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Article

Developing a Qualitative Urban Green Spaces Index Applied to a Mediterranean City

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Abstract: As a primary goal, urban green spaces (UGSs) have been linked to several aspects of inhabitants' wellbeing. Quality could be a way to intervene in the UGS–human health interaction. For that purpose, we developed an urban green space quality index (UGS QIndex) applied to a Mediterranean region, Sousse City. This index was based on a set of criteria, indicators, and elements chosen after bibliographical research related to UGS quality assessment tools and their contribution to the Sustainable Development Goals. Then, we evaluated the quality of the Sousse Ramparts Gardens using the UGS QIndex. In fact, this index includes 41 elements grouped into 23 indicators covering seven thematic criteria: environmental regulating capacity, functional amenities, aesthetic amenities, landscape features, integration in its surroundings, development policy objectives, and space issues. According to the UGS QIndex, Bab El Gharbi garden exceeds Bab El Finga garden in terms of its scenery, aesthetics, and functionality. This index could be used by city planners to improve their UGS's capacity to satisfy the inhabitants' requirements. Otherwise, it needs to be enhanced and tailored to various types of UGSs and then applied to other Mediterranean cities, as well as cities suffering from UGS degradation.

Keywords: urban green spaces; quality; index; wellbeing; Mediterranean

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1. Introduction

In the field of urban planning, the relevance of urban green spaces (UGSs) has been widely discussed [1–3]. Aside from its aesthetic impact, urban green spaces offer recreational activities, as well as a variety of environmental and health benefits [4–6]. UGSs are known for all the green paved, open, and burial places. It is also related to sports fields, private gardens, formal and informal green forests, road verges, derelict land, and horticulture within a city [7,8]. They provide a natural meeting point for the residents and facilitate social interaction, as well as community integration. Moreover, they promote physical activities, as well as mental and psychological relaxation, provide oxygen for breathing, and purify air pollutants [9]. Previous research has demonstrated that growing urbanization threatens both mental health and biodiversity [10,11].

On the one hand, many researchers, such as Macintyre and Ellaway [12], have studied the link between neighborhood features and individual wellbeing. Traditionally, sociological and psychological elements, such as social cohesiveness, social capital, and feeling of the community, have been the focus of their studies. On the other hand, physical neighborhood conditions are increasingly recognized as both sources of stress and resources that might help inhabitants manage them [13]. Subsequently, according to Van Den Berg [14], researchers and politicians have increasingly focused their attention on UGSs as a potentially significant physical neighborhood resource.

UGSs, as public spaces, are important contributions to the resiliency of urban systems as they have a variety of health, physical, and social benefits. They also have ecosystem services, as well as sustainability that help to offset the negative effects of urbanization [11,15,16]. People perceive the feelings and emotions produced in parks and gardens as extremely essential contributions to their wellbeing, according to the findings. Direct advantages include their restoration of psychophysical balance, relaxation, an escape from the daily routine, and a promotion of spiritual connection with nature. All of these emotional and psychological advantages create a significant difference in people's lives [17].

Due to changes in global urbanization, the United Nations (UN) has included sustainable urban development in its recent Sustainable Development Goals (SDGs) agenda [18]. This recent modification addressed the planning and sustainable management of cities that foster inclusive social and economic growth and face climate change [19]. This detailed the creation of multi-modal transportation networks, green spaces, green designs, and sustainable approaches to the utilization of the environment's resources (land, water, etc.) [20].

Thus, UGSs can have an immense impact on the Sustainable Development Goals (SDGs) [21]. Well-managed UGSs can both directly and indirectly help achieve 15 of the 17 SDGs [22]. In consequence, sustainable management, along with the use of UGSs, can be a pragmatic and cost-effective way to achieve the SDGs' benefits [23]. Meanwhile, the quality of green spaces is decreasing, and nature areas are shifting far away from city centers, increasingly alienating inhabitants from nature [24]. According to Van Den Berg et al. [25] and Sugiyama et al. [26], this tendency conflicts with common values of restorative environments, as people prefer relatively natural environments, which they feel offer them psychological restoration and suitable places for physical activity. Urban densification processes and emphasis on the compact city as a model for future cities have created needs within planning to address issues related to the recognition and prioritization of urban green space qualities in the urban fabric [27].

Additionally, parks and gardens have been proven to help people cope with stress by promoting social support. Overall, neighborhood greenery has a direct stress-relieving benefit, but this can be offset via its detrimental influence on social support [28]. According to Littke et al. [29], park areas have a greater beneficial influence on health and wellbeing than the total amount of neighborhood greenery if their effect sizes are likened. Similarly, Fan et al. [28] recommended that policymakers should focus on developing organized green spaces, with public leisure and sociability possibilities instead of merely protecting green areas in the community. In this way, the greening process for health benefits will be more intentional, concentrating on various components of UGSs rather than just providing additional green areas of different aspects of UGSs, and not simply focusing on providing more green spaces [30].

Many recent studies have aimed to identify the aspects of the landscape and environment of UGSs that interact to enable the relationship with health and wellbeing [8,31–33]. For example, Lee et al. [34], in their study, assumed that walking pathways, shade, water features, irrigated lawns, birds, illumination, athletic facilities, playgrounds, the nature of neighboring roadways, and the availability of water were all used to characterize quality. Their study also found that various user groups have varied needs for public open spaces; for example, some people may find water features relaxing and appealing, while parents of small children may consider them to be a safety threat.

