RESEARCH ON ASSESSMENT METHOD FOR RURAL INFORMATIZATION LEVEL BASED ON AHP

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Abstract: Based on rural informatization connotation and five essential elements that affect rural informatization assessment, which are development environment, information infrastructure, information resource, information service system and application of information technology in rural areas, This paper designs an indicator system for rural informatization level assessment. Through AHP method, it sets up the hierarchical construction model of rural informatization assessment and weight of each indicator is calculated. Thus the evaluation method for assessment on rural informatization level is proposed in this paper. It combines subjective evaluation with objective appraisal and will help direct rural informatization management departments with jobs and promotes rural informatization development.

Keywords: Rural informatization; Assessment, Analytic Hierarchy Process(AHP); Indicator system

1. INTRODUCTION

Agriculture and rural informatization is an important component of the national economy informatization. Rural informatization is the inevitable requirment to realize countryside modernization and an important means of

resolving the problems facing our agriculture, rural areas and farmers (Zang Chunrong et al., 2004). By strengthening rural broadcast television networks, telecommunication and computer networks and other information infrastructure construction, fully developing and using each kind of information resource, constructing comprehensive information platform and service system, promoting the exchange of information and knowledge sharing, Rural informatization will promote the application of advanced information technology in countryside production and management, public services, government affairs management, life expense and so on each aspect(Tan Guoliang et al., 2007).

Rural informatization assessment is to evaluate the level and effect of rural informatization construction by adopting mathematical statistics, operation research principle and specific indicator system (Liu Shihong et al., 2007).To do that, It should compare the unified standard, compute quantitativly and qualitatively and make contrastive analysis in accordance with certain procedures. By evaluating rural informatization level of our country through quantitative analysis method, the rural informatization conditiongs of different area and rural informatization degree of the same area can be revealed quantitatively (Sheng Qifeng et al., 2005). Evaluating rural informatization level comprehensivly and scientificly, measuring and grasping the information development level of each rural area accurately will help to find problems and shortcomings in the process of rural informatization, thus to direct every area to get information technology work forward and provide basis for formulating long-term rural informatization development planning and information-based strategy (Yi Yaxin et al., 2004).

2. INDICATOR SYSTEM OF RURAL INFORMATIZATION ASSESSMENT

Rural informatization assessment is a huge system engineering that synthesizes technological innovation and institutional innovations. Its implementation involves all aspects of rural business and information techonology (Qin Xiangyang et al., 2008). The comprehensive assessment of rural informatization belongs to information system appraise category and involves assessment on many aspects of rural informatization such as exterior development environment, information infrastructure, rural information resource, information organizations and agencies engaged in the countryside information service work and application of information technology in rural areas.

2.1 Selection of indicator

The core content of rural informatization assessment includes five mutually and closely contacted planes: development environment, information infrastructure, information resource, information service system and application of information technology in rural areas. Rural informatization assessment bases on the construction of scientific and rational evaluation indicator system. In order to objectively evaluate the level, indicators that affect rural informatization level should be selected according to results of expert consultation and questionnaire survey. Factor choice should obey the following principles(Liu Shihong et al., 2007; Lu Lina et al., 2007):

1) Comprehension: The factor must reflect each side of the appraised object and study its connotation and extension deeply in the process of construction, making every effort to fullly and actually manifest it.

2) Operability: Weight of each indicator shoule be determined based on the actual development of rural informatization. The evaluation method stresses on availability of indicator data.

3) Guidance：Prospective and tendency factors should be introduced to guide the direction of rural informatization development.

4) Connection: The indicator system should link up with national and regional informatization assessment index system and reflect the development characteristic of rural informatization downward.

5) Comparability: International and domestic general targets should be introduced in. Each target should be fairly comparable corresponding to every appraised object.

2.2 Construction of indicator system

According to the concept of rural informatization and above principles, This paper chooses twenty indicators from the above five planes of rural informatization. Its schematic diagram is shown in Fig.1.

