Identification and assessment of the driving forces for the use of urban green parks and their accessibility in Colombo, Sri Lanka, through analytical hierarchical processing

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Abstract

Urban green parks perform a remarkable role for the physical, social and psychological wellbeing of the urban public by providing space for relaxation and recreation, directly influencing public health through mitigation of the urban heat impact, noise reduction and moderation of air and water pollution. An indicator-based approach on analytical hierarchical processing was used to identify and assess the driving forces for the utilization of urban green parks and their accessibility. Eight indicators: location, topography and geography, facility and services, safety and security, social and culture, ecology, demography, and weather and climate (further divided into 50 factors) were used in the study. Data were collected through a questionnaire survey in which 887 regular park users participated. A standardized study design was implemented to study and assess four urban green parks in the Colombo metropolitan district, Sri Lanka. The study identified park facilities and services as well as safety and security measures maintained by the park as the key factors of appeal, while location, ecology, topography and geography, including weather and climate, had a lower relative influence when selecting a park for recreation. Social, cultural and demographic factors appeared to be of the least interest. The study recommends park managers to assess their parks using this model to enhance the characteristics found to be the most important. It further suggests developing models also for other park types by considering which factors would have the highest relative influence in providing a better service for the regular park user.

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Introduction

As a result of rapid population growth and transition from rural to economical and industrial areas of development, urban expansion is widespread, specially, in the metropolitan areas of developing countries (Shi *et al.*, 2009; Abubakr and Pradhan, 2016). This can be taken as a positive initiative (Fan, 1999), since people can afford more opportunities and resources to improve the standard of living in cities than they can in a village (Poyil and Misra, 2015). Urban expansion is, however, often associated with unplanned, uncoordinated and uncontrolled change (Noor and Rosni, 2013) and the intensified pressure on resources and natural environment influence the city space negatively (Dadras *et al.*, 2015), particularly when the cities expand into the adjoining rural areas (Hegazy and Kaloop, 2015). From an economic perspective, population growth and rise in income lead to increased land values and residents therefore seek less expensive options in suburban and ex-urban areas (Pendall, 1999). As a result, urban areas and suburbs experience a remarkable reduction of size and quality of green spaces, eventually leading to an ecological imbalance.

Green spaces play a vital role in maintaining human physical, social and psychological wellbeing (De Ridder, 2003; Berg *et al.*, 2010, Arabi *et al.*, 2014) by mitigating the urban heat island effect as well as air and water pollution (Jennings *et al.*, 2016) and also noise. There is a close relationship between public health and the quality of green spaces (Berg *et al.*, 2010) and urban parks perform a big role for recuperation. They also play a role for the local economy by generating revenues for municipal councils and increase property values by providing an aesthetic and pleasant environment. The general public uses urban green parks for various purposes, such as rest, leisure or physical training. However, papers by Gilbert (1989) and Uy and Nakagoshi (2008) both mention that physical parameters such as size, shape and diversity within parks influence green-space functions. Availability of, and accessibility to, green parks are dimensions that can be used to assess the ecological sustainability of a city and spatial standards have been introduced by various organizations. United Nations, European Union and World Health Organization suggest that 30 m^2, 26 m^2 and 9 m^2, respectively, be kept as green space per capita in a city (Khalil, 2014), while the National Recreation and Park Association in the United States says that at least 0.41 km^2 park space should be allocated per 1,000 people (Nicholls, 2001). The Six Acre Standard defined by the UK National Playing Fields Association argues that 0.24 km^2 space is needed to be maintained as an open area per 1,000 residents (Nicholls, 2001). Herzele and Wiedemann (2003) stated that urban parks should be located within a distance of 400 m (5 min walking distance) from people's residences. Handley *et al.* (2003) mention that residents should live in areas no further than 300 m away from natural green spaces of at least 0.02 km^2 in size and that at least 0.01 km^2 of natural space per 1,000 urban residents should be provided.

The pattern with respect to the use of, and accessibility to, urban parks has been considered taking different aspects into account. Herzele and Wiedemann (2003) used an indicator-based geographical information systems (GIS) approach to study the urban public's interest in parks in Belgium, while Nicholls (2001) prioritised accessibility and equity leading to a management system for leisure. Cho *et al.* (2008) attempted to identify the amenity value of open spaces with Ordinary Least Squares and regression analysis considering quantitative parameters (size and proximity) and qualitative parameters (spatial configuration). The usage pattern of urban parks by different ethnic categories has been analyzed (Comber *et al.*, 2008) and a GIS-based regression analysis applied to understand the spatial distribution of, and accessibility to, urban parks in Switzerland (Germann-Chiari and Seeland, 2004). Meanwhile, Rosa (2014) has proposed an indicator-based approach with simple distance and proximity components to evaluate the accessibility of the general public to urban parks. Based on the results of network analysis, it can be argued the vital role of availability of data and resources in modelling the accessibility (Rosa, 2014).

