Journal of Applied Sciences

ISSN 1812-5654

science alert

ANSInet
an open access publisher
http://ansinet.com

Journal of Applied Sciences 13 (7): 1123-1127, 2013
ISSN 1812-5654 / DOI: 10.3923/jas.2013.1123.1127

Optimization of Design Proposal of Community Environment Landscape based on ANP Model

[1]Lifang Qiao and [2]Lei Feng
[1]School of Horticulture and Landscape Architecture,
Henan Institute of Science and Technology, Xinxiang, Henan Province, 453003, China
[2]Department of Architecture, Henan Technical College of Construction,
Zhengzhou, Henan Province, 450064, China

Abstract: The optimization of design proposal of community environmental landscape plays an important role in the reasonable construction of community environment. In this article, the indexes influencing the optimization of community environmental landscape were selected and an index system containing three layers was established. Among the three layers, criterion layer concerned eco-environment, aesthetics environment, place environment, cultural environment and facilities environment, etc. and index layer involved 15 indexes. ANP (Analytic Network Process) model was established in accordance with the impact relationship between the design proposal and evaluation index of community environmental landscape. Supper Decisions (SD) software was used to calculate data as an assistant approach. According to this model, the hybrid weight of 15 impact factors and the comprehensive advantage measure of 3 proposals were calculated and the optimal proposal was determined. ANP model was suitable for the optimization decision of design proposal of community environmental landscape and SD software provided a computerized approach of ANP model calculation, which made possible a simplified process and calculation of optimization.

Key words: ANP, supper decisions software, community, landscape design, proposal, optimization

INTRODUCTION

China is in the midst of the world's largest urbanization process (Chen *et al*., 2013). China's Code for Classification of Urban Land Use and Planning Standards of Development has specified that residential land accounts for 20-32% of the total area of urban construction land. Therefore, urbanization led to a rapid increase of urban resident demand and almost all the Chinese cities were in construction of a large number of communities. The community environment consists of building environment and landscape environment. With the development of people's living quality, requirement of landscape quality from the public is getting higher and higher (Mahdavinejad and Abedi, 2011). Bidding is an approach of optimization of the design proposals of community landscape environment. In China, the optimal proposal is usually determined by organizing the experts to vote. Although, it is in some extent reasonable, the actual voting is often affected by subjective factors of the experts, which results in low persuasiveness. Hence, many evaluation methods emerged, such as SD, AHP, which were applied more often. AHP (Analytic Hierarchy Process) (Vizzari, 2011; Vidal *et al*., 2011) is also one of the methods that have been widely applied in recent years. In this approach, the qualitative data are converted into quantitative data to make the analysis result more reliable. However, there is a precondition in the application of AHP: A hierarchical relationship without interdependency should exist among layers.

Actually, large error exists in the decision-making of AHP in some cases. For example, two buildings, named A and B respectively, are evaluated in function and form. From a professional standpoint, it is obvious, function has a higher weight. Thus, given the function evaluation of building A is higher than B, A is selected. But in fact, although the function of A is better than B, B can still be the final option because B has a far better form than A, with its function good enough according to the actual requirement. This case indicated that a feedback effect exists between evaluation factors. Therefore, ANP (Yuksel and Dagdeviren, 2007), which was put forward by (Niemira and Saaty, 2004) becomes the most common method to deal with multi-index comprehensive evaluation problem (Jung and Seo, 2010; Sun *et al*., 2007; Hsu *et al*., 2012). ANP is considered to be able to overcome the

Corresponding Author: Lifang Qiao, School of Horticulture and Landscape Architecture,
Henan Institute of Science and Technology, Xinxiang, Henan Province, 453003, China

defect of AHP, namely, unidirectionality and the requirement in factors or criteria independence. Therefore, ANP method is more suitable for a complex decision-making process, which means, the elements of system are not in a network structure instead of a recursive hierarchy structure. In addition, each node of network represents an element or a cluster, which means each element of the system can influence or control other elements, or might be influenced or controlled by other elements. Because of its flexibility in application, ANP model is widely used in all kinds of evaluation and decisions. In this study, ANP method is applied in the optimization of design proposals of community landscape environment.

