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Research on Collaborative Evaluation of Offshore Wind Power Value Chain in Guangxi-Based on BWM-FVIKOR Model

Qiushuang Wei, Shuting Yang, Yunying Lu

School of Politics and Public Administration, Guangxi Normal University, Guilin Guangxi 541006, China

Abstract: With the dynamic development of the offshore wind power industry and the global value chain, the traditional wind power industry is gradually turning to the offshore wind power value chain system that focuses on the value effect of the value chain, and it is of great significance to carry out value chain collaborative evaluation research. This paper puts forward the evaluation index system of Guangxi offshore wind power value chain from the comprehensive system dimension, key node dimension, subject contribution dimension and resource endowment dimension, builds the BWM-FVIKOR evaluation model, and proves the validity of the evaluation index and the feasibility of the evaluation model through example analysis, and this paper provides scientific and effective decision-making basis for the coordination of Guangxi offshore wind power value chain.

Keywords: Offshore Wind Power Value Chain; BWM; VIKOR; Evaluation.

1. Introduction

The global offshore wind power industry is undergoing a key node of adjustment, transformation and reconstruction, and the development of renewable energy and sustainable energy technologies has made it a more intensive, efficient, green and complex value creation and value addition system. Under this background, Guangxi offshore wind power industry has gradually changed from a traditional power supply chain to a complex value chain system that focuses on the internal and external values of the system, emphasizing the collaborative operation and coupling between the internal and external entities of the system. The "14th Five-Year Plan for Guangxi Energy Development" puts forward "scale, intensive development of offshore wind power, in accordance with the principle of 'mature a batch, develop a batch', focusing on promoting the development and construction of offshore wind power projects in the Beibu Gulf, and actively promoting the demonstration of the development of deep-sea offshore wind power projects". [1]. Driven by relevant policies such as the "14th Five-Year Plan for Renewable Energy Development in Guangxi", Qinzhou International Offshore Wind Power Industrial Park and Fangchenggang Offshore Wind Power Demonstration Project have been approved one after another, which has breakthrough significance for Guangxi to build a 100 billion-level offshore wind power industry cluster. However, compared with developed offshore wind power countries and places, Guangxi offshore wind power industry started late, and the value chain synergy has problems such as weak resource endowment, insufficient participation of collaborative subjects and low degree of collaborative coupling [2], which makes it face multi-dimensional factors such as economy, management and policy, which seriously restricts the healthy development of Guangxi offshore wind power value chain. Therefore, how to use systematic and scientific methods to evaluate Guangxi offshore wind power value chain synergy and tap the potential of value chain synergy development is a key issue worthy of further research.

2. Literature Review

Due to the greater intensity of offshore wind energy resources and the more uniform wind speed, the development speed of offshore wind power is obviously faster than that of onshore wind power [3]. Domestic and foreign researchers have carried out multi-dimensional research on offshore wind power. On the one hand, scholars have discussed the industrial policy, current situation, existing problems and solutions of offshore wind power. Li Zhichuan et al. [4] analyzed the development status of wind power industry in China from the perspective of resource distribution and upstream, midstream and downstream enterprises in the industry chain. Yang Guangya [5] discussed the industrialization process of offshore wind power in Europe and summarized the experience, which provided experience for the development of offshore wind power in Guangxi. Huang Junhui et al. [6] analyzed the characteristics of offshore wind energy resources and carried out fuzzy comprehensive evaluation, which provided ideas for offshore wind power related evaluation. On the other hand, some scholars have provided solutions to improve the quality of offshore wind power development from a technical level. Cai Xu et al. [7] and Zhang Zhankui et al. [8] discussed the status and problems of offshore wind power at the technical level of control, protection, etc. for the issue of offshore wind power output and grid connection. Yao Gang et al. [9] analyzed the situation of large-capacity offshore wind turbines and related technologies, and summarized the relevant development trends. Vinhoza Amanda et al. [10] assessed Brazil's offshore wind potential based on spatial multi-criteria decision analysis.

