Research on the Performance Evaluation of the Tobacco Supply Chain–Based on the AHP and the Fuzzy Comprehensive Evaluation Method

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Abstract. An objective and scientific evaluation of the performance of the tobacco supply chain has important theoretical and practical significance for improving the efficiency of the supply chain and promoting regional economic development. This article constructs a tobacco supply chain evaluation index system from four aspects: farmers, cooperatives, consumers, and leading companies. Combining actual data and using analytic hierarchy process and fuzzy comprehensive evaluation method to comprehensively evaluate the tobacco supply chain of the "farmer + cooperative + company" model. The results show that the overall performance of the tobacco supply chain in Guizhou Province is at a medium level, the performance of the consumer and farmer dimensions is low, the performance of the supermarket and the cooperative is at a medium level, and there may be unstable docking, information asymmetry, and inadequate subsidies, etc. It also provides certain solutions and countermeasures in terms of quality and safety governance, internal supervision of cooperatives, and government subsidy mechanisms.

Keywords: Supply chain performance · tobacco supply chain · Fuzzy comprehensive evaluation method

1 Introduction

The tobacco supply chain is a supply chain that is specially engaged in the supply, product, and sale of tobacco commodities. Tobacco products have two attributes. First, they are a special commodity under the monopoly system. At present, China's tobacco industry implements the management mode of "monopoly, unified leadership and vertical management", must strictly abide by the relevant regulations of the State Department in charge of tobacco production and management. In addition, it is also a fast consumer good, it must follow the law of market circulation, must be consumer-oriented, to be able to provide real consumer demand to meet the product. This is also the tobacco supply chain is different from the general supply chain and needs special attention two aspects, the supply chain, and the enterprise's benefit are closely related, the high-efficiency

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supply chain level may reduce the enterprise's cost expenditure, enhances the operation efficiency, however, there are many performance indicators to evaluate the supply chain, and the change level of different indicators varies over the years.

Therefore, the performance evaluation system should be simplified, and after simplification, the performance level of the supply chain can be objectively reflected. At present, there are abundant achievements in the research on tobacco supply chain, for example, Chang et al. (2006) set up a mathematical model of the fuzzy comprehensive evaluation of suppliers, combined AHP with the FCE method to select suppliers, and verified its rationality and reliability, Liu (2015) develops as tobacco information terminal service linkage management platform based on information technology and Internet of things (IoT) technology. Zhang (2016) constructs the seasonal variation forecast model, the stochastic inventory model, and the plan control coordinated utilization, establishes the industry-commerce cooperation model and in the cigarette inventory classification control, adopts the ABC classification subdivision inventory. Zhang (2017), guided by the concept of linear programming of operations research, explores the establishment of a cigarette purchase model and uses the linear programming solution to find out the optimal purchase quantity of each cigarette brand, to maximize the total value of purchased cigarettes, to provide scientific reference for precise purchasing, Bingkun (2019) constructed a supply chain model of the tobacco business, combining game theory and economic theory, focused on the coordination among members of the tobacco supply chain.

At present, most of the research on the tobacco supply chain is based on some node of the supply chain, such as the Enterprise Supply Chain, inventory management and purchase, etc. however, most of them are theoretical explorations, and many simplifications have been made for specific examples. This paper is based on the specific situation of the smoking areas in Guizhou province, evaluating the performance of the tobacco supply chain based on the channel model of "Farmers + cooperatives + companies", which has a positive role in promoting national rural revitalization and industrial revitalization, exploring the supply chain performance evaluation mechanism suitable for the tobacco industry can improve the working efficiency of the tobacco supply chain, has certain practical significance for the national economic construction and development, and can also help to build the tobacco brand in Guizhou, promoting the brand competitiveness of Guizhou province to play an important role.