In general, park visitors appreciate a mix of biotic, abiotic, and man-made park infrastructure components, as well as attributes. For that reason, Voigt et al. [17] suggested that these three elements of structural variety have an impact on how people utilize and appreciate urban parks. This is why there is a broader link between the streetscape's aesthetics or beauty and particular sorts of activities. Attractiveness was linked to people's walking behavior [35], exercise [36], and leisure [37]. The aspects of quality, absence of annoyance, and decent pathways of a neighborhood's green space have also been linked to increased walking time [38]. Therefore, Chen et al. [39] and Knobel et al. [24] considered that each quality aspect is related to a particular element of the quality tool,

such as the availability of amenities and services, accessibility, safety, or biodiversity. However, recent studies have tended, while developing the UGS assessment tool, to focus on several dimensions (e.g., *accessibility, facilities, amenities, aesthetics*, and *incivilities*), while others are neglected (e.g., *surroundings, activities, policies*, and *vegetal biodiversity*) [40]. As an example, the Public Open Space Tool (POST) [41] only considers green spaces' accessibility, aesthetics, and amenities related to physical activity and recreation. The Natural Environment Scoring Tool (NEST) [42] and urban green space quality assessment tool (RECITAL) [33] include many quality dimensions (surroundings, biodiversity, facilities, amenities, aesthetics, incivilities, safety, etc.) but neglect the policies dimension. Thus, there is a need to conduct a study to develop a comprehensive UGS evaluation multi-dimensional tool that assesses all dimensions equally, including the "Development policy objectives" dimension, and to simultaneously understand the relationship between the SDGs and UGS and its amenities.

The aims of this paper were: (1) to develop and implement an urban green space quality index (UGS QIndex) related to the SDGs, and (2) to apply the tool developed for the city of Sousse (Tunisia) in order to evaluate the quality of the Sousse Ramparts gardens.

2. Materials and Methods

2.1. Study Area

The study area, the municipality of Sousse, which covers an area of 2669 km^2, is situated in the eastern coastal zones at 35° 49′32″ N and 10° 38′28″ E of Tunisia. It includes five boroughs: Sousse Medina, Sousse Khzema, Sousse Sidi Abd Elhamid, Sousse Jawhara, and Sousse Riadh (Figure 1). Sousse is one of the colonial North African cities currently under pressure from both within (densification, destruction and rebuilding, gentrification, pauperization, etc.) and from the areas outside them, where fast urbanization has profoundly changed the environment. The ever-receding or vanishing urban vegetation in many parts of these cities is the consequence of the new connections that the public and decisionmakers retain with this "heritage". Although extensively recognized in the North, where they have been incorporated into public policy, the issues of urban vegetation, particularly in terms of context, quality of life, and ecological services have only recently started to gain attention in cities in southern nations, such as French colonial countries. However, in these cities, which are typically hot and dirty, with a sizeable working-class population, and beset via mismanaged urban expansion, the advantages of plants, sometimes known as ecosystem services, may be more substantial. Although they are uniquely adapted to their social, climatic, environmental, and urban surroundings and problems, the functions (or ecosystem services) of vegetation in the city are still underappreciated in these cities today [43].

The municipality of Sousse benefits from a both stable and mild climate, offering its inhabitants a context that is particularly conducive to living in public spaces. It belongs to the lower semi-arid bioclimatic stage. This implies a low level of precipitation, varying between 200 mm/year and 300 mm/year. In addition, evaporation often exceeds precipitation, which favors short, bushy vegetation strewn with grasses or shrubs [44]. As for temperature, August is the warmest month, with an average of 26 °C, while January is the coldest month, with an average of 11.5 °C. According to Bousemma et al. [45], this city is well known for its diverse cultures and beautiful sceneries, which have boosted tourism. The occupation of the soil is dominated by olive trees, particularly in suburban areas on the outskirts of the city, which are notable for their economic prosperity and scenic landscapes. Indeed, the municipality, which serves as the governorate's capital, has been a recognized "city garden" since December 2009, and, as a result, has several green spaces and green-lined thoroughfares, the distribution of which may be studied.

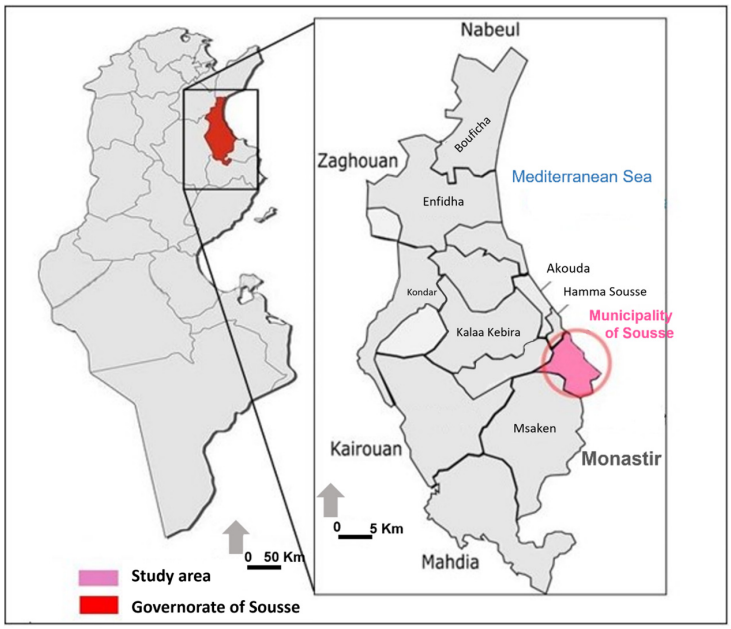

Figure 1. Localization of the study area.

