Study on Organizational Guarantee System of Integrated Design of Infrastructures in Large-scale Park

Jun Fang, Dingyuan Wu and Yifan Wu

ABSTRACT

As the basic carrier of the development and construction of large-scale parks, infrastructure is an important driving force to promote the overall function of it and achieve economic benefits. Considering the universality and complexity of the integrated design of infrastructures in large-scale park, it is of great significance to conduct in-depth research on which in terms of organizational guarantee. This article first expounds the related concepts of infrastructures in large-scale park, and weights the indexes by using AHP weighting method on the basis of experts’ investigation. Then, combined with variable weight comprehensive evaluation method, this article evaluates the maturity of the comprehensive design and guarantee system of integrated design of infrastructures in large-scale park. Finally, an empirical analysis is used to verify the validity of the model.

INTRODUCTION

As a new form of industrial organization, large-scale park has accelerated the flow of information, knowledge and trade, playing a fundamental role in the process of economic development [1]. The design of infrastructures in large-scale park needs to formulate integrated design objectives, organizational structure, working mechanism and management system in terms of the design requirements. Each design unit takes the integrated design objective as the guidance, following the integrated design pattern management system and the work flow, so as to form the organic organization through the organization member's adjustment.

1Jun Fang, Dingyuan Wu, Yifan Wu. School of Civil Engineering and Architecture, Wuhan University of Technology, Wuhan, China, 430070.
Figure 1. The logic of the organization of integrated design patterns.

For the construction of organizational guarantee system, mainly based on the progress and development trend of railway and coal mine projects, a series of suggestions on the construction and improvement of the security system are put forward from different angles [2][3]. Based on the study of different planning systems, the characteristics of research activities carried out by different types of research organizations in accordance with the paradigm are discussed [4]. Some scholars mainly optimize it from three aspects: evaluation organization, expert system and material security system, but the research on the construction of organizational security system mainly focuses on organizational level, organizational objectives, organizational functions and management system [5]. Current research on organizational hierarchy usually focuses on specific innovation project stages or innovative management concepts. Due to different organizational hierarchies, there are differences in the execution of dynamic capabilities between routines and expected plans [6][7]. Changes in organizational goals are closely related to organizational commitment (OC), organizational trust (OT) and organizational identity (OI) [8]. And organizational cognitive framework determines the allocation of resources for organizational development, is an important guarantee for sustainable development of enterprises [9]. For the organization management system, we should follow the connotation, driving type and characteristic of timeliness [10].

RELATED CONCEPTS

Large-scale Park

The definition of infrastructure in the world development report (1994 edition) is: permanent engineering equipment, buildings, and facilities for production by all enterprises, as well as services for the living needs of enterprises and residents. This article defines the infrastructures in large-scale park as: the social and economic
infrastructures with the basic objectives of production and the stable service functions, serving the enterprises and residents in large-scale parks. On the whole, the infrastructures in large-scale park as a complete system, has a long construction cycle, involving a wide range of uncertainties. In addition, once the infrastructures in large-scale park are completed, the public goods and public services they provide do not have specific objectives, and no organization or individual can exclude the use of resources by others. While the enterprises and residents enjoy the relevant public goods and services, their cost of living naturally covers the service value of infrastructures. This reflects the significant basic, shared, advanced and complex characteristics of infrastructures in large-scale park.

Organizational Guarantee System

According to the management theory, organization refers to an open system with specific functions, which is combined by certain structures, forms and activity laws to achieve a common objective in a certain environment. In terms of the smooth realization of security objectives, the organizational guarantee system is an integrated system established on the basis of specific organizational elements, through scientific and reasonable allocation and connection of them. For the integrated design of infrastructures in large-scale park, "guarantee" reflects a dynamic development trend, which is mainly reflected in the implementation subject and content of the integrated design, from the "government-oriented" integrated design of infrastructure to the integrated design of basic design involving multi-interest groups. "System" covers all the elements in the internal structure and their correlation, providing a controlled and overall decision-making environment for the implementation of integrated design from the time and space dimensions.

