



# FAHP-Based Performance Evaluation of Rural E-Commerce for Poverty Alleviation in Sichuan Province

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**Abstract.** Rural e-commerce is an important vehicle for achieving precise poverty alleviation. The development of rural e-commerce is an important way to realize the rural revitalization strategy. This study uses the Fuzzy Analytic Hierarchy Process (FAHP) method to assess the performance of rural e-commerce in poverty alleviation in Sichuan Province. Firstly, an evaluation system of the performance of rural e-commerce in poverty alleviation was constructed, including policy support ( $A_1$ ), development model innovation ( $A_2$ ), domestic sales of agricultural products ( $A_3$ ), and rural e-commerce management ( $A_4$ ), with a total of 14 indicators at four levels. Secondly, the evaluation system was tested for consistency in conjunction with expert opinions. Finally, taking Sichuan province as an example, the indicators of the four guiding levels were found to have an impact on the development of rural e-commerce in the order of importance  $A_3 > A_2 > A_4 > A_1$ . It is hoped that this study can provide some theoretical guidance for improving the performance level of rural e-commerce poverty alleviation and maintaining the ability of rural e-commerce poverty alleviation to “gain more benefits”.

**Keywords:** Rural e-commerce · Poverty alleviation · FAHP · Performance evaluation

## 1 Introduction

In October 2020, the Fifth Central Committee of the 19th Central Committee proposed to give priority to the development of agriculture and rural areas and to comprehensively promote the revitalization of the countryside. As an important vehicle for precise poverty alleviation, rural e-commerce has provided new impetus for rural revitalization [2]. In recent years, China's rural e-commerce has been developing to a certain extent. With the deepening development of “Internet+”, rural e-commerce is becoming an important tool for precise poverty alleviation and a new driving force for rural revitalization [3, 8].

In 2016, the General Office of the Sichuan Provincial Government issued the “Implementation Plan for Accelerating the Development of Rural E-Commerce in Sichuan Province”, which stated that it would combine the actual situation in the province to accelerate the development of rural e-commerce and further promote agricultural upgrading, rural development, and farmers’ income growth. After years of efforts, rural e-commerce in Sichuan Province has achieved rapid development, and the work of rural e-commerce to alleviate poverty has also made great progress. However, the rapid growth has been accompanied by several problems: the “last mile” problem of rural logistics; the difficulty of integrating agricultural products into the e-commerce chain; and the sustainable development of grassroots rural e-commerce and so on. China’s economy has shifted from a stage of high growth to a stage of high-quality development. The qualities of high quality determine the necessity of high-quality development of rural e-commerce. How to solve the problems of rural e-commerce in Sichuan Province at this stage, to promote the consolidation and expansion of the achievements of poverty alleviation and rural revitalization, and to take the road of high-quality sustainable development, these are the important issues that need to be studied urgently [21].

Most scholars have examined the current state of development, models, issues and policy implications of rural e-commerce [8]. A few scholars have innovated research issues from the perspectives of regional inequality, industrial structure, and quality management [11, 14]. However, among the existing studies, only a very small proportion of studies have focused on post-practice performance evaluation. China’s rural areas are highly individualized, it is necessary to carry out performance evaluation of rural e-commerce based on regional characteristics [18]. Scientific performance evaluation is not only an important task to promote the development of rural e-commerce poverty alleviation, but also can enrich the theory and case studies of rural e-commerce poverty alleviation at home and abroad. In particular, it can provide ideas and experiences for the development of e-commerce poverty alleviation in other regions.

This study takes rural e-commerce in Sichuan Province as the object. On the basis of expert assessment, adopting the fuzzy integrated hierarchical evaluation method (FAHP) to construct a performance evaluation system for rural e-commerce poverty alleviation. The study has certain theoretical guidance significance for the development of the performance evaluation system of rural e-commerce poverty alleviation.

