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Research on the Evaluation of Digital Village Development Readiness Taking Changfeng County as an Example

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Abstract: With the implementation of the national digital village strategy, digital construction is gradually sinking and infiltrating into rural areas. China's Rural Revitalization has entered a new stage of development. The application of digital technology in rural areas provides a new direction for rural revitalization. This paper takes Changfeng County, one of the first batch of national digital village pilot projects in Anhui Province, China, as the research object. Firstly, it analyzes the development status of digital village in Changfeng County and looks for the problems existing in the development of digital village in Changfeng County. Secondly, it constructs the evaluation index system of digital village development readiness in Changfeng County, and uses APH (analytic hierarchy process) and entropy weight method to calculate the weight of each index to measure the readiness of digital village development in Changfeng County. Finally, it puts forward the countermeasures and suggestions for the development of digital economy in Changfeng County.

Keywords: Digital countryside, Readiness evaluation, APH.

1. Introduction

Since the successful launch of the G20 Summit in 2016 in Hangzhou, the development of digital economy has become the primary goal of China's current economic development. With cloud payment, cloud shopping and various live broadcasting platforms in recent years, the development of digital economy in most domestic cities has formed a certain scale, which makes the development conditions of digital economy constantly improve, and new forms of development emerge in one after another, and the development space gradually expands. While the urban digital economy is booming, there is still a large gap in the development of rural digital economy. To realize the needs of national informatization strategy and rural revitalization planning, in May 2019, the general office of the Communist party of China and the State Council jointly issued the digital rural development strategy outline, clearly proposed in the present new generation of information technology unprecedented active, during the new technology, new model, new products should gradually realize with the integration of modern agriculture, stimulate the internal development of agriculture, can explore the development potential of modern agriculture, promote agriculture upgrade, cultivate new farmers under the information age.

The country is facing the bottleneck of the transformation and upgrading of industrial structure, the development of digital countryside is undoubtedly a breakthrough to break the bottleneck, internal structure of rural economy is digital rural development at the same time, some new business model and economic development form will be introduced, agricultural industry chain is extended, is of great significance to effectively promote industrial structure reform.

Readiness, first used in the e-commerce industry, is an index used to evaluate the maturity of e-commerce development. Both the digital countryside and the e-commerce belong to the category of the data economy, so this paper applies the theory of readiness to the data rural areas to evaluate the maturity of the data rural areas. At present, China has no suitable for data of rural development maturity evaluation system, its research with pioneering, compared with the existing problems for the causes of rural revitalization, digital rural development readiness evaluation more completely, consider more diverse factors, the digital rural future development direction guidance more realistic significance.

2. Literature Review

Rural revitalization needs the deep integration of rural e-commerce with the Internet, digitalization and informatization. In the research on the influencing factors of rural e-commerce, some scholars believe that the development of rural e-commerce market requires the active participation of enterprises. Some scholars believe that the industrial foundation, platform construction, infrastructure and other Internet channels affecting rural products (Guo Hongdong, 2016). Some scholars have also studied the regional development of rural e-commerce, and analyzed the development mode of rural e-commerce in Zhejiang, Jiangsu, Hebei and other regions (Yao Qingrong, 2016). In view of the above, many scholars have made active exploration of the development of digital economy and rural revitalization, but there are few studies on the construction and evaluation mode of digital rural development indicators. This project fully draws on the research ideas of previous experts and scholars, combines with the digital economy, explores the digital rural construction under the rural revitalization, and calculates the current level of digital rural development, which plays a certain role in building the digital countryside.

3. Construction of the Evaluation Index System of Digital Rural Development Readiness

In the process of digital rural development readiness evaluation index system in Changfeng County, the construction of the evaluation system is undoubtedly important and basic. In the selection of readiness indicators, this paper draws the economic Cooperation Organization (OECD), the World Economic Forum (WEF, 2015) and the Digital China Construction and Development Report (2018), and fully combines the current academic research on rural e-commerce index construction system, and selects the relevant and important indicators.