Regrettably, as pointed out by Wolch *et al.* (2014), city parks are not always distributed consistently and equitably. In areas where low- income people live, the number of parks is inadequate with limited facilities, while the situation is the opposite where rich people live. Wolch *et al.* (2014) stated that this well-known, worldwide scenario is an environmental injustice. Generally, accessibility is totally dependent on various technical, social and cultural factors. According to Rosa (2014), accessibility has to do with environmental justice and that it represents a flexible concept with different interests and different public categories. The appeal of green parks is governed by proximity (or access by transport), availability of facilities, safety and security, quality of space, social interactions and privacy (Masnavi, 2000; Moirongo, 2002; Herzele and Wiedemann, 2003; Abubakar and Aina, 2006). Therefore, the usage of parks need to be promoted by guaranteeing space for sports, walking paths, wooded areas and play areas for children (McCormack *et al.*, 2010). Kaczynski and Henderson (2007) emphasize that the distance from residency to park is inversely proportionate to its regular usage. Further, according to McCormack *et al.* (2010), use and accessibility is significantly dependent on the general physical and mental health situation of the public. Therefore, anybody involved with park planning and management must consider and learn to understand the proper use of parks by the general public as well as what the limits of accessibility are.

Compared with other countries, the use of urban parks by the general public in Sri Lanka is commonly limited due to low-income levels, busy life, few available park facilities and petty crime. The land tenure system practiced plays an important role which has led to the tradition of living in separate family houses, even in Colombo and suburbs, where they maintain small residential gardens of their own. However, there is currently a trend to change the land tenure pattern by introducing tall buildings with many apartments in order to get more land for commercial and industrial activities. As a result, the use of parks is increasing and it is suggested to maintain urban parks at accessible distances. However, the present scenario of available parks in the city needs to be analyzed. The present study was initiated to introduce an indicator-based approach that could identify and assess the driving forces for usage and accessibility of urban parks leading to a park management system ultimately supporting the physical and mental health of urban residents. The specific objectives of the study were to analyze the physical, social, cultural and environmental parameters of urban parks with the ulterior motive of finding out how to grant all city residents access to areas for relaxation, rest and leisure as well as safety and security.

Materials and Methods

Study site

Colombo City is the main industrial, commercial and economical hub of the country and its metropolitan area is responsible for more than 80% of industrial output and 50% of the Gross Domestic Product of the country (Subasinghe *et al.*, 2016). The residential population of Colombo was 0.55 million in 2012 (Department of Census and Statistics of Sri Lanka, 2012) with a growth rate of 1.1% according to world development indicators of the World Bank in 2017 with a *floating population* of approximately 0.5 million (Department of Census and Statistics of Sri Lanka, 2012). The city area covers 37.29 km^2 in size.

The locations of available parks in Colombo City and suburbs were identified using existing maps and digital data layers at the scale 1:10,000 produced by the Survey Department of Sri Lanka, the national mapping agency. Four main, well-known urban parks: Viharamahadevi Park in the Colombo metropolitan area, Diyatha Uyana amusement park in Baththaramulla, Bellanvila urban park in Boralesgamuwa and Seethawaka Wet Zone botanical garden in Labugama were selected for the case study. Among them, Seethawaka Park is situated just outside Colombo main City, while Diyatha Uyana and Bellanvila parks are situated closer to the city centre (Figure 1).

Data collection

Two types of data were used, locations and attributes, where the latter represent the characteristics of the selected urban parks. Information on the parks was collected from existing maps, Google Earth images, individual site plans, field investigations and discussions with park users and park administrations. The site plans were available as large-scale surveyed plans with contours under the operation of the Urban Development Authority of Sri Lanka, the governmental organization for urban planning and administration. Important buildings and places nearby such as government and private offices, famous temples and other places were identified using these maps and images. Past records on temperature, humidity, air pollution and noise were obtained from the Meteorological Department of Sri Lanka, while the Disaster Management Centre of Sri Lanka was contacted for data on weather patterns of the study areas and disaster occurrences. The characteristics of the four parks selected for the study are summarized in Table 1.

Methodological approach

The relative importance, generally referred to as weights of indicators and factors utilized to assess the use of, and ease of accessibility to, urban parks, was determined by the analytical hierarchical process (AHP) technique, which consists of three steps: development of the hierarchical tree structure, pair-wise comparison analysis and development of a pair-wise matrix (Nonis *et al.*, 2007). Data related to the use of the parks were collected through a questionnaire survey in which 887 regular park users participated. In selecting participants for the survey at different time intervals, firstly, their gender, age, education level, occupation and the time of usage were ascertained in order to get unbiased results (Table A1 in the Appendix).

