Digital Barriers to the Construction of China's Digital Villages and Countermeasures

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Abstract:

In recent years, the digital economy has flourished in China, and the convergence of new technologies such as big data and cloud computing has promoted the rapid development of the Internet of Things, bringing rare development challenges and opportunities to the construction of China's countryside. Some new digital information technologies are gradually integrated into China's agricultural and rural production, and the agricultural economy continues to increase its productivity and value, and the digital economy has become an important force in the development of digital countryside and digital agriculture. Although the current rural information service system is accelerating its construction and development and gradually improving, there are also problems such as digital divide, weak infrastructure and insufficient resources such as technicians. In order to develop rural areas, it is urgent to deeply explore the great potential of digital countryside in the development of digital economy, and to avoid harm in order to accelerate the process of rural construction, so that agriculture can be upgraded, infrastructure can be improved, farmers can be developed, and the overall progress of rural areas can be promoted. In this paper, on the basis of the important theories of digital countryside, we take agriculture, rural areas and farmers as the research objects, build an evaluation index system based on digital perspective, evaluate the development level of digital countryside by using the entropy-weighted TOPSIS method and use the obstacle degree model to focus on diagnosing the obstacle factors in the actual work of digital countryside construction, and propose corresponding countermeasures to overcome them with the results of empirical analysis. The research results show that the development progress of China's digital countryside construction from 2015 to 2019 is obvious, and the comprehensive evaluation value has increased from 0.039 to 0.952 in five years, and the digital countryside development has moved from a poor level to an increasingly good development level. The most important digital barriers affecting the digital countryside construction from 2015 to 2019 are the proportion of non-Internet users in rural areas and the scale of rural Internet users. Overall, the level of agricultural production is the most obvious obstacle to the development of digital countryside, and the construction of digital countryside should continue to promote the development of "Internet+" modern agriculture, enhance the application of new digital information technology in agriculture, and continuously improve the digital level of agricultural production.

Keywords: *Digital countryside; Digital barriers; Entropy TOPSIS model; Barrier degree model; Countermeasure research.*

I. INTRODUCTION

Digital countryside is the strategic direction of rural revitalization and an important element in building digital China. [1] The revitalization of the countryside is an important strategy put forward by the 19th National Congress, aiming at accelerating the development of informatization in agriculture and rural areas and bridging the digital divide between urban and rural areas. The strategy of rural revitalization and the construction of digital countryside is a strategic direction to promote the high-quality development of agriculture and rural areas, and the process of building digital countryside is the process in which the strategy of rural revitalization is put into practice.

In recent years, the digital economy has been booming and a new generation of network information technology is constantly innovating and breaking through, resulting in new products, new models and new forms, and promoting profound changes in the global industrial form and economic structure. In the context of the digital economy pervading the world and the implementation of the rural revitalization strategy, China's economic form is rapidly transforming into a digital economy, and big data has become the core means of production for economic and industrial development, which has created a historic opportunity for the development of digital agriculture and rural areas and injected new momentum for the smooth promotion of China's rural revitalization strategy. 2019, the Central Government's Document No. 1, as well as the Outline of the Digital Rural Development Strategy Outline" and the "Digital Agriculture and Rural Development Plan (2019-2025)" have been issued one after another, setting digital agriculture and rural areas on a preliminary stage of development. In the context of the new pneumonia epidemic in 2020, the Central Government issued Document No. 1, which continues to focus on the "three rural areas" and emphasis the need to carry out national digital rural pilot projects. The issuance of these documents has provided a strong foundation for the construction of digital villages and the realization of a comprehensive rural revitalization strategy. The construction of digital villages has become an inevitable trend in the development of the digital economy. We can see the emergence of many online e-commerce and cloud network services in the new crown epidemic, and it is clear that the epidemic has accelerated the transformation of the economic structure to digital. With the tilt of national policies towards rural areas, the economy as well as infrastructure such as communication and transportation in rural areas have also improved and developed to a certain extent, with some farmers being able to lift themselves out of poverty and become rich, and the gap between urban and rural areas gradually narrowing. However, as the province is still in the early stages of digital village construction, the challenges of rural digital construction are greater than the opportunities, and there are still new digital obstacles in the process of popularizing and developing digital village construction. How to clear the key obstacles to the construction of digital villages and promote the construction of digital villages has become an urgent issue to be solved now.

China's digital countryside construction only began to sprout at the beginning of this century, when the digital countryside first started China mainly focused on the exploration of digital countryside construction methods, with the rapid development of artificial intelligence and other modern information technology, the national digital countryside construction in the past two years was only formally proposed, the relevant

domestic personnel, scholars at this time began to focus their research efforts on the Internet engineering, big data engineering and digital countryside engineering measurement, set The development of IoT big data will show the way for the development of digital countryside construction, which is undoubtedly an important breakthrough for China's digital countryside construction and rural digital economy development. However, at the same time, from the number of literature collected, we can see that there is still a lack of research on digital countryside construction in China's academia, which also directly reflects the loss of weight in China's digital countryside construction work. Some European countries have been digitising since the last century, and research on digitisation and digital technology is relatively extensive and sophisticated. However, the term "countryside" may be a restriction, and there is generally less research on digital countryside construction modules abroad.