First of all, the index is divided into two basic levels: first-level index and second-level index. The first-level index is the comprehensive index of the macro direction, and the second-level index is the corresponding detailed differentiation index.

It is believed that the construction of digital rural development readiness evaluation index system should be conducted from five first-level indicators: macro background environment, infrastructure construction, digital information environment, policy environment and application environment. Macro environment is the background of the development of digital countryside in Changfeng County, including the overall national investment of transportation, postal service, storage, computer services, scientific and technological research and other resources, as well as the overall consumption environment of rural residents. Infrastructure construction is the cornerstone of the development of digital countryside in Changfeng County, electronic information digital industry for hardware has an inevitable hardware conditions from a certain point of view also reflects the construction of digital countryside, here we mainly discuss broadband access, optical cable laying, website construction and other basic facilities.

Table 1. Construction of digital rural evaluation index in Changfeng County

Target layer	Primary index	Secondary indicators	Indicator code
Digital rural development readiness evaluation index system	Macro-background environment	Information transmission services and software industry assets investment (100 million yuan)	a11
		Average transportation and communication expenditure of township residents (yuan)	a12
		Fixed asset investment absorbed by science and technology research and technology service industry (100 million yuan)	a13
	Infrastructure support	Number of rural broadband access users (ten thousand households)	a21
		The length of the optical cable (km)	a22
		Number of Web sites (ten thousand)	a23
	Digital Information Environment	Post and telecommunications business volume (100 million yuan)	a31
		Postal service outlets (office)	a32
		The contribution rate of the tertiary industry to GDP (%)	a33
	Policy environment	Local financial technology expenditure (100 million yuan)	a41
		Financial expenditure of local transportation industry (100 million yuan)	a42
		Local financial supervision and financial expenditure (100 million yuan)	a43
	Application Environment	E-commerce purchase amount (100 million yuan)	a51
		Number of express items (ten thousand pieces)	a52
		Number of active e-commerce transactions (enterprises)	a53

4. Analysis and Evaluation of Digital Rural Readiness in Changfeng County

4.1. Data Source and Processing

Data related to Hefei Changfeng county, after consulting Changfeng county people's government statistical yearbook after the National Statistical Yeardata in the table, because the evaluation index system and properties between certain differences, so the evaluation index data standardization, to eliminate the influence of data difference, make the evaluation index more accurate and identifiable. All the data presented in this paper were processed with standardization.

4.2. Evaluation Method

The methods applied to the evaluation of data analysis include the qualitative analysis method, data envelope analysis method, fuzzy comprehensive evaluation method, hierarchical analysis method, entropy weight method, etc. Because the fuzzy comprehensive evaluation method needs subjective decision weight, the results are greatly influenced by willingness and relatively vague.

Hierarchical analysis method can refer to the experience and suggestions of experts and scholars, which is highly professional but also influenced by subjectivity; entropy weight method can systematically and objectively obtain the corresponding weight of each index. Therefore, this time, we choose the combination of hierarchical analysis method and entropy power method to learn from each other, so as to be more objective and more truly reflect the weight of each index.

The hierarchical analysis method is empowered by subjective experience, and the entropy method is empowered by the algorithm data, but the combination of the two can

work well in many evaluation studies. Based on this situation, to reduce the subjective deviation and objective quality deviation caused in the empowerment of hierarchical analysis and entropy method, this paper calculates the combined weight of evaluation indexes.

4.2.1. Constent Analysis Based on Hierarchical Analysis

According to the evaluation and analysis of the digital rural readiness by experts and scholars, for the 1-9 scale measure used in the article, the data are relatively discrete and accurate. Establish a judgment matrix capable of pairwise comparisons: $A= (a_{ij})_{nxn}$. Where, a_{ij} representation a_i to a_j.

The relative importance, and the judgment matrix needs to satisfy condition $a_{ij}>0$; $a_{ji}>1/ a_{ji}$, $a_{ij}=1$. Here, the arithmetic average is used to find the corresponding maximum eigenvalue and derive the index weight.