The 1895 French occupation of Sousse resulted in the embellishment of the new European city, with spacious avenues, squares, and tree-lined pathways. Consequently, under the French protectorate, efficient landscape designs enabled the establishment of functional and aesthetic green facilities. Since the 1990s, there has been increasing awareness of the significant contribution that green spaces can make to enhancing living circumstances in the municipality of Sousse. It thus rebuilt the green areas along the Ramparts, Sahloul area, and Erriadh area after the revolution. The lack of monitoring and evaluation are among the biggest challenges in the management of green spaces in Sousse, despite the initiatives that the municipality has taken to preserve its green spaces, resulting in the emergence of the importance of developing a tool to facilitate the UGSs' assessment in terms of quantity and quality.

2.2. Methodology

As the first step, we identified the Sustainable Development Goals related to urban public green spaces and then classified them according to seven thematic criteria. Then, the UGS quality index was developed, as well as the scoring tool. Following this, the UGS QIndex was used to assess the Rampart Gardens in Sousse. Finally, the study areas were visited to assess the aesthetic quality and the other quality tool item, which is a trustworthy manner. In addition to that, we used Google Earth Pro to measure items that should be conducted via remote technique assessments to have an efficient result (Figure 2).

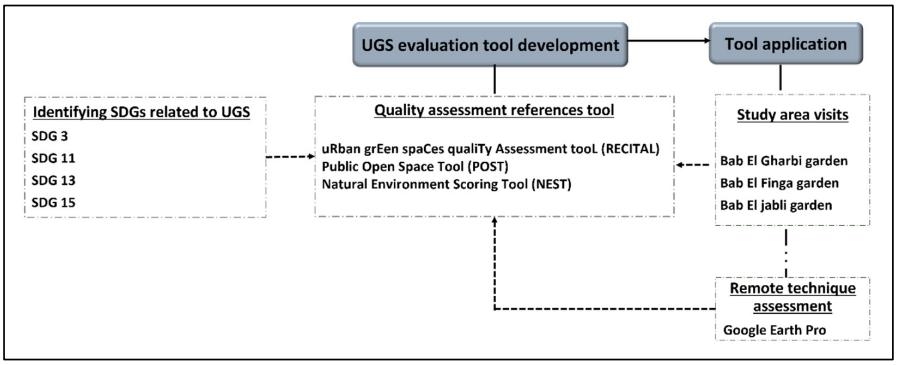

Figure 2. A conceptual framework for research methodology.

2.2.1. Tool Development

Three existing quality assessment tools were selected and used as our primary references for developing the UGS QIndex: Public Open Space Tool (POST) [41], Natural Environment Scoring Tool (NEST) [42], and urban green space quality assessment tool (RECITAL) [33]. Furthermore, as green spaces exhibit a significant impact on the social, environmental, and economic dimensions of sustainable development, which form the basis of the SDGs [18], we took into consideration four goals: SDG 11—sustainable cities and communities, SDG 13—climate action, SDG 15—life on land, and SDG 3—good health and wellbeing [46,47]. These green areas serve as recreational areas regulating the bioclimate, which is its main local role [48].

Based on existing reviews of UGS quality assessment tools by Lee et al. [34] and their contribution to the SDGs, a set of scientifically validated thematic criteria and indicators were selected, with a total of 41 items divided into 23 indicators organized into 7 quality criteria: "Environmental regulating capacity", "Functional amenities", "Aesthetic amenities", "Landscape features", "Space issues" [49], and "Integration in its surroundings" [50]. We added the "Development policy objectives" criteria, which are important, but there is no tool for assessing it (Table 1).

Table 1. Description of the thematic criteria.

Sustainable Development Goal	Thematic Criteria	Description
SDG 13 SDG 15 SDG 11	Environmental regulating capacity	Based on temperature, energy, etc., it depends on the surface area and the physiological state of the vegetation, as well as the plant life composition.
SDG 3 SDG 11	Functional amenities	Corresponds to the different functional facilities in the UGSs (urban furniture, entrances, playgrounds for children, etc.)
SDG 3 SDG 11	Aesthetic amenities	Depends on the beautification and the requalification functions.
SDG 3 SDG 13 SDG 11	Landscape features	Based on the history, economy, and biodiversity of the UGSs.
SDG 3 SDG 11	Integration in its surroundings	Based on the spatial and social integration of the space in its environment (demands of people, the framework of the space, etc.).
SDG 3 SDG 11	Development policy objectives	Corresponds to the planning process about the Sustainable Development Goals and the participatory approach of the inhabitants.
SDG 3 SDG 11	Space issues	Based on the disadvantages of the space, like the existence of quality-of-life offenses, unpleasant smells, dogs, mosquitoes, noise nuisance, etc.

For example, goal 11 of the SDGs refers to urban development, and target 11.7 of goal 11 especially aims to develop urban green spaces. This explains why goal 11 is connected to all the UGS Quality Index's criteria. By giving residents access to areas where they can practice physical activities, target 11.7 will help in achieving SDG 3 [51]. Moreover, all urban green spaces, regardless of kind, help mitigate the effects of climate change. Liu and Shen [52] provided evidence that urban green spaces alter the microclimate and air pollutants that directly cause climate change related to SDG 13 and the "Environmental regulating capacity" criteria. Additionally, urban green spaces offer adequate habitats for species, which helps conserve the local ones [53,54]. This contribution of urban green spaces is related to SDG target 15.5: take immediate and meaningful action to reduce the degradation of habitat and biodiversity loss. The "Functional amenities" and "Aesthetic amenities" criteria enhance residents' physical and mental wellbeing, as well as improve

the quality of life in their neighborhoods. Thus, the contribution of green spaces to reducing mortality and the maternal mortality rate [55] is linked with SDG 3 (Table 1).