CONSTRUCTION OF AN EVALUATION MODEL FOR THE MATURITY OF ORGANIZATIONAL GUARANTEE SYSTEM

Selection of Indexes

PRINCIPLES OF SELECTION OF INDEX

(1) Principle of systematization. The evaluation indexes must be interrelated and interacted with each other. And the construction of the index system should take into account the relevance, objective, orderliness and integrity of the indexes.

(2) Principle of independence. The evaluation indexes must be mutually verified and complementary, but the overlapping of the connotations of the indexes should be avoided. Otherwise, they will affect the objectivity of the index system.

(3) Principle of measurability. The measurement cost and difficulty of the evaluation indexes should not be too great, and it should be convenient to transform the qualitative description of the indexes to the quantitative scale.
(4) Principle of flexibility. According to specific needs, the selection of evaluation indexes must be adjusted to meet the function of dynamic evaluation of evaluation model promptly.

(5) Principle of effectiveness. The selection of evaluation indexes must be based on key factors. Too many indexes will result in cumulative calculation complexity and errors, which will greatly increase the cost of evaluation.

PRELIMINARY SELECTION OF INDEXES

Mature and perfect organizational guarantee system is an important factor to promote the integrated design level of infrastructures in large-scale park. In order to investigate the maturity of its organizational guarantee system, the following evaluation indexes are set up for analysis.

(1) Structural establishment. The organizational structure of the integrated design team is directly related to the efficiency of the design work. It exists mainly for the operation of planning, decision-making, execution and inspection. In order to ensure the independent operation of the design work, it is necessary to clearly divide the organizational structure.

(2) Process management. Efficient process management is the basis of organizational coordination of integrated design team, which can provide a basis for the operation of various design work and avoid their interaction, so as to achieve the optimal allocation of resources.

(3) Information management. The advancement of design information depends on the application and innovation of new information technology. All links of design work need to obtain timely and accurate information, so as to enhance the level of cooperation of integrated design team.

(4) Risk management. Risk management of organization covers the whole process of integrated design, including planning, decision-making, execution, inspection and other links. In order to ensure the smooth progress of design work, it identifies, evaluates and responds to the possible risk factors.

(5) Culture construction. In order to continuously promote the design ability of the integrated design team, it is necessary to build an organizational culture that conforms to its own characteristics and reflects its own characteristics, continuously enhancing the cohesion and identity of the team, and creating a united working atmosphere.

(6) Resource allocation. The organizational resources include human resources and material resources. The introduction of professional talents makes the integrated design team competent for all kinds of design work, and the allocation of material resources is conducive to the development of professional design level.

(7) Importance of leadership. Leader's attention will directly affect the sensitivity of the integrated design team around the allocation of design resources, constantly eliminates the interference of potential uncertainties, and grasps the overall design progress and design results.
Construction of Index System

SELECTION OF EXPERTS

The experts in this article come from excellent construction enterprises and well-known colleges of architecture. They are mainly engaged in project management, and have rich professional knowledge and practical experience.

<table>
<thead>
<tr>
<th>Organizational Guarantee ($A_1$)</th>
<th>Structural establishment ($A_{11}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Process management ($A_{12}$)</td>
</tr>
<tr>
<td></td>
<td>Information management ($A_{13}$)</td>
</tr>
<tr>
<td></td>
<td>Risk management ($A_{14}$)</td>
</tr>
<tr>
<td></td>
<td>Culture construction ($A_{15}$)</td>
</tr>
<tr>
<td></td>
<td>Resource allocation ($A_{16}$)</td>
</tr>
<tr>
<td></td>
<td>Leader’s attention ($A_{17}$)</td>
</tr>
</tbody>
</table>

ASSESSMENT OF EXPERTS

(1) Based on the effective questionnaires, the membership of the index has been analyzed after completing the survey data. Suppose the number of the index is $M_i$, and there $W_i$ experts think $M_i$ is an important index, so its membership $r_i$ satisfies the formula (1). If the $r_i$ is big, it suggest that the index is importance. According to the size of the $r_i$, the least will be eliminated.

$$r_i = \frac{W_i}{10}$$ (1)

