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## Performance evaluation and application research of management system

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### ABSTRACT

This paper applied the theory of systems engineering, took the manage object as a system, analysed the management system which was affected by determining factors and uncertainties, combined with mathematical statistics, proposed system should be established to reflect the accurate and complete index system. We must have working index, and also have assessment indicators, the selection method of evaluation indicators and working index should be consistent with the characteristics of the system, and therefore the mathematical model is established for the choice of indicators, and finally this method in the subject, "research of enterprise technological innovation which was based on intellectual property strategy mechanism", is effectively applied, so that the subject received the second prize of the National Supply and Marketing Cooperative Research Award.

### KEYWORDS

Management system; Performance evaluation; Uncertainty index.



## INTRODUCTION

Management is an important task in socio-economic activities, we call the objects of management "system." It is a combination which has specific function made up of several mutual difference, interdependent, interacting elements. System can be divided into general physical systems and human istic systems. Managed Objects bascially are humanistic systems. Humanistic system is a system that has highly complexity and highly openness, whose behavior is so closely related to human judgements, perception, thinking. From the scale and complexity, the humanistic system generally is a large system. Large system has characteristics such as complicated structure, large and numerous parameters, function integrated and diverse. On the humanistic system, people know and transform it in order to control the system to develop in accordance with the requirements of people, for this reason, the way to deal with such systems, mainly to describe the system's operational rules objectively, and make judgments on the system behavior to predict the consequences. The main features of these activities are dealing with highly complex systems. L. A. zadeh has ever summarized by exclusion principle: "When a system's complexity increases, our ability to make it precise will be reduced. In a certain value, complexity and accuracy will be mutually exclusive. Or that the higher the complexity of the system, the higher the pursue of the accuracy of the results, will inevitably lead to the reduce of ability to handle complex systems. "

System process procedure, in essence, is the procedure of system information processing. Resolution is a problem of information processing, resolution describes the level of index distinguishes system information. For complex systems, information to distinguish is too small, easily leading to information analysis, statistical work being too cumbersome, traditional quantitative mathematical theory, methods and models can not adapt the processing of humanistic system, particularly with regard to human knowledge, thinking and other issues, according to zadeh's exclusion principle, taking into account the human's ability to handle complex systems, there must be a compromise between the system complexity and accuracy, and simplify the complexity of the system. An effective method to deal with complexity and the processed precision is to address system to describe the system by introducing a certain degree of uncertainty.

Uncertainties, there are two categories. One in which accidental factors play a role, is the random uncertainty of the probability in the traditional sense; the other is the existence of the ambiguity, that is to say, fuzzy type. Fuzzy uncertainty which can be divided into two types: one is the ambiguity due to incomplete information of objective things, so that people can not form a precise perception and concepts; the other is the general nature, it is also because objective things have the incompleteness of the information, only know that it is in a certain range, and can not give precise descriptions, that is, call this interval uncertainty. To simplify the complexity of the system, the introduction of uncertainty is the fuzzy uncertainty model (including fuzzy and vague nature), which includes the ambiguity of the system and human understanding of the ambiguity of the system, what results in blurred type of uncertainty, first, things have developed mediation between the poles of the transition (for example, a person's height, from high to low knocked in quite some average height), the second is the complexity of the system, that is, the diversity of elements and complexity of relationship, which makes the handling of the system difficult to proceed accurately, the third is the development and changes of things which are difficult to grasp accurately.

The description of the system for processing system is to describe the system properties and the relationship between them. Because the system property is to describe the system basic structure, features and related factors on the variations, and the system description of the property is the index description, thus indicators are the technical parameters that can describe the system basic structure, features and variable quantity that can describe related factors' changes in system.

With the continuous development of society, the change from industrial society to information society is taking place, what people need to understand and transform are humanistic systems, Due to

the complexity of humanistic systems, and the descriptions have to rely on the system uncertainty, thus the indicators reflecting the system properties contains not only certain information, but also includes uncertainty information. As there are large numbers of indicators and indicators related to each other in complex systems, how to avoid duplication of information when the system is described, that is, how to select the representative indicators and how to deal with uncertain information from the complex and diverse system indicators, becomes the key to a processing system.