The use of, and accessibility to, the parks were modelled based on the eight indicators shown in Figure 2, which also includes different types of factors used to define these indicators. A semi-structured questionnaire was designed to guide the participants to deliver their opinions according to the hierarchical model. To that end, a pair-wise matrix based on the 9-degree Likert scale (Caklovic and Radas, 2014) was prepared considering two criteria at a time comparing their relative importance as shown in Table A2 (in the Appendix). The indicators were arranged as a multilevel decision structure, in which the views of the participants were used to arrange the indicators according to priority. The relative importance of each pair of indicators was determined as seen in Figure 3 with Level 2 of the tree structure developed further producing 50 separate factors that were given rank values according to the views expressed in the survey, in turn producing the final influence of each indicator (Table 2).

The relative influence of factors and ranks shown in Table 2 determined the value of each indicator, the computation of which is shown in Figure 4 using the topography and geography indicator as an example.

Separate indicator values were calculated from the individual influences of indicators as shown in Eq. 1. The Use and Accessibility indices of the parks were determined from the values of indicators and their relative importance using Eq. 2.

$$\text{Indicator value} = \sum \text{Value of the factor} \times \text{Relative Importance} \quad \text{Eq. 1}$$

$$\text{Use and Accessibility Index} = \sum \text{Indicator value} \times \text{Relative Importance} \quad \text{Eq. 2}$$

The pair-wise comparison matrices were produced to determine the relative importance of the factors for each indicator was based on the results obtained from the questionnaires using the minority rule where the minority abides by the majority. For example, the facility and services indicator (consisting of 14 factors) was obtained by the matrix shown in Table 3 (the numbers of the

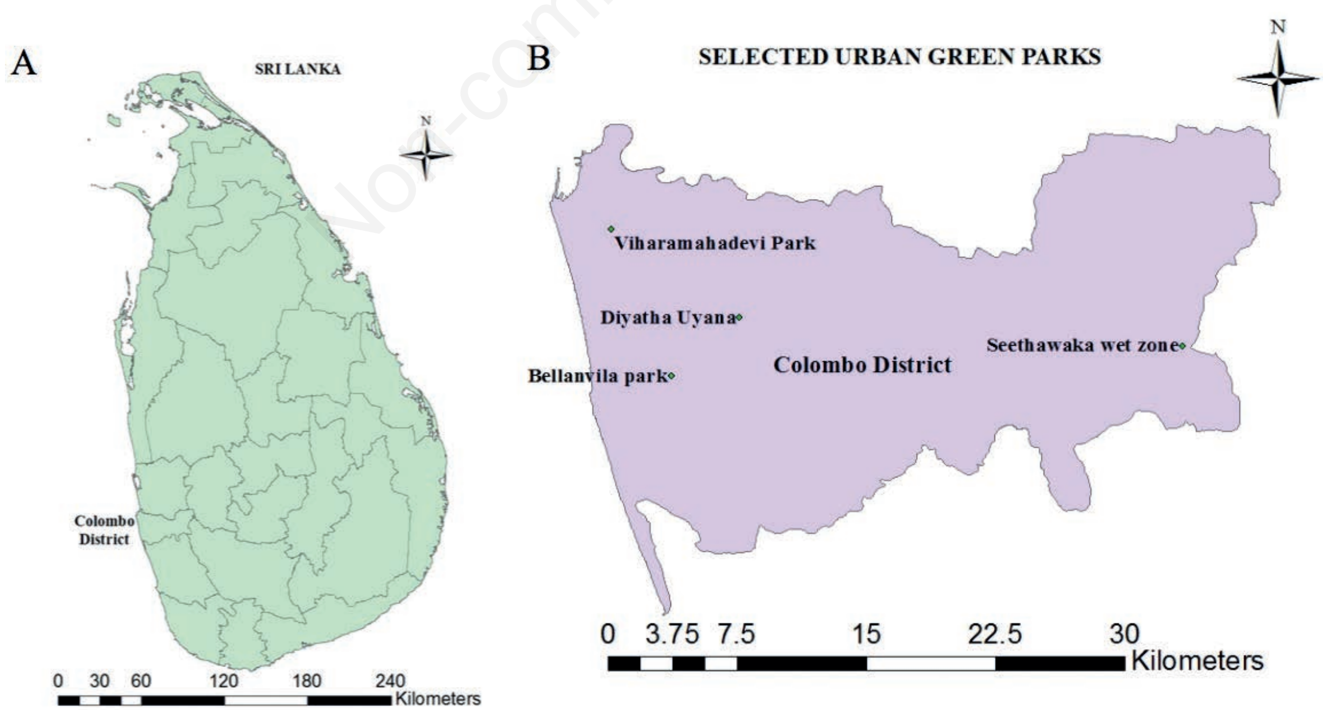

Figure 1. Colombo City (A) shown with its place in Sri Lanka (B).