## 2 Methodology

### 2.1 The Fuzzy Analytic Hierarchy Process

The analytic hierarchy process (AHP) is one of the most commonly used methods of assessment [17]. It is also often used in poverty alleviation research. This is made possible by the fact that AHP has a combination of qualitative and quantitative features. The use of AHP helps the researcher to simplify complex problems using a hierarchical structure to enable decision-making on complex problems. However, the AHP does not fully reflect the mindset of

decision-makers. In some practical situations, decision-makers are usually more confident in giving interval judgments rather than expressing their judgments in precise numerical form. To circumvent the strong subjectivity of the decision-maker, Van Laarhoven and Pedrycz (1983) evolved the AHP into the FAHP by introducing the triangular fuzzy numbers from fuzzy set theory directly into the pairwise comparison matrix of the AHP [16]. The aim is to resolve the ambiguity that arises in the analysis of criteria and the judgement process [1]. It is because of the FAHP's ability to tolerate ambiguity that the FAHP should be more appropriate and effective in practice than the traditional AHP [10].

The fuzzy analytic hierarchy process (FAHP) is widely used in academia to evaluate performance in many areas. In terms of ecological assessment, Li et al. (2009) used FAHP to evaluate the ecological vulnerability of the Danjiangkou reservoir area in China, and the distribution of ecological vulnerability and the main problems of the ecological environment were analyzed and discussed [5]. In terms of facility construction evaluation, Zhengzhou, Yijian, and Lei (2021) used FAHP to establish an effective evaluation system and model to conduct a study with university laboratories [4]. In terms of decision making, Mikaeil et al. (2009) combined the FAHP and TOPSIS approaches to study decision support systems for optimal underground mining methods [9]. Noorollahi et al. (2016) used FAHP to analyze the suitability of land for farm development based on GIS [12].

In summary, it is feasible to apply FAHP to carry out an assessment of poverty alleviation performance. This study has invited three experts who participated in the research on rural e-commerce poverty alleviation in Sichuan Province to score the indicators. In addition, in academia, scholars often combine FAHP with other research methods in order to make decision results more accurate. Considering the possibility of inconsistency or omission in the scoring matrix of FAHP, this study plans to use Particle Swarm Optimization (PSO) to correct the scoring matrix of three experts. Therefore, this study combines PSO with FAHP to evaluate the performance of rural e-commerce poverty alleviation in Sichuan Province, which further circumvents the excessive subjectivity of traditional AHP models.

### 2.2 Construction of Fuzzy Consistency Matrix

This section will state how to construct the judgment matrix at each level. Assuming that the elements  $G$  in the previous level are associated with the elements  $A_1, A_2, \dots, A_n$  in the next level, the fuzzy consistent judgment matrix can be expressed as:

$$\begin{array}{cccc}
 G & A_1 & A_2 & \dots & A_n \\
 A_1 & r_{11} & r_{12} & \dots & r_{1n} \\
 A_2 & r_{21} & r_{22} & \dots & r_{2n} \\
 \dots & \dots & \dots & \dots & \dots \\
 A_n & r_{n1} & r_{n2} & \dots & r_{nn}
 \end{array}$$

Factor  $r_{ij}$  has the following practical meaning:  $r_{ij}$  indicates that when comparing factor  $a_i$  and factor  $a_j$  with respect to factor  $G$ , factor  $a_i$  and element  $a_j$  have a fuzzy relationship, which can be understood as the affiliation of “...much more important than...”. A two-by-two comparison of the factors using the 0.1–0.9 scale method (as shown in Table 1) was able to obtain the fuzzy hierarchical analysis scoring judgment matrix  $R = (a_{ij})_n \times n$ .

