Research on the Evaluation System of Fire Fighting Information Based on Fuzzy Comprehensive Evaluation

Ma Jinqiang
Chinese People’s Armed Police Forces Academy, Langfang, Hebei, China
e-mail: wjxy001@126.com

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Abstract. The requirements of fire fighting informatization is the development of the times. The only way to achieve modernization of the fire fighting work and to adapt to the rapid development of society and economic. The level of fire fighting informatization construction must be evaluated scientifically and objectively so that it can provide basis about fire fighting informatization construction for the higher authorities. In this paper, establishing a set of fire fighting informatization evaluation system with the the characteristic of clear results, systematic and better to solve the problem of ambiguous, difficult to quantify through fuzzy comprehensive evaluation method. Firstly, to establish a new mechanism to reflect the level of fire fighting informatization and effect, that is, "former -mid-after" information evaluation mechanism; then establish a scientific, reasonable and feasible index system in accordance with the principle of fuzzy comprehensive evaluation method, then transform the informatization construction's quality from qualitative evaluation into quantitative evaluation and give informatization construction fire fighting assessment calculation method based on fuzzy theory.

Introduction

Nowadays, the informatization construction has increasingly become the foundation of the world's social development. the informationization level has become a measure of a country, a region, a sign the industry -developed standards. Fire prevention information is the development of the times, the public security and fire building work to adapt to the rapid socio-economic development and achieve the fire service modernization. Establishment of fire prevention digitization, standardized management, command of modern information network, office automation fire information system , is directly related to the fire brigade fire supervision of law enforcement and the efficiency and quality of fire fighting and rescue work is also related to the development of firefighting work global. In order to give full play to the role of information technology in the fire service, to improve the level of fire protection information must be evaluated for fire information technology applications to help fire departments to identify gaps and problems that exist in the application of information technology, but also facilitate higher authorities to understand the situation of Fire Information Management Therefore, it is necessary to establish a fire protection information technology assessment system to measure the level of modernization of fire management, decision-making basis for the higher authorities to provide information on the construction of the fire.

1. The structure of fire fighting informatization construction evaluation system

The so-called fire fighting informatization evaluation evaluation system refers to the established fire informatization construction activity evaluation guiding ideology, assessment principles, organizational assessment, evaluation index system, evaluation criteria, evaluation model and evaluation method and other systems. The research purpose is through a series of problems in the construction of fire fighting informatization evaluation to strategic planning and decision-making for the fire information services. For fire fighting informatization construction projects to indicate the investment direction. Navigation for fire fighting informatization construction project ,and constantly
revise its construction strategy, summing up the experience of the informatization construction of fire fighting. Conversely, if we don't evaluate the informatization construction project (proposed projects, projects under construction, completion of the project), the fire fighting informatization construction decision-making may be blind, appearing with the problems that "high investment, low output" and "information island" and so on. Therefore, it is very necessary to build the information evaluation system. Any assessment system to solve the "who evaluate? Evaluate what? How to evaluate". For the basic problem "who evaluate" is, in fact, to describe the evaluation subject, which is a person or organization who evaluate. "evaluate what" is to describe the evaluation object, namely around what to evaluate, assess what is object? "How to evaluate" is a more complicated problem, has a certain systematic frame. First, under the guidance of evaluation target to form a certain evaluation ideas, followed the ideas to build evaluation model. evaluation models, including evaluation methods, evaluation criteria, evaluation index, evaluation data, following certain assessment steps. Using the evaluation model to evaluate the object of evaluation, finally get the evaluation result and the formation of evaluation report. Fire fighting informatization evaluation system an shown blow:

![Evaluation system structure.](image)