4.2.2. Hierarchical Single Sorting and Consistency Inspection

After forming the corresponding matrix, the matrix is subject for consistency test, and the consistency index CI of each judgment matrix is calculated, such as equation (1), UI and one-time index RI.

$$CI = \frac{Y_{\max} - n}{n-1} \tag{1}$$

When, n is set to the maximum eigenvalue, Y_{max} is set as biased eigenvalues and tested for consistency indicators. When CI=0, A is completely consistent. When CI <0.10, the proof matrix A passed the consistency test. The random one-time index RI was also introduced to correct the larger CI to achieve consistency, that is, CR=CI / RI (see Table 2).

As can be seen from Table 2, in the constituted index system, macro background environment (a1), infrastructure support (a2), digital information environment (a3), policy environment (a4), and AHP weights are 0.0866, 0.0639, 0.1637, 0.0398, 0.5360. The consistency test result data of the matrix meet CR <0.10, that is, passed the consistency test, indicating that the consistency of the word matrix is qualified.

Table 2. Level of single ranking and consistency test table

Evaluating indicator		Indicator weight	Y_{max}	CI	RI	CR
a_{11}-a_{1i}(0.0866)	a11	0.3582	6.3521	0.1142	1.24	0.0965
	a12	0.2163				
	a13	0.4255				
a_{21}-a_{2i}(0.1639)	a21	0.0665	5.6959	0.1023	1.23	0.0858
	a22	0.3921				
	a23	0.5414				
a_{31}-a_{3i}(0.1737)	a31	0.4236	6.6517	0.0084	1.24	0.0083
	a32	0.2595				
	a33	0.3169				
a_{41}-a_{4i}(0.0398)	a41	0.2417	6.3585	0.1364	1.16	0.0965
	a42	0.2631				
	a43	0.4952				
a_{51}-a_{5i}(0.5360)	a51	0.1618	6.4522	0.1058	1.21	0.0897
	a52	0.4428				
	a53	0.3954				

4.3. Hierarchy General Ranking and Consistency Inspection

The consistency ratio index of total ranking is calculated as follows:

CR=0.0866×0.1142+0.1629×0.1023+0.1737×0.0084+0.0398×0.1364+0.5360×0.1058/0.0866×1.240+0.1629×1.230+0.1737×1.240+0.0398×1.160+0.5360×1.210.

After calculation: the total ranking of the consistency ratio index CR=0.0740 <0.1, passed the consistency test. Moreover, it is no need to adjust the element of the judgment matrix, so that the satisfactory consistency of the digital rural evaluation readiness index selected in this paper is qualified.

4.4. Hierarchical Analysis (AHP) Weights

After passing the hierarchical single ranking test and the consistency test of the hierarchical total ranking, the weight of the digital rural development readiness evaluation index under the AHP can be obtained:

$$W = \begin{pmatrix} 0.0592 & 0.0723 & 0.2356 \\ 0.2532 & 0.2103 & 0.0758 \\ 0.4236 & 0.5102 & 0.0844 \\ 0.2306 & 0.3651 & 0.1437 \\ 0.1547 & 0.1207 & 0.1836 \end{pmatrix}$$

4.5. Empowerment Based on the Entropy Right Method

Firstly, the data matrix $A=(a_{ij})_{mxn}$ in the original state is subject to negative elimination and standardization, and apply formula (2) to measure the entropy of each evaluation index.

$$e_j = -k\sum_{i=1}^{m} p_{ij} \times \ln p_{ij} \tag{2}$$

Secondly, calculate the entropy right of a certain index.

$$W_j = (1-e_j)/\sum_{j=1}^{n}(1-e_j) \tag{3}$$

Therefore, we can conclude that the entropy weight method of the digital rural development readiness index.

$$W = \begin{pmatrix} 0.0344 & 0.1132 & 0.0520 \\ 0.0337 & 0.0135 & 0.0828 \\ 0.0713 & 0.0128 & 0.0985 \\ 0.0623 & 0.0441 & 0.0367 \\ 0.1610 & 0.0759 & 0.0623 \end{pmatrix}$$

