The Site Suitability Evaluation of Potential Urban Park: A Case Study of Surabaya, Indonesia

A Dissertation Submitted to

the Graduate School of Life and Environmental Sciences,

the University of Tsukuba

in Partial Fulfillment of the Requirements

for the Degree of Doctor of Philosophy in Science

(Doctoral Program in Geoenvironmental Sciences)

Hepi Hapsari HANDAYANI

Abstract

Urban expansion has increased rapidly in size and density, and green space as a protector of the environment has come under more pressure during the urbanization process. Comprehensive studies have confirmed the importance of publicly accessible green space, such as urban park, and its ability to provide benefits to the general public. Urban park is a vital environmental component of urban land use to supply leisure and recreational activity for neighbourhood and to offer a spot for social interaction that preserves neighborhood connections. To develop urban park, a sustainable concept should be adopted. Sustainable development is characterized as "dynamic process" deriving from a planned design and striking a "balance" among environmental, social, and economic values. Consequently, a sustainable plan should predict and shape the extent of future development, recognize current and emerging requirement, and ensure that the residents' needs have been met. Herein, the sustainable development of urban park should facilitate the social life of the neighborhood to promote their satisfaction.

Surabaya in Indonesia has experienced economic growth and increases in population, especially in the central Surabaya where Central Business District (CBD) was established. However, in this central area, the amount of urban park per capita is low, approximately on 0.301 m^2. Thus, the sustainable development of urban park is crucial in in providing local residents with a satisfactory standard of living. Bareland and grassland can be proposed as potential site of urban park. Therefore, the purpose of this study is to investigate and evaluate the site suitability of sustainable development of potential urban park in central Surabaya. The specific objectives are as follows: (1) to investigate the site suitability of potential urban park using the Analytic Hierarchy Process (AHP) approach; (2) to evaluate the site suitability of potential urban park; (3) to propose a Potential Satisfaction of Urban Park Index (PSPI) in order to assess the neighbourhood satisfaction objectively; and (4) to conduct a case analysis based on the

combination of site suitability with different level to select the most recommended plan concerning sustainable perspective.

For the AHP analysis, two concepts including site and neighbourhood characteristics were applied. A total of four sub-criteria and 12 factors were included in the AHP model, with their relative weight determined by experts and specialists from various backgrounds. The AHP analysis indicated that the land ownership factor was ranked highest, followed by walking distance, and then safety of the environment. To check the consistency of the factor ranking, Kendall's coefficient of concordance was applied, using a 95% confidence interval. The coefficient had a moderate level of 0.737, indicating consistency of ranking between the experts.

The Suitability Index (SI) of potential urban park had the lowest value of 0.3 and the highest value of 0.779. Four potential sites had an SI greater than 0.677, indicating very high suitability, these were located mainly in the north area as part of Gading village. Low and intermediate levels of suitability applied to the same number of potential sites (22 each), which were found mostly to the west. However, a large number of 20 potential sites assigned for very low suitability which were identified in the east and west part and three of them were located in the CBD area. The evaluation of site suitability revealed that portion of the government asset and land value affected the assessment. The accessibility and the safety environment came next in importance. Thus, the high proximity and volume of potential user should be considered in order to encourage usage of urban parks that is efficient and that meets the requirements of sustainable development.

Urban park development based on sustainable spatial planning should consider economy, social and neighbourhood environment. The neighborhood environment is expected to become more livable as the ecosystem gets healthier and economic development becomes more responsive to the needs of efficient usage. In the present study, a case analysis was conducted to determine the most appropriate urban park development plan in terms of satisfying residents. In applying the case analysis, an assessment was made on the basis of efficiency in social, economic, and resource

terms. First, the domain factors of the AHP were used as an indicator for the case analysis; second, the case analysis involved resident as potential park user. Hence, the evaluation was based on the effectiveness of potential park usage. Neighbourhood satisfaction level was used as an indicator for the second assessment.

The PSPI therefore involved four parameters: area, shape, built-up volume (in regard to the volume of potential users), and proximity. The PSPI also evaluated the possibility of providing satisfaction for other neighborhoods, in cases where the built-up pixel representing a building was taken as belonging to more than one neighborhood zone. A questionnaire was used to obtain reference data in order to validate the PSPI map. The regression presented a coefficient value of 0.89, indicating a robust correlation. Hence, the result showed that PSPI worked well to assess the potential satisfaction of urban park for resident as user in terms of occupancy and accessibility.

The case analysis revealed that case 3 with 67 new urban parks including 24 existing urban parks and 43 potential parks with an SI greater than 0.448 (indicating suitability in the range from intermediate to very high), was the preferred option for achieving sustainable development of urban park. Nevertheless, certain aspects should be taken into account. The distribution of the urban park was a critical concern. In some regions, the number of urban parks located nearby was sufficient such as Tambaksari district which has the largest number of 30 urban parks, of which 27 parks are the potential site. A reduction in the number of potential sites could therefore be proposed, with some sites being transferred to areas with a smaller number of potential sites, such as Simokerto and Tegalsari districts. However, for the CBD area, three sites had very low suitability, mainly because of the long walking distance involved. Overall, this study can be used as a point of reference in plans to provide a green environment for neighborhoods and to present a positive image of the city. Additionally, the amount of 76% residents including businessmen and workers need the urban park surrounding the business centers and offices.

Keywords: urban park, site suitability, central Surabaya, sustainable development.

List of Contents

List of Figures

List of Tables

Acronyms / Abbreviations

CBD	Central Business District
AHP	Analytic Hierarchy Process
PSPI	Potential Satisfaction of Urban Park Index
SI	Suitability Index
UN	United Nations
WCED	World Commission on Environment and Development
LSA	Land Suitability Analysis
GIS	Geographic Information System
RS	Remote Sensing
BO	Building Occupancy
UD	Unit Development
DSM	Digital Surface Model
LiDAR	Light Detection and Ranging
ALOS	Advanced Land-Observing Satellite
MCDA	Multi Criteria Decision Analysis
GI	Green Index
LU/LC	Land Use/Land Cover
JAXA	Japan Aerospace Exploration Agency
UTM	Universal Transverse Mercator
GCPs	Ground Control Points
RMSe	Root Mean Square error
KBS	Kebun Binatang Surabaya
CR	Consistency Ratio
CI	Confidence Interval

LSI	Landscape Shape Index
ANGSt	Accessible Natural Greenspace Standards
FLG	First Law of Geography
OA	Overall Accuracy
DTM	Digital Terrain Model
EBK	Empirical Bayesian Kriging
SFH	Surface Feature Height
TS	Total Station
K^	Kappa coefficient
OE	Omission Error
CE	Commission Error
WD	Walking Distance
A	Area of potential site
DW	Distance to Water body
LO	Land Ownership
FI	Family Income of user
Q	Quietness
SF	Safety
S	Shape of potential site
DH	Distance to High voltage transmission
ST	Soil Type
FAO	Food and Agriculture Organization of the United Nations
CSR	Corporate Social Responsibility