Research on the revitalization of the countryside and the construction of digital villages. Some scholars have already elaborated and analyzed the construction of information technology and digital countryside in China from different fields and regions. For example, Comrade Wang Jiubo (2019) analyzed the current situation and dilemma of digital countryside construction in Liaoning Province from the aspects of rural information infrastructure construction, agricultural and rural information service system, digital application of agricultural production, digital level of agricultural operation, and digital coverage of agricultural services [2]. Mao Wei and Wang Xian (2019) conducted a study on China's rural information service model in "Internet + agriculture", "Internet + rural governance", "Internet + rural education ", "Internet + rural culture", "Internet + rural medical care" and other aspects of the future digital countryside construction model [3]. In China's research on the construction or measurement of the evaluation index system of rural revitalization and digital countryside development readiness, Zhang Hong,Du Kaiwen and Jin Bingyan (2020) firstly constructed an evaluation system of digital countryside development readiness indicators from five primary indicators and 29 secondary indicators[4]; Zhang Ting , Li Minrong and Xu Yanmei (2018) filtered the evaluation system of digital countryside development readiness from five aspects: prosperous industry, ecological livability, civilized countryside style, effective governance and The evaluation index system of rural revitalization was constructed by screening 15 three-level indicators and 44 four-level indicators in five aspects, and 35 villages in 11 provinces were empirically evaluated and analyzed by using this evaluation index system[5]. Hu, Jing and Liu, Yang (2018) mainly conducted practical, example and empirical analysis in the area of network information to help agricultural development [6]. Zhang Shuzhen and Li Lei (2019) provide an in-depth discussion on how mainstream media can help the construction of digital villages, promote digital economy and rural revitalization, and rural cultural life [7]. Scholars such as Sarah Rotz, Evan Gravely, Ian Mosby (2019) in India [8] conducted a front-end study on the potential impact of digital farming technologies on agricultural labour and rural communities; Townsend L (2013) analysed the importance of broadband for rural communities to develop a digital economy and summarised the government's solutions to the broadband problem [9]; Mareike Meyn (2020), a German scholar, provides a relevant account of how to harness today's digital possibilities in rural areas in the US and Germany and examines possible solutions to use digitalization as a means to empower people in rural areas, finding that digitalization offers great potential for rural communities to not only create revolutionary changes in rural but also to bring about a leapfrog impact on rural communities [10].

Scholars Liu Jun, Zhang Lei and Yu Liping (2019) established a digital divide measurement index system from four perspectives: awareness, access, use and environment of network technology, and used factor analysis to conduct a measurement study. [11] Li J and Wu XO (2018) constructed an indicator system for measuring the urban-rural digital divide, conducted an empirical analysis of the urban-rural digital divide and its influencing factors in Chongqing from 2003 to 2014, and proposed corresponding countermeasures to bridge the urban-rural digital divide [12].Erdiaw Kwasie M O, Alam K (2015) studied the digital divide in rural Australia, and he argued that the digital divide is a serious threat to the development of rural areas [13]. Indian scholar Manushi (2018) [14] mentioned that incomplete communication infrastructure creates a barrier for residents to access the internet.

Zhang Qin and Zhou Zhuo (2015) summarized the main influencing factors of rural e-commerce development through factor analysis of relevant index data from 31 provinces and cities in China, and put forward relevant countermeasure suggestions [15]. Chen Junliang, Lin Ying and Shi Huanhuan (2020) expanded 18 specific evaluation indicators from the five dimensions of the general requirements of rural revitalization strategy, and constructed an evaluation index system for rural revitalization, using factor analysis to empirically evaluate and analyze and compare 40 cities in three provinces of Jiangsu, Zhejiang and Anhui in the Yangtze River Delta region [16]. Yu, Xiaoling, Song, Kangkang and Lin, Zhenming (2019) constructed an evaluation index system for land ecological security, and used a comprehensive subjective and objective assignment method combining hierarchical analysis and entropy value method to evaluate and analyze the regional land ecological security status and the corresponding barrier factors through the comprehensive index method and barrier degree model [17]. Li Wenzheng, Liu Yufeng and other scholars (2019) took the panel data of 10 prefecture-level cities in Shaanxi Province from 2008 to 2016 as the research object, constructed an urban green development level evaluation index system containing 3 criterion-level indicators, 11 intermediate-level indicators and 35 basic indicators, and used TOPSIS model and barrier degree model to evaluate the spatial and temporal evolution characteristics of urban green development level in Shaanxi Province and the barrier factors were diagnosed [18]. From this, it can be seen that most of the studies on barrier factors are in information technology, e-commerce and rural revitalisation, and there are very few relevant studies on digital countryside barriers, whether in China or abroad. If domestic experts and scholars can pay more attention to and conduct research on this aspect of digital countryside barrier factors, it will be an important breakthrough for the digital countryside to move forward and develop.

To sum up, based on their own theoretical perspectives, Chinese scholars have mainly focused on the evaluation of rural revitalization development, urban-rural digital divide, digital tourism and digital rural development readiness evaluation index system, while foreign scholars' research mainly focuses on the digital divide and the impact of modern infrastructure construction on rural communities. Both at home and abroad, the existing literature rarely explores the barrier factors in studying the construction of digital villages. Based on the development of digital village construction and the analysis of literature, this paper constructs a barrier evaluation index system for digital village construction, uses the TOPSIS model based on entropy power and the barrier degree model to diagnose and analyse the digital barriers to digital village construction, and puts forward corresponding suggestions and countermeasures on this basis.

II. MODELS AND METHODS

2.1 Establishment of Evaluation Indicators

As there are few statistical data for the digital aspects of the countryside in China at present, some indicators and data are difficult to obtain. Therefore, following the above-mentioned principles of indicator construction, taking into full consideration the issue of accessibility of indicator data, according to the current status of statistics of digital countryside related development reports, referring to the results of relevant research experience of domestic scholars, and combining with the current actual situation of China's digital countryside construction, a guideline layer of four dimensions of support and security (a), agricultural production (b), farmers' life (c) and rural governance (c) and 38 specific indicators to evaluate the level of development of digital villages. (See TABLE I)

TABLE I. Indicator system for measuring barriers to digital village construction.

