the other hand, from the ecological sustainability domains, protection received the highest importance. Therefore, there is a significant emphasis for cities to apply protection and preservation programs to protect natural resources, including UGS, to ensure urban sustainability. In addition, the results of the survey indicated a close relationship between all affecting key factors in both the social and ecological domains, which implies considering all the critical factors when planning for UGS in cities systematically.

The existence of nature in cities cannot be in isolation. A suitable connection between nature and people is crucial to maximising the benefits of UGS and developing more liveable and sustainable cities. UGS can increase overall urban sustainability when people can receive positive socio-ecological impacts together. This study can be further improved by investigating and evaluating the critical factors of UGS applied to some real-world case studies. Such research would provide clear and applied insights for researchers and urban planners involved in UGS planning and enhancing urban social and ecological sustainability.

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