**Table 1.** Definition of judgment matrix scales

Fuzzy number	Implication
0.5	Factor $a_i$ and factor $a_j$ are equally important
0.6	Factor $a_i$ is a little more important than factor $a_j$
0.7	Factor $a_i$ is more important than factor $a_j$
0.8	Factor $a_i$ is extremely more important than factor $a_j$
0.9	Factor $a_i$ is absolutely more important than factor $a_j$
0.1, 0.2, 0.3, 0.4	If factor $a_i$ is compared with factor $a_j$ to obtain the judgment $r_{ij}$ , then the judgment obtained by comparing factor $a_j$ with factor $a_i$ is $r_{ji} = 1 - r_{ij}$

The judgment matrix  $R$  satisfies the fuzzy complementary matrix with the condition:  $0 < r_{ij} < 1$ ;  $r_{ij} + r_{ji} = 1$ ;  $a_{ij} = 0.5$ , ( $i = j$ ). If the conditions of the fuzzy matrix are met, it is possible to sum the matrix  $R$  by rows, and this summation formula is shown in Eq. (1).

$$r_i = \sum_{k=1}^n r_{ik}(i, k = 1, 2, \dots, n). \tag{1}$$

From this, the weight determinant of each factor can be found as follows:

$$w_i = \frac{1}{n} - \frac{1}{2\alpha} + \frac{r_i}{n\alpha}, \tag{2}$$

$$WI = (w_i)_{n \times 1} = [w_1, w_2, \dots, w_n]^T. \tag{3}$$

In the Eq. (2),  $\alpha = \frac{n-1}{2}$ .

Finally, the consistency of the matrix is judged and the weight matrix  $W$  is constructed as follows:

$$w_{ij} = \alpha(w_i - w_j) + 0.5, \tag{4}$$

$$W = \begin{bmatrix} w_{11} & w_{21} & \dots & w_{1n} \\ w_{21} & w_{22} & \dots & w_{2n} \\ \dots & \dots & \dots & \dots \\ w_{n1} & w_{n2} & \dots & w_{nn} \end{bmatrix}$$

This study proposes to use CI to test the consistency of the scoring matrix, and it is generally agreed that a  $CI < 0.1$  indicates that the consistency requirement is met. a smaller CI value indicates better consistency [20]. If the expert

matrix cannot meet the consistency requirement, PSO is required to be corrected to make the scoring results meet the consistency requirement. Where the CI is calculated as follows:

$$CI(A, W) = \frac{\sum_{i=1}^n \sum_{j=1}^n |w_{ij} - r_{ij}|}{n^2}. \tag{5}$$

### 3 The Fuzzy Analytic Hierarchy Process

In this study, FAHP was used to determine the index weights. Based on the purpose and tasks of rural e-commerce poverty alleviation, in evaluating the performance of rural e-commerce poverty alleviation, this study decomposed the decision-related elements into a total of three levels: goal layer, criterion layer, and program layer, and conducted qualitative and quantitative analysis at different levels.

#### 3.1 Criterion Layer and Index Layer

According to the report on rural e-commerce poverty alleviation in Sichuan Province and the research on the field situation, the recommendations of relevant experts are integrated. At the same time, considering the characteristics and evaluation principles of rural e-commerce poverty alleviation, this study selects the four levels of policy support ( $A_1$ ), development model innovation ( $A_2$ ), in-sales agricultural products ( $A_3$ ), and rural e-commerce management( $A_4$ ) as the guideline layer of the evaluation system. It also corresponds to the distillation of 14 specific evaluation indicators, as shown in Table 2.

**Table 2.** Rural e-commerce performance evaluation system for poverty alleviation

Target layer (G)	Criteria layer (A)	Indicator layer (B)
Performance evaluation of rural e-commerce for poverty alleviation	Policy support ( $A_1$ )	Coverage of policies ( $B_1$ )
		Policy implementation ( $B_2$ )
		Radiation effect of the policy ( $B_3$ )
	Development model innovation ( $A_2$ )	Relevance of the development model to the region ( $B_4$ )
		The degree of informatization of the development model ( $B_5$ )
		The agglomeration effect of development patterns ( $B_6$ )
		Expansion of development model ( $B_7$ )
	In-sales agricultural products ( $A_3$ )	Branding of agricultural products ( $B_8$ )
		Quality monitoring of agricultural products ( $B_9$ )
		Degree of agricultural product distinctiveness ( $B_{10}$ )
	Rural e-commerce management ( $A_4$ )	Rural e-commerce personnel cultivation degree ( $B_{11}$ )
		The degree of user-friendliness of government approval ( $B_{12}$ )
		Modernization of logistics management ( $B_{13}$ )
		Attractiveness to talented specialists ( $B_{14}$ )