In the scientific research projects " research of enterprise technological innovation which was based on intellectual property strategy mechanism ", I recognize the mechanism of enterprises in technological innovation play a decisive role in the humanistic system which has many uncertain factors that influenced technological innovation of enterprises. For example, the cultural factors in the humanistic system decide the main methods, power and results of enterprises' technical innovation, at present, uncertain information of the index to systems' function is still a subjective decision by artificial experience, and using scientific means to complete is needed.

The accurate and complete description of humanistic systems is essential. The traditional method of selecting indicators can be divided into two major categories of qualitative and quantitative, including on behalf of the Amalfi method (Delphi), membership function, fuzzy weighted clustering, principal component analysis, fuzzy comprehensive evaluation method, etc., they have something in common : in the choice of indicators, take indicators of the technical parameters (such as indicators of actual value) as the main basis, by means of establishing continuous function to select the indicators, is a processing procedure for certain information of systems, for uncertain information, although refer to fuzzy math, but not really combine the factors of certainties and uncertainties in system's description.

Hence, I think that an objective description of the system information is comprehensive description of both certainty and uncertainty, some of the uncertainty factors must be combined with the certainties in order to reflect the role of the uncertainty, such as the complete description of indicators of technological innovation and performance index assessment, not only should include the difference between assessment of the value and the ideal target value (target), the size of the index itself should also contain technological innovations, which do affect the degree of importance uncertainties. Therefore, how to deal with uncertainty and certainty relations and through them the choice of indicators to describe the system correctly are the key point of this text.

### **Management systems analysis**

System is composed by the elements. Systems that humans know have certain structure and function. Structure can be understood as way and order between the association and interaction within the space and time aspects about constituent elements, and the system structure is hierarchical, it is an objective of complex system, in accordance with the contact elements way, the system is running a similar law, functional characteristics and scale of human knowledge to be divided. Function of the system can be understood as interconnected systems and external environment, the interaction of order and ability, it reflects the material, energy and information exchange capabilities between the external environment and a system

In sum, the system structure is the order of the interaction of the elements within the system, the system function is the role of process system to the outside. System function  $F$  and system elements  $C$ , the structure  $T$ , the environment  $E$  can be expressed as:

$$F = f(E \bullet C \bullet T) \quad (1)$$

Implementation of system functions can be seen by the interaction of elements of the system, structure, environmental. Description of the system reflects the influence of certainties and uncertainties.

### **The principle and characteristics of composing index system**

Based on the above analysis of the system, constitute a special index system proposed by the principle: selection of indicators to describe the system properties should consider indicators of the certain information and uncertain information synthetically. To deal with certain information on the difference between actual value and ideal value in quantitative dimension; refer to fuzzy uncertainty information, quoting systems engineering approach, comprehensive consideration of the function and the environment, systems and indicators, the relationship between indicators and targets, finally selecting "most representative" indicators of describing system properties.

"Most representative" in this principle, there the following meanings:

1) *High information content of index refers to the deviation between the actual value and the ideal value (reference value) is large.*

2) *High weight coefficient of index.*

Based on large amount of information, weight coefficient shows the interaction between indicators and system environment, weight coefficient's big or small is determined by the degree that index affects on the system. The choice of indicators should be selected from indicators of the larger weights. For example, Taiyuan, environmental pollution due to dust pollution mainly, therefore exhaust emission index associated with the dust pollution is greater than the weight of water pollution index.

Comprehension of certain information and uncertain information can rely on a theory of information integration theory. The description of System S under the influence of uncertain factors is expressed as:

$$S = \sum W_i S_i \quad (2)$$

In the formula:

$W_i$  is the system under the influence of uncertain factors in determining information on the results of the likelihood values, you can use the "weight" to represent.

$S_i$  is a system's result on certain information's effect.