MATERIALS AND METHODS

Model construction: An ANP model containing control layer and network layer is built (Lin *et al*., 2008) (Fig. 1). The control layer contains target and decision criteria, which is a typical AHP recursive hierarchy structure. Specifically, the criteria are independent with each another; the next is controlled only by the previous one; the weight of each criteria can be obtained by the traditional AHP method. The network layer consists of clusters and element nodes. Matrix obtained by comparing the importance of nodes in the same cluster or nodes in different cluster is called comparison matrix, or local dominance. For the same overall goal, matrix obtained by comparing the importance of clusters is called weight matrix, or global dominance. The matrix constituted by the local dominance of all nodes in one cluster over all father nodes in another cluster is called matrix component.

The comprehensive weights of all affecting factors are calculated in accordance with matrix component.

The calculation process of ANP model is very complicated. However, the SD software invented by Saaty provides a programming solution of ANP model calculation, which has simplified the calculation process (Garcia-Melon *et al*., 2012).

Optimization samples: Among the community environment landscape designs accomplished by students of department in Henan institution of Technology with landscape architecture major in grade 2010, three design proposals were screened out by the specialized teachers as the final proposals to participate in optimization. The area of central green land of this community is 61544 square meters. SD software is used in decision.

Selection of impact index: There are many evaluation factors of design proposals of community environment landscape. Fifteen indexes were selected out according to 5 aspects to build the hierarchical model with reference to the information and expert advices. This hierarchical structure of the optimization of design proposals of community environment landscape (Table 1) is made up of 3 layers including the target layer, the criteria layer and the index layer and the model tree is established by the relationship of administrative subordination.

RESULTS AND ANALYSIS

An ANP model was built (Fig. 2, 3). The comprehensive dominance of weight and optimal design of each evaluation factor were calculated by Super Decisions software. The concrete steps were as follows:

Step 1: Design-cluster-new command was used to establish Goal, Criteria and Alternative Clusters; design-node-new command was used to establish Elements inside the Clusters and do connexions command is used to establish the connection in the same cluster (internal dependence) and the connection of different clusters (external dependence)

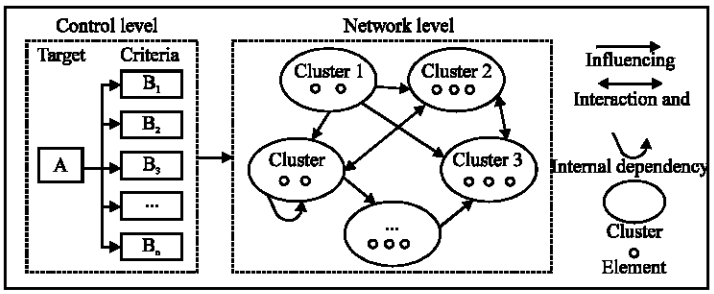


Fig. 1: Sketch of ANP model structure

Table 1: Hierarchical structure of the optimization of design proposals of community environment landscape

Target layer	Criteria layer	Index layer
Optimization of proposal (A)	Eco-environment (B_1)	Three-dimensional green amount (B_{11})
		Rationality of green land distribution (B_{12})
		Green coverage ratio (B_{13})
	Aesthetics environment (B_2)	Novelty of form (B_{21})
		Coordination of art (B_{22})
		Perception of art (B_{23})
	Place environment (B_3)	Completeness of place function (B_{31})
		Rationality of space distribution (B_{32})
		Richness of space (B_{33})
	Cultural environment (B_4)	Suitability of landscape theme (B_{41})
		Significance of cultural characteristics (B_{42})
		Reality of culture expression (B_{43})
	Facilities environment (B_5)	Completeness of facilities (B_{51})
		Humanization of facilities (B_{52})
		Rationalities of facilities distribution (B_{53})