(1) Policy support ( $A_1$ )

First, policy support ( $A_1$ ) refers to the relevant policies implemented by the government in the area of e-commerce for poverty alleviation [6], which have effectively promoted the development of rural e-commerce in Sichuan Province. The development of rural e-commerce in Sichuan is strongly supported by the state and the government. This study is assessing three specific indicators in terms of coverage of policies ( $B_1$ ), policy implementation ( $B_2$ ) and radiation effect of the policy ( $B_3$ ). First of all, policy coverage ( $B_1$ ) was chosen because of the high priority given to rural e-commerce in China. In recent years, the central government has issued several policies to guide the development of rural e-commerce. Next, the degree of policy implementation ( $B_2$ ) was adopted. With policy support, Sichuan has accelerated the cultivation of rural e-commerce participants. According to data from the Sichuan Provincial Department of Commerce, in 2018, the national-level demonstration counties of Sichuan Province for e-commerce into rural areas carried out e-commerce training for a total of 167,900 people, including training for returning migrant workers and rural youth for a total of 145,700 people and 5,431 agriculture-related e-commerce enterprises. Last, the policy radiation effect ( $B_3$ ) is considered because policy support is likely to lead to effective income growth. Sichuan relies on the advantageous industries of each region to vigorously develop the sale of special agricultural products. At the same time, we have been fostering the construction of distinctive agricultural product e-commerce brands and the “online and offline integration” of rural product production and marketing, which has expanded the market scope of rural products [19].

(2) Development model innovation ( $A_2$ )

Secondly, the development model innovation situation ( $A_2$ ) refers to the vast differences in rural realities within Sichuan Province, which require the exploration of a rural e-commerce development model suitable for the region, taking into account local realities [15]. Combine rural e-commerce and precise poverty alleviation, and use the development of rural e-commerce to promote precise poverty alleviation. In this study, four indicators were assessed: relevance of the development model to the region ( $B_4$ ), the degree of informatization of the development model ( $B_5$ ), the agglomeration effect of development patterns ( $B_6$ ) and expansion of development model ( $B_7$ ). First of all, the inclusion of the relevance of the development model to the region ( $B_4$ ) indicator. It is based on the fact that in recent years Sichuan has been innovative in its rural e-commerce development model under local conditions. Some of the more representative models include the “rural e-commerce + precision poverty alleviation” model. This model is represented by areas such as Aba, Ganzi and Liangshan. In recent years, Sichuan has vigorously carried out comprehensive demonstrations of e-commerce in rural areas, achieving full coverage in 66 national-level poverty-stricken counties. Next, the assessment is considered in terms of the degree of informativeness of the development model ( $B_5$ ). It is because to develop e-commerce, we must improve the e-commerce infrastructure [7]. Sichuan Province has made great efforts to

build an e-commerce big data centre to monitor transaction data from over 5,000 e-commerce platforms online in real time. The Big Data Centre not only provides detailed big data services for Sichuan, but also provides data related to rural e-commerce transactions to the Ministry of Commerce on a monthly basis. Then, consider the agglomeration effect of the development pattern ( $B_6$ ). This is because the e-commerce industrial park agglomeration model has been carried out in some areas of Sichuan province. For example, Renshou County has taken advantage of the technical advantages of IBM's Southwest Cloud Computing Centre of Excellence to build an e-commerce cluster park. In Zhongjiang and Santai counties, the "agricultural products distribution enterprises + tens of thousands of villages and thousands of township contractors to cooperate and build" model was put into practice. Last, the expansion of the development model ( $B_7$ ) is included in the assessment indicators. In the development of rural e-commerce in Sichuan Province, some areas (such as Jiajiang County) actively promote the deep integration of rural e-commerce and rural finance, using financial means to promote the accelerated development of rural e-commerce. Other regions (such as Li County) have organically combined rural e-commerce with the advantages of tourism resources, using e-commerce as a means to promote rural tourism comprehensively. All these practical examples show that rural e-commerce in Sichuan Province is seeking to expand more widely in the development process.