Table 1. Characteristics of the four parks studied.

Factor	Unit	Viharamahadevi Park	Diyatha Uyana	Bellanvila Park	Seethawaka Park
1. Sport activities	No.	12	17	18	6
2. Walking paths	m	2300	1800	1600	2500
3. Bicycle paths	m	400	600	1500	200
4. Toilets	No.	12	10	8	8
5. Water fountains	No.	18	24	25	12
6. Rubbish bins	No.	25	40	43	24
7. Tuck shops	No.	4	29	23	3
8. Picnic tables and chairs	No.	54	148	120	20
9. Light posts	No.	12	54	48	18
10. Parking spaces	No.	120	400	240	50
11. Information boards	No.	21	43	40	16
12. Cleanliness/maintenance	No.	Not bad	Very good	Very good	Good
13. Maintenance workers	No.	40	50	40	12
14. Meeting areas	m2	1000	1200	800	800
15. Entrance limitations	No.	0	2	2	4
16. Security officers	No.	5	15	12	4
17. Street children	No.	100	0	0	0
18. Park fencing	%	0	25	35	75
19. Violence events/week	No.	10	1	2	0
20. Harassments/week	No.	4	0	1	0
21. Park accidents	No.	1	0	0	0
22. Pets allowed	No.	No	Yes	No	No
23. Homeless dogs	No.	20	0	0	2
24. Thefts per week	No.	3	1	0	1
25. Important places	No.	14	12	8	2
26. Distance by main road	m	5	10	12	250
27. Distance to park	Min.	1	2	2	10
28. Distance to next park	km	5	5	8	25
29. Public transportation		Abundant	Abundant	Abundant	Rare
30. Distance to city centre	km	0.1	0.5	0.5	12
31. Topography (flat areas)	%	100	100	100	50
32. Size	km2	5	2	2	8
33. Shape		Broad	Broad	Broad	Broad
34. Daily average no. of visitors	No.	200	600	400	14
35. Average time spent in park	Hour	1	2	2	3
36. Shaded area	%	40	20	15	75
37. Water area	%	5	30	15	25
38. Wooded area	%	0	20	5	45
39. Noise level	dB	65	60	60	5
40. Air pollution (SO_2)	ppm	35	34	36	8
41. Air pollution (NO_2)	ppm	45	42	23	6
42. Biodiversity (animals)	No.	<15	15-30	<25	>60
43. Biodiversity (trees)	No.	<50	>100	>100	>200
44. Ethnic groups		Equal	Equal	Equal	Biased
45. Gender		Equal	Equal	Equal	Equal
46.Average annual temperature	°C	28	27	27	25
47. Rainy days	Day	58	65	59	122
48. Average rainfall	mm	2000	2000	1800	2400
49. Average rel. humidity-day	%	85	75	75	50
50. Disaster occurrence		Not at all	Not at all	Yes	Yes