The theory thinks that the impact of uncertainties on the system, thus the system's operating result on the merely certain element's effect may arise deviation, this deviation can reflect from the likelihood values of  $S_i$  ( $W_i S_i$ ) to reflect.

Indicator system determined according to the principle and the analysis of system structure to form the index system should have the following characteristics:

1) *orientation*. The so-called orientation is the final selection of indicators to describe the system corresponds with the system objectives, and support the achievement of goals, means that there is relevance of information between indicators and system objectives.

2) *Integrity*. Final selection of the indicators reflects and covers the system properties comprehensively and accurately in their mutual cooperation.

3) *Scientificity*. Selected indicators should accurately reflect the nature of the system.

4) *Objectivity*. Selected indicators on the basis of corresponding objectives should objectively reflect the system and the role of environment on the system.

5) *Information redundancy small*. As indicators of information are in association and a number of indicators, complicated relationship, easily lead to duplication of information, so on the overall basis, the selected "primary indicators" must have a very small number, thereby reducing the information redundancy.

### **The elements of indicators selection basis**

Target selection process is essentially a process that the properties of the system integrated, based on the following elements:

1) *Objectives*. Goal is a description of the system state expectations which is the basis for index selection criteria.

2) *Index*. Selecting indicators is based on the indicators set, the indicators in the indicators set are the description of system properties, they can be quantitative (including semi-quantitative), and understandable. Understandable is to ask the index value sufficient to show the extent of objectives to be met.

3) *Index selection rules*. These are principle used to arrange the relative importance, it requires not only indicators contains much information, but also a large index weight.

4) *State of the system*. State is the characteristics of the system at a particular time, it is made up of the index value at T. Index selection theory proposed to select index based on the difference between the actual state value and the ideal is one of the basis.

### The method for determining system indicators' resolution

Based on the system indicators identified theory, index selection must clear understand the purpose of the system firstly. The purpose of understanding of the system and then manage the system, are generally divided into two: one is horizontal comparison to the system and find the differences between systems, thus highlighting the characteristics of each system. The selected indicators in such a target are assessment indicators, under it is often compared by the examination systems of the system to evaluate the process and results of operation, so the same system for the assessment have different indicators; the other purpose of understanding the system is to evaluate the development of the system, forecasting, which requires the system to reflect its true objective of the development cycle, the focus. The different periods in the same system, due to the development of a different direction, focusing on different indicators selected as indicators of performance.

#### A. The method of selecting evaluation indicators

Comparability between systems realized through comparison indicators of each system, according to elements of the system indicators selected, with the purpose of assessment indicators selection and the principal component analysis, a mathematical model of assessment indicators selected were:

$$X_{ij} = \frac{W_j (C_{ij}(t) - \bar{C}_j(t))}{S_j} \quad (3)$$

$$R_{jk} = \frac{1}{N} \sum_{i=1}^n X_{ij} \cdot X_{jk} \quad (4)$$

$$R = (r_{jk}) \quad (5)$$

$$\frac{\sum_{j=1}^m \lambda_j}{\sum_{j=1}^p \lambda_j} \geq 85\% \quad (6)$$

Where:  $C_{ij}(t)$  -refers to the actual state values.

$C_{ij}(t)$  - the dimensionless value affected by fuzzy factors.

$\overline{C_j}(t)$  - j-all system indexes in the mean at time t. system of indicators at time t the actual state value.

$$S_j \text{ -index standard deviation } S_j = \left[ \frac{1}{N} \sum_{i=1}^n W_j^2 (\overline{C_{ij}}(t) - C_j(t))^2 \right]^{\frac{1}{2}}$$

$r_{jk}$  -indices j and k index the correlation coefficient between.

$W_j$  -index j weight.  $R$  -correlation matrix of the system.  $\lambda_j$  -correlation matrix  $\lambda$  eigenvalues.

$$\lambda_1 \geq \lambda_2 \geq \dots \geq \lambda_p \geq 0$$

$m$  -the number of indicators  $\lambda$ .