(3) In-sales agricultural products ( $A_3$ )

Thirdly, the situation of agricultural products on sale ( $A_3$ ) is concerned with the products themselves in the process of poverty alleviation through rural e-commerce. Agricultural products are perishable and difficult to package. Therefore, this study considers the need to assess in-sales agricultural products. This study assessed a total of 3 indicators from branding of agricultural products ( $B_8$ ), quality monitoring of agricultural products ( $B_9$ ) and degree of agricultural product distinctiveness ( $B_{10}$ ). First of all, the situation of branding of agricultural products ( $B_8$ ). Because branding is a promise of quality for produce. In 2017, the Sichuan Provincial Government issued the document "Opinions on Strengthening the Branding of Agricultural Products". Next, the regulation of agricultural quality ( $B_9$ ) is included in the assessment indicators. Agricultural products are not well-equipped for transport and cannot adapt to the needs of quality assurance of fresh produce for e-commerce. In the process of achieving rural e-commerce development, attention needs to be paid to the effectiveness of agricultural product quality regulation. Last, degree of agricultural product distinctiveness ( $B_{10}$ ). This is because the effective development of rural e-commerce cannot be achieved without the focused support of regional characteristics. Anyue County, Sichuan Province, is a major lemon-producing county. The county has been able to enhance the e-commerce service capacity of "Anyue Lemon Network" and form a local e-commerce service team to take advantage of the development of the Anyue lemon e-commerce cluster and the brand effect.

(4) Rural e-commerce management ( $A_4$ )

Fourthly, rural e-commerce management ( $A_4$ ) refers to the practice of various aspects of the management system. Rural e-commerce development is a systematic project involving talent management, government management, and logistics management. This study will carry out the assessment from a total of 4 indicators: rural e-commerce personnel cultivation degree ( $B_{11}$ ), the degree of user-friendliness of government approval ( $B_{12}$ ), modernization of logistics management ( $B_{13}$ ), and attractiveness to talented specialists ( $B_{14}$ ). First of all, consider the rural e-commerce personnel cultivation degree ( $B_{11}$ ) indicator. Personnel is central to the development of rural e-commerce. At present, the lack of relevant talents in rural areas is a major factor hindering the development of local e-commerce. The rural grassroots generally lack leading cadres and industry leaders who are knowledgeable about e-commerce and can plan scientifically and guide practically. Next, the degree of user-friendliness of government approval ( $B_{12}$ ). This is because the further improvement of the regulatory system, the approval of a certification material often requires separate confirmation from multiple departments, which directly increases the waiting time for implementation for rural e-commerce. Then, modernization of logistics management ( $B_{13}$ ). Logistics is the key to the development of rural e-commerce. Sichuan's rural e-commerce development should grasp the opportunity of the national vigorous implementation of the "Internet + circulation" project and strive to improve the local logistics information infrastructure. Solve the problems associated with the intelligent transportation of agricultural products in the cold chain. Last, attractiveness to talented specialists ( $B_{14}$ ). A short training session alone cannot develop a comprehensive knowledge system for farmers and rural e-commerce operations are very difficult.

### 3.2 Determination of Weights and Consistency Tests for the Criterion Layer

Through the discussions of the research team, combined with expert advice. This study concludes that in the rural e-commerce poverty alleviation process, the functions that directly correspond to the poverty alleviation objectives are at the core of the process and their efficiency and effectiveness best reflect the overall performance. Therefore, this study considers the development model innovation ( $A_2$ ) and in-sales agricultural products ( $A_3$ ) as the two most important factors. Rural e-commerce management ( $A_4$ ) is an important factor influencing future sustainable development. This is a second important factor. Policy support ( $A_1$ ) was a previously prioritized factor. It is now a secondary important factor at this stage. This is because rural e-commerce needs to achieve its own development in the future and cannot rely entirely on policy support. From this, a judgment matrix R for the criterion level can be constructed:



$$R = \begin{bmatrix} 0.5 & 0.2667 & 0.2333 & 0.3667 \\ 0.7333 & 0.5 & 0.4667 & 0.6333 \\ 0.7667 & 0.5333 & 0.5 & 0.6 \\ 0.6333 & 0.3667 & 0.4 & 0.5 \end{bmatrix}$$