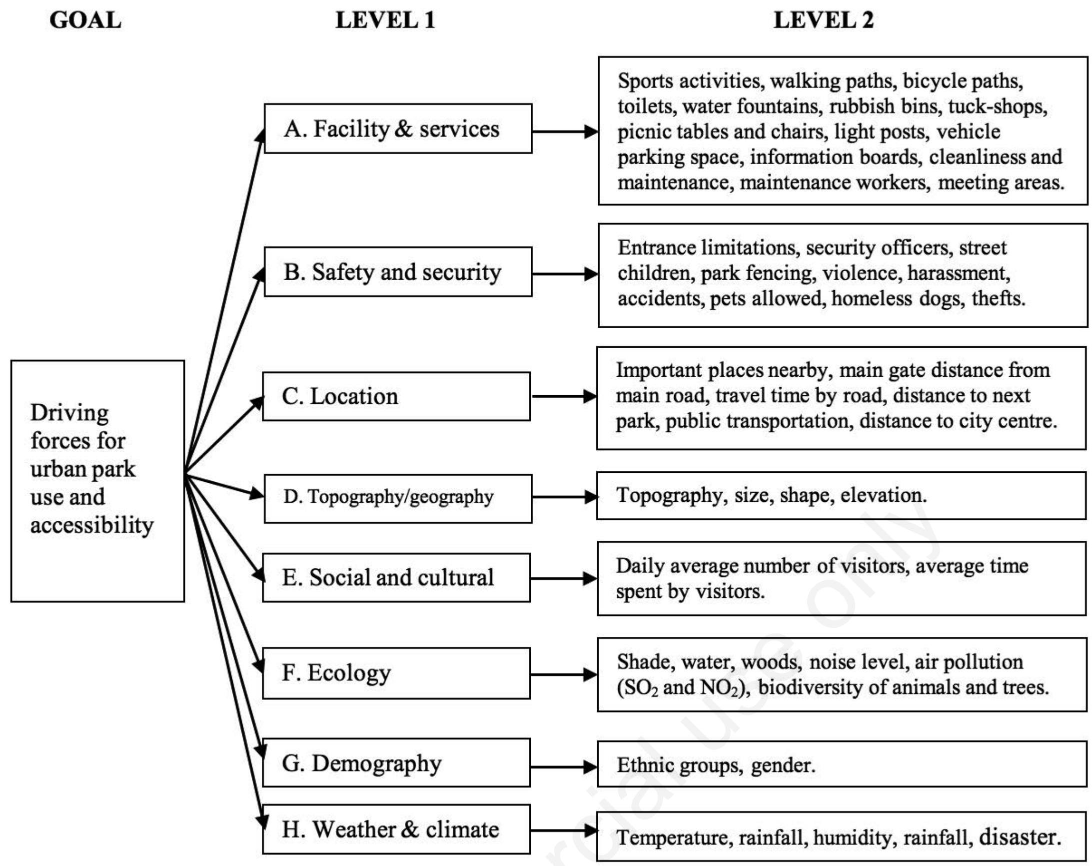

Figure 2. Hierarchical tree structure.

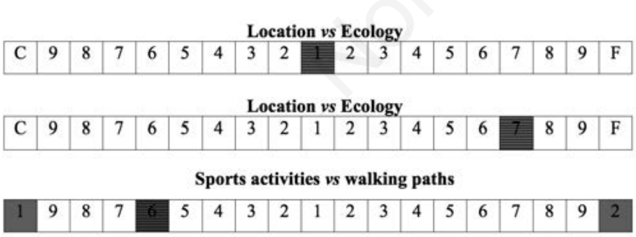

Figure 3. Examples of scoring. The first example indicates that the location indicator (C) and the ecology indicator (F) are equally important in the pair-wise comparison (score 1), while the second example indicates that the ecology indicator (F) can be assumed to be much more important than the location indicator (C) by another participant (score 7). However, in the third example dealing with the determination of the relative importance of sports activities and walking paths under the facility and services indicator (A), a participant may feel that the importance of sports activities falls between *clearly more important and much more important* (Table A2 in the Appendix) than walking paths, he would then select 6 as the score in the pair-wise comparison. The rule saying that *the minority should abide by the majority* was used to prepare the final pair-wise comparison matrix.

Calculation of the topography/geography indicator as an example

Factor	Value	Rank
Topography	60% flat	4
Size	7.5 km^2	3
Shape	Broad	5

$$TG = \frac{1.02 \text{ x } T + 1.42 \text{ x } Si \text{ x } 0.56 \text{ x } Sh}{1.02 + 1.42 + 0.56} = 3.71$$

Figure 4. Computation of indicator values. TG, topography/geography indicator; T, value of the topography factor; Si, value of the size factor; Sh, value of the shape factor.

factors are the same as those in Table 2). The normalized matrix shown in Table 4 for the facility and services indicator was obtained by dividing each cell value in Table 3 by its column sum. The sums across each row (shown in the last column to the right) were taken as the relative influence of each factor. The same methodology was used to determine the relative influence of all eight indicators used in this study.

By using the individual rank values and the relative importance of factor, the indicator values for each park under study were obtained (Table 5). This was done by first multiplying the rank of each factor with the relative influence of that factor (Tables 3 and 4). And then, the arithmetic sum of the multiplication was divided

Table 2. Rank values of the factors investigated.