Target level	Guideline layer (weighting)	Specific indicator layers	Dimensions	Effective state	Weighting factor
	Support Guarantee (a)	Number of rural broadband access subscribers (a1)	10,000 households	+	2.38%
A study of digital barriers to the construction of digital villages and their counter measures	Support Guarantee (a) (0.2344)	Number of computers per 100 households in rural areas (a2)	Terrace	+	1.81%
		Rural Internet penetration rate (a3)	%	+	2.94%
		Size of rural digital TV subscribers (a4)	billion households	+	2.55%
		Rural e-commerce market size (a5)	billion	+	1.63%
		Coverage of rural e-commerce service sites (a6)	%	+	3.52%
		Beneficial farming information society coverage (a7)	%	+	1.95%
		Overall level of digital agricultural rural development (a8)	%	+	2.41%
		Amount of financial investment in agricultural and rural informatization (a9)	billion	+	2.12%

		Number of demonstration bases for agricultural and rural informatization (a10)	individual	+	2.15
Agricultural production (b) (0.3192)		Online retail sales of agricultural products (b1)	billion	+	2.56
		Level of informatization of crop cultivation (b2)	%	+	2.59
		Level of information technology in livestock and poultry farming (b3)	%	+	2.21
		Number of agricultural technicians (b4)	Number of persons	-	4.7
		Combined crop cultivation, planting and harvesting mechanization rate (b5)	%	+	1.70
		Level of digitisation of agricultural production (b6)	%	+	2.12
		Number of operational agrometeorological observation sites (b7)	individual	-	5.41
		Number of operational ecological and agrometeorological test sites (b8)	individual	+	4.48
		Agricultural digital economy as a share of sectoral value added (b9)	%	+	2.83
		Conversion rate of agricultural science and technology innovation results (b10)	%	+	2.21
		Contribution of scientific and technological progress in agriculture (b11)	%	+	2.76
		Number of people employed in agriculture, forestry and fisheries (b12)	10,000 people	-	3.71

Continued from TABLE I

Target level	Guideline layer (weighting)	Specific indicator layers	Dimensions	Effective state	Weighting factor
A study of digital barriers to the construction of digital villages and their countermeasures	Farmers' livelihoods (c) (0.2069)	Disposable income per rural resident (c1)	Yuan	+	2.15
		Ratio of rural villagers with undergraduate education level and above (c2)	%	+	5.41
		Per capita expenditure on transport and communications (c3)	Yuan	+	1.88
		Number of village informants trained (c4)	Number of persons	+	2.30
		Size of rural internet users (c5)	billion people	+	2.90
		Percentage of non-Internet users in rural areas (c6)	%	-	2.23
		Incidence of rural poverty (c7)	%	-	2.02
		Urban-Rural Income Disparity Index (c8)	——	-	3.02
	Rural governance (d) (0.2395)	Urbanisation rate (d1)	%	+	1.90
		Maturity of online processing of government online services (d2)	——	+	2.57
		Government Digital Government Capacity (d3)	——	+	2.52
		Degree of effectiveness of government online government services (d4)	——	+	2.48
		Proportion of administrative villages with open government services (d5)	%	+	1.91
		Coverage of integrated service facilities in rural communities (d6)	%	+	1.86
		Coverage of rural domestic waste collection and transportation facilities (d7)	%	+	1.72
		Online monitoring of wastewater treatment plant coverage (d8)	%	+	2.60

2.2 Data Sources

This paper combines the established evaluation index system with the extraction of research data for the time period 2015-2019. The data were mainly obtained from the Information Centre of the Ministry of Agriculture and Rural Affairs, the Ministry of Agriculture and Rural Affairs' China Digital Countryside Development Report (2019), the China Statistical Yearbook and China Rural Statistical Yearbook of the National Bureau of Statistics in various years, as well as the State Ministry of Industry and Information Technology, China Internet Network Information Centre (CNNIC), the State Ministry of Commerce, the Ministry of Science and Technology of China, the State Administration of Radio and Television, the Ministry of Housing and Urban-Rural Development, the China Business Industry Some of the data were obtained from public sources such as the statistical bulletin on the development of various industries in the past years, and directly from relevant data sources; some were calculated, and certain missing indicator data were interpolated with adjacent statistics.

2.3 Construction of the Evaluation Model

This paper adopts the entropy-based TOPSIS model to comprehensively evaluate the development level of digital villages. The entropy-weighted TOPSIS model is a modified version of the traditional TOPSIS, which first determines the weights of evaluation indicators through the entropy-weighted method, then measures the closeness of each evaluation object to the "positive ideal solution" and "negative ideal solution" through the TOPSIS method and ranks the merits of each evaluation object. The evaluation indexes are then ranked by the TOPSIS method.[29] The entropy weighting method can better reflect the information contained in the data, and it determines the index weights according to the dispersion degree of the sample data, and the greater the dispersion degree of the sample data, the greater the index weights. Compared with the traditional TOPSIS method, the entropy-based TOPSIS model makes the evaluation results more objective and scientific, and its specific calculation steps are as follows.

(1) Dimensionless processing of indicator data: Let's say we want to evaluate the development of digital villages in n years, and there are m evaluation indicators, which constitute the sample set as follows:

$$\left\{ X_{ij} \mid i = 1, 2, 3, ..., n; j = 1, 2, 3, ..., m \right\}, X_{ij}$$ is the original value of the jth indicator in the ith year.

As the data of each indicator used in this paper has different levels, in order to make the data comparable, firstly, the original data of all evaluation indicators are normalised using the extreme value method to eliminate the differences in levels between different indicators and make them uniform. The processing formula is as follows:

$$\begin{cases} Y_{ij} = \dfrac{X_{ij} - \min X_{ij}}{\max X_{ij} - \min X_{ij}} \\[2mm] Y_{ij} = \dfrac{\max X_{ij} - X_{ij}}{\max X_{ij} - \min X_{ij}} \end{cases} \tag{1}$$

where the upper formula is the forward indicator normalisation formula and the lower formula denotes the reverse indicator normalisation formula, X_{ij} denotes the raw data, i.e. the raw value of the jth indicator in year i; Y_{ij} denotes the quantified value, i.e. the normalised value of the jth indicator in year i; $\min X_{ij}$ and $\max X_{ij}$ denotes the minimum and maximum values of the raw data, respectively. The results of the normalised processing are:

$\{ Y_{ij} \mid i = 1, 2, 3, ..., n; j = 1, 2, 3, ..., m \}, 0 \le |Y_{ij}| \le 1$, Where n denotes the year and m denotes the number of indicators. Considering that the entropy weighting method requires logarithmic processing, the evaluation matrix is shifted to the right by 0.1 units in order to avoid 0-value indicators, and the final result of the normalisation process is:

$$\{ Y_{ij} \mid i = 1, 2, 3, \cdots, n; j = 1, 2, 3, \cdots, m \}, 0.1 \le |Y_{ij}| \le 1.1 \tag{2}$$

(2) Determine the indicator weights using the entropy weighting method. The information entropy is calculated from the standardised data as the proportion of the indicator value of the jth indicator in the total value of that indicator in year i:

$$P_{ij} = Y_{ij} \Big/ \sum_{i=1}^{n} Y_{ij} \tag{3}$$

Based on equation (3) the information entropy redundancy can be expressed as:

$$c_j = 1 + \frac{1}{\ln(n)} \times \sum_{i=1}^{n} \left[P_{ij} \times \ln\left(P_{ij}\right) \right] \tag{4}$$

The weights of each indicator in the indicator layer can be derived from equation (4):

$$w_j = \frac{c_j}{\sum_{j=1}^{m} c_j} \tag{5}$$

(3) Construct the normalized decision matrix. Firstly, the weighted normalised decision matrix is

constructed according to equations (1) and (5), i.e.: multiplying the dimensionless matrix with the weights of each indicator to obtain the weighted decision matrix:

$$H = \left(h_{ij}\right)_{n \times m} = \begin{vmatrix} Y_{11}w_1 & Y_{12}w_2 & \cdots & Y_{1m}w_m \\ Y_{21}w_1 & Y_{22}w_2 & \cdots & Y_{2m}w_m \\ \vdots & \vdots & & \vdots \\ Y_{n1}w_1 & Y_{n2}w_2 & \cdots & Y_{nm}w_m \end{vmatrix} = \left(Y_{ij} \times w_j\right)_{n \times m} \tag{6}$$

h_{ij} denotes the weighted normalized value of the jth indicator in year i.

Second, determine the positive ideal solution and negative ideal solution of the evaluation object. Let be the maximum value of the jth indicator in the evaluation data among the i evaluation objects, called the positive ideal solution; be the minimum value of the jth indicator in the evaluation data among the i evaluation objects, called the negative ideal solution, and its calculation method is:

Positive ideal solution:

$$V^+ = \left\{\max h_{ij} \mid j = 1,2,3,...,m\right\} = \left\{V_1^+, V_2^+, V_3^+, ..., V_m^+\right\} \tag{7}$$

Negative ideal solution:

$$V^- = \left\{\min_{1 \le i \le n} h_{ij} \mid j = 1,2,3,...,m\right\} = \left\{V_1^-, V_2^-, V_3^-, ..., V_m^-\right\} \tag{8}$$

Next, the distance between each evaluation object's index value and and is calculated using the more commonly used Euclidean distance formula here.
Distances to positive ideal solutions:

$$S_i^+ = \sqrt{\sum_{j=1}^{m} \left(h_{ij} - V_j^+\right)^2} \qquad (i = 1, 2, 3, n). \tag{9}$$

Distance to negative ideal solution:

$$S_i^- = \sqrt{\sum_{j=1}^{m} \left(h_{ij} - V_j^-\right)^2} \qquad (i = 1, 2, 3, n). \tag{10}$$

Finally, the relative proximity of each indicator value to the ideal solution and the evaluation result are

calculated, the higher the value the better the level of development. The calculation formula is as follows:

$$N_i = \frac{S_i^-}{S_i^- + S_i^+} \qquad (i = 1, 2, 3, n). \tag{11}$$

The higher the value, the further away from the negative ideal solution and the closer to the positive ideal solution, the better the state of the evaluated object, i.e. the higher the level of development of the digital village. In the same way, the score of each criterion level can be calculated. The proximity is divided into four levels to indicate the degree of digital village development, as shown in TABLE II.

TABLE II. Evaluation criteria for the level of construction of digital villages

Proximity	0.00~0.30	0.31~0.60	0.61~0.80	0.81~1.00
Degree of evaluation	Poor	Moderate	Good	Excellent

2.4 Construction of a Diagnostic Model for the Disorder Factor

The focus of this study is to diagnose the barriers to the construction of the digital village, so as to better target the construction and development of the digital village. Therefore, three basic variables of the barrier identification model are introduced: factor contribution w_{ij}, index deviation E_{ij} and barrier degree Q_{ij}. The calculation steps are as follows:

Firstly, the contribution of the factor:

$$w_{ij} = f_{ij} \times e_{ij} \tag{12}$$

w_{ij} indicates the degree of influence of the indicator tier factors on the target tier; f_{ij} indicates the weight of the jth indicator factor in year i; e_{ij} indicates the weight of the jth indicator factor in year i corresponding to the factor weight of the criterion tier.

Next, determine the indicator deviation:

$$E_{ij} = 1 - Y_{ij} \tag{13}$$

E_{ij} denotes the deviation gap between the individual indicators and the barrier value for the

construction of the digital village; Y_{ij} denotes the standardised value of the jth indicator in year i.

Finally, to calculate the degree of barrier:

$$Q_{ij} = \frac{w_{ij} \times E_{ij}}{\sum_{j=1}^{m} \left(w_{ij} \times E_{ij} \right)} \times 100\% \tag{14}$$

Q_{ij} indicates the degree to which a single indicator is an obstacle to the construction of the digital village. By ranking Q_{ij} in order of magnitude, we can determine the priority of the obstacles to the construction of the digital village and the degree of influence of each obstacle on the construction of the digital village. In addition, based on the analysis of the barrier degree of each single indicator, the barrier degree of each single indicator under this criterion layer can be arithmetically summed up to obtain the barrier degree evaluation score of each criterion layer.