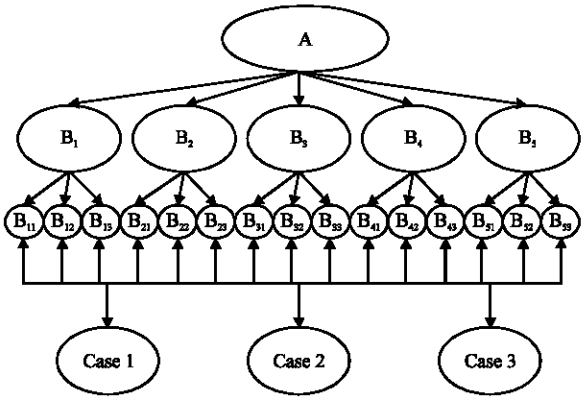


Fig. 2: Sketch of ANP structure of optimization of design proposal of community environment

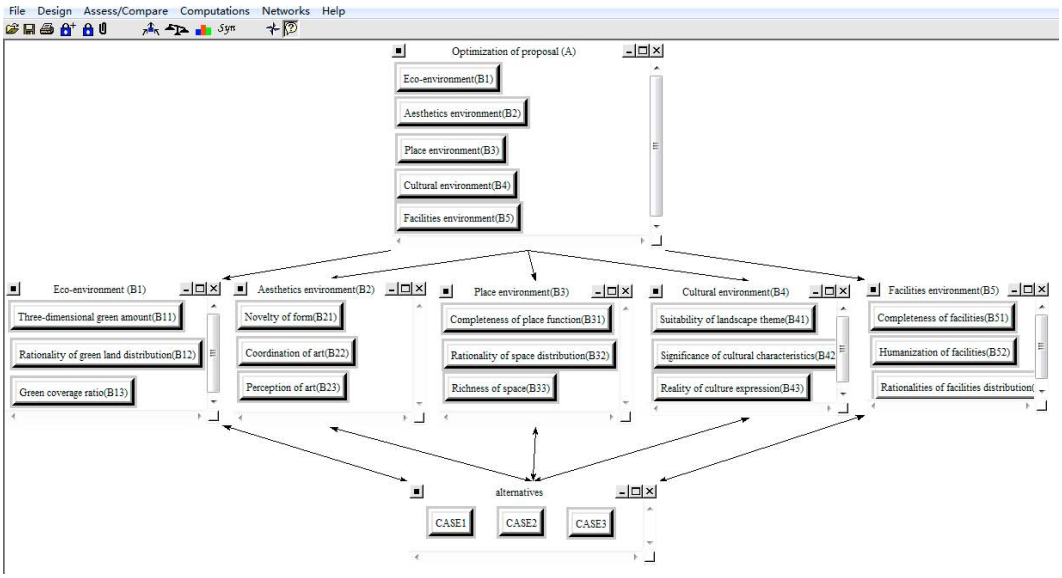


Fig. 3: The ANP structure diagram of optimization of design proposals of community environment landscape in SD software

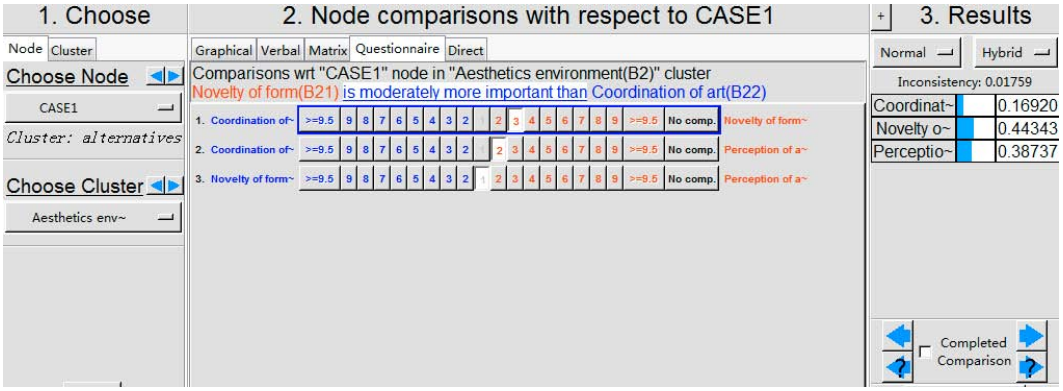


Fig. 4: Comparison of relative importance of scaling in 1-9 (Questionnaire mode)