Indicator	Factor	Unit	Rank value					
			0	1	2	3	4	5
A. Facility and services	1. Sports activities	No.	0	1-3	4-6	6-10	10-15	>15
	2. Walking paths	m	0	100	101-300	301-500	501-1000	>1000
	3. Bicycle paths	m	0	100	101-300	301-500	501-1000	>1000
	4. Toilets	No.	0	1	2	3	4	>4
	5. Water fountains	No.	0	1	2-3	4-5	5-10	>10
	6. Rubbish bins	No.	0	2	3-5	6-10	10-20	>20
	7. Tuck shops	No.	0	1	2	3	4	>4
	8. Picnic tables and chairs	No.	0	<10	11-20	21-50	51-100	>100
	9. Light posts	No.	0	<5	6-10	11-20	21-50	>50
	10. Vehicle park space	No.	0	<10	11-20	21-50	51-100	>100
	11. Information boards	No.	0	<5	6-10	11-20	21-50	>50
	12. Cleanliness/maintenance	Level	Very bad	Bad	Neither/nor	Moderate	Good	Very good
	13. Maintenance workers	No.	0	<5	6-10	11-20	21-50	>50
	14. Meeting areas	m^2	0	<100	101-500	501-1000	1001-2000	>2001
B. Safety and security	15. Entrance limitations	No.	>10	10-9	8-6	5-3	2-1	0
	16. Security officers	No.	0	1	2-5	6-10	11-20	>20
	17. Street children	No.	>20	20-16	15-11	10-6	5-1	0
	18. Fencing around park	%	0	20	40	60	80	100
	19. Violence events/ week	No.	>5	5	4	3	2-1	0
	20. Harassments/ week	No.	>5	5	4	3	2-1	0
	21. Accidents/week	No.	>5	5	4	3	2-1	0
	22. Pets allowed	No.	No	NA	NA	NA	NA	Yes
	23. Homeless dogs	No.	>5	5	4	3	2-1	0
	24. Thefts per week	No.	>5	5	4	3	2-1	0
C. Location	25. Important places	No.	0	1	2	3	4	>4
	26. Main gate - Road gap	m	>1000	751-1000	501-750	251-500	101-250	<100
	27. Distance by main road	Min.	>60	30-60	20-30	10-20	5-10	<5
	28. Distance to next park	km	<5		5-10	11-20		>20
	29. Public transportation		No	Very rare		Rare		Abundant
	30. Distance to city centre	km	>20	11-20	6-10	3-5	1-2	<1
D. Topography/ geography	31. Topography (flat area)	%		0-25	26-50	100	51-75	50
	32. Size	km^2		<1	2-5	6-10	11-20	>20
	33. Shape			Narrow				Broad
E. Social and cultural	34. Daily average of visits*	No.	<10 or >500	11-20 or 401-500	21-50 or 301-400	51-75 or 251-300	76-100 or 201-250	101-200
	35. Average time in the park	Hour		<1	1-2	2-3	3-4	>4
F. Ecology	36. Shaded area	%		0-20	21-40	41-60	61-80	81-100
	37. Water area	%		0-20	21-30	31-40	41-50	51-100
	38. Wooded area	%	0-5	6-10	11-15	16-20	21-25	25-100
	39. Noise level	dB	>60	56-60	51-55	46-50	40-45	<40
	40. Air pollution (SO_2)	ppm	>30	26-30	21-25	16-20	10-15	<10
	41. Air pollution (NO_2)	ppm	>30	26-30	21-25	16-20	10-15	<10
	42.Bio diversity (animals)	No.	<10	10-20	21-30	31-40	41-50	>50
	43. Bio diversity (trees)	No.	<10	10-20	21-30	31-40	41-50	>50
G. Demography	44. Ethnic groups	Bias		High	Middle	Moderate	Equal	Very equal
	45. Gender	Bias		High	Middle	Moderate	Equal	Very equal
H. Weather and climate	46. Average annual temp.	°C	>35	35-32	31-29	28-26	25-23	<23
	47. Rainy days	Day	>49	49-40	39-30	29-20	19-10	<10
	48. Average rainfall	mm	>3000	3000-2501	2500-2001	2000-1501	1500-1001	<1000
	49. Average. rel. humidity-day	%	>80	76-80	71-75	66-70	61-65	<60
	50. Disaster occurrence	Yes/no	Yes	NA	NA	NA	NA	Not at all

*There is a low limit which concerns people who avoid the park due to security reasons, and there is a high limit which concerns people who would not come to the park if it is too crowded, since they would then feel their privacy incroached.