III. EMPIRICAL EVIDENCE AND ANALYSIS OF RESULTS

3.1 Digital Village Development Level Evaluation Results

Firstly, to determine the weights and positive and negative ideal solutions, the weight coefficients of each criterion layer as well as the specific indicator layer are calculated according to the previous equations (3) to (5) and using the entropy weighting method (as in TABLE I); according to equations (1) (5) (6), the positive and negative ideal solutions of the indicators are determined as in TABLE III and TABLE IV.

TABLE III. Positive and negative ideal solutions for specific indicator layers

Indicator items	Positive ideal solution V^+	Negative ideal solution V^-	Indicator items	Positive ideal solution V^+	Negative ideal solution V^-
a1	0.024	0	b10	0.022	0
a2	0.018	0	b11	0.028	0
a3	0.029	0	b12	0.037	0
a4	0.025	0	c1	0.022	0
a5	0.016	0	c2	0.054	0
a6	0.035	0	c3	0.019	0
a7	0.019	0	c4	0.023	0

a8	0.024	0	c5	0.029	0
a9	0.021	0	c6	0.022	0
a10	0.021	0	c7	0.02	0
b1	0.026	0	c8	0.03	0
b2	0.026	0	d1	0.019	0
b3	0.022	0	d2	0.026	0
b4	0.045	0	d3	0.025	0
b5	0.017	0	d4	0.025	0
b6	0.021	0	d5	0.019	0
b7	0.054	0	d6	0.019	0
b8	0.045	0	d7	0.017	0
b9	0.028	0	d8	0.026	0

TABLE IV. Positive and negative ideal solutions for the criterion layer

Indicator items	Positive ideal solution V^+	Negative ideal solution V^-
a	0.234	0
b	0.319	0.002
c	0.197	0.008
d	0.24	0

Equations (7) to (12) were then used to calculate the specific indicators of the digital village construction in these five years as well as the relative proximity of the guideline levels and determine the evaluation results based on the evaluation criteria, as shown in TABLE V and TABLE VI.

TABLE V. Indicator layer evaluation results and proximity

Year	Distance to positive ideal solution S^+	Distance to negative ideal solution S^-	Relative proximity N	Sort results	Evaluation results
2015	0.171	0.007	0.039	5	Poor
2016	0.154	0.035	0.184	4	Poor
2017	0.132	0.06	0.313	3	Moderate
2018	0.062	0.125	0.669	2	Good
2019	0.009	0.171	0.952	1	Excellent

TABLE VI. Results of the evaluation of the guideline layer and progress of succession

Year	Distance to positive ideal solution S^+	Distance to negative ideal solution S^-	Relative proximity N	Sort results	Evaluation results
2015	0.499	0	0	5	Poor
2016	0.406	0.097	0.193	4	Poor
2017	0.315	0.192	0.379	3	Moderate
2018	0.166	0.334	0.669	2	Good
2019	0	0.499	1	1	Excellent

From the evaluation results, it can be seen that in 2019, China's digital countryside development level evaluation index is the highest, the posting progress of the positive ideal solution is 0.952, corresponding to the evaluation result of excellent, indicating the best digital countryside development level in five years; in 2018, China's digital countryside development level evaluation index ranks second, the posting progress of the positive ideal solution is 0.669, corresponding to the evaluation result of good; in 2017, China The evaluation index of China's digital countryside development level ranked third, with a posting progress of 0.313 for the positive ideal solution, corresponding to a medium evaluation result; the evaluation index of China's digital countryside development level ranked fourth in 2016, with a posting progress of 0.184 for the positive ideal solution, corresponding to a poor evaluation result; the evaluation index of China's digital countryside development level ranked the lowest in 2015, with a posting progress of 0.039 for the positive ideal solution, corresponding to a poor evaluation result. The corresponding evaluation result is poor. It can be seen that the level of development of the digital countryside has varied significantly from year to year over these five years, but overall, as the years increase, the digital countryside is developing on a better path. The evaluation results show that the years 2015-2017 were all poor, indicating that China's digital countryside did not really develop until 2017, and that the gradual start of development came after the end of 2017, which is in line with the actual development of China. With the development of the digital economy in recent years, China began to realize the importance of the construction of digital countryside, national policies began to tend to the rural areas, focusing on the digital development of the countryside, the digital countryside began to show good development in 2018, and in early 2019, the digital countryside was officially proposed and then began to promote in the country, and the digital construction of the countryside made important progress.

3.2 Results of the Identification of Barriers to Digital Village Construction

Using the above-mentioned barrier model, we diagnose the barriers to digital development in the countryside and identify the main barriers according to the single-indicator and normative level indicators.

(1) Single-indicator barrier analysis. After standardizing the indicators and calculating the weights, the barrier degree model was then applied to calculate the barrier degree of each evaluation factor of the digital village construction from 2015 to 2019, and the results of identifying the barrier factors of the digital

village construction from 2015 to 2019 were obtained (see TABLE VII).