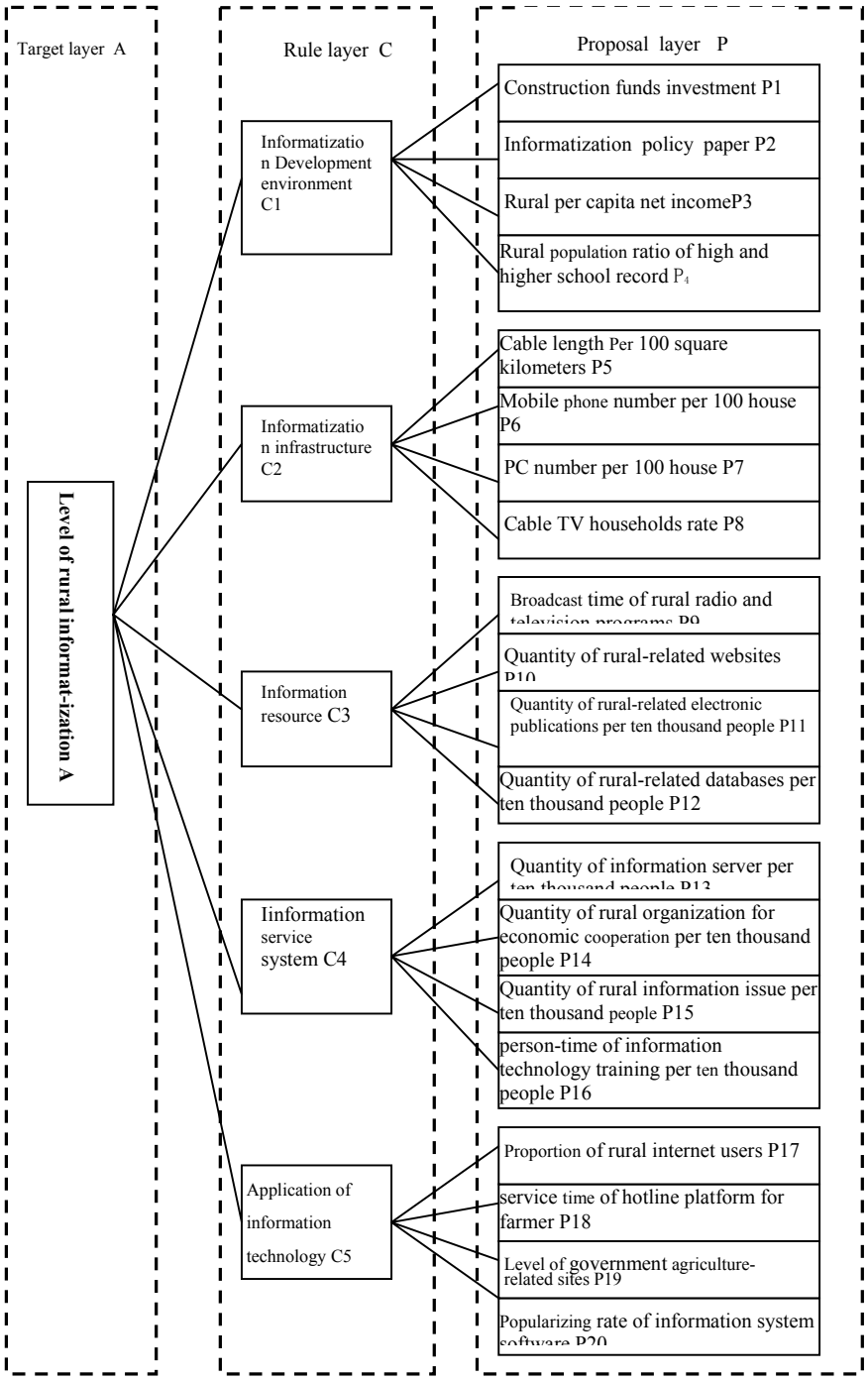

Fig.1: Hierarchical construction of rural informatization assessment

3. MODEL OF RURAL INFORMATIZATION ASSESSMENT

3.1 Form assessment indicator set

Based on the indicator system above, the assessment factor set X could be formed and expressed as $X=\{X_1,X_2,X_3,X_4,X_5\}$,And $X_i=\{X_{i1},X_{i2},\cdots,X_{ij}\}$, $(i=1,2,3,4,5;\ j=1,2,3,4)$.

3.2 Establish stepped hierarchical construction

The graded hierarchical construction model of rural informatization assessment includes three layers, they are: the level of rural informatization development, the main content of rural informatization and the rural informatization assessment factors. Its structure drawing is shown in Fig.1.

3.3 Ascertain the weight of the indices

The weight coefficients of indicators at all levels are fixed by Analytic Hierarchy Process algorithm (AHP) developed by Saaty. (An Shaoshan et al. 2003). AHP algorithm is a multi-objective decision analytical method that combines qualitative with quantitative analysis and also a kind of optimization techniques. AHP algorithm combines qualitative analysis with quantitative analysis organically during programmed decision-making, so it can be used to calculate the weight of each indicator(Cai Kangying et al., 2008; Chen Ruyun et al., 2007)

1) Construct comparison judgment matrix:

By pairwise comparing elements of the same layer in accordance with certain upper factor, each element of the judgment matrix is able to be defined.The relative importance of each element followes 1-9 proportion evaluation scale. Several judgment matrixes can be eatablished based on the scores that experts provided.The judgment matrixes of rural informatization assessement are shown in Table1-6.