(1) evaluation mechanism of fire fighting informatization construction

Firstly, Fire fighting informatization construction evaluation is to establish a set of new mechanism to reflect fire fighting informatization level and effect. namely "after" one China, one before informatization evaluation mechanism, which is "before -during -after" informatization evaluation mechanism. The so-called pre-assessment is to evaluate the planning project of fire fighting informatization. Mid-term evaluation is to track the fire fighting informatization project that has been built. Post-assessment is to learn a lesson about the projects have been built. The reason for all these three assessments is to ensure scientific decision-making about the construction of informatization, prevent making mistakes, improve the level and economic effect of fire fighting informatization construction. Draw the lessons of informazation construction from the past 20 years and sum up the successes and failures of Chinese enterprise informatization construction, it is not difficult to avoid "information island" "low level repeated construction," fragmented" "high investment, low output " and other problems, it will be difficult to adhere the battle effectiveness standard of the informatization construction. Therefore, to establish a full set of mechanism suitable for fire fighting informatization evaluation is very necessary and urgent.

(2)The evaluation content of fire fighting informatization construction

The second core of structuring fire fighting informatization construction evaluation system is to determine the evaluation content of fire fighting informatization, which is according to the behaviour of informatization construction happens in chronological order, the evaluation content of fire fighting informatization construction is divided into three sections: before evaluation, during evaluation, and after evaluation. These three parts covering the infrastructure of fire fighting informatization, the technology of fire fighting informatization, the resource management of fire fighting informatization, The construction system of fire fighting informatization, the technical standard of fire fighting informatization construction, the talented person of fire fighting informatization construction, the laws and regulations of fire fighting informatization construction and so on.
2. The content of fire fighting informatization construction based on fuzzy comprehensive evaluation method

(1) layering each evaluation factor and establishing fuzzy evaluation factor collection

Establishing a scientific, reasonable and feasible index system is premise and foundation to evaluate the performance of fire fighting informatization construction correctly. So in the process of establishing the index system to follow the principle of systematic, scientific simplicity and feasibility, Considering the inspection of each stage of fire fighting informatization construction, establish three layers of index system corresponding to each stage of fire fighting informatization.

(2) establishing the weight of factor set

Each expert has effect of different sizes on fire fighting informatization construction according to various indicators, grade in the given range of values (which quantified the importance of indicators as shown in table ). Suppose the i-th expert based on the importance of factors grade the j-th index as Rij. Therefore : i=1,2,3 ⋯ n , n is the total number of experts ; j = 1,2,3 ⋯ m, m is the total number of indicators.

<table>
<thead>
<tr>
<th></th>
<th>Very Important</th>
<th>Important</th>
<th>General Important</th>
<th>Not Important</th>
<th>Completely Not Important</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qualitative score</td>
<td>1</td>
<td>3</td>
<td>5</td>
<td>7</td>
<td>9</td>
</tr>
</tbody>
</table>

Table 1. The importance of quantitative indicators.

<table>
<thead>
<tr>
<th>Status indicators</th>
<th>Very Poor</th>
<th>Poor</th>
<th>Average</th>
<th>Good</th>
<th>Excellent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantitative score</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Cost indicators</td>
<td>10</td>
<td>9</td>
<td>7</td>
<td>5</td>
<td>3</td>
</tr>
</tbody>
</table>

① The i-th expert's credit rating is r, r=1, 2, 3. r=1, meaning that the expert is familiar with the content being evaluated, r=2, meaning that the expert is better familiar with the content being evaluated. r =3, meaning that the expert is not so familiar with the content. yir is the credit weight of the i-th expert, in addition yil=1, yi2=0.8, yi3=0.5.

② The j-th index's comprehensive credit is

\[ R_{ij} = \frac{\sum_{i=1}^{n} y_{ir} \cdot R_{ij}}{\sum_{i=1}^{n} y_{ir}} \] (i=1,2,..,n; j=1,2,..,m)

③ index weight's normalization processing,

\[ \eta_j = \frac{\eta_j}{\sum_{i=1}^{n} \eta_i} \] (j=1,2,..,m)

Other index levels' weight can get the weight set like the method above is; A=(a1, a2,..,am), Ai=(ai1, ai2,..,aim), Aij=(aij1, aij2,..,aijm)and satisfy \( \sum_{i=1}^{n} \eta_i = 1 \), \( \sum_{j=1}^{m} \eta_j = 1 \), ai>0.