Calculate the determinant  $R_1$  of the sum by rows according to the matrix R:

$$R_1^T = (r_i)_{4 \times 1} = [1.3367, 2.3333, 2.4, 1.9]$$

Calculate the weight value WI for each factor, which can be obtained according to Eq. 2, where  $\alpha = \frac{n-1}{2} = 1.5$ .

$$WI = (w_i)_{4 \times 1} = [0.1444, 0.3056, 0.3167, 0.2333]$$

Then the weight matrix W constructed from the criterion layer is:

$$W = \begin{bmatrix} 0.5 & 0.2583 & 0.2417 & 0.3667 \\ 0.7417 & 0.5 & 0.4833 & 0.6083 \\ 0.7583 & 0.5167 & 0.5 & 0.625 \\ 0.6333 & 0.3917 & 0.375 & 0.5 \end{bmatrix}$$

Using Eq. 5, a consistency CI = 0.0104 (<0.1) was calculated for the criterion layer, at which point the consistency of the matrix was considered acceptable.

### 3.3 Determination of Weights and Consistency Tests for the Indicator Layer

The method described above was next used to construct separate fuzzy consistency matrices for the indicator layers, calculate the importance weights of each indicator relative to the previous layer, and perform consistency tests. The results are shown in the following tables respectively (Tables 3, 4, 5 and 6).

**Table 3.** Determination of weights for indicator layers B1, B2, B3 for criterion layer A1

A1	B1	B2	B3	W1
B1	0.5	0.3	0.6	0.3
B2	0.7	0.5	0.6667	0.4556
B3	0.4	0.3333	0.5	0.2444

The fuzzy consistency matrix constructed, based on the three indicators of the A1 criterion layer, passed the consistency test with CI = 0.0296 (<0.1).

The fuzzy consistency matrix constructed, based on the four indicators of the A2 criterion layer, passed the consistency test with CI = 0.0188 (<0.1).

The fuzzy consistency matrix constructed, based on the three indicators of the A3 criterion layer, passed the consistency test with CI = 0.0148 (<0.1).

The fuzzy consistency matrix constructed, based on the four indicators of the A4 criterion layer, passed the consistency test with CI = 0.0104 (<0.1).

**Table 4.** Determination of weights for indicator layers B4, B5, B6, B7 for criterion layer A2

A2	B4	B5	B6	B7	W1
B4	0.5	0.6	0.7	0.6667	0.3278
B5	0.4	0.5	0.5	0.6	0.25
B6	0.3	0.5	0.5	0.5333	0.2222
B7	0.3333	0.4	0.4667	0.5	0.2

**Table 5.** Determination of weights for indicator layers B8, B9, B10 for criterion layer A3

A3	B8	B9	B10	W1
B8	0.5	0.4667	0.5	0.3222
B9	0.5333	0.5	0.6	0.3778
B10	0.5	0.4	0.5	0.3

**Table 6.** Determination of weights for indicator layers B11, B12, B13, B14for criterion layer A4

A4	B11	B12	B13	B14	W1
B11	0.5	0.7	0.6	0.5	0.3
B12	0.3	0.5	0.4667	0.3	0.1778
B13	0.4	0.5333	0.5	0.3667	0.2167
B14	0.5	0.7	0.6333	0.5	0.3056

## 4 Results and Discussions

A fuzzy matrix was constructed for this study and a total of four assessment criteria, policy support ( $A_1$ ), development model innovation ( $A_2$ ), in-sales agricultural products ( $A_3$ ), and rural e-commerce management( $A_4$ ), were found to pass the consistency test. This results in a table of the weight distribution of all indicators (Table 7).