Based on the collaborative operation and coupling of multiple participants in upstream, midstream and downstream of the value chain, the wind power value chain realizes value creation and value appreciation [2]. Li Congdong et al. [11] proposed a comprehensive solution for value chain and built a wind power value chain management platform. Liu Jicheng et al. [12] discussed the driving factors affecting the value-added effect of wind power value chain. Liu Jicheng et al. [13-

14] constructed the wind power value chain model, analyzed and discussed it with diamond model, and made collaborative decision analysis and modeling on wind power-energy storage value chain system from the aspects of benefit management, capacity management and energy consumption management.

To sum up, the existing literature discusses the development status, existing problems and technical solutions of offshore wind power industry from the perspective of qualitative analysis, or discusses technical problems related to offshore wind power value chain based on quantitative analysis. There are still some deficiencies: Firstly, wind power value chain is a complex value chain system involving multi-agents, multi-links and multi-factors. The existing literature on wind power value chain mainly focuses on influencing factor analysis and wind-storage capacity management, and lacks relevant research on comprehensive evaluation of offshore wind power value chain synergy from a comprehensive perspective. Secondly, the existing literature on wind power value chain collaborative evaluation index system needs to be enriched, and it is unable to analyze the importance differences between various collaborative evaluation indicators, and it has not yet provided a comprehensive and integrated evaluation pathway. Finally, Guangxi has unique geographical advantages, offshore wind energy resources endowment has particularity, and the development of wind power industry lags behind. Based on the actual situation of Guangxi offshore wind power development, it is necessary to carry out relevant research on the synergy of offshore wind power value chain. There has not been relevant research from the perspective of complex value chain system to explore the synergistic situation between multiple subjects, multiple links, multiple factors, which to a certain extent affects the scientific nature of the design of Guangxi's wind power industry policy.

In view of the above research deficiencies, this paper starts from the perspective of complex management system and value chain synergy, constructs Guangxi offshore wind power value chain synergy evaluation index system from the dimensions of integrated system dimension, key node dimension, subject contribution dimension, resource endowment dimension, etc., and constructs BWM-FVIKOR comprehensive assessment model for the evaluation of Guangxi offshore wind power value chain synergistic degree based on the BWM (Best-worst Method) and FVIKOR (Fuzzy ViseKriterijumska). According to the results, the impact of each evaluation index on the synergy of value chain is analyzed and targeted suggestions are put forward.

3. Construction of Indicator System

The collaborative development of the value chain depends on the collaborative operation and coupling among multiple entities of the value chain, while the offshore wind power value chain realizes the benefit appreciation and collaborative development of the whole value chain by integrating multiple factors such as different industry departments, different participating entities and relevant domestic and foreign policies[15]. On the basis of fully drawing lessons from domestic and foreign research and research reports, according to the objective, comprehensive and scientific principles of evaluation index selection, combined with the actual situation of offshore wind power value chain development, the offshore wind power value chain collaborative evaluation index system is established, as shown in Table 1.

Table 1. Collaborative Evaluation Index System of Offshore Wind Power Value Chain

Target	First-level indicators	Secondary indicators	Symbol
Collaborative evaluation of offshore wind power value chain	Integrated system dimension (B_1)	Synergy capability of offshore wind power system	C_1
		Offshore supply service capability	C_2
		Offshore wind power project development capacity	C_3
	Key node dimension (B_2)	Efficiency of electric energy supply	C_4
		Efficiency of power transmission node operation	C_5
		Demand response capability of power consuming nodes	C_6
	Subject contribution dimension (B_3)	Expertise and competence in installation of large offshore equipment	C_7
		Cost of project design, installation, operation and grid connection	C_8
		Direct economic benefits of the project	C_9
	Resource endowment dimension (B_4)	Offshore wind resource endowment	C_{10}
		Information flow, logistics, energy flow resources	C_{11}
		Development planning and incentive policies	C_{12}
		Energy technology development	C_{13}

(1) Integrated system dimension(B_1)

Offshore wind power value chain synergy is affected by multi-dimensional factors such as policy system, technical level, economic level, project development and management, and largely depends on the support of renewable energy policies and climate change-related policies. Therefore, the indicators of offshore wind power system synergy capability (C_1), offshore supply service capability such as logistics and ships (C_2), and offshore wind power project development capability (C_3) are selected for evaluation.