2.2.2. Tool Application

We used the UGS QIndex to characterize the quality of the Rampart Gardens, located in the middle east of Sousse in Sousse Medina (Figure 3). The Rampart Gardens, namely Bab El Jabli garden, Bab El Finga garden, and Bab El Gharbi garden, cover an area of 8230 m^2, 3950 m^2, and 6824 m^2, respectively. These French-style gardens, used for commercial activities before the colonization, were maintained and improved in the 2000s and then redeveloped in 2010.

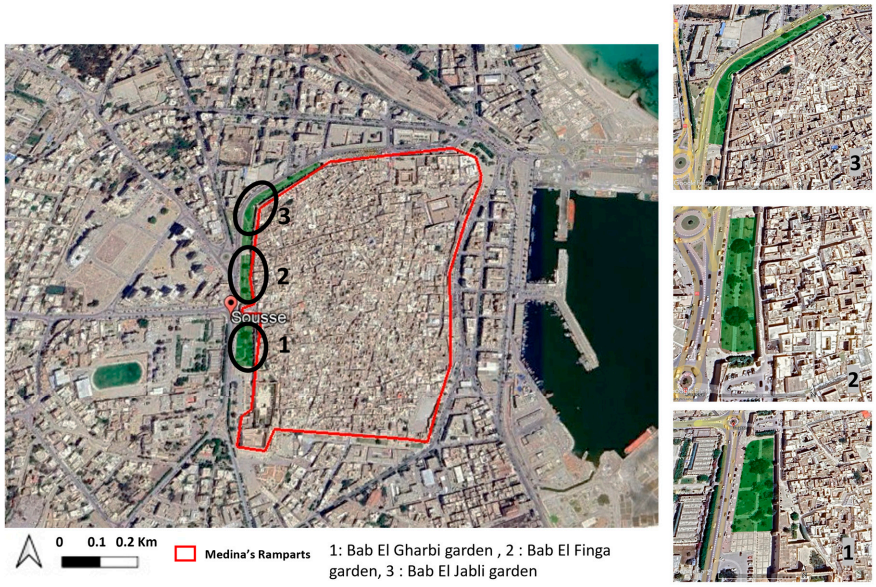

Figure 3. Localization maps of Bab El Gharbi garden, Bab El Finga garden, and Bab El Jabli garden.

A straightforward additive method was applied to determine a coefficient for all the characteristics and items measured. We used the developed index at three different levels: global scores, thematic scores, and scores via indicators. Google Earth Pro software 7.3.6 was used to assess two items, namely tree cover and vegetation cover rate. For the other items, field visits, interviews with public decision makers, and surveys among the inhabitants were carried out, and the archives were consulted.

3. Results

3.1. UGS QIndex Development and Scoring

The UGS QIndex includes seven criteria, namely environmental regulating capacity, functional amenities, aesthetic qualities, landscape features, integration in its surroundings, development policy objectives, and space issues. For the environmental regulating capacity criterion, it is based on temperature, energy, etc. This depends on the surface area and the physiological state of the vegetation, as well as the plant life composition. The functional amenities criterion corresponds to the different functional facilities in the urban green spaces, such as urban furniture, entrances, parking, etc. The integration in its surroundings criterion is based on the spatial and social integration of the space in its environment, including the demands of locals, as well as the framework of the space, etc. The space issues criterion bears on the disadvantages of the space, such as the existence of quality-of-life offenses, unpleasant smells, dogs, mosquitoes, noise pollution, etc.

According to the green spaces' development goal, these criteria might be weighted differently: one for a desired criterion, two for a required criterion, and three for an obligatory criterion for quality development. The weighting of the thematic criteria is only useful for public policymakers when there is a specific development objective to

be achieved. Each criterion may contain a range from one to five indicators. In all, the evaluation tool includes 23 indicators divided into 41 items. Table 1 explains how each criterion was divided into the indicators and items. It also shows the type of scoring for each one. For example, the functional amenities criterion contains five indicators, such as urban furniture development, path layout, entrance layout, security, and multifunctionality. The urban furniture development indicator contains two items, like benches, seats, kiosks, and water protection with their related facilities, which are weighted based on quantity and quality. The path layout indicator includes three items, namely the presence of user tracks, path diversity, and path compliance with width standards.

Each item has its source of information. For example, to find out whether the green space meets the needs of the population or not, surveys must be carried out among the inhabitants. However, in order to know if the space has experienced a striking historical event or not, we must refer to historical documents. Other sources of information exist, such as interviews with decision makers and field visits. For example, benches, seats, kiosks, visibility from ground level, children's play facilities, colors of flowering shrubs, trees, plant beds, public art, and cleanliness, among other items, are evaluated during the field visit. Regarding the embellishment of a neighborhood or city criteria, the information provided regarding the means of access, schedules, activities, differentiated management, etc., is evaluated based on interviews with decision makers (Table 2).

Table 2. Description of the UGS QIndex's items, scoring, and source of information.