2 Construction of Evaluation Index System of "Peasant Household + Cooperative + Company" Model

2.1 Principles of Establishing Performance Evaluation Index System for Tobacco Supply Chain Operation

At present, under the strong impetus of the rural revitalization policy, the rural planting industry has been highly developed, the operation mode is diversified, and the operation mode is also diversified. The existing operation mode of 'cooperatives + bases + farmers', 'enterprises + village collectives + cooperatives + farmers', 'party construction + cooperatives', 'farmers + cooperatives + companies' and so on. For tobacco planting

and management, it is not only a part of the rural planting industry but also has its particularity. At present, the 'farmers + cooperatives + companies' model is commonly used in the tobacco industry. Most of the tobacco complex areas are using this model, and it is also the main mode of rural tobacco planting and supply. Therefore, this paper chooses the 'farmers + cooperatives + companies' model as an example, considering the characteristics of tobacco and regional characteristics and the actual situation of 'farmers + cooperatives + companies' model. To establish a matching performance evaluation system, it is necessary to follow the principles of systematicness, feasibility, objectivity, qualitative and quantitative combination, and evaluate the efficiency of tobacco supply chain performance represented by the Guizhou tobacco supply chain.

2.2 Establishment of Performance Evaluation Index System of Tobacco Supply Chain

The tobacco supply chain based on cooperatives includes tobacco farmers, cooperatives, logistics enterprises and tobacco companies. Agricultural cooperatives are service centers, providing a series of agricultural activities for farmers (such as procurement of production materials, technical guidance, learning and training, sales, etc.), directly docking agricultural suppliers and logistics enterprises, purchasing agricultural production materials and logistics transportation and distribution services. It is also a brand operation center, focusing on improving and enhancing the quality and service quality of tobacco, establishing a reliable partnership with the upstream and downstream of the tobacco supply chain, and creating a brand image of consumer trust. Tobacco farmers are mainly responsible for the specific agricultural activities of tobacco production, purchasing a series of agricultural production materials and services from cooperatives, and supplying tobacco to cooperatives according to voluntary principles, and creating higher tobacco value through cooperative brand marketing platform. Logistics enterprises focus on long-term cooperation with cooperatives and obtain more orders. Compared with cooperation with small order small tobacco farmers, logistics enterprises are more conducive to improving customer satisfaction, reducing the overall loss of tobacco and transportation costs, and improving the overall profit of the supply chain. Tobacco companies purchase raw tobacco directly from the cooperative marketing platform, which can reduce the purchase trust crisis and tobacco safety risks, reduce transaction costs, experience better services, and directly enhance the acquisition and purchase intention of tobacco companies.

Starting from the above several subjects, this paper refers to the indexes used in the research of Xiao Jing, Hou Yuan, and Shan Wang Yong, by the principles of systematicness, enforceability, objectivity, qualitative and quantitative, the following indicators are established based on the four dimensions of cooperatives, farmers, companies, and consumers, as shown in Table 1. The weight of the index is obtained in the third part.

Table 1. The indicators set up in this article

Index	First grade indexes	Index	First grade indexes
A	A1	C	C1
	A2		C2
	A3		C3
	A4		
	A5		
B	B1	D	D1
	B2		D2
	B3		D3
	B4		
	B5		

Table 2. Cooperative judgment matrix

A	A1	A2	A3	A4	A5
A1	1.00	3.00	3.00	0.50	0.50
A2	0.33	1.00	0.50	0.33	2.00
A3	0.33	0.50	1.00	0.50	2.00
A4	2.00	3.00	3.00	1.00	2.00
A5	2.00	0.50	0.50	0.50	1.00

3 Application Examples Analysis

3.1 Determination of Index Weights by Analytic Hierarchy Process

This part takes the cooperative index as an example to analyze, the experts are invited to judge the Cooperative Index, and the judgment matrix is obtained as Table 2, then use the tool of MATLAB to deal with the index and get the result.

3.1.1 The Judgment Matrix is Normalized and the Consistency Ratio is Calculated

Given the judgment matrix, the CR, CR $= 0.9257 < 0.1$ is calculated by using formula (1) and formula (2), which shows that the matrix can be used as the weight vector by using its normalized characteristic vector through consistency test. The reuse formula (3) gives the weight of each index, $=$ (0.2340, 0.1258, 0.1378, 0.3447, 0.1577), The overall picture is shown in Table 3.

