TOWARDS SUCCESSFUL URBAN GREEN SPACE DESIGN FRAMEWORK IN IPOH CITIES

Azuin Ramli[1], Rufaizal Che Mamat[2]

[1]Politeknik Ungku Omar
azuinramli@gmail.com
[2]Universiti Kebangsaan Malaysia
rufaizal_chemamat@yahoo.com

ABSTRACT

In industrialized and rapidly developing countries, population growth and new infrastructure developments such as buildings and housing areas are threatening green spaces in the urban areas. Today, urban green spaces such as parks do not only play an important role in contributing to a city's quality and environment but also for physical activities and relaxation of the mind after working in less active and stressful situations. Thus, this study is conducted to understand the demands and needs of community in the green areas of major Malaysian cities. The main factors that encourage communities to use the green spaces should be well identified in order to enable optimal utilisation of green spaces by the population. In order to meet the objectives of the study, various methods have been used, including information gathering and documentation, interviews with authorities of green spaces, and survey questionnaires to visitors of three selected parks in Ipoh. A total of 120 questionnaires were distributed to visitors of the green spaces. Quantitative data was collected to assess the suitability of factors based on judgment from experts and questionnaires. Questionnaire data was analysed using exploratory factor analysis (EFA) and the results indicated that the instrument satisfies the criteria for a valid and reliable research instrument. Limitations and suggestions for future research are also discussed.

Keywords: green space, urban area, factors, factor analysis.

1. Introduction

Urban development is a major source of greenhouse gas (GHGs) emissions, which contribute to global climate change(Martos et al., 2016). Driven by population growth, this situation will worsen unless measures are taken to implement green and sustainable development. In line with the above commitments, the Ministry of Energy, Green Technology and Water (KeTTHA) in collaboration with Malaysia's Green Technology Corporation (Greentech Malaysia) has developed the Low Carbon Cities Framework and Assessment System (LCCF) to create sustainable communities and environment. The LCCF also serves as a guide to stakeholders in providing affordable planning and development that contributes to reducing greenhouse gas (GHG) emissions.

The effort to create quality and sustainable environment is the government's commitment to creating prosperous life. The concept of green city development is based on ecological, social and economic sustainability (Dolezal & Spitzbart-Glasl, 2015). Ecological sustainability can be achieved by minimizing the negative impacts on the environment & optimising the use of resources. This in turn can be achieved by promoting relationships between humans and nature to improve the quality of life and to maximize economic well-being. One of the main green township pioneers is the Putrajaya Federal Government Administrative Center. It is a leader in sustainable low-carbon cities, with the aim of reducing the GHG emission intensity of 60 per cent by 2025 compared to 2012 levels, and reducing the city's heat by two degrees Celsius. Most government buildings in Putrajaya have adopted green building standards and are evaluated against the Green Building Index.

Cities and urban green spaces can be defined as an integrated neighbourhood that is integrated in terms of prioritizing protection, use and recycling of natural resources, while improving the public health, safety and welfare of the urban population (Rojas et al., 2016). The main features of the city and the green neighbourhood are a minimum carbon emission level, waste-free, efficient transport system with extensive public transport facilities, pedestrian-friendly and promoting bicycle use, promoting green areas and parks as 'city breathing focus' as well as clean air quality and implementation of energy efficient initiatives. However, the creation of green spaces needs to take into account environmental changes, the needs of local authorities and local communities. Local authorities should establish long-term vision for cities by integrating infrastructure requirements (housing, transport, business, community and healthcare) with green spaces (Addanki & Venkataraman, 2017). Engagements with local stakeholders and communities are important to ensure that the municipal processes are well received and well respected. Currently in Malaysia, a framework to define the features and attributes of green spaces that serves as a practical guide for the restoration and development of urban green spaces of the future is yet to be developed. In this regard, this research seeks to create a platform to develop a model framework that contains important attributes for urban green spaces in Malaysia.