(2) Key node dimension(B_2)

The key nodes of offshore wind power value chain synergy include the synergy of nodes such as the efficiency of electricity supply for offshore power generation (C_4), the operational efficiency of the electricity transmission nodes (C_5), and the demand responsiveness of the electricity consumption nodes (C_6), all of which have an impact on the overall synergistic benefits of the value chain.

(3) Subject contribution dimension(B_3)

The offshore wind power value chain involves the contributions of project developers, wind turbine manufacturers, relevant government departments, power grid systems and other participants, including professional knowledge and capabilities of offshore large-scale equipment installation (C_7), project design, installation, operation and maintenance and grid connection costs (C_8), direct economic benefits of the project (C_9), etc.

(4) Resource endowment dimension(B_4)

The resource endowment dimension not only involves the actual situation of offshore wind energy resource endowment (C_{10}), but also involves the information flow, logistics, energy flow (C_{11}) and other resources flowing in the value chain. On the one hand, government departments have formulated a series of development plans and incentive policies for high-quality development of offshore economy and offshore wind power industry (C_{12}). On the other hand, the development of clean energy technology, energy storage technology, green transportation and other technologies (C_{13}) provides a good environment for offshore wind power value chain collaboration.

4. Construction of Evaluation Model based on BWM-FVIKOR

4.1. Determining Index Weights based on BWM

Assuming that the number of evaluation indicators and the number of alternative schemes are *n* and *m* respectively, combined with expert scoring method, the main steps for determining indicator weights by using BWM method include: 1) determining the optimal indicator (C_B) and the weakest indicator (C_W) among the primary indicators and secondary indicators;2) referring to literature [16], evaluating the importance of indicators by using a scale from 1 to 9, wherein 1 and 9 represent the optimal and weakest indicators respectively, comparing the optimal indicator (C_B) with other indicators one by one to construct a contrast matrix $D_B=(d_{B1},d_{B2},\cdots,d_{Bn})$, and then comparing the weakest indicator (C_W) with other indicators one by one to construct a contrast matrix $D_W=(d_{1W},d_{2W},\cdots,d_{nW})$; 3) determining indicator weights $\tilde{W}=(w_1,w_2,\cdots,w_n)$ by using equation (1), and the optimal weight of indicators C_j shall meet equation (2);4) solving equations (1) and (2) by MATLAB to obtain the optimal indicator weights and consistency indexes.

$$\begin{gathered}\min_{j}\max\left\{\left|\frac{w_B^i}{w_j^i}-a_{Bj}^i\right|,\left|\frac{w_j^i}{w_W^i}-a_{jW}^i\right|\right\}\\ \beta=\left\{\left|\frac{w_B^i}{w_j^i}-a_{Bj}^i\right|,\left|\frac{w_j^i}{w_W^i}-a_{jW}^i\right|\right\}\end{gathered}\tag{1}$$

Wherein, $\sum_{j=1}^{n}w_j^i=1$, $i=1,2,\cdots,m$, $j=1,2,\cdots,n$, β is the consistency index.

$$\begin{cases}\text{For each pair } w_B/w_j,\ \text{there is } a_{Bj}^i=w_B/w_j\\ \text{For each pair } w_W/w_j,\ \text{there is } w_W/w_j=a_{jW}^i\end{cases}\tag{2}$$