Thematic Criterion	Indicators	Items	Type of Scoring	Source of Information
Environmental regulating capacity	Surface area and physiological condition of plant life.	Surface area and physiological condition of the planted surface	Quantity and quality	Remote sensing and/or field visit
	Surface area and physiological condition of tree cover	Surface area and physiological condition of tree cover	Quantity and quality	Remote sensing and/or field visit
	Plant life composition	Number of species	Quantity	Field visit
Functional amenities	Urban furniture development	Benches, seats, and kiosks	Quantity and quality	Field visit
		Water protection and related facilities	Quantity and quality	Field visit
	Path layout	Presence of users' tracks	Reverse quantity	Field visit
		Path diversity	Quantity and quality	Field visit
		Paths comply with width standards	Standard	Field visit
	Entrance layout	Entrance diversity	Quantity and quality	Field visit
		Entrances comply with width standards	Standard	Field visit
	Security	Security guard	Yes/no	Field visit
		Space enclosure	Quantity and quality	Field visit
		Surveillance cameras	Quantity and quality	Field visit
		The lighting of the space	Quantity and quality	Field visit
	Multifunctionality	Children's play facilities	Quantity and quality	Field visit
		Sports facilities	Quantity and quality	Field visit
		An open area for activities (sports, socio-cultural, etc.)	Quantity and quality	Field visit
		Biodiversity conservation facilities (botanical gardens, wild gardens, urban forests, etc.)	Quantity	Field visit

Table 2. *Cont.*

Thematic Criterion	Indicators	Items	Type of Scoring	Source of Information
Aesthetic qualities	Embellishment function	Diversity of vegetation (type, colors, textures, etc.)	Quantity and quality	Field visit Field visit
		Waterpoint	Quantity and quality	Field visit
		Public art	Quantity and quality	Field visit
		Cleanliness	Quantity	Field visit
		Shade	Quantity	Field visit
	Requalification function	Valuation of world heritage or historical element	Yes/no	Field visit
Landscape features	History and heritage	Striking historic event/heritage and/or historical elements	Yes/no	Historical documents
	Past agricultural biodiversity	Vestiges of past agriculture	Quantity and quality	Field visit Historical documents
	Natural biodiversity	Species of pollinators	Quantity and quality	Field visit
	Socio-economic interest	Private services with an economic interest	Quantity and quality	Field visit
	Atmospheres of the space	Special atmosphere or several types of atmospheres	Quantity	Field visit
		Topography (hill/gutter/slope lowering or raising an artificial surface)	Yes/no	Field visit
Integration in its surroundings	Connection of the space with its surroundings	Linear connections with the outside	Quantity and quality	Field visit
	Visibility of the space	Surrounded by primary or secondary pathways	Quantity	Field visit
		Guidance signs	Quantity and quality	Field visit
	The functionality of the space	Meeting the needs of the population	Quantity	Surveys among the inhabitants
		People feel at home in the space	Yes/no	Surveys among the inhabitants
Development policy objectives	Planning and sustainable development	Development objectives included in the Sustainable Development Goals	Yes/no	Interviews with public decision makers
	Participatory approach in urban design	Surveys and comments/ meetings with residents/ field observations	Yes/o	Interviews with public decision makers
	Provision of information related to the project carried out	Information provided about means of access, schedules, and activities	Yes/no	Interviews with public decision makers
Space issues	Quality-of-life offenses	Vandalism	Reverse quantity	Interviews with public decision makers/field visit
		Drug use/alcohol use/sexual activity	Reverse quantity	Interviews with public decision makers
	Other drawbacks	Unpleasant odors/noise pollution/visual impact/harmful plants (toxic, allergenic, etc.)	Reverse quantity	Field visit

The tool weighting was based on a percentage scale (0%, 25%, 50%, 75%, and 100%). With the various scoring systems, we established a guideline that included all the item types (Table 3). Quantity scoring evaluates things whose significance is contingent on their existence, such as the number of species. In this situation, reversed quantity evaluates things whose importance is determined by their existence. However, in this case, less presence was preferable (e.g., unpleasant odors or noise). Quality type, on the other hand, refers to objects whose use is determined via their level of upkeep and visual appeal, such

as the physiological condition or visibility of planted areas. The yes/no question scoring type is for questions that must be answered with yes or no, such as the presence of historical elements and differentiated management. As for the standard scoring type, this evaluates aspects where the standards have not been met, almost not met, somewhat met, mostly met, or met. For example, the entrances comply with width standards, while the paths comply with width standards items. Regarding coverage scoring type, the evaluated items were quantitative, such as planted surface area and tree cover surface area. UGS QIndex data may be used at four different levels: single-item scores, scores by indicators, thematic scores, and global scores.

Table 3. Guidelines for scoring the UGS QIndex items.

	0%	25%	50%	75%	100%
Quantity	No presence	Almost no presence	Somewhat present	Mostly present	Sufficiently present
Reverse quantity	Very present	Mostly present	Somewhat present	Almost no presence	No presence at all
Quality	Bad	Poorly maintained and aesthetically unpleasant	Poorly maintained or aesthetically unpleasant	Well-maintained and aesthetically pleasing	Exceptionally well maintained and aesthetically pleasing
Quantity and quality	Not present	Not fit for purpose	Suitable but in need of repair or insufficient quantity	Suitable and sufficient	Suitable, sufficient, and aesthetically pleasing
Standard	Not met	Almost not met	Somewhat met	Mostly met	Met
Yes/no	No	----------	----------	----------	Yes
Coverage rate	5% or less	From 5% to 25%	From 25% to 50%	From 50% to 75%	75% and above

3.2. Rampart Gardens Assessment with the UGS QIndex

The results show that the three gardens, which share the same history as the first green spaces during the colonial period, are of "good quality", as the total score was above 50%. Bab El Gharbi gardens reported the best score for several aesthetic and functional reasons. According to field observations, it is the most frequented space of the three gardens. However, more precisely, they have a different score for each criterion. It shows the weaknesses of each area according to the criteria, which led to the development of guidelines to improve the area as a whole and particularly its weaknesses. Table 4 shows that the Bab El Gharbi garden has a higher environmental regulation capacity than the other two gardens, with a score of about 78%. It also has more aesthetic appeal (76%) and few disadvantages (83.75%). Bab El Finga garden is a space with a strong landscape character (34.37%) compared to Bab El Gharbi garden (26.87%) and Bab El Jabli garden (30.62%). Regarding the other criteria, the Rampart Gardens had the same score regarding the integration in its surroundings (62%) and development policies objectives (60%) items.