3. establishing remark set

Fuzzy remark set is: V={v1, v2, v3, v4, v5}, therefore, v1, v2, v3, v4, v5 representing "very poor", "poor", "average", "good", "excellent"

① one level fuzzy comprehensive evaluation

To evaluate Rijk with one level fuzzy evaluation. According to the standard for evaluation, carried out by experts on the evaluation of the actual situation of each object index score (its scoring criteria.
shown in table 2), quantificat according to remark set, we can get Rijk to remark set V's membership is tijkh, membership vector is $T_{ijk} = (t_{ijk1}, t_{ijk2}, t_{ijk3}, t_{ijk4}, t_{ijk5})$, therefore, $T_{ijkh} = v_{ijkh}/n$, $h=1, 2, 3, 4, 5$, n is the total number of contestant experts, $V_{tijkh}$ is the total number of experts that consider index Rijk belong to set vh, evaluation matrix is:

$$
T = \begin{bmatrix}
B_1 \\
B_2 \\
\vdots \\
B_5
\end{bmatrix} = \begin{bmatrix}
b_{11} & b_{12} & \cdots & b_{15} \\
b_{21} & b_{22} & \cdots & b_{25} \\
\vdots & \vdots & \ddots & \vdots \\
b_{51} & b_{52} & \cdots & b_{55}
\end{bmatrix}
$$

Between the equation "*" representing fuzzy matrix composition operator symbol. Adoption of "*" is different. The result is not all the same, but the difference is not significant.

② two level fuzzy comprehensive evaluation

Consider the result of one level fuzzy comprehensive evaluation as the single factor to evaluate two level comprehensive evaluation, so the single factor evaluation membership matrix is:

$$
T = \begin{bmatrix}
B_1 \\
B_2 \\
\vdots \\
B_5
\end{bmatrix} = \begin{bmatrix}
b_{11} & b_{12} & b_{13} & b_{14} & b_{15} \\
b_{21} & b_{22} & b_{23} & b_{24} & b_{25} \\
\vdots & \vdots & \vdots & \vdots & \vdots \\
b_{51} & b_{52} & b_{53} & b_{54} & b_{55}
\end{bmatrix}
$$

Then two level fuzzy comprehensive remark set is $B_i = A_i * T_i$, $B_i$ is Ri to Vi's membership vector

③ three fuzzy comprehensive evaluation remark

Consider the result of two level fuzzy comprehensive remark as the single factor to evaluate the three fuzzy comprehensive remark, so the membership matrix is

$$
T = \begin{bmatrix}
B_1 \\
B_2 \\
\vdots \\
B_5
\end{bmatrix} = \begin{bmatrix}
B_{11} & B_{12} & \cdots & B_{15} \\
B_{21} & B_{22} & \cdots & B_{25} \\
\vdots & \vdots & \ddots & \vdots \\
B_{51} & B_{52} & \cdots & B_{55}
\end{bmatrix}
$$

Three level fuzzy comprehensive comprehensive remark set is $B=A*T={b1, b2, \cdots, bi}$, B is R to V's membership vector. This is total evaluation result. Use the largest membership rules to determine the object's specific evaluation results, namely: if $B_t = \max\{bj\}$, the evaluation results belong to v1. Then we can use evaluation membership vector each stage as a single factor fuzzy evaluation, similar to the above method is used on a single factor fuzzy evaluation, get the evaluation results of firefighting informatization construction. Not to elaborate here.

Summary

Fuzzy comprehensive evaluation method in the comprehensive consideration on the basis of many uncertain factors, paying attention to the combination of qualitative analysis and quantitative analysis, determine the appropriate weights allocation to carry on the comprehensive evaluation, improve the accuracy of the information construction decision-making and scientific. The construction of fire fighting informatization system is a long-term systematic project, it is not achieved overnight, need the joint efforts of all levels of departments and personnel.

References