$i$  - the total number of system.  $i = 1, 2, \dots, N$

$J$  -the number of indicators to be selected.  $j = 1, 2, \dots, P$

The approach of the above modeli is that firstly principal component analysis obtained some components from original index, the amount of information of these components included reduced in turn. the last contained little information, so linear-type component which weight is large can be removed. Because the indicators play a major role in the component, and the component contribution to all of the information is small, removing the indicator has no important influence on the description of the system, then repeat the process of analyzing the remaining principal component and removing indicators, finally N representative indicators can be got.

The steps to determine assessment indicators:

- 1) the system's total index according to the system, characteristics system (index set), usually adopted expert consultation in systems engineering.
- 2) Determine the weight of each index based on Indicators and the relative importance of indicators

$$W_j (j = 1, 2, \dots, P)$$

- 3) Using each index of (1-1) type, witch make dimensionless processing to achieve comparable purpose.
- 4) Calculating coefficient of correlation matrices  $r_{jk}$  of each system which use index of (1-2) type and coefficient of correlation matrix  $R$ .
- 5) Ask the eigenvalues of the correlation matrix, written for  $\lambda_1 \geq \lambda_2 \geq \dots \geq \lambda_p \geq 0$  and the corresponding feature vector.

$$C_L = [C_{L1}, C_{L2}, \dots, C_{LP}] \quad L = 1, 2, \dots, P \tag{7}$$

- 6) Select M principal components, according to the type (1-4). M principal components include above 85% of the entire information, and  $B_{ij} \geq B_0$ .

7) Determine the evaluation index. According to the provisions to select enormous power major index as a system of transverse comparison between assessment index of this section selecting the evaluation index of thought in M principal components.

**B. The method of selecting performance index**

Another purpose of understanding the system requirements on the system is to determine the work index. Index of the target refers to some indexes in the system objective conditions should be allowed to achieve the expected in a week period. The objective conditions of the system is essentially a system determined by the internal and external factors and uncertainties conditions.

This is the choice model of performance indexes:

$$B_{ij} = P_{ij} \quad (8)$$

$$B_{ij} \geq B_0 \quad \text{indicators selected} \quad (9)$$

$$B_{ij} < B_0 \quad \text{index is not selected} \quad (10)$$

Where:  $B_{ij}$  -the index distinguish degrees of  $i$  system and  $j$  index. It is the basis of index selection.

$B_0$  - the index selection thresholds. According to index distinguish  $B_{ij}$  to reflect the system information degrees and the human processing system ability artificial determine.

$P_{ij}$  -index discrimination of  $i$  system and  $j$  index.

The index discrimination:

$$P_{ij} = \frac{(D_{ijs \text{ standard}} - D_{ij})}{S_j} \quad (11)$$

Where:  $P_{ij}$  -Index discrimination of  $j$  index for  $i$  system

$S_i$  -the index variance of  $i$  system  $i = 1$

$$S_i = \left[ \frac{1}{P} \sum_{i=1}^p (D_{ij} - D_{ij})^2 \right]^{\frac{1}{2}}_{\text{基准}} \quad (12)$$

$D_{ij}$  benchmarks –in working index, the fuzzy factors influence the system on different systems through the same indicators to reflect the different target, means standard  $D_{ij} = D_{ij}$  target. This is due to different systems with different starting point in the same period, the objective conditions and different uncertain factors' effect, from the work ability and work performance evaluation perspective, the target value should be different in different systems (reference value).

The above model reflected: discriminability index is big, means index information content is big, so indicators can be selected, discriminability index is small, means that the index in the system has reached the reference value, or close to the reference value, current period is not a key point.

## CONCLUSION

Through the above study of assessment indicators and methods of selecting working index, it can be seen, in order to reflect the homochronous comparability of each system, assessment indicators should have global quality, comparability, comprehensiveness, objectivity and other characteristics ; in

order to reflect different working point and outstanding performance of the same system, working index should be comprehensive, and pertinent. Only in this way can evaluate a system be accurately and objectively, make the system had further development through the evaluation and management.

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