Cluster / Node Labels		Aesthetics environment(B2)			alternatives			Cultural environment(B4)	
		Coordination of art(B22)	Novelty of form(B21)	Perception of art(B23)	CASE1	CASE2	CASE3	Reality of culture expression(B43)	Significance of cultural characteristics(B42)
Aesthetics environment(B2)	Coordination of art(B22)	0.010293	0.010293	0.010293	0.010293	0.010293	0.010293	0.010293	0.010293
	Novelty of form(B21)	0.015457	0.015457	0.015457	0.015457	0.015457	0.015457	0.015457	0.015457
	Perception of art(B23)	0.018818	0.018818	0.018818	0.018818	0.018818	0.018818	0.018818	0.018818
alternatives	CASE1	0.225444	0.225444	0.225444	0.225444	0.225444	0.225444	0.225444	0.225444
	CASE2	0.148100	0.148100	0.148100	0.148100	0.148100	0.148100	0.148100	0.148100
	CASE3	0.126456	0.126456	0.126456	0.126456	0.126456	0.126456	0.126456	0.126456
Cultural environment(B4)	Reality of culture expression(B43)	0.027305	0.027305	0.027305	0.027305	0.027305	0.027305	0.027305	0.027305
	Significance of cultural characteristics(B42)	0.017794	0.017794	0.017794	0.017794	0.017794	0.017794	0.017794	0.017794

Fig. 5: Limit super matrix in super decision software

Step 2: Assess/compare-pairwise comparisons command was used to compare the relationship between the clusters and element nodes in accordance with scaling of 1-9 (Fig. 4), forming the comparison matrix. The questionnaire mode was used as the comparison method

Step 3: According to the comparison matrix, computations-unweighted super matrix command was used to calculate the unweighted super matrix of ANP model

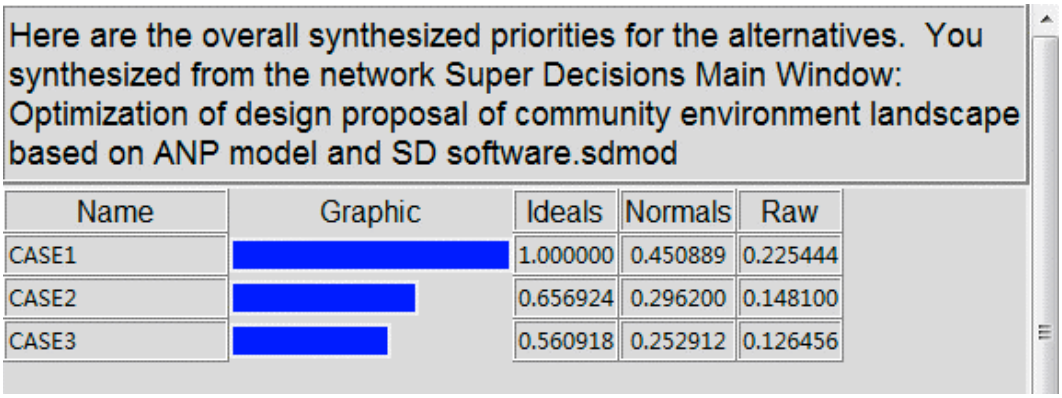
Step 4: Computations-weighted super matrix was used to calculate the weighed super matrix

Step 5: Computations-limit matrix command was used to calculate the limit super matrix (Fig. 5), which is derived from doing power operation on the weighted super matrix and its weighted value tends towards stability. That is to say, all columns of the matrix were consistent. Then, a column of the matrix, namely, the ordering vector of evaluation indexes, or specifically the weighting value of elements relative to the target, was selected