Table 1. A-C_i Comparison judgment matrix

A	C_1	C_2	C_3	C_4	C_5
C_1	1.000	0.7639	1.0234	0.6806	0.7556
C_2	1.4263	1.000	1.6226	0.9250	1.0694
C_3	1.1592	0.9528	1.000	0.8222	0.8250
C_4	1.5929	1.1194	1.7782	1.000	1.0167
C_5	1.4925	1.1639	1.5048	1.0333	1.000

Table 2. C_1-P Comparison judgment matrix

C1	P1	P2	P3	P4
P1	1.000	1.819	1.522	1.825
P2	0.625	1.000	0.995	1.119
P3	0.739	1.414	1.000	1.2361
P4	0.626	1.097	0.862	1.000

Table 3. C_2-P Comparison judgment matrix

C2	P5	P6	P7	P8
P5	1.000	0.944	0.814	0.962
P6	1.083	1.000	0.869	1.045
P7	1.264	1.181	1.000	1.191
P8	1.139	1.083	0.907	1.000

Table 4. C_3-P Comparison judgment matrix

C3	P9	P10	P11	P12
P9	1.000	1.097	1.200	1.053
P10	1.002	1.000	1.193	1.058
P11	0.867	0.953	1.000	0.851
P12	1.093	1.213	1.233	1.000

Table 5. C_4-P Comparison judgment matrix

C4	P13	P14	P15	P16
P13	1.000	1.197	1.170	1.035
P14	0.910	1.000	1.014	1.008
P15	0.881	1.083	1.000	0.957
P16	0.970	1.137	1.013	1.000

Table 6. C_5-P Comparison judgment matrix

C5	P17	P18	P19	P20
P17	1.000	1.138	1.268	0.885
P18	0.940	1.000	1.155	0.822
P19	0.810	0.890	1.000	0.696
P20	1.217	1.352	1.486	1.000

2) Monolayer weights order

The importance that each element of No.(k+1) layer relative to No.k layer is orderd according to the judgment matrix. The order is expressed by the relative value such as follows:

$$W_C = \begin{bmatrix} W_{C_1} \\ W_{C_2} \\ W_{C_3} \\ W_{C_4} \\ W_{C_5} \end{bmatrix} \qquad \sum_{i=1}^{5} W_{C_i} = 1 \tag{1}$$

Where: W_{Ci} is the importance value of the *i*th *C* layer relative to *A* layer.

W_{C_i} is calculated by adopting geometric average algorithm.The steps are as follows:

a) Calculate the product of elements of each row:

$$M_{C_i} = \prod_{j=1}^{5} C_{ij} \qquad (i = 1,2,3,4,5) \tag{2}$$

b) Calculate the 5th root of M_{C_i} :

$$\overline{W}_{C_i} = \sqrt[5]{M_{C_i}} \tag{3}$$

c) Do standardization with $\overline{W}_{C_i}$:

$$W_{C_i} = \frac{\overline{W}_{C_i}}{\sum_{i=1}^{5} \overline{W}_{C_i}} \tag{4}$$

3) **Consistency test**

To ensure the monolayer weights order are correct, the judgment matrix should be dealed with consistency test. They are judged by the random consistency ratio CR. If CR<0.1, the results can meet the requirements. Consistency should be tested as follows:

a) Computing consistency index *CI:*

$$CI = (\lambda_{\max} - n)/(n-1) \tag{5}$$

Where: λ_{max} is the eigenvalue of maximum, n is the number of the order of judgment matrix.

b) Checking the value of the average random consistency index *RI* from Table7.

Table 7. Values of *RI*

n	1	2	3	4	5	6	7	8
RI	0.00	0.00	0.58	0.89	1.12	1.24	1.36	1.41
n	9	10	11	12	13	14	15	
RI	1.46	1.49	1.52	1.54	1.56	1.58	1.59	

a) Calculating consistency ratio *CR :*

$$CR = CI/RI \tag{6}$$

If $CR < 0.1$, the consistency of the judgment matrix can be satisfied and so the order weights accepted.

By means mentioned above, all of the monolayer weights order can be get: W_1 = [0.344, 0.210, 0.245, 0.201], W_2 = [0.226, 0.243, 0.281, 0.251],W_3 = [0.259, 0.253, 0.218, 0.270]; W_4 = [0.269, 0.241, 0.239, 0.252]; W_5 = [0.262, 0.239, 0.207, 0.308]; W = [0.153, 0.217, 0.174,0.232,0.224],

The values of λ_{max} of the the judgment matrix are: 4.262, 4.094, 4.184, 4.084, 4.082, 5.389.

The values of CR are:0.098, 0.036, 0.069, 0.031, 0.031,0.087. they are all less than 0.1, so can pass the consistency test.

3.4 Value of Comprehensive assessment

Based on the assessment factor matrix X and the monolayer weights matrix W_{Ci}, the value of comprehensive assessment of rural informatization level can be determined, the formula is described as follows:

$$V = \sum_{i=1}^{5} \overline{X_i} \square W_{Ci} \qquad (i = 1,2,3,4,5) \qquad (7)$$

Where: V is the level of comprehensive assessment on rural informatization development, $\overline{X_i}$ is the assessment factor matrix that made by standard operation.

4. CONCLUSION

From five main contents of rural informatization which are: development environment, information infrastructure, information resource, information service system and application of information technology in rural areas, This paper establishes an indicator system for rural informatization assessment and make a study of evaluation method furthermore. By use of AHP algorithm, the paper constructs the hierarchical structure model of rural informatization assessment and calculates the weight of each factor. The comprehensive assessment model we design has preferable operability and practicability. It combines subjective evaluation with objective appraisal, qualitative with quantitative study, and fully considers each assessment factor. Therefore, it is scientific and reasonable and suit to be used to evaluate the level of rural informatization development.

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