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Table 3. Pair-wise matrix for the facility and services indicator.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	1	1	2	1	1	7	9	6	5	7	9	1/5	5	6
2	1	1	1	1/7	1/8	1/4	5	8	1/3	1/5	7	1/7	3	1/4
3	1/2	1	1	1/6	1/5	1/3	1/2	1/4	1/3	1/5	6	1/5	7	1
4	1	7	6	1	1	4	3	5	7	5	9	1	9	8
5	1	8	5	1	1	1	1	5	4	6	7	1/4	6	9
6	1/7	4	3	1/4	1	1	1	6	5	8	6	1	5	1/6
7	1/9	1/5	2	1/3	1	1	1	7	5	5	6	1/5	2	9
8	1/6	1/8	4	1/5	1/5	1/6	1/7	1	1/4	1/3	4	1/6	5	1
9	1/5	3	3	1/7	1/4	1/5	1/5	4	1	1	6	1/9	3	1/7
10	1/7	5	5	1/5	1/6	1/8	1/5	3	1	1	1/9	1/6	3	1/6
11	1/9	1/7	1/6	1/9	1/7	1/6	1/6	1/4	1/6	9	1	1/9	1/6	1/9
12	5	7	5	1	4	1	5	6	9	6	9	1	3	6
13	1/5	1/3	1/7	1/9	1/6	1/5	1/2	1/5	1/3	1/3	6	1/3	1	1/5
14	1/6	4	1	1/8	1/9	6	1/9	1	7	6	9	1/6	5	1
SUM	10.74	41.80	38.31	5.78	10.36	22.44	26.82	52.70	45.42	55.07	85.11	5.05	57.17	42.04

Table 4. Normalized matrix for the facility and services indicator.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Relative importance
1	0.09	0.02	0.05	0.17	0.10	0.31	0.34	0.11	0.11	0.13	0.11	0.04	0.09	0.14	1.81
2	0.09	0.02	0.03	0.02	0.01	0.01	0.19	0.15	0.01	0.00	0.08	0.03	0.05	0.01	0.71
3	0.05	0.02	0.03	0.03	0.02	0.01	0.02	0.00	0.01	0.00	0.07	0.04	0.12	0.02	0.45
4	0.09	0.17	0.16	0.17	0.10	0.18	0.11	0.09	0.15	0.09	0.11	0.20	0.16	0.19	1.97
5	0.09	0.19	0.13	0.17	0.10	0.04	0.04	0.09	0.09	0.11	0.08	0.05	0.10	0.21	1.51
6	0.01	0.10	0.08	0.04	0.10	0.04	0.04	0.11	0.11	0.15	0.07	0.20	0.09	0.00	1.14
7	0.01	0.00	0.05	0.06	0.10	0.04	0.04	0.13	0.11	0.09	0.07	0.04	0.03	0.21	1.00
8	0.02	0.00	0.10	0.03	0.02	0.01	0.01	0.02	0.01	0.01	0.05	0.03	0.09	0.02	0.41
9	0.02	0.07	0.08	0.02	0.02	0.01	0.01	0.08	0.02	0.02	0.07	0.02	0.05	0.00	0.50
10	0.01	0.12	0.13	0.03	0.02	0.01	0.01	0.06	0.02	0.02	0.00	0.03	0.05	0.00	0.52
11	0.01	0.00	0.00	0.02	0.01	0.01	0.01	0.00	0.00	0.16	0.01	0.02	0.00	0.00	0.28
12	0.47	0.17	0.13	0.17	0.39	0.04	0.19	0.11	0.20	0.11	0.11	0.20	0.05	0.14	2.47
13	0.02	0.01	0.00	0.02	0.02	0.01	0.02	0.00	0.01	0.01	0.07	0.07	0.02	0.00	0.27
14	0.02	0.10	0.03	0.02	0.01	0.27	0.00	0.02	0.15	0.11	0.11	0.03	0.09	0.02	0.98

Table 5. Index values of urban green parks.

Indicator	Characteristic				Indicator relative importance	Indicator value × relative importance			
	Vihara. park	Diyatha Uyana	Bellan. Park	Seetha. Park		Vihara. park	Diyatha Uyana	Bellan. Park	Seetha. Park
Facility and services	3.93	4.87	4.79	3.88	1.91	7.51	9.30	9.15	7.41
Safety and security	1.71	4.52	4.22	3.84	1.68	2.87	7.59	7.09	6.45
Location	4.74	4.74	4.74	2.90	1.23	5.83	5.83	5.83	3.57
Topography/geography	2.90	2.90	2.90	4.05	0.87	2.52	2.52	2.52	3.52
Social and cultural	3.18	0.91	2	1.91	0.23	0.73	0.21	0.46	0.44
Ecology	0.72	1.64	1.25	4.34	1.02	0.73	1.67	1.28	4.43
Demography	4.00	4.00	4.00	2.79	0.22	0.88	0.88	0.88	0.61
Weather and climate	1.88	2.37	1.83	2.43	0.84	1.58	1.99	1.54	2.04
Use and accessibility with regard to the urban green parks index values					Sum	22.66	30.00	28.74	28.47
					Average	2.83	3.75	3.59	3.56

by the number of factors involved. After that, the individual indicator values were multiplied by the relative importance of indicators to get the final index value.

Results

The results of the questionnaire survey showed that the Facilities and Services indicator provided was the most significant when selecting a park. The participants gave second priority to Safety and Security measures, while the Ecology, Topographical/Geography and Weather/Climate indicators received lower levels of priority. The park location also played an important role, but the indicators related to social, cultural and demography issues were felt to be of least influence.