2. Literature Review

The definition of a green space is based on the existence of open space that has been exploited. Open spaces provide recreational areas for residents and help to enhance the beauty and environment quality of a neighbourhood. According to Rojas *et al.,* (2016), an open space is any open piece of land that is undeveloped and is accessible to public, which includes green spaces (parks, community gardens and cemeteries), schoolyards, playgrounds, public seating areas, public plazas and vacant lots. Thus, the open space concept indirectly creates the concept of green spaces, in urban or rural areas. The features of green spaces are influenced by development areas in both urban and suburban areas. According to Futcher *et al.,* (2017), a green space is any open piece of land that is undeveloped and is accessible to public, which can include parks, public gardens, schoolyards, playgrounds, public seating areas, public plazas and vacant lots. While Anguluri and Narayanan (2017) argues that urban green space is defined as any vegetation found in the urban environment including parks, open spaces residential garden or street trees set apart for recreational purposes.

In developing countries such as Malaysia, the loss of green spaces is associated with other developments such as buildings, industrial and municipal infrastructures (Hisyam, Jamirsah, & Said, 2012). Rapid population growth across the world have led to pressures on natural sceneries. With the loss of natural areas, ecosystem services such as providing improved air and water quality and recreational chances have come under hazard. The importance of urban green spaces has been long recognised, but in recent decades, more information has become available on the wide range of benefits they provide. Good quality parks and green spaces contribute to individual comfort, and through their social, economic and environmental values, contribute to more functional and attractive towns and cities (Karteris et al., 2016).

Malaysia is facing challenges in implementing green spaces to achieve urban sustainability. The percentage of people living in urban areas will increase from 50% (2010) to nearly 70% (2020) throughout the world. Migration to urban areas continues globally; the need for sustainable urban development has become increasingly important (Addanki and Venkataraman, 2017). Malaysia has been rated as average (Green Cities Index, 2011) in green spaces and it is projected that only 75% of places in Malaysia will be green spaces in 2020. The majority of locations in Malaysia that were categorised as green spaces are located in Kuala Lumpur, Pulau Pinang, Selangor, and Perak (Karuppannan *et al.,* 2013). These locations are surrounded by environmental elements such as trees, rivers, lakes etc. Previous studies on green spaces identified a few factors contributing to green spaces such as quality and quantity of green space, developments of free emission, city size and population, green infrastructure and land use, physical health improvements, smart city infrastructure and ecosystem services (Rojas et al., 2016; Futcher et al., 2017; Addanki & Venkataraman, 2017). This type of area is more environmentally friendly and can improve human well-being and reduce inequalities over the long run but Malaysia is improving with lots of effort to increase its level. Clearly, green space plays a role in urban and environmental quality. Nonetheless, despite efforts to attract the public to use the green spaces for landscape and recreational activities, the number of visitors participating in recreational activities remain low, including children (Martos *et al.,* 2016). Therefore, changes must be done to attract more visitors to use recreational park, more often. Malaysians of today are physically inactive, which creates major public health risk.

The development and upgrading of urban green areas should consider four key features, namely availability / accessibility, aesthetic, amenities / equipment and management (Caruso et al., 2015; Carbonara, Tiberi, & Astiaso Garcia, 2015). However, the characteristics of each of these factors need to be identified based on the development and unique characteristics of the environment and population of a particular city. Urban green spaces should be designed and built in a flexible manner, so that they can always be upgraded to meet future demands and needs of the city. This is because green spaces are a long-term investment that requires careful planning before it can be fully utilized, as well as long-term maintenance. The design of green spaces such as walkable paths and landscapes should have design features that are not costly to maintain. In addition, the process of inspecting and maintaining green areas and facilities or equipment should be done on a regular basis.

The provision of green spaces is a worthy investment in the health, well-being and quality of life, creating spaces and avenues for leisure, recreation and social interaction. In addition, it can contribute to improving the overall level of health and well-being of the population by enabling stress reduction, through physical activities, better social interaction and improved community linkages (Rojas et al., 2016). The health benefits include mental and physical health, as well as the enhancement of one's cognitive and immune function. As such, it is important to conduct a study to identify the features of the green area that meet the demands and needs of the community. This study involves the community of green space areas as they are the primary users who understand the needs and requirements of such areas for mutual benefit. These identified factors are impactful for the authorities as a guide for the future development and upgrading of green areas.

3. Methodology

One Hundred and Twenty (120) self-administered questionnaires were used for gathering data from the respondents. The process of distribution and collection of questionnaires was carried out over a period of three (3) months. The study was conducted in four areas in Ipoh which is D.R. Seenivasagam Park, Gunung Lang Recreational Park, Eco Park 1 and Sultan Abdul Aziz Recreational Park (Polo Ground) (Figure 1). Ipoh listed as sustainable cities by city council 2015. The sustainability index for Ipoh is 94% where it is nearer to 100%, (MURNInets, 2015). In recent years, Ipoh's popularity as a tourist destination has been significantly boosted by efforts to conserve its British colonial-era architecture. Ipoh city also well-known for its cuisine and natural attractions, such as its limestone caves hills and caves within which Buddhist temple were built.