Firstly, in-sales agricultural products ( $A_3$ ), with a weighting of 0.3167, are the most important factor in the criteria layer. Among them, branding of agricultural products ( $B_8$ ), quality monitoring of agricultural products ( $B_9$ ), and degree of agricultural product distinctiveness ( $B_{10}$ ) accounted for 0.102, 0.1196, and 0.095 respectively of the overall weighting. Combined with a survey of the current situation of rural e-commerce poverty alleviation in Sichuan Province, it was found that Sichuan has made every effort to create and cultivate well-known brands of agricultural products around specialties such as Sichuan cuisine, Sichuan tea, Sichuan medicine, Sichuan fruits and Sichuan pigs, promoting industrial advantages through brand advantages. The “Huili Pomegranate”, “Sichuan Pickle”,

**Table 7.** Evaluation system weightings

Target layer (G)	Criteria layer (A)	Weight	Indicator layer (B)	Weight (in A)	Weight (in G)
Performance evaluation of rural e-commerce for poverty alleviation	A1	0.1444	B1	0.3	0.0433
			B2	0.4556	0.0658
			B3	0.2444	0.0353
	A2	0.3056	B4	0.3278	0.1002
			B5	0.25	0.0764
			B6	0.2222	0.0679
			B7	0.2	0.0611
	A3	0.3167	B8	0.3222	0.102
			B9	0.3778	0.1196
			B10	0.3	0.095
	A4	0.2333	B11	0.3	0.07
			B12	0.1778	0.0415
			B13	0.2167	0.0506
			B14	0.3056	0.0713

“Sichuan-Tibet Black Pig” and “Tianfu Dragon Bud” brands have gained a certain popularity in the country. In summary, it can be argued that in-sales agricultural products, as one of the important products for poverty alleviation through rural e-commerce in Sichuan Province, have an important impact on poverty alleviation performance. In the process of rural e-commerce development, farmers should focus on product quality, buyers should strengthen their control over the quality, and the government needs to pay more attention to the level of branding.

Secondly, Development model innovation ( $A_2$ ) has a weighting of 0.3056, again the most important factor in the criteria tier. Relevance of the development model to the region ( $B_4$ ), the degree of informatization of the development model ( $B_5$ ), the agglomeration effect of development patterns ( $B_6$ ) and expansion of development model ( $B_7$ ) account for 0.1002, 0.0764, 0.0679 and 0.0611 of the overall weight respectively. A survey of the current situation of rural e-commerce in Sichuan province revealed that Aba and Ganzi counties (cities) within their jurisdictions are implementing the special development model of “precise poverty alleviation + rural e-commerce”. These regions have enhanced the marketing and promotion of agricultural products such as Mii tomatoes, Liangshan onions and Zhaojue potatoes on e-commerce platforms such as JD, Suning Tesco and the Sichuan Museum of Poverty Alleviation. In 2018, net sales of agricultural products in Sichuan province online were 16.78 billion yuan, an increase of 44.3% over the same period last year. In addition, there is the development model of rural tourism. For example, Li County is rich in tourism resources, and the development of e-commerce in rural tourism in Li County has contributed to the development of the local economy. In the Spring Festival 2019, the county received more than 290,000 visitors in 15 days, an increase of 20.57% year-on-year. Total tourism revenue during the Spring Festival reached RMB 202,744,600, a year-on-year increase of 22.49%. This shows that innova-

tive development models tailored to local conditions are conducive to the positive effects of rural e-commerce on poverty alleviation in Sichuan Province.

Thirdly, the management of rural e-commerce ( $A_4$ ) has a weighting of 0.2333. Among them, rural e-commerce personnel cultivation degree ( $B_{11}$ ), the degree of user-friendliness of government approval ( $B_{12}$ ), modernization of logistics management ( $B_{13}$ ) and attractiveness to talented specialists ( $B_{14}$ ) account for 0.07, 0.0415, 0.0506 and 0.0713 of the overall weighting ratio respectively. Combined with a survey of the current state of rural e-commerce poverty alleviation in Sichuan Province, several notable problems in management were identified: for example, the disorderly supervision of rural e-commerce platforms, and the lack of close contact and cooperation between commerce, agriculture, supply and marketing, postal services, telecommunications and banks. In rural areas, logistics sites more stop in the township, express into the village into the household is more difficult. Improvements are needed to address these shortcomings. More importantly, about the attraction and training of talent for rural e-commerce. Professionals who know how to promote agricultural brands and operate e-commerce businesses are even more scarce.