TABLE VII. Diagnostic results of the barriers to digital village construction indicator layer, 2015-2019

Year	2015	2016	2017	2018	2019
a1	0.373805224	0.31806132	0.216496098	0.091637358	0
a2	0.492957746	0.183098592	0	0.323943662	0
a3	0.315334773	0.282937365	0.233261339	0.168466523	0
a4	0.363636364	0.318181818	0.227272727	0.090909091	0
a5	0.460545687	0.27426767	0.153758307	0.111428336	0
a6	0.327954191	0.327433628	0.219677251	0.12493493	0
a7	0.379661017	0.274576271	0.208135593	0.137627119	0
a8	0.36492891	0.309636651	0.224328594	0.101105845	0
a9	0.371134021	0.288659794	0.216494845	0.12371134	0
a10	0.378181818	0.301818182	0.207272727	0.112727273	0
b1	0.405526665	0.375378131	0.087182625	0.131912579	0
b2	0.325153374	0.27607362	0.226993865	0.171779141	0
b3	0.362385321	0.28440367	0.229357798	0.123853211	0
b4	0.311436753	0.303764604	0.293583691	0.091214951	0
b5	0.404040404	0.242424242	0.202020202	0.151515152	0
b6	0.373737374	0.292929293	0.212121212	0.121212121	0
b7	0.333333333	0.333333333	0.333333333	0	0
b8	0.278020378	0.295487627	0.286754003	0.139737991	0
b9	0.32375	0.28625	0.24	0.15	0
b10	0.372881356	0.305084746	0.203389831	0.118644068	0
b11	0.363636364	0.340909091	0.193181818	0.102272727	0
b12	0.316901408	0.298483207	0.277356446	0.107258938	0
c1	0.375468386	0.298591779	0.211322911	0.114616923	0
c2	0.333333333	0.333333333	0.333333333	0	0
c3	0.414478135	0.293437481	0.20167292	0.090411464	0
c4	0.423119334	0.366208954	0.150313976	0.060357736	0
c5	0.317919075	0.283236994	0.23699422	0.161849711	0
c6	0.25	0	0.261363636	0.352272727	0.136363636
c7	0.404761905	0.30952381	0.198412698	0.087301587	0
c8	0.310344828	0.275862069	0.24137931	0.172413793	0
d1	0.414746544	0.299539171	0.191705069	0.094009217	0

d2	0.346936244	0.302902506	0.226866782	0.123294468	0
d3	0.344078054	0.295418056	0.228109176	0.132394714	0
d4	0.340459713	0.286950074	0.230474543	0.14211567	0
d5	0.428954424	0.310098302	0.190348525	0.070598749	0
d6	0.407158837	0.284116331	0.203579418	0.105145414	0
d7	0.486842105	0.315789474	0.144736842	0.052631579	0
d8	0.346938776	0.306122449	0.224489796	0.12244898	0

In combination with the actual situation, it can be found that as time goes by and the digital village strategy advances, the categories, the degree of barriers and even the number of barriers are in a dynamic state of change. An analysis of the main barriers to the digital countryside shows that the number of barriers to digital development in the countryside has been decreasing year by year, with the most frequent occurrence of a single barrier indicator being the proportion of non-Internet users in rural areas (c6), followed by the scale of rural Internet users (c5), indicating that there are still a large number of non-Internet users in rural areas in China. Many farmers' mobile phones are only communication tools and have not become Internet tools, which also reflects the relatively low level of informatization of rural residents in China; the third most frequent occurrences of barrier degree are rural Internet penetration rate (a3), the number of computers per 100 rural households (a2), coverage of rural e-commerce service sites (a6), online retail sales of agricultural products (b1), agricultural digital economy as a proportion of industry value added (b9), number of ecological and agricultural meteorological observation business sites (b7), income disparity index between urban and rural residents (c8), ratio of villagers with undergraduate education level or above in rural areas (c2), number of trained village information officers (c4), proportion of administrative villages with open government affairs (d5), and coverage of rural domestic waste collection and transportation equipment (d7). In terms of vertical time, the main barrier factor in 2015 was the number of computers per 100 rural households (a2), reflecting the low level of consumption of rural residents at that time. Although some statistics show that the consumption structure at that stage was at the stage of upgrading from subsistence to development, due to the innate geographical influence of rural areas and the relatively large size of each rural household, the overall consumption was in a subsistence state, with a consumption The environment is weak and the transition cycle of development is also long, and the effectiveness of the consumer economy that wants to stimulate the rural market will not be immediately apparent, which in turn becomes one of the main factors hindering rural development. Since 2016, when China's rural informatization development started to get on track, the amount of online retail sales of agricultural products (b1), the contribution rate of agricultural science and technology progress (b11), and the number of trained village informants (c4) have become the main obstacles to rural development. 2016-2017, two obstacle factors, the ratio of villagers with a bachelor's degree or higher education level in rural areas (c2) and the number of agricultural meteorological observation operational sites (b7), ranked in the ranked in the top five for two years, indicating that the low application of modern equipment in agriculture and the unbalanced development of farmers' knowledge are also restricting the development of digital rural construction. c2 and b7, the two barrier factors, gradually withdrew from the main barrier factors of digital agricultural rural development after 2018, and c6 and a2, the two barrier factors, are

prominent in their influence.

(2) Analysis of the barrier degree at the guideline level. In order to clarify which aspects of the obstacles to the development of digital agriculture and rural development from 2015 to 2019 are mainly concentrated and analyze their change trends, this paper further calculates the obstacle degrees of the indicators of the four dimensional guidelines layer according to the obstacle degrees of specific indicator layers (as shown in TABLE VIII).

TABLE VIII. Diagnosis of barriers at the digital village building guidelines level, 2015-2019

Year	2015	2016	2017	2018	2019
a	0.376528686	0.291284755	0.19737407	0.134812488	0.00
b	0.341982211	0.297829597	0.245400246	0.114787946	0.00
c	0.348595705	0.267368353	0.23331168	0.133221548	0.01750271
d	0.383496085	0.299531093	0.208245655	0.108727167	0.00

From an overall perspective, the level of agricultural production is always the biggest obstacle factor limiting the development of the digital village, with the obstacle degree ranging from 10% to 40%, with the highest being 38.35%. As can be seen from the results of the guideline level barrier degree diagnosis, the overall barrier degree in 2015 was above 30%, and the barrier degree value was obviously high; from 2015 to 2019, the greater barrier degree in the process of digital village construction was in the aspects of basic support, agricultural production and digitalisation of farmers' life, indicating that some factors in these aspects were the main barriers to the development of digital village construction in these years, but the barrier degree values of both In 2019, agricultural production gradually withdrew from the main obstacle factors, and the obstacle degree of digital farmers' life increased significantly, indicating that with the development of the rural economy, the infrastructure in rural areas is being gradually improved, but the problem of farmers' own reasons for not integrating digitalization in their life patterns has become the most critical obstacle to the digitalization of the countryside.