Figure 1. Research Location

4. Exploratory Factor Analysis of The Research Instrument

The EFA test was used to simplify and purify the measures of the proposed relational framework quantitatively (Hair, Black & Anderson, 2010). Since the aim of the researcher was to identify the minimum number of factors based on the total variance in the data as well as to minimize the number of items to a more manageable set, principal component analysis was used. In order to successfully perform exploratory factor analysis (EFA) some basic assumptions need to be satisfied. Firstly, a minimum sample size of 50 observations is required (Hair, Black & Anderson, 2010; Field, 2009), which was satisfied in this research (n = 120). Secondly, the ratio of cases to variables in a principal component analysis should be at least 5 to 1 [11]. With 120 and 29 variables, the ratio of cases to variables is 4.3, which less than the requirement for the ratio of cases to variables. In order to fulfil this assumption, constructs were divided into four groups with a maximum of 8 items per group (Table 1).

Table 1. Groups as defined for Exploratory Factor Analysis (EFA)

Group	Constructs and Measures	Number of Item
Group 1 (FC)	Facility - Facilities for Relaxion, Facilities for Sport And Play, Facilities for Children, Security Services, Maintenance Services, Shelter and Seat, Food Outlets.	7
Group 2 (AT)	Aesthetic - Attractive Plants, Attractive Wildlife, Quality of Vegetation, Privacy Areas, Tranquillity, Beauty of Landscape, Shaded Areas, Safe and Clean.	8
Group 3 (AC)	Activities – Active/Sport, Passive/Relax, Interaction with Nature, Charity, Water Elements, Festival Celebration, Cultural and Regional Precedents.	7
Group 4 (PC)	Potency – Topography Naturalness, Proximity to water, Eco Tourism, Business Centre, Recreational Centre, Historical Value, Accessibility.	7

4.1 Exploratory Factor Analysis – Group 1

The first group present exploratory factor analysis for facility (FC) constructs (Table 2). All variables correlated on an acceptable level without showing undesired extreme correlation. That is, numerous variables with correlations greater than 0.05 but no values above 0.90 were detected. Next, the determinant of the correlation matrix was 0.07 which exceeds the threshold value of 0.00001, indicating the absence of multicollinearity (Field, 2005). In a next step Kaiser-Meyer-Olkin measure of sampling adequacy (KMO) and Bartlett's Test of Sphericity (BTS) were examined. Firstly, KMO statistics was 0.722, thus exceeding the required minimum of 0.50 (Hair, Black & Anderson, 2010; Field, 2009). In addition, KMO values for individual items were examined and all items had values exceeding the minimum value of 0.50 (Hair, Black & Anderson, 2010; Field, 2009). Secondly, Bartlett's Test of Sphericity was inspected and was found to be significant with $p < 0.001$, thus suggesting that the correlation matrix is not an identity matrix (Hair, Black & Anderson, 2010; Field, 2009). As a result of the first run of the EFA, two factors were extracted based on the latent root criterion (eigenvalue) that was supported by the examination of the scree plot. In addition, analysis revealed the presence of two components with eigenvalue exceeding 1, explaining 2.793% and 1.673%. This factor had explained a total of 63.802% of the variance. Next, each item highly loaded on only one factor with all factor loadings exceeding the 0.722 threshold level.

Table 2. The Rotated Component Matrix for facility (FC) constructs

Item	Component	
	1	2
FC1	0.334	0.728
FC2	0.340	0.753
FC3	-0.119	0.725
FC4	0.815	0.153
FC5	0.755	0.086
FC6	0.858	0.154
FC7	0.763	0.146
Eigenvalues	2.793	1.673
%Variance (63.802)	39.895	23.906

4.2 Exploratory Factor Analysis – Group 2

The second group present exploratory factor analyses for aesthetic (AT) construct (Table 3). Results of correlation matrix showed that all variables correlated acceptably well but not perfectly, which is preferable when conducting exploratory factor analysis (Field, 2005). While there was majority of variables with correlations greater than 0.05 and no value above 0.90 was found. Next, the value of the determinant of the correlation matrix was 0.045 which is greater than 0.00001, thus indicating that multicollinearity was not a problem (Field, 2005).