Table 4. Rampart Gardens' thematic evaluation in Sousse, 2021.

Thematic Criteria	Bab El Jabli Garden	Bab El Finga Garden	Bab El Gharbi Garden
Environmental regulating capacity	58.75	73.75	78.12
Functional amenities	51.62	65	65
Aesthetic qualities	61.62	70.62	75.62
Landscape features	30.62	34.37	26.87
Integration in its surroundings	62	62	62
Development policy objectives	60	60	60
Space issues	79.37	83.75	83.75

To uncover more details, an evaluation of the three gardens, based on the indicators, was carried out. Figure 4 shows that the Bab El Jabli and Bab El Gharbi gardens have a higher plant life surface area and better physiological condition (75%) than that of Bab El Finga (62.5%). However, the tree cover physiological conditions of the Bab El Finga and Beb El Gharbi gardens (62.5%) were much better than Bab El Jabli's (50%). The Bab El Finga garden's floristic composition was more heterogeneous (100%) than that of the Bab El Gharbi garden (70%). Regarding the Bab El Jabli garden, its floristic composition is somewhat homogeneous (50%). As a result, the sanitary condition of plant life and tree cover should be improved. As illustrated in Figure 5, the urban furniture development score of Bab El Gharbi garden (60%) is much better than the other gardens. The Bab El Gharbi garden has much better-quality street furniture. The three gardens' paths and entrance layout are in good condition, sufficient, and varied. The Rampart Gardens are not very safe and protected (40%). They are not protected by a security guard, nor equipped with cameras. The three spaces are not multifunctional, with a score of 30% for the Bab El Finga and Bab El Jabli gardens and 37.5% for the Bab El Gharbi garden. Indeed, these gardens lack facilities for sports and children's play. Bab El Jabli garden's function of aesthetics was not fulfilled (22.5%), since the vegetation was not varied in terms of color and texture, nor was there any shade along the pathway. However, the other two gardens responded moderately to the function of embellishment (Figure 6).

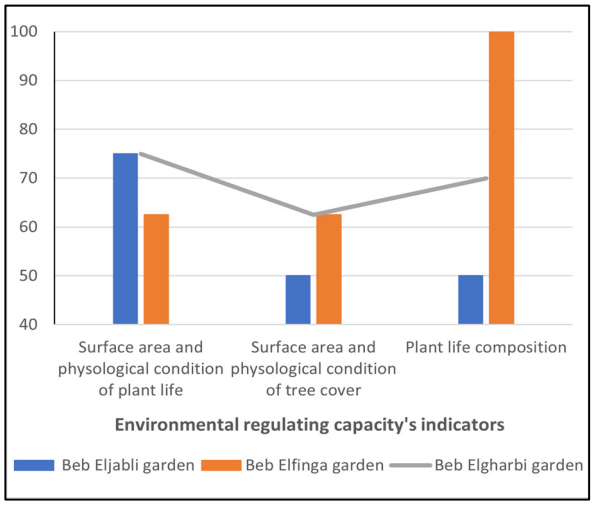

Figure 4. Environmental regulating capacity' indicators' evaluation of the Rampart Gardens in Sousse, 2021.

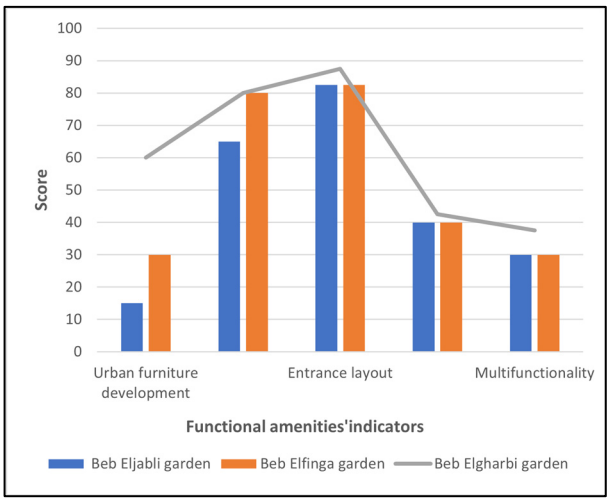

Figure 5. Functional amenities' indicators' evaluation of the Rampart Gardens in Sousse, 2021.

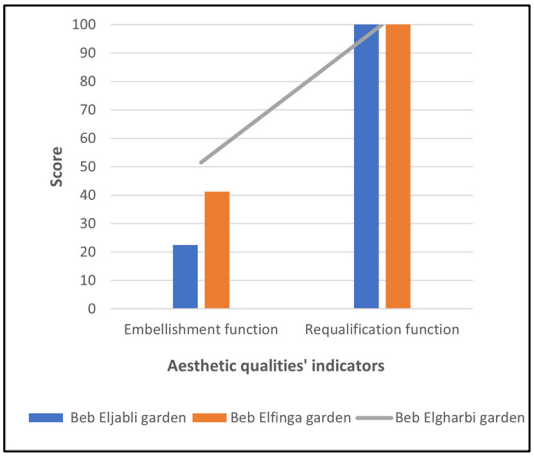

Figure 6. Aesthetic qualities' indicators' evaluation of the Rampart Gardens in Sousse, 2021.