Fourthly, policy support ( $A_1$ ) has a weighting of 0.1444. Among them, coverage of policies ( $B_1$ ), policy implementation ( $B_2$ ), and radiation effect of the policy ( $B_3$ ). Account for 0.0433, 0.0658 and 0.0353 of the overall weight respectively. Combined with a survey of the current situation of rural e-commerce poverty alleviation in Sichuan Province, it is found that in recent years, the Sichuan Provincial Government has attached even greater importance to the development of rural e-commerce, creating a good policy support environment for it. In 2016, the Sichuan Provincial Government issued the “Implementation Opinions on Accelerating the Development of E-Commerce Industry”; in 2017, the Sichuan Provincial Department of Commerce, together with the Provincial Bureau of Poverty Alleviation and Migration Work, issued the “Implementation Opinions on the Comprehensive Demonstration Project of E-Commerce in Rural Areas in 2017”. Under the impetus of strong policy implementation, the development of rural e-commerce in Sichuan Province has become faster and more convenient for farmers to produce and live. Rural e-tailing reached RMB 92.622 billion in 2018, ranking 4th in the country, with a year-on-year increase of 30.45%. For the future development of rural e-commerce, it is necessary to enhance its own “blood-making function” [13].

## 5 Research Conclusions and Future Prospects

This study constructs a performance evaluation system for rural e-commerce in Sichuan Province from a total of four levels and 14 indicators. FAHP was applied to conduct performance evaluation, to test the consistency of evaluation indicators, and to derive the weighting of different dimensions and indicators. It is hoped that this will provide a reference for the relevant authorities to realize the development of rural e-commerce. Based on the research and analysis, this paper puts forward the following six development recommendations.

First, the infrastructure construction related to e-commerce in rural Sichuan needs to be vigorously improved. In particular, we should increase investment in infrastructure development in remote rural poor areas such as transportation, logistics and broadband networks, and actively improve the development conditions in remote rural poor areas. Second, actively build an intelligent rural e-commerce logistics system. Logistics is the key to the development of rural e-commerce. Improve the local logistics information infrastructure and solve the problems associated with the wisdom of transporting agricultural products in the cold chain. Build a wise logistics system with the help of Internet of Things technology. Third, promote agricultural branding and accelerate the standardization and standardization of agricultural production. It is important to obtain the joint collaboration of many parties, including farmers, enterprises, government and industry experts. Fourth, strengthen the quality traceability of agricultural products and enhance the legal awareness of rural e-commerce operators. Ensure that the entire process of agricultural products from offline production to online sales is intelligently monitored, data managed and product traceable. At the same time, the rule of law publicity should be strengthened to raise the legal awareness of farmers and related practitioners and to firmly eliminate unlawful acts in rural e-commerce from the source. Fifth, integrate relevant resources and promote the joint development of rural e-commerce. Relevant departments of rural e-commerce should strengthen their ties and form synergies. Government departments, as the leading units, should strengthen coordination and planning. Sixth, encourage the rural masses to participate in rural e-commerce and attach importance to the introduction and training of compound talents. Rural e-commerce cannot be achieved without the support of talents. In order to promote the development of rural e-commerce, it is necessary to increase the cultivation and introduction of relevant talents.

Finally, there are more shortcomings in this study. After establishing the evaluation system, no empirical research was conducted on the level of rural e-commerce performance in poverty alleviation in specific places, and the applicability of the indicators in the practical application was not further tested. It is expected that in future studies, data will be collected to carry out empirical research, and that attempts will be made to use other evaluation methods to compare the results.

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