4.2. Constructing Comprehensive Evaluation Model based on FVIKOR

VIKOR is a multi-criteria compromise decision-making model based on the ideal solution, which determines the compromise solution by calculating the distance between the indicators of the program and the positive and negative ideal solution, which this kind of program is the closest to the positive ideal solution, and accordingly determines the ranking of the alternatives, which requires that the value of the evaluation is unambiguous. Because of the fuzziness and uncertainty in the collaborative evaluation process of Guangxi offshore wind power value chain based on expert evaluation method, it is necessary to transform fuzzy linguistic variables into explicit numerical variables before using VIKOR method. Therefore, triangular fuzzy numbers are introduced to transform fuzzy linguistic variables into interval numerical variables, which are constructed in FVIKOR comprehensive evaluation model for the application of offshore wind power value chain collaborative evaluation. The FVIKOR comprehensive assessment model is calculated as follows:

Table 2. Evaluation of semantic values and relative triangular fuzzy numbers

Semantic value	Triangular fuzzy number
Very High (VH)	(0.7,1,1)
High (H)	(0.5,0.7,1)
Medium (M)	(0.3,0.5,0.7)
Low (L)	(0,0.3,0.5)
Very Low (VL)	(0,0,0.3)

Step 1: According to the actual situation of m alternatives $A=A_i(i=1,2,\cdots,m)$, experts are invited to combine n evaluation indicators $C=C_j(j=1,2,\cdots,n)$ and evaluate them using the evaluation language in Table 2, and the evaluation information matrix $X_i=(x_{ij})_{m\times n}$ is obtained after converting the linguistic variables to the corresponding triangular fuzzy numbers, where x_{ij} is the evaluation value

of program A_i on the indicator C_j, $x_{ij}=(x_{ij}^L,x_{ij}^M,x_{ij}^U)$. The arithmetic rules of the triangular fuzzy numbers are referenced in literature [17].

Step 2: Determine the positive ideal solution $PX=\left(x_i^{LP},x_i^{MP},x_i^{UP}\right)$ and negative ideal solution $NX=\left(x_i^{LN},x_i^{MN},x_i^{UN}\right)$ of each evaluation index, wherein:

$$PX=\begin{cases}\left\{\max x_{1j},\max x_{2j},\cdots,\max x_{nj}\right\}, & x_{ij} \text{ is a benefit index}\\ \left\{\min x_{1j},\min x_{2j},\cdots,\min x_{nj}\right\}, & x_{ij} \text{ is a cost index}\end{cases} \tag{3}$$

$$NX=\begin{cases}\left\{\min x_{1j},\min x_{2j},\cdots,\min x_{nj}\right\}, & x_{ij} \text{ is a benefit index}\\ \left\{\max x_{1j},\max x_{2j},L,\max x_{nj}\right\}, & x_{ij} \text{ is a cost index}\end{cases} \tag{4}$$

Step 3: Calculate the group utility value $S_i=(S_i^L,S_i^M,S_i^U)$ and individual regret value $R_i=(R_i^L,R_i^M,R_i^U)$ by using equations (5)-(6):

$$S_i=\sum_{j=1}^{n}(w_j\otimes\tilde{d}_{ij}) \tag{5}$$

$$R_i=\max_j(w_j\otimes\tilde{d}_{ij}) \tag{6}$$

wherein, $\tilde{d}_{ij}=d(x_j^P,x_{ij})/d(x_j^P,x_j^N)$,at the same time:

$$d(x_j^P,x_{ij})=\sqrt{\frac{1}{3}\left[(x_i^{LP}\text{-}x_{ij}^L)^2+(x_i^{MP}\text{-}x_{ij}^M)^2+(x_i^{UP}\text{-}x_{ij}^U)^2\right]} \tag{7}$$

Step 4: Use Formula (8) to calculate the comprehensive index value Q_j:

$$\begin{cases}Q_j=v\dfrac{S_i\text{-}S_i^P}{S^N\text{-}S^P}+(1-v)\dfrac{R_i\text{-}R_i^P}{R^N\text{-}R^P}\\ S^P=\min\limits_i S_i,S^N=\max\limits_i S_i\\ R^P=\min\limits_i R_i,R^N=\max\limits_i R_i\end{cases} \tag{8}$$

Wherein, $(1-v)$ is the weight of individual regret value, generally let v =0.5.