The score of the history and heritage indicator of the three gardens was 100%. The Rampart Gardens have a significant history since the pre-colonial period, being, in the past, a space where the cattle market is held every Sunday. In addition, these gardens aim to enhance a world heritage site, which is the ramparts of the medina (Figure 7). On the other hand, there are no vestiges of past agriculture (e.g., olive trees and eucalyptus) (0%), nor species of melliferous interest (0%), that do not offer private services of any economic interest (0%). Bab El Finga has the best atmosphere among the three gardens, with a score of 62.5%. In contrast, Bab El Gharbi has the worst atmosphere among the three gardens, with a score of 12.5%. Bab El Finga garden has a unique ambiance due to its topography, unlike Bab El Gharbi, which lacks any atmosphere.

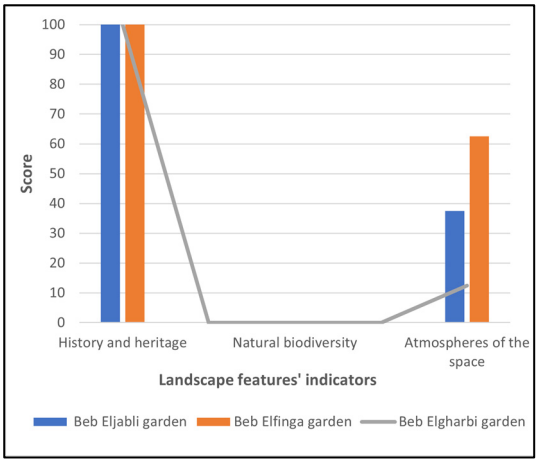

Figure 7. Landscape features' indicators' evaluation of the Rampart Gardens in Sousse, 2021.

Figure 8 shows that the three gardens have linear connections with the outside environment (100%). Being located on main roads, their visibility is good (90%). However, it seems that the inhabitants' requirements are not fulfilled in these areas (12.5%). According to Figure 9, the Rampart Gardens' development goals do not align with the Sustainable Development Goals (0%). After meeting with representatives from the municipality of Sousse, we found that observations and interviews with residents had been conducted before the development of these areas (100%). Sources of information on the three spaces are available to city inhabitants (85%), as their development comprises the objectives to attract tourists and residents to visit the Medina. As can be noticed in Figure 10, the gardens are safe, where the practice of drugs or sex, for example, is absent, with a quality-of-life offenses reverse score equal to 93.75%. On the other hand, we noticed the presence of some

unpleasant smells, noise, and visual nuisances (70%). In the future, it is advised that some actions must be made, including improving the quality and quantity of the street furniture, adding other amenities (such as sports fields and playgrounds) to create multifunctional areas, and increasing the area's security. The UGS QIndex is extremely useful, since it allows users to extract data at four different levels: a top-level overview, a second-level look at the thematic criteria, a third-level look at the indicators for each criterion, and finally a fourth-level look at the indicator elements. However, this tool must be applied to other UGSs of different sizes and functions to measure the reliability and effectiveness of the tool.

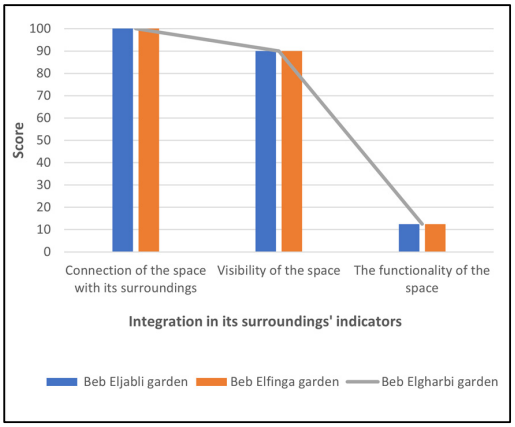

Figure 8. Integration in its surroundings' indicators' evaluation of the Rampart Gardens in Sousse, 2021.

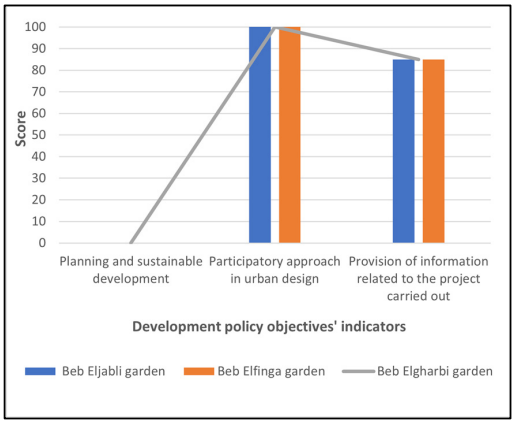

Figure 9. Development policy objectives' indicators' evaluation of the Rampart Gardens in Sousse, 2021.

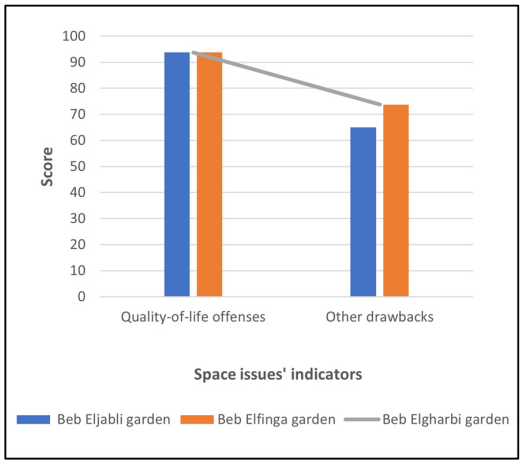

Figure 10. Space issues' indicators' evaluation of the Rampart Gardens in Sousse, 2021.