Out of the 14 factors of the Facilities and Services indicator, commonly available in urban parks, the highest priority was given to cleanliness and maintenance, including availability of basic facilities such as toilets and water; however presence of sports facilities were also felt to be important. Less priority was given to information boards and the number of maintenance workers. Out of the 10 factors used to determine the indicator value of Safety and Security the participants selected presence of homeless dogs and thefts as the most prominent factors for avoiding a park, while factors, such as park fences, entrance limitations, presence of pets and street children accorded less negative preference.

The study used six factors in the analysis of the importance of location of urban parks,. Here the availability of public transportation making it possible to easily enter into the park was the most prominent factor. Distance to a neighbour park and distance to the main gate from the main road were the least influencing factors. Under the topographical and geographical indicator, the size was the most important, while the shape played no role. The daily average number of visitors was the main factor of the social and cultural indicator, while allocation of areas including water, shade and copses of trees were the most influential factors under the ecology indicator with the biodiversity factors felt to of little importance. The ethnicity of the majority visitor groups was more important compared to gender diversity under the demographic features. Generally, weather and climatic factors are important for the assessment of urban parks. Here, it was found that average rainfall and humidity were the most important factors with the possibility for disaster occurrences also seen as an important factor.

After determining the relative influences of individual factors, we integrated the indicators into a composite index. The relative influence of each indicator was determined using the views of the questionnaire participants. A higher priority was given for the indicators facility and services together with safety and security. Further, the participants choose location and ecology indicators as their second priority, while topography and geography together with weather and climate were ranked lower with social, cultural and demography as the lowest.

According to the results of the study, it can be clearly noticed that the park users are given priority for the Facilities and Services rendered by the park and the safety and security measures in selecting a place for their leisure activities and spending. It, further, clarifies from the results of the case study, which are having higher index values for the parks with more facilities and secured. In the case study, Diyatha Uyana has been ranked as the most popular park compared to other selected parks, since it provides a number of facilities and a safer place for the users. Diyatha Uyana is well famous among the park users, due to its location as well. Though Viharamahadevi park is situated in the heart of the city, park users are reluctant to use it due to safety issues and, specially, due to ecological unsuitability. Further, it can be noticed that though Seethawaka park is little bit far away from Colombo city limits, it has a good index value, since it has better inherent characteristics such as topography and geography, ecology and weather.

Discussion and Conclusions

The AHP-based study to understand park use from spatial and attribute data presented here was totally dependent on the views of the park users who participated in the survey. In order to get a well-balanced response, data were collected from different categories of park users from different park locations at different times. This was done to get a variation of views from people who visit urban parks for different purposes. An even better balance could be achieved by extending the questionnaire survey by including a larger number of participants and selecting people representing an even broader spectrum of people. In addition, the study model used could be further enriched by including experts in the disciplines of park management, landscape management, leisure management and health management for the development of future questionnaire surveys. Also the indicators and their respective factors used could be enlarged or modified to fit the model. Although the approach discussed here can be directly applied to assess urban green parks, it cannot be directly applied to assess other types of parks. It would then need to be adapted to other park types by changing the model parameters according to the scenarios at hand. When assessing usage of, and accessibility to, special parks in government and private institutions, *e.g.*, hospital parks, it is clear that user interests and ambitions by managers are different compared to the general public visiting green parks in cities. In such cases, the indicators and factors of the proposed model should be altered asking help of experts and park users through questionnaire surveys and discussions with related parties. In addition, the systematic approach presented here can be further modified to evaluate public parks situated in other cities and countries, introducing additional factors as needed. Importantly, the weighting values of the model may need to be altered to suit the intended set of regular park users and according to experts from various parts of the country (even other countries if need be), since each park scenario would only be known by its regular users.

Finally, it can be concluded that the type of hierarchical processing analysis utilized here is indeed useful for the assessment of public parks with the aim to understand the real situation which may be hidden. We feel that the study provides an improved approach to rank urban green parks using a set of specific indictors. An index-based ranking system is mainly required to enhance an understanding of current park situations with the view to provide a better service for the users. Implementation of a method for park evaluation, further helps park managers to undertake improvements of available features and characteristics where needed. After analyzing the rank of a park, a better understanding about the pros and cons makes possible to provide a good service to the general park users. Though different authors have introduced a number of suggestions to evaluate parks, they have paid attention to a limited number of parameters, while there may be more such variables consistent with the indicators and factors developed here. Hence, the proposed approach provides an innovative technique to assess the usage of, and accessibility to, urban green parks.

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