IV. REFLECTIONS ON MITIGATING DIGITAL BARRIERS TO DIGITAL VILLAGE CONSTRUCTION AND COUNTERMEASURES

By constructing a digital village development evaluation index system and evaluating digital barriers, this paper concludes that indicators such as digital village foundation support, agricultural production and digital farmers' life have a greater impact on digital village construction, while rural governance barriers account for a relatively small proportion.

4.1 Improving Rural Network Information Infrastructure

The construction of rural information infrastructure is directly related to the level of rural information

construction, the government should attach great importance to the digital construction of rural information, increase funding for rural network facilities, promote the comprehensive coverage of broadband networks, improve the level of rural network facilities, improve information service terminals, and enhance the level of information services for agriculture, rural areas and farmers. The next step is for the government and the relevant departments to provide "after-sales service" to ensure that the existing TV networks are clear and stable, so that farmers can make good use of the network and enjoy the benefits of information technology. It is also possible to use the internet for distance education, telemedicine and digital living, allowing farmers to enjoy the convenience of a digital society, and to begin to popularise the use of 5G technology in the countryside and publicise it effectively to promote urban-rural integration.

4.2 Promoting the Modernisation of "Internet + Agriculture"

Agricultural production is a major obstacle to the digitalisation of the countryside. The "Internet + modern agriculture" is commonly known as the use of digital technology to equip modern agriculture and promote digital transformation of agriculture. Governments at all levels should actively promote the application of digital technology in modern agricultural industrialisation and production, realise the digital and intelligent development of agriculture, and develop new business models such as smart farming; use drones or RS technology and high-definition remote video surveillance systems to monitor vulnerable ecological areas in rural areas; make full use of modern information technology such as mobile communications and smart terminals to strengthen the monitoring and management of agriculture; and actively guide farmers to to make full use of the growth dividend of the digital economy and change their traditional methods of cultivation, production, processing and marketing; to support the development of new agricultural services and agricultural business entities, promote the establishment of family farms and planting cooperatives in rural areas, and introduce intelligent agricultural equipment to promote the transformation of agriculture towards digitalisation.

From the empirical results, the amount of online retail sales of agricultural products, the proportion of the agricultural digital economy in the value added of the industry, and the index of income disparity between urban and rural farmers are all important factors affecting the development of the digital level of agricultural production. We should adhere to the main position of farmers, increase technical training, popularise digital knowledge and input digital technology for villages through joint online and offline channels, establish an "Internet+" marketing system for special agricultural products, and cultivate a new type of digital professionals who understand the digital economy, know technology, and are proficient and good at managing e-commerce network platforms. A team of professional and technical talents in the digital era. After the team has matured, it will be possible to carry out training for one person to one household or one person to several households. On the basis of the "Internet+" model for small farmers, it is recommended that digital training be provided for large-scale farming and planting households to enhance their development capacity and fully mobilise the initiative and creativity of the majority of rural farmers, so that they can understand the big data of the Internet and make their own products available through the Internet platform. and can sell their agricultural products through the internet platform. Local governments can make full use of existing network resources, "matchmaking" for farmers through the

Internet, allowing cooperatives to cooperate with e-commerce platforms or enterprises to bring agricultural products to the market through live streaming and other means, continuously promoting farmers' sustainable income and achieving rural consumption upgrading. Data from China's Ministry of Commerce shows that in 2019, China's rural network retail sales amounted to 1.7 trillion yuan, an expansion of 8.4 times compared to 2014, thus showing the huge potential of the rural consumption market.

4.3 Strengthen Digital Talent Support and Enhance the Digital Level of Farmers' Lives

This is not only due to the low education level of the majority of the rural population, but also partly due to the fact that university graduates in rural areas are not willing to return to the countryside to work at the grassroots level after graduation. Counties and towns can issue relevant policies to encourage university graduates to return to rural areas to engage in digital grassroots services, but, of course, it is difficult to encourage university students to go to rural areas for grassroots services. Secondly, there is a need to develop the tertiary sector in rural areas in order to provide more employment opportunities and thus make the countryside more attractive.

The findings also show that the development of the digital village has long been constrained by barriers such as the proportion of non-Internet users in rural areas and the size of rural Internet users. Although China's rural infrastructure has been gradually improved, the scale of rural non-Internet users still exists in the majority, in the future digital development, in addition to the improvement of hardware construction, but also focus on the development of farmers themselves information, intelligence, digital, guide farmers gradually understand digital and strengthen the application of intelligent technology software, increase the promotion of digital equipment, intelligent equipment in rural areas, so that farmers In particular, it is necessary to strengthen the popularisation of Internet knowledge among rural disadvantaged groups such as left-behind children, the elderly, rural women and farmers with low literacy levels, to strengthen the training of disadvantaged groups in informatisation and digitisation, to improve their Internet literacy, to guide residents to widely understand the advantages of Internet technology, and to reduce the degree of digital barriers in the process of digital development.

In conclusion, the digital countryside is still in its primary stage, and the awareness of the construction of digital countryside in rural areas is still weak. At present, there are still some poor households in the bottleneck stage of poverty eradication in China's rural areas, and although the digital countryside strategy has been written into local policy documents, how to effectively connect the digital countryside with rural revitalization and poverty eradication, so that the accumulation of experience in rural revitalization can help the steady development of digital countryside and the policy of digital countryside The combination of support for promoting the completion of rural revitalization development is not yet clearly and maturely thought out in various localities. Therefore, it is necessary to build an effective mechanism for linking the rural revitalization strategy with the digital countryside strategy as soon as possible, so as to, on the one hand, give full play to the active role of rural revitalization and the digital economy in agriculture and rural farmers, and provide experience reference and practical guidance for the realization of digital life and digital living in rural areas; on the other hand, make use of On the other hand, we will make use of the

opportunity of urban-rural integration under the rural revitalization strategy to drive the development of the digital countryside with the digital city, so that urban digital resources can be brought to the countryside and the digital countryside can be developed in depth.