Table 3. Cooperative judgment matrix

A	A1	A2	A3	A4	A5	weight	sort
A1	1.00	3.00	3.00	0.50	0.50	0.219	2
A2	0.33	1.00	0.50	0.33	2.00	0.252	1
A3	0.33	0.50	1.00	0.50	2.00	0.152	5
A4	2.00	3.00	3.00	1.00	2.00	0.169	4
A5	2.00	0.50	0.50	0.50	1.00	0.208	3
CR							0.097

Table 4. Weight results of the index system

Index	Criterion layer weight	Sort	first grade indexes	Index layer weight	Sort	combination weight	Total ranking
A	0.35	2	A1	0.22	2	0.084	4
			A2	0.25	1	0.045	10
			A3	0.15	5	0.049	9
			A4	0.17	4	0.123	3
			A5	0.21	3	0.056	7
B	0.36	1	B1	0.19	2	0.074	5
			B2	0.13	4	0.038	12
			B3	0.17	3	0.060	6
			B4	0.12	5	0.044	11
			B5	0.39	1	0.140	2
C	0.21	3	C1	0.67	1	0.143	1
			C2	0.21	2	0.050	8
			C3	0.12	3	0.022	15
D	0.07	4	D1	0.36	2	0.026	14
			D2	0.23	3	0.009	16
			D3	0.41	1	0.037	13

3.1.2 Analytic Hierarchy Process Weighted Results

After the treatment of the cooperative index, the corresponding indicators of farmers, consumers and enterprises are treated in turn, and the results are shown in Table 4.

Table 5. Fuzzy relationship matrix

Evaluating indicator	worse	poor	qualified	good	excellent
A1	0.0	0.0	0.3	0.4	0.3
A2	0.0	0.0	0.2	0.4	0.4
A3	0.0	0.1	0.1	0.3	0.6
A4	0.0	0.1	0.2	0.3	0.4
A5	0.0	0.2	0.2	0.3	0.3
B1	0.0	0.1	0.2	0.3	0.3
B2	0.1	0.1	0.3	0.4	0.1
B3	0.0	0.1	0.3	0.5	0.2
B4	0.0	0.2	0.6	0.2	0.1
B5	0.1	0.2	0.2	0.3	0.2
C1	0.0	0.1	0.2	0.3	0.4
C2	0.2	0.2	0.2	0.2	0.1
C3	0.1	0.1	0.4	0.2	0.2
D1	0.0	0.1	0.4	0.3	0.2
D2	0.1	0.2	0.5	0.1	0.1
D3	0.1	0.1	0.4	0.3	0.1

3.2 Fuzzy Comprehensive Evaluation

The results of each index in the performance evaluation index system are divided into 5 grades: "excellent performance, good performance, qualified performance, poor performance, poor performance", which constitutes a finite set of comments V, then V = {excellent, good, qualified, poor, worse} = {100, 80, 60, 40, 20}. The fuzzy relation matrix determined from the modified evaluation set is shown in Table 5.

3.3 Calculate Final Score

In Sect. 3.1.2, the weight of each index has been calculated, and the fuzzy relation matrix has been given in Table 5. The scores of comprehensive evaluation can be obtained by using formulas (4) and (5), as shown in Table 6.

3.4 Analysis of Results

Based on the above data analysis, the results of the performance evaluation of the tobacco supply chain in Guizhou province are as follows: Combining with the layer weight value, the individual importance ranking of the performance level of the tobacco supply chain of the "farmers + Cooperatives + companies" channel model in Guizhou is: Enterprise > cooperatives > Farmers > consumers.

Table 6. Fuzzy comprehensive evaluation results

	worse	poor	qualified	good	excellent	The final score
A	0	0.074	0.207	0.275	0.238	61.126
B	0.052	0.152	0.280	0.335	0.194	70.088
C	0.055	0.121	0.225	0.267	0.312	71.934
D	0.064	0.123	0.422	0.254	0.136	65.454
E	0.035	0.115	0.252	0.297	0.231	66.884

As the link between the upper cooperative, the farmer and the lower consumers in the supply chain, the enterprise is directly affected by whether the supply chain is effective, because of the multitudinous stakeholders of the enterprise, the enterprise affects the performance level of the channel mode of "Farmers + cooperatives + companies" to the greatest extent. It is easy to note from the data that the weight of cooperatives is almost equal to that of enterprises, which also reflects the crucial role of cooperatives throughout the supply chain, one is that it is in the same position as the enterprise as a whole, and the other is the farmers cooperative organization, which is an important organization supporting the development of Rural People's livelihood and poverty alleviation because the nature of cooperative organizations is the Association of vulnerable groups, it is cooperative farmers who can participate in the supply chain in a real sense, participate in the production of profits.