Step 5: Arrange the group utility value S_i, individual regret value R_i and comprehensive index value Q_j, and select the scheme with the minimum comprehensive index value Q_j as the optimal scheme. The sequence $Q_{\theta i}(i=1,2,\cdots,m)$ is obtained based on ascending sorting of values Q_j and the optimal solution is determined according to the following conditions:

Condition 1: $Q(Q_{\theta 2})-Q(Q_{\theta 1})\geq 1/(m-1)$;

Condition 2: $Q_{\theta 1}$ is the first evaluator in the S_i or R_i ordering.

It is worth noting that if condition 1 and condition 2 cannot be completely satisfied, the optimal solution is obtained by:

Method 1: If condition 2 cannot be satisfied, the optimal solution set is $(Q_{\theta 1},\ Q_{\theta 2})$;

Method 2: If condition 1 cannot be satisfied, compute $Q_{\theta r}\text{-}Q_{\theta 1}<1/(m-1)$ to obtain the maximum value r and let the set of optimal solutions be $(Q_{\theta 1},\ Q_{\theta 2},\cdots,\ Q_{\theta r})$.

5. Case Analysis of Collaborative Evaluation of Offshore Wind Power Value Chain in Guangxi

5.1. Basic Data

After full investigation of Guangxi offshore wind power development project and offshore wind power industrial park, three options are determined, and the value chain synergy degree of each option is comprehensively evaluated, aiming to fully identify and analyze the multidimensional factors affecting the value chain synergy of offshore wind power, and provide a comprehensive and comprehensive value chain collaborative evaluation solution. To this end, for options $A_i(i=1,2,3)$,experts are invited to assess the importance of primary and secondary evaluation indicators $C_j(j=1,2,\cdots,14)$ and the value chain synergy of each option to obtain initial evaluation information. The initial evaluation values of each option are shown in Table 3.

Table 3. Initial evaluation values for options

Indicators	A1	A2	A3
C1	VH	M	H
C2	H	L	M
C3	H	VL	M
C4	VH	L	H
C5	H	L	M
C6	H	VL	M
C7	VH	L	H
C8	M	VH	H
C9	VH	L	H
C10	VH	H	H
C11	H	L	M
C12	VH	M	H
C13	H	L	M

5.2. Index Weight Calculation

Determine the weight of the primary indicators based on BWM method: firstly, determine the optimal indicators (C_B) and the weakest indicators (C_W) among the four primary indicators, and then compare the importance of the indicators one by one, as shown in Table 4, and construct the primary indicator importance matrix accordingly; secondly, determine the optimal indicators and the weakest indicators of the secondary indicators under different dimensions, and then compare the importance of the indicators one by one, and construct the secondary indicator importance matrix accordingly; Finally, Matlab software is used to solve equations (1) and (2) to obtain the optimal index weight and consistency index of primary and secondary indicators. The results are shown in Table 5, and the weight matrix $\tilde{W}=(w_1,w_2,\cdots,w_n)$ is obtained.

Table 4. Comparison results of importance of primary indicators

	Integrated system dimension (B1)	Key node dimension (B2)	Subject contribution dimension (B3)	Resource endowment dimension (B4)	
Best And Other	1	6	3	5	Best: B1
Other Weakest	8	1	6	3	Weakest: B2

Table 5. Results of determining index weights by BWM method

Primary indicators	Secondary indicators	Weight	Total weight	Sort
Integrated system dimension (B_1)		0.4913		
	Synergy capability of offshore wind power system (C_1)	0.6838	0.3360	1
	Offshore supply service capacity (C_2)	0.1	0.0491	7
	Offshore wind power project development capacity (C_3)	0.2161	0.1062	3
Key node dimension (B_2)		0.0664		
	Energy supply efficiency (C_4)	0.6	0.0398	8
	Operating efficiency of electric energy transmission nodes (C_5)	0.3	0.0199	10
	Demand response capability of energy consuming nodes (C_6)	0.1	0.0066	13
Subject contribution dimension (B_3)		0.3061		
	Offshore large equipment installation expertise and competence (C_7)	0.1111	0.0340	9
	Cost of project design, installation, operation and grid connection (C_8)	0.1627	0.0498	6
	Direct economic benefits of the project (C_9)	0.7262	0.2223	2
Resource endowment dimension (B_4)		0.1362		
	Offshore wind resource endowment (C_{10})	0.3939	0.0536	5
	Information flow, material flow, energy flow resources (C_{11})	0.4478	0.0610	4
	Development planning and incentive policies (C_{12})	0.1022	0.0139	11
	Energy technology development (C_{13})	0.0551	0.0075	12