4.6. Combination Empowerment

When the hierarchical analysis method (AHP) and the entropy weight method are used, the practicality and accuracy of the evaluation indicators are fully considered, and the information contained in the original data itself is accurately quantified and reflected.

$$\overline{w} = \{\frac{u_1 w_1}{\sum_{j=1}^{n} u_j w_j}, \frac{u_2 w_2}{\sum_{j=1}^{n} u_j w_j} \cdots \frac{u_n w_n}{\sum_{j=1}^{n} u_j w_j}\} = (\overline{w_1}, \overline{w_2}, \ldots \overline{w_n})' \quad (4)$$

Where, $\sum_{j=1}^{n} \overline{w_j} = 1$; $\overline{w_j} \geq 0$

Obviously, the combined weights with $\overline{w_j}$, u_i and w_i should be all as close as possible. Lagrange multiplication was optimized to obtain the optimized combined weights.

$$\overline{w'} = \{\frac{(u_1 w_1)^{0.5}}{\sum_{j=1}^{n} (u_j w_j)^{0.5}}, \frac{(u_2 w_2)^{0.5}}{\sum_{j=1}^{n} (u_j w_j)^{0.5}}, \ldots, \frac{(u_n w_n)^{0.5}}{\sum_{j=1}^{n} (u_j w_j)^{0.5}}\} = (\overline{w_1}, \overline{w_2}, \ldots, \overline{w_n}) \quad (5)$$

The combination of the two reduces the influence of subjective factor empowerment, and is more objective and accurate. We obtain the optimized combination weight according to the above formula.

$$W = \begin{pmatrix} 0.0579 & 0.3648 & 0.1251 \\ 0.1655 & 0.1894 & 0.1509 \\ 0.2837 & 0.1885 & 0.2030 \\ 0.1202 & 0.0987 & 0.3376 \\ 0.1497 & 0.2402 & 0.4045 \end{pmatrix}$$

4.7. Verification of the Combined Empowerment Advantage

As shown in Figure 1, the application of hierarchical analysis method and entropy weight method is consistent with the distribution trend of the optimized combination weight, indicating that the optimized combination weight does take into account the knowledge and experience of experts and scholars and the data itself, and can comprehensively quantify the readiness of digital rural development.

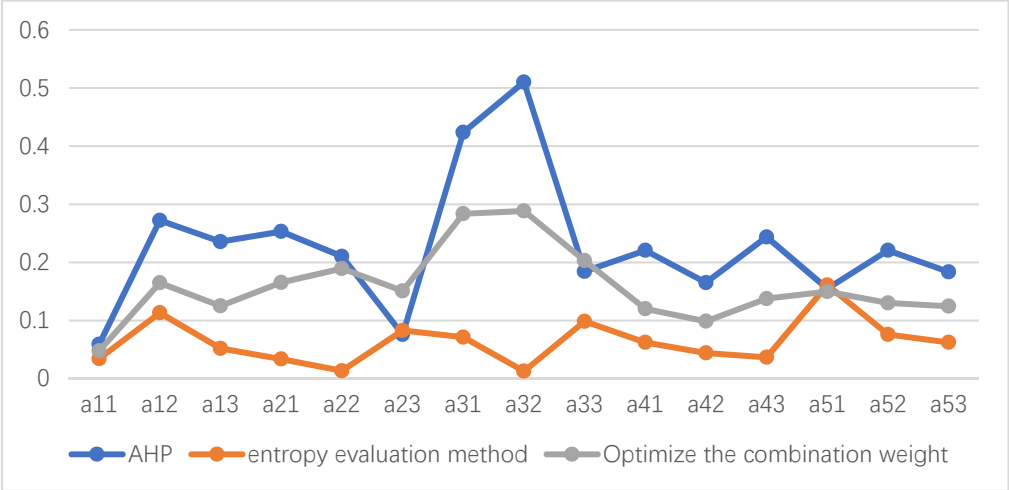

Figure 1. Hierarchical analysis method, entropy method and optimized combination weight