(2) After the preliminary screening of the indexes, the remaining indexes are evaluated according to the expertise and practical experience of experts. Firstly, suppose that the evaluation index system of the evaluation objects is $C = (C_1, C_2, \ldots, C_n)$, m experts are invited to evaluate the elements in the evaluation index system C in terms of the importance degree; Secondly, determine the weight of each expert, which is defined as $P_j$ ($j = 1, 2, \ldots, m$), and it satisfies the formula (2); Finally, complete the scoring of the importance of each index.

$$\sum_{j=1}^{m} P_j = 1, (j = 1, 2, \ldots, m)$$ (2)

DETERMINATION OF INDEX WEIGHT

The experts use the 1-9 scale method to collect the scores at the same level, and construct judgment matrix by using three level index averages, which is Quasi-
optimal transfer matrix. The new matrix itself is consistent, directly avoiding consistency checks.

<table>
<thead>
<tr>
<th>Degree of importance</th>
<th>Equally important</th>
<th>Slightly Important</th>
<th>Obviously important</th>
<th>Very important</th>
<th>Absolutely important</th>
<th>Importance interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assignment</td>
<td>1</td>
<td>3</td>
<td>5</td>
<td>7</td>
<td>9</td>
<td>2,4,6,8</td>
</tr>
<tr>
<td>Opposite value</td>
<td>1</td>
<td>1/3</td>
<td>1/5</td>
<td>1/7</td>
<td>1/9</td>
<td>1/2,1/4,1/6,1/8</td>
</tr>
</tbody>
</table>

Table II. 1-9 RATION SCALE METHOD SCALE AND ITS MEANING.

Firstly, use the mean formula to get the judgment matrix
\[
A = \begin{bmatrix}
    a_{11} & \cdots & a_{1n} \\
    \vdots & \ddots & \vdots \\
    a_{n1} & \cdots & a_{nn}
\end{bmatrix}.
\]

Secondly, use the formula (3) to get the quasi-optimal transfer matrix
\[
C = \begin{bmatrix}
    10^{c_{11}} & \cdots & 10^{c_{1n}} \\
    \vdots & \ddots & \vdots \\
    10^{c_{n1}} & \cdots & 10^{c_{nn}}
\end{bmatrix}.
\]

\[
c_{ij} = \frac{1}{n} \sum_{k=1}^{n} (\log a_{ik} - \log a_{jk})
\]

(3)

Finally, use the formula (4) to normalize the \(\omega_i\) to get the maturity index weight
\[
\omega = [\omega_1, \omega_2, \omega_3 \cdots, \omega_n]^T.
\]

\[
\omega_i = \sqrt[n]{\prod_{j=1}^{n} 10^{c_{ij}}}, i = 1,2,3\cdots,n
\]

(4)

Construction of Evaluation Model

Firstly, after the experts has scored the indicators according to the scoring criteria of the indicators and has completed the standardized processing of the scoring of the indicators, use formula (5) to calculate the variable weight vector in the specific indicator state.

\[
s_j(x) = \begin{cases}
    \frac{c-1}{\alpha} x_j, & x_j \in [0, \alpha] \\
    c, & x_j \in [\alpha, \beta] \\
    \frac{1-c}{1-\beta} x_j + \left[1 - \frac{1-c}{1-\beta}\right], & x_j \in [\beta, 1]
\end{cases}
\]

(5)

Where \(\alpha\), \(\beta\) and \(c\) are the parameters in \([0, 1]\), respectively, \(\alpha\) is defined as negative level, \(\beta\) is defined as incentive level, and \(c\) is defined as adjustment level. The specific values of \(\alpha\), \(\beta\) and \(c\) are uniformly agreed by the enterprise experts, and \(x_j\) is the standardized evaluation value of the index.
Secondly, combined with the constant weight vector of each index \( w = (w_1, w_2, \cdots, w_m) \), the standardized evaluation value of the index \( x = (x_1, x_2, \cdots, x_m) \), variable weight vector for each index \( s(x) = (s_1(x), s_2(x), \cdots, s_m(x)) \), use the formula (6) to get the variable weight vector of each index.