Step 6: The comprehensive dominance of three proposals were obtained by using Computations/Synthesize command or clicking shortcut icon syn (Fig. 6)

Seen from the limit super matrix, the weight of impact indexes including rationality of green land distribution, humanization of facilities, three-dimensional vegetation, completeness of place function, completeness of facilities, green coverage ratio, rationality of space distribution and suitability of landscape theme were relatively high. These indexes belong to eco-environment, place environment and facilities environment, which showed that functional factors possess a high weight in the choice of function and form of community environment landscape. However, with the development of society and appreciation level of the public, the weight of cultural environment and aesthetics environment tend to escalate.

According to the diagram of comprehensive dominance, the dominance of proposal 1 is much higher than proposal 2 and proposal 3 and the dominance


Here are the overall synthesized priorities for the alternatives. You synthesized from the network Super Decisions Main Window: Optimization of design proposal of community environment landscape based on ANP model and SD software.sdmod

Name	Graphic	Ideals	Normals	Raw
CASE1		1.000000	0.450889	0.225444
CASE2		0.656924	0.296200	0.148100
CASE3		0.560918	0.252912	0.126456

Fig. 6: The comprehensive dominance of three proposals

of proposal 2 is close to proposal 3. Therefore, proposal 1 is the optimal proposal.

CONCLUSION

The optimization of design proposal of community landscape environment can be obtained from five aspects: eco-environment, aesthetics, environment, place environment, cultural environment and facilities environment, which are further subdivided into 15 indexes.

The ANP model established by the feedback relationship between the evaluation index and the candidate design proposals of community environment landscape enables a quantitative treatment of decision. Supper Decisions software is used in calculation to obtain the hybrid weight of the 15 indexes and the comprehensive dominance of 3 proposals and finally the optimal proposal is obtained.

ANP model is very suitable for the optimization decision of design proposals of community environment landscape. SD software provides a computerized approach of ANP model calculation, which greatly simplifies the process and calculation of optimization.

REFERENCES

Chen, M., W. Liu and X. Tao, 2013. Evolution and assessment on China's urbanization 1960-2010: Under-urbanization or over-urbanization? Habitat Int., 38: 25-33.

Garcia-Melon, M., T. Gomez-Navarro and S. Acuna-Dutra, 2012. A combined ANP-delphi approach to evaluate sustainable tourism. Environ. Impact Assess. Rev., 34: 41-50.

Hsu, T.H., L.C. Hung and J.W. Tang, 2012. A hybrid ANP evaluation model for electronic service quality. Applied Soft Comput., 12: 72-81.

Jung, U. and D.W. Seo, 2010. An ANP approach for R and D project evaluation based on interdependencies between research objectives and evaluation criteria. Decision Support Syst., 49: 335-342.

Lin, Y.H., C.C. Chiu and C.H. Tsai, 2008. The study of applying ANP model to assess dispatching rules for wafer fabrication. Expert Syst. Appl., 35: 2148-2163.

Mahdavinejad, M. and M. Abedi, 2011. Community-oriented landscape design for sustainability in architecture and planning. Proc. Eng., 21: 337-344.

Niemira, M.P. and T.L. Saaty, 2004. An analytical network process model for financial-crisis forecasting. Int. J. Forecasting, 20: 573-587.

Sun, H.C., G.Y. Xu and P. Tian, 2007. Evaluation of the design alternatives of emergency bridge by applying Analytic Network Process (ANP). Syst. Engin. Theo. Pract., 27: 63-70.

Vidal, L.A., F. Marle and J.C. Bocquet, 2011. Using a Delphi process and the Analytic Hierarchy Process (AHP) to evaluate the complexity of projects. Expert Syst. Appl., 38: 5388-5405.

Vizzari, M., 2011. Spatial modelling of potential landscape quality. Applied Geogr., 31: 108-118.

Yuksel, I. and M. Dagdeviren, 2007. Using the Analytic Network Process (ANP) in a SWOT analysis. A case study for a textile firm. J. Inform. Sci., 177: 3364-3382.