4. Discussion

The UGS QIndex was introduced and developed as a striking multidimensional instrument for measuring various quality aspects of UGSs that are important for the urban residents' wellbeing. In terms of the number of aspects and items assessed, the UGS QIndex's components are more detailed in this study compared to others mentioned in different studies [17,33,45]. It includes 23 indicators divided into 41 items. The single-item ratings of the tool could give information that can be used to directly target the characteristics of UGSs interacting with human health. It was used to assess the Rampart Gardens of Sousse, whose surface area does not exceed 9000 m^2. The findings show that Bab El Jabli garden meets its environmental regulation, aesthetic qualities, and development policy objectives. It integrates into the surroundings, but with far less aesthetic and functional design criteria. When comparing the Bab El Finga and Bab El Gharbi gardens, the latter exceeds the other in terms of scenery, aesthetics, and functionality. Based on these results, we recommend that the municipality's green space department focus on the problem of these spaces to ensure better-quality UGSs in Sousse City. The purpose is to evaluate the quality of the city's green spaces, identify their weaknesses to improve them, and monitor their long-term condition.

Over time, the number of tools available has increased. Several large studies needed a multidimensional evaluation instrument for urban green areas; hence, they created their own, suited to their needs and resources, for example, RECITAL, POST, EARPS, and BRAT-DO [33,56–58]. However, future works should focus on the reliability of the tool and its items. According to Knobel et al. [33], the assessment of quality items is very sensitive and exposed to subjectivity, for example, aesthetic aspects, as well as quality-of-life offenses. The existing quality-of-life offense items serve as a proxy for specific undesirable behaviors (e.g., vandalism, drug use, or sex work). While it is difficult to be uniformly objective, these acts and the aesthetic items could be more objectively measured and help to mitigate their impact. The use of clear and concise definitions is required for the tool's validity, comparability, and replicability, as it creates a shared foundation from which to operate [40]. Thus, we have defined the UGS QIndex, which was created for assessing urban parks and gardens. However, it must be adjusted to be applied to other types of green spaces such as public squares and green spaces around buildings.

The UGS QIndex combines structural measures (functional and aesthetical amenities), biodiversity measures (tree cover, planted area, and number of species), and social measures (history, geography, and policies), which allows for a richer characterization of quality. Indeed, the survey conducted with the residents in parallel to assess their perceptions and the aspects of the UGSs that are essential to them adds value to our research. It has been used to improve the measurement of some items, such as the physiological condition of plant life, space multifunctionality, meeting the needs of the population, etc. The development of a green space quality index is important for policymakers to monitor the condition and evolution of UGSs.

The high-quality data provided via the UGS QIndex can help public health researchers better understand the link between urban green spaces and human wellbeing through the index quality and its link with the SDGs. This would allow for urban planners and policymakers to tweak the UGSs in their cities to meet their SDGs and the needs of the target population. However, the use of a parallel evaluation approach, such as in situ repeated observation assessments through fieldworker training, is necessary for further studies on the tool's reliability [59]. The lower size used for the tool's application was chosen for practical reasons not related to the tool's capabilities. The tool can be used with larger and smaller sizes. However, some items should be adjusted to be applied to different types of UGSs such as squares. For example, assessing biodiversity-related items, such as "Surface area and physiological condition of tree cover", can be complicated for non-expert fieldworkers. We suggest conducting a workshop to train the technicians on how to utilize this tool. The tool was designed to be applied in other Mediterranean countries, particularly the Maghreb countries, but its items and scores may be adjusted

to fit diverse contexts and the SDGs. Using this tool with its detailed information, urban planners, and policymakers might be able to support and encourage the management of UGSs towards achieving Agenda 2020. The findings of this study will help promote the conservation and development of UGSs in rapidly developing Northeast Africa, as well as the management and uses of UGSs.

5. Conclusions

The UGS QIndex is a multidimensional instrument assessing several quality features of UGSs that are significant to urban residents' health. It has forty-one elements grouped into seven thematic criteria. In today's increasingly diverse population, UGSs must cater to a wide range of needs and demands. Therefore, it must be planned accordingly. Thus, this tool's aims include assessing the quality of the city green areas, identifying their shortcomings so they may be improved, and keeping track of their long-term maintenance. As the findings suggest, several features of green spaces are contributing to the use of these spaces, such as biotic and abiotic features, as well relaxation facilities, security, and/tranquility. Our study has focused on three elements which are different from the recent studies: (i) we have refined and detailed definitions, such as the definition of urban green spaces, adapted to Maghreb countries. It is necessary for the comparability and replicability of the tool; (ii) by adding the policy dimension, we increased the comprehensiveness of the tool. All the tools that have been constructed have focused on the dimension, description, item, and type of scoring. We have added important information, which is the "source of information" of each item, (iii) and we have considered the SDGs when developing our tool so that urban planners and policymakers can better meet the needs of the citizens and achieve the SDGs, contributing to a sustainable city. Having such detailed information about the UGSs' features and characteristics via many different quality dimensions will enable us to better understand the importance of the quality aspect. It can be used by urban planners and policymakers to enhance their UGS's ability to better meet their inhabitants' needs and according to the SDGs. This tool can also be used to study other aspects of the UGSs, such as urban vegetation management or spatial disparity in the management of green areas. The UGS QIndex was created to fit the features of the Tunisian and Maghreb cities, but its items and scoring may be tweaked to fit different environments and the SDGs. After applying the tool for the different types of UGSs, researchers will be able to estimate the value of each item and tailor them to various goals. We acknowledge a few limitations, which were mostly for practical reasons. First, only one type of green space was evaluated. Thus, further applications of this tool on other UGS types must be conducted. Second, the technicians, with the help of experts, must be trained before using the tool, especially when assessing biodiversity-related items. This tool fit the Maghreb cities. Therefore, we suggest applying this tool on other cities (e.g., Alger, Morrocco) and consider other UGS types.

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