For farmers, although its overall weight is not as large as that of cooperatives and enterprises, the weight of its index of tobacco farmers rate of return is the largest among the first-class indicators, as the consumer of the tobacco supply chain and the starting point of the tobacco supply chain, the farmers income is the key to the success of the supply chain, we should earnestly safeguard the interests of farmers and solve the problem at its source. It is worth noting that consumers have the lowest weight in the whole process. The author believes that this does not mean that consumers are not important, mainly because of the particularity of tobacco products, as the tobacco industry is a state monopoly industry with a certain degree of addiction, the tobacco consumers often have great stickiness and stability, reflected in the data is lower in China, but with the progress of science and technology, the manufacturing process of tobacco has also improved a lot. The diversification of taste brands, especially the rise of e-cigarettes in recent years, may have a great impact on changing consumer habits, so its importance can not be underestimated. From the comprehensive score of the fuzzy comprehensive evaluation, it can be concluded that the overall performance score of the tobacco supply chain of the "farmers + Cooperatives + companies" channel model in Guizhou is 66.884.

From the perspective of cooperatives, enterprises and farmers, the scores of consumers perspective were 61.126, 70.088, 71.934 and 65.454 respectively. The overall performance score is less than 70 points, indicating that the overall performance of the tobacco supply chain of the "farmers + Cooperatives + companies" channel model in

Guizhou is still in the middle level, on the whole, the performance of consumer dimension and farmer dimension is low, and the performance of supermarket and cooperative dimension is in the middle level.

Recommendations
Improve the overall supply chain coordination ability, and further strengthen the awareness of collaboration between tobacco supply chain members. Farmers how to reflect the latest agricultural technology in tobacco planting, cooperatives how to optimize the logistics network, reduce the defective rate, enterprises how to reduce management costs, optimize the price mechanism, will eventually be reflected in the price and quality of tobacco products.

Improve information transmission and sharing mechanism. The establishment and improvement of information transmission and sharing mechanism including supply and demand, logistics and capital flow is a powerful guarantee for broadening the cooperation channels between enterprises and agricultural cooperatives. We should gradually build a comprehensive information platform of 'government-led, enterprise-led, cooperative cooperation, farmers' participation', encourage members to share docking information timely and effectively, and reduce the cost of information search and transaction between supply chain nodes.

Improve the government subsidy mechanism. In order to change the relatively weak position of government and consumers, the government needs to further improve its subsidy mechanism. While adopting direct subsidy policy for agricultural cooperatives, certain tax reduction measures can also be taken for tobacco products traded by enterprises and cooperatives. For farmers who join the unified planting of agricultural cooperatives, their dividends and subsidies should also be implemented. In order to enhance the tobacco supply chain cooperation performance.

4 Conclusions

In this paper, the performance evaluation index system of the tobacco supply chain in Guizhou Province is established by literature research and reliability test. Then, taking the channel model of 'farmers + cooperatives + companies + consumers' as an example, the weight of each criterion layer and index layer is determined by the fuzzy analytic hierarchy process (FAHP). Finally, the comprehensive performance evaluation score is obtained by fuzzy comprehensive analysis. Some solutions are put forward from the aspects of supply chain coordination ability, information transmission and sharing mechanism, and government subsidy mechanism. In order to provide certain management and decision-making basis for the long-term and stable operation of the tobacco supply chain performance model represented by the tobacco industry in Guizhou Province as the channel mode of 'farmers + cooperatives + companies + consumers', it has a positive role in promoting the national rural revitalization and industrial revitalization, improving the efficiency of the tobacco supply chain, having practical significance for the construction and development of the national economy, and playing an important role in creating Guizhou tobacco brands and improving the brand competitiveness of Guizhou Province.

Appendix

A: Agricultural Cooperative
A1: Cooperative sales management capabilities
A2: Internal Governance Capability
A3: Service quality
A4: The rationality of the internal structure
A5: Brand building and promotion ability
B: Enterprise
B1: Product quality stability
B2: Cooperative trust in business
B3: The speed of the cooperative's response to the market
B4: The tobacco demand stability
B5: Customer complaint rate
C: Farmers
C1: The tobacco farmers' yield
C2: The ability of tobacco farmers to resist risks
C3: Channel convenience
D: Consumers
D1: Customer sense of gain
D2: Customer confidence in cooperative
D3: Price satisfaction
E: The tobacco supply chain

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