5.3. Collaborative Evaluation of Guangxi Offshore Wind Power Value Chain

1) Process the initial evaluation value with triangular fuzzy numbers to obtain an evaluation matrix $X_i = (x_{ij})_{3\times 12}$, $x_{ij}=(x_{ij}^L, x_{ij}^M, x_{ij}^U)$,and determine the positive ideal solution $PX\left(C_j\right)$ and negative ideal solution $NX\left(C_j\right)$ of each evaluation index C_j according to equations (3) and (4), wherein the ideal solution result of evaluation index C_1 is:

$$PX\left(C_1\right)=\left(0.70, 1.00, 1.00\right),$$

$$NX\left(C_1\right)=\left(0.30, 0.50, 0.70\right).$$

2) Combined with the index weights, calculate the group utility value S_i and individual regret value R_i by using equations (5) and (6), convert the interval value of triangular fuzzy number into definite value by using equation (7), and then calculate the comprehensive index value Q_j . The results are as follows:

$$S_1 = 0.0000, S_2 = 0.7570, S_3 = 0.2158;$$

$$R_1 = 0.0000, R_2 = 0.3360, R_3 = 0.0873;$$

$$Q_1 = 0.0000, Q_2 = 1.0000, Q_3 = 0.2726.$$

3) Sort the alternatives in ascending order based on the above calculations. Since $S_1 < S_3 < S_2$, $R_1 < R_3 < R_2$,and $Q_1 < Q_3 < Q_2$, the ranking of alternatives is $A_1 > A_3 > A_2$, A_1 should be selected as the best alternative. However, the result obtained does not satisfy condition 1 of VIKOR method, i.e., it cannot be satisfied $Q(Q_{\theta 2}) - Q(Q_{\theta 1}) \geq \frac{1}{3-1}$ .Therefore, $Q_{\theta r}\text{-}Q_{\theta 1} < 1/(3-1)$ should be calculated to obtain the maximum solution value r as $r = 2$, and the optimal solutions are determined as A_1 and A_3 according to the ranking. Therefore, in the evaluation and decision-making of Guangxi offshore wind power value chain collaboration, priority should be given to the scheme A_1 and scheme A_3 .

5.4. Evaluation Index Analysis

This paper will observe the change of Guangxi offshore wind power value chain synergy by adjusting the importance (weight) of four primary indicators, so as to explore the impact of different evaluation index assignment changes on the value chain synergy evaluation. In this part, the weight of secondary indicators in each dimension will increase and decrease by 15% on the basis of the obtained weight, and the remaining weights will be changed proportionally to ensure that the sum of indicator weights is 1. The evaluation matrix will be processed by using the constructed value chain collaborative evaluation model, and the results will be as shown in Figure 1. In each group of results, the values Q_1 were 0 ,the values Q_2 were 1,and the values Q_3 were 0.2726, 0.2778, 0.2678, 0.2735, 0.2717, 0.273, 0.2721, 0.2684 and 0.2767 respectively. In each group of observations where the evaluation index changes by 15% according to the weight of the primary index, the ranking of the collaborative evaluation of the alternative value chain is consistent (i.e., $A_1 > A_3 > A_2$). Therefore, the evaluation index system constructed in this paper has stability and effectiveness in the collaborative evaluation of offshore wind power value chain. The BWM-FVIKOR comprehensive evaluation model constructed presents certain applicability and can be used in the relevant decision-making of the collaborative evaluation of Guangxi offshore wind power value chain.