From Figure 1, we can get that in the optimized combination weights, there have high influence on digital rural readiness per capita transportation and communication expenditure of rural residents (RMB) (a12), science and technology research and technology services, the whole social fixed assets investment (100 million yuan) (a13), the number of broadband access users in rural areas (10,000 households) (a21), the length of optical cable (km) (a22), post and telecommunications business volume (RMB 100 millionyuan) (a31), postal service branch (office) (a32), expenditure on local finance and financial supervision and other affairs (100 million yuan) (a43), e-commerce purchase amount (RMB 100 million Yuan) (a51), this shows that the above 8 indicators is the main variable affecting digital rural readiness, this said, Changfeng county digital rural readiness should focus on digital environment, policy environment and application environment, and related infrastructure and macro background, because in recent years the country increase infrastructure construction and related policies to support the development of digital industry, so these factors are not the main variables restricting readiness.

5. Conclusions and Suggestions

In the process of building Changfeng county digital rural development readiness evaluation index system, we through the data analysis, think Changfeng county digital rural level index, application environment, digital information environment, policy environment of Changfeng county the

influence of digital rural development readiness is larger, and infrastructure support is relatively small.

5.1. Digital Rural Construction in Changfeng County Should Continue to Improve the Infrastructure Construction

Infrastructure construction is the foundation of digital rural construction. To improve the infrastructure construction of Changfeng County, we should further improve the broadband, post and telecommunications business outlets, optical cable laying and other important infrastructure. To build the rural Internet of Things, improve the logistics and transportation capacity of Changfeng County, and realize the purpose of truly using the digital rural construction to improve the rural ecological environment and improve the quality of life of rural residents.

County town of digital information infrastructure construction is still far lower than the city, in the process of development, should pay attention to infrastructure construction more mature city construction experience, should increase broadband operation service node, ensure the popularity of the Internet in the villages and towns, broadband operators also deal with rural users to provide various preferential measures, reduce the economic pressure of rural residents, make rural residents can enjoy the convenience of the Internet, to promote the township information construction.

5.2. Develop the Township Digital Economy Industry in Changfeng County Area

Agriculture is the core industry of township residents, and the construction of digital towns can also benefit agriculture. The development results of digital countryside should be applied to agriculture. For example, UAV aerial photography monitoring of farmland growth, installation of digital sensing facilities, overall control of farmland indicators, accurate irrigation and accurate quantitative distribution of chemical fertilizer, which not only improves efficiency, but also saves the consumption of irrigation and fertilizer, and saves manpower.

At the same time, the digital rural construction can promote the villages and towns outside the industry, such as online selling township agricultural specialty products, increase the economic benefits, through the Internet township scenery propaganda, propaganda local culture, actively promote the depth of the Internet and agricultural fusion, health agriculture, farmhouse, creative new industries, the development of rural tourism, can promote township image, but also can obtain economic benefits.

5.3. Strengthen the Intelligence of Agricultural Equipment

Digital rural construction can promote intelligent agricultural equipment, need agricultural equipment manufacturing and a new generation of information technology, improve the level of agricultural machinery equipment and agricultural machinery services and new agricultural equipment management, improve agricultural equipment technology innovation service, perfect agricultural mechanization, industrial technology gradually applied in agricultural field, such as drones pesticide pest, crop temperature control, wet control, weather warning control system, large agricultural machinery sowing, harvest, etc. Optimize the digital rural supply chain management, and drive the transformation and upgrading of traditional agriculture through the construction of digital countryside.

5.4. Use the Digital Construction of Changfeng County to Connect with the City Market

Agricultural products sales market from traditional offline sales to online sales, to make full use of Internet resources, each big electricity platform resources, use the Internet development positive effect of agriculture, use electricity management mode to agricultural products market and urban market docking, use high quality agricultural products impact urban market, increase the county town economic benefit.

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