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REFERENCES

[1] The General Office of the Central Committee of the Communist Party of China issued the "Digital Village Development Strategy Outline". [2019-05]. http://www.gov.cn/zhengce/2019-05/16/content_5392269. htm

[2] Wang Jiubo. Current Situation, Practices and Difficulties of Digital Village Construction in Liaoning Province. Agricultural Economy, 2019(09):47+83.

[3] Mao Wei, Wang Xian. Research on rural information service mode and strategy under the background of digital rural construction. Information Science, 2019,37(11):116-120.

[4] Zhang Hong, Du Kaiwen, Jin Bingyan. Research on the evaluation of digital rural development readiness under the rural revitalization strategy. Journal of Xi'an University of Finance and Economics, 2020, 33(01): 51-60.

[5] Zhang Ting, Li Minrong, Xu Yanmei. Construction of Rural Revitalization Evaluation Index System and Empirical Research. Management World, 2018,34(08):99-105.

[6] Hu Jing, Liu Yang. How to integrate rural network information construction into rural revitalization strategy. Academic Exchange, 2018(12):128-135.

[7] Zhang Shuzhen, Li Lei. Digital Communication and Rural Revitalization. Journalism and Writing, 2019(09): 4.

[8] Sarah Rotz, Evan Gravely, Ian Mosby, et al. Automated pastures and the digital divide: How agricultural technologies are shaping labour and rural communities. JOURNAL OF RURAL STUDIES.2019.01.023,68:112-122.

[9] Townsend L, Sathiaseelan A, Fairhurst G, etal. Enhanced broadband access as a solution to the social and economic problems of the rural digital divide. Local Economy, 2013, 28(6):580-595.

[10] Meyn M. Digitalization and Its Impact on Life in Rural Areas: Exploring the Two Sides of the Atlantic: USA and Germany. Patnaik S., Sen S., Mahmoud M. (eds), Smart Village Technology. Modeling and Optimization in Science and Technologies, vol 17,2020.

[11] Liu Jun, Zhang Lei, Yu Liping. Research on China's Digital Divide Assessment: Based on the Perspective of Mobile Communication Tools. Statistics and Decision, 2019, 35(05): 32-35

[12] Li Jian, Wu Xiaoou. An empirical study on the urban-rural digital divide and its influencing factors in Chongqing under the background of coordinating urban and rural development. Modern Intelligence, 2018, 38(03): 87-91+132.

[13] Erdiaw-Kwasie M O, Alam K. Towards understanding digital divide in rural partnerships and development: A framework and evidence from rural Australia. Journal of Rural Studies,2015,(43):214-224.

[14] Manushi. Rural India in the Digital Age. Research Ethics in the Digital Age.2018(01):95-99.

[15] Zhang Qin, Zhou Zhuo. Research on the influencing factors of the development of rural e-commerce in my country. Logistics Engineering and Management, 2015, 37(11): 181-183.

[16] Chen Junliang, Lin Ying, Shi Huanhuan. Research on Comprehensive Evaluation of Rural Revitalization and Development Level in the Yangtze River Delta Region. East China Economic Management, 2020,34(03):16-22.

[17] Yu Xiaoling, Song Kangkang, Lin Zhenming. Evaluation of Land Ecological Security in Industrial Cities and Analysis of Obstacle Factors. Jiangsu Agricultural Science, 2019, 47(11): 271-275.

[18] Li Wenzheng, Liu Yufeng, Zhang Xiaolu, Deng Chenhui. Spatial-temporal evolution and obstacle factor analysis of urban green development level in Shaanxi Province. Research on Soil and Water Conservation, 2019,26(06):280-289.

[19] Tapscott Don.The Digital Economy: Promise and Peril in the Age of Networked Intelligence. New York:McGraw-Hill,1996

[20] G20 Summit. G20 Digital Economy Development and Cooperation Initiative. [2016-09]. http://www.g20chn.org/hywj/dncgwj/201609/t20160920_3474.html

[21] Wang Yaozong, Niu Minglei. Thoughts and Suggestions on Promoting Agricultural and Rural Informatization in the New Era with the Strategy of "Digital Village". Journal of Management Cadre College of Ministry of Agriculture, 2018(03):1-8. https://www.xzbu.com/7/view-5153089.htm

[23] Xi Jinping's report on behalf of the 18th Central Committee at the 19th National Congress of the Communist Party of China. "A decisive victory in building a moderately prosperous society in an all-round way and winning the great victory of socialism with Chinese characteristics in the new era" [2017- 10].

[24] Information Asymmetry Theory. MBA Think Tank [2020-5]

[25] Opinions of the General Office of the People's Government of Yunnan Province on the Implementation of "Digital Village" Project Construction. Yunnan Political News, 2007, 000(014):P.13-15.

[26] Fu Jicai. The practice and exploration of agricultural and rural informatization in Yunnan Province. China Rural Economy, 2007(S1): 83-86.

[27] Yuan Ye, Zeng Jianqiu, Zhao Hongyun, Zhang Xianhua. Research on the Service Mode of Rural Informatization——Taking the "Digital Village" in Yunnan Province as an Example. Journal of Beijing University of Posts and Telecommunications (Social Science Edition), 2014,16(01) :73-78.

[28] The 45th "Statistical Report on Internet Development in China" by China Internet Network Information Center. [2020-04]. http://www.cac.gov.cn/2020-04/27/ c_1589535470378587.htm

[29] Zhang Linying, Xu Songjun. Comprehensive evaluation of the Pearl River Delta Nature Reserve based on entropy weight. Journal of Ecology, 2011(18)