\[
    w(x) = \left[ \frac{w_1 s_1(x)}{\sum_{j=1}^m w_j s_j(x)}, \frac{w_2 s_2(x)}{\sum_{j=1}^m w_j s_j(x)}, \cdots, \frac{w_m s_m(x)}{\sum_{j=1}^m w_j s_j(x)} \right] \tag{6}
\]

Finally, use the formula (7) to calculate the comprehensive evaluation value of maturity.

\[
    v(x) = \sum_{i=1}^m w_i(x) x_i \tag{7}
\]

**Analysis and Evaluation of Maturity**

Based on the relevant research results at home and abroad, this article divides the maturity into five grades, each grade and its related characteristics are as follows:

1. Preliminary level: The organizational guarantee system has been initially constructed, but the division of powers and responsibilities of various internal departments is unclear, and the design teams lack the necessary cooperation.

2. Growth level: The organizational guarantee system has yet to be deepened, and the internal responsibilities of various departments have been defined ambiguously. Besides, the concept of cooperation has been established between design teams.

3. Specification level: The organizational guarantee system is relatively standardized, the division of powers and responsibilities of various internal departments is relatively clear, and the design teams form a certain degree of closeness.

4. Control level: The organizational guarantee system is relatively mature, the internal powers and divisions of each department have a basis, and the design teams can complete the work based on cooperation.

5. Optimization level: The organizational guarantee system is very perfect, the division of powers and responsibilities of each internal department is scientific and reasonable. The design teams can complete the work efficiently, and has the potential of continuous optimization and innovation.

After completing the classification of maturity level, experts will discuss the comprehensive evaluation value range of maturity level and obtain the final evaluation of maturity.
EMPIRICAL ANALYSIS

To take the organizational guarantee system of integrated design of infrastructures in large-scale park in a city as an example, a total of 10 enterprise experts and school experts were selected to participate in the empirical analysis.

Determination of Parameters

According to the above seven evaluation indicators, namely, structural establishment (A11), process management (A12), information management (A13), risk management (A14), culture construction (A15), resource allocation (A16), importance of leadership (A17). After the evaluation by experts, it is considered that the risk management (A14) of the organization is too broad, the specific measures of which also overlap with the measures such as process management and information management, and thus, it should be eliminated. And then, through the formula (1), formula (2) and 1-9 scale method, the summary of the importance of the residual evaluation indexes after expert scoring is as follows:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural establishment (A11)</td>
<td>1.0</td>
<td>1.8</td>
<td>1.6</td>
<td>1.9</td>
<td>2.0</td>
<td>2.2</td>
</tr>
<tr>
<td>Process management (A12)</td>
<td>1.0</td>
<td>1.0</td>
<td>2.2</td>
<td>2.3</td>
<td>2.3</td>
<td>2.4</td>
</tr>
<tr>
<td>Information management (A13)</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>2.5</td>
<td>2.4</td>
<td>2.5</td>
</tr>
<tr>
<td>Culture construction (A14)</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>0.8</td>
<td>1.1</td>
<td>1.0</td>
</tr>
<tr>
<td>Resource allocation (A15)</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.5</td>
<td>1.0</td>
</tr>
<tr>
<td>Importance of leadership (A16)</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td></td>
</tr>
</tbody>
</table>
Firstly, use the mean formula to get the judgment matrix

\[ A = \begin{bmatrix}
1 & 1.8 & 1.6 & 1.9 & 2 & 2.2 \\
0.56 & 1 & 2.2 & 2.3 & 2.3 & 2.4 \\
0.63 & 0.45 & 1 & 2.5 & 2.4 & 2.5 \\
0.53 & 0.43 & 0.4 & 1 & 0.8 & 1.1 \\
0.5 & 0.43 & 0.42 & 1.25 & 1 & 1.5 \\
0.45 & 0.42 & 0.4 & 0.91 & 0.67 & 1
\end{bmatrix}. \]