Then, results from Kaiser-Meyer-Olkin measure of sampling adequacy (KMO) and Bartlett's Test of Sphericity (BTS) were examined to test whether factor analysis is appropriate. KMO statistics was 0.695 which is well above the minimum of 0.50 (Hair, Black & Anderson, 2010; Field, 2009). In addition, KMO values for individual items as presented in the Anti-Image Correlation Matrix were examined. Results showed that the measure of Sampling Adequacy (MSA) for all of the individual variables included in the analysis was greater than threshold value of 0.50 (Hair, Black & Anderson, 2010; Field, 2009). Next, Bartlett's Test of Sphericity was significant ($p < 0.001$) which indicated that the correlation matrix is not an identity matrix (Hair, Black & Anderson, 2010).

As a result of the first run of the EFA, a two factors structure was suggested with eigenvalue of 3.217% and 1.239% of the variance respectively. The two factor solution explained a total of 63.649% of the variance. This was also supported by the visual examination of the scree plot. Furthermore, all items have factor loadings exceeding the 0.722 threshold level except for item AT4 which is loaded on factor three (0.690). Finally, communalities for all items were greater than 0.60 except for AT4 (0.483) (Hair, Black & Anderson, 2010). Based on the presented results of the first round of EFA, in a next step item AT4 was dropped due to factor loading and low communalities and a second round of CFA was performed. As a result of this EFA the two factors structure was confirmed, Kaiser-Meyer-Olkin measure of sampling adequacy (KMO) and Bartlett's Test of Sphericity (BTS) showed good values (KMS statistic = 0.697; BTS p < 0.001) and KMO values for all individual items showed values well above 0.50. Moreover, all factor loadings had significant values ranging from 0.730 (AT3) to 0.931 (AT6) and all communalities exceeded the 0.60 threshold value. In addition, all values for item-total correlations had satisfactory levels.

Table 3. The Rotated Component Matrix for aesthetic (AT) constructs

Item	Component		Item	Component	
	1	2		1	2
AT1	0.879	0.135	**AT1**	0.845	0.281
AT2	0.772	0.338	**AT2**	0.739	0.380
AT3	0.776	0.116	**AT3**	0.730	0.339
AT4	-0.077	0.690	**AT5**	0.033	0.931
AT5	0.166	0.761	**AT6**	0.799	-0.158
AT6	0.765	-0.183	**AT7**	0.799	-0.158
AT7	0.793	-0.066	**AT8**	0.829	-0.095
AT8	0.793	-0.066			
Eigenvalues	3.217	1.239	**Eigenvalues**	2.290	1.543
%Variance (63.649)	45.951	17.698	**%Variance (66.657)**	28.627	19.284

4.3 Exploratory Factor Analysis – Group 3

The third group present exploratory factor analyses for visitor's activities (AC) construct (Table 4). Results of correlation matrix showed that all variables correlated acceptably well but not perfectly, which is preferable when conducting exploratory factor analysis (Field, 2005). While there was majority of variables with correlations greater than 0.05 and no value above 0.90 was found. Next, the value of the determinant of the correlation matrix was 0.096 which is greater than 0.00001, thus indicating that multicollinearity was not a problem (Field, 2005).

Then, results from Kaiser-Meyer-Olkin measure of sampling adequacy (KMO) and Bartlett's Test of Sphericity (BTS) were examined to test whether factor analysis is appropriate. KMO statistics was 0.737 which is well above the minimum of 0.50 (Hair, Black & Anderson, 2010; Field, 2009). In addition, KMO values for individual items as presented in the Anti-Image Correlation Matrix were examined. Results showed that the measure of Sampling Adequacy (MSA) for all of the individual variables included in the analysis was greater than threshold value of 0.50 (Hair, Black & Anderson, 2010; Field, 2009). Next, Bartlett's Test of Sphericity was significant (p < 0.001) which indicated that the correlation matrix is not an identity matrix (Hair, Black & Anderson, 2010).

As a result of the first run of EFA, two factors were extracted based on the latent root criterion with eigenvalue exceeding 1, explaining 2.964% and 1.483% of the variance respectively. An inspection of the screeplot showing points of inflection that would justify the extraction of three factors, which would confirm the result based on the latent root criterion. The two factors solution explained a total of 63.520% of the variance, with component 1 contributing 42.339% and component 2 contributing 21.182% respectively. Next, all items factor loadings were above 0.722 on at least one factor (Field, 2009). As a result of the first run of EFA, no variables need to be removed because they are the only variable loading on a component. Finally, examination of communalities showed that all of the variables included on the components were greater than 0.6 and all variables had simple structure (Field, 2009). Therefore, the principal component analysis has been completed.

Table 4. The Rotated Component Matrix for visitor's activities (AC) constructs

Item	Component	
	1	2
AC1	0.773	0.270
AC2	0.784	0.074
AC3	0.770	0.000
AC4	0.748	0.151
AC5	0.758	0.053
AC6	0.136	0.845
AC7	0.067	0.815
Eigenvalues	2.964	1.483
%Variance (63.520)	42.339	21.182

4.4 Exploratory Factor Analysis – Group 4

The fourth group present exploratory factor analyses for potency (PC) construct (Table 5). Results of correlation matrix showed that all variables correlated acceptably well but not perfectly, which is preferable when conducting exploratory factor analysis (Field, 2005). While there was majority of variables with correlations greater than 0.05 and no value above 0.90 was found. Next, the value of the determinant of the correlation matrix was 0.007 which is greater than 0.00001, thus indicating that multicollinearity was not a problem (Field, 2005).

Then, results from Kaiser-Meyer-Olkin measure of sampling adequacy (KMO) and Bartlett's Test of Sphericity (BTS) were examined to test whether factor analysis is appropriate. KMO statistics was 0.770 which is well above the minimum of 0.50 (Hair, Black & Anderson, 2010; Field, 2009). In addition, KMO values for individual items as presented in the Anti-Image Correlation Matrix were examined. Results showed that the measure of Sampling Adequacy (MSA) for all of the individual variables included in the analysis was greater than threshold value of 0.50 (Hair, Black & Anderson, 2010; Field, 2009). Next, Bartlett's Test of Sphericity was significant ($p < 0.001$) which indicated that the correlation matrix is not an identity matrix (Hair, Black & Anderson, 2010).

As a result of the first run of EFA, three factors were extracted based on the latent root criterion with eigenvalue exceeding 1, explaining 3.575%, 1.096% and 1.483% of the variance respectively. An inspection of the screeplot showing points of inflection that would justify the extraction of three factors, which would confirm the result based on the latent root criterion. The three factors solution explained a total of 81.630% of the variance, with component 1 contributing 51.079%, component 2 contributing 15.651% and component 3 contributing 14.90% respectively. Next, all items factor loadings were above 0.722 on at least one factor (Field, 2009). As a result of the first run of EFA, no variables need to be removed because they are the only variable loading on a component. Finally, examination of communalities showed that all of the variables included on the components were greater than 0.6 and all variables had simple structure (Field, 2009). Therefore, the principal component analysis has been completed.

Table 5. The Rotated Component Matrix for potency (AC) constructs

Item	Component		
	1	2	3
PC1	0.844	-0.175	0.041
PC2	0.842	-0.133	0.199
PC3	0.897	0.228	0.047
PC4	0.743	0.115	-0.175
PC5	0.064	0.962	0.039
PC6	0.033	0.042	0.983
PC7	0.891	0.236	0.024
Eigenvalues	3.575	1.096	1.043
%Variance (81.630)	51.079	15.651	14.900

5. Conclusion

The significance of the proposed framework was empirically assessed in a quantitative study using questionnaire survey. From the results, item AT4 (Privacy areas) was dropped from the scale due to low factor loading and communalities, leaving only 28 items in the framework. The measures in the framework were shown to be valid and reliable and hence can serve as a valid foundation for future research. It is hoped that this paper could initiate more research to further refine the instrument with the aim to provide valid and reliable assessment tool in causal research. In addition, future research may also utilize other multivariate statistical test to assess the reliability and validity of the instrument. It is also recommended that structured equation modeling (SEM) and confirmatory factor analysis be undertaken in a larger sample among communities to support the generalizability of the questionnaire. The researcher believes that this research significantly contributes to and advances the existing knowledge in urban green space performance. Moreover, the researcher sincerely hopes that this research will stimulate the thinking of academics and practitioners alike regarding the urban green space performance in their future work.

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