Secondly, use the formula (3) to get the quasi-optimal transfer matrix

\[ C = \begin{bmatrix}
1 & 1.07 & 1.34 & 2.59 & 2.28 & 2.84 \\
0.93 & 1 & 1.24 & 2.41 & 2.13 & 2.64 \\
0.74 & 0.81 & 1 & 1.94 & 1.71 & 2.13 \\
0.39 & 0.42 & 0.52 & 1 & 0.88 & 1.09 \\
0.44 & 0.47 & 0.58 & 1.13 & 1 & 1.24 \\
0.35 & 0.38 & 0.47 & 0.92 & 0.81 & 1
\end{bmatrix}. \]

Finally, use the formula (4) to normalize the \( \omega_i \) to get the maturity index weight

\[ \omega = [0.26, 0.24, 0.19, 0.11, 0.11, 0.09]^T. \]

**Analysis of Maturity**

The normalized scores obtained after scoring by experts are recorded as \( x = (0.48, 0.49, 0.49, 0.32, 0.17, 0.25) \). Based on the formula (5), defined after expert discussion, \( \alpha = 0.4 \), \( \beta = 0.8 \) and \( c = 0.2 \). That is, when an index score is less than 4 points, it is necessary to reduce its weight to punish it. When an index score is greater than 8 points, it needs to increase its weight to motivate it, and the index whose score is between 4 points and 8 points is neither punished nor motivated.

The maturity level is divided into five grades: optimization level: \( V(X) \geq 0.8 \), control level: \( 0.6 \leq V(X) \leq 0.8 \), specification level: \( 0.4 \leq V(X) \leq 0.6 \), growth level: \( 0.2 \leq V(X) \leq 0.4 \), preliminary level: \( V(X) < 0.2 \).

Combined with the constant weight vector of each index \( w_i(x) = (0.13, 0.12, 0.09, 0.06, 0.06, 0.05), i = 1, 2, 3, 4, 5, 6 \), variable weight vector for each index \( s_j(x) = (0.20, 0.20, 0.20, 0.20, 0.36, 0.66, 0.50), j = 1, 2, 3, 4, 5, 6 \), use the formula (6) to get the variable weight vector of each index \( w(x) = (0.169, 0.156, 0.117, 0.140, 0.257, 0.162), r = 1, 2, 3, 4, 5, 6 \).

Finally, use the formula (7) to calculate the comprehensive evaluation value of maturity is 0.344. It can be seen that the organizational guarantee system of integrated design of infrastructures in large-scale park is in the growth level of the mature level.

**Proposed Proposal**

From the feedback of the score sheet, the scores of organization's resource allocation (\( A_{16} \)) and Importance of leadership (\( A_{17} \)) are relatively low. This article
analyzes and demonstrates the corresponding improvement measures for the above two indexes after consulting the experts.

In order to optimize the allocation of organizational resources in the organizational guarantee system of integrated design of infrastructures in large-scale park, it is necessary to deepen the understanding of the meaning of effective allocation of resources, establish a scientific work target sequence under the premise of limited resources, and introduce a contingency management mechanism in resource allocation.

Given the importance of improving the leadership of the organizational guarantee system of integrated design of infrastructures in large-scale park, it is necessary to clarify the construction of the organizational security system. It is of great significance to promote the integrated design mode, strengthen the ability of integrated design and expand the means of integrated design. It is also helpful to enhance the foresight and foresight of related work.

CONCLUSIONS

(1) This article studies the organizational guarantee system of integrated design of infrastructures in large-scale park, describes the related concepts of infrastructure and organizational guarantee systems in large-scale park, and clarifies the important role of the construction of organizational guarantee systems in the integrated design of infrastructures.

(2) In this article, the weighted method of AHP and the comprehensive evaluation method of variable weights are used to construct the evaluation model, which can be used to quantitatively describe the maturity of the integrated design guarantee system of infrastructure in large-scale parks. The validity of the model is verified by empirical analysis and some pertinent suggestions are put forward.

(3) The construction of evaluation mode in this article also has some shortcomings. In the future research, we need to overcome the influence of human factors on the selection of indicators. At the same time, the universality of the index system needs to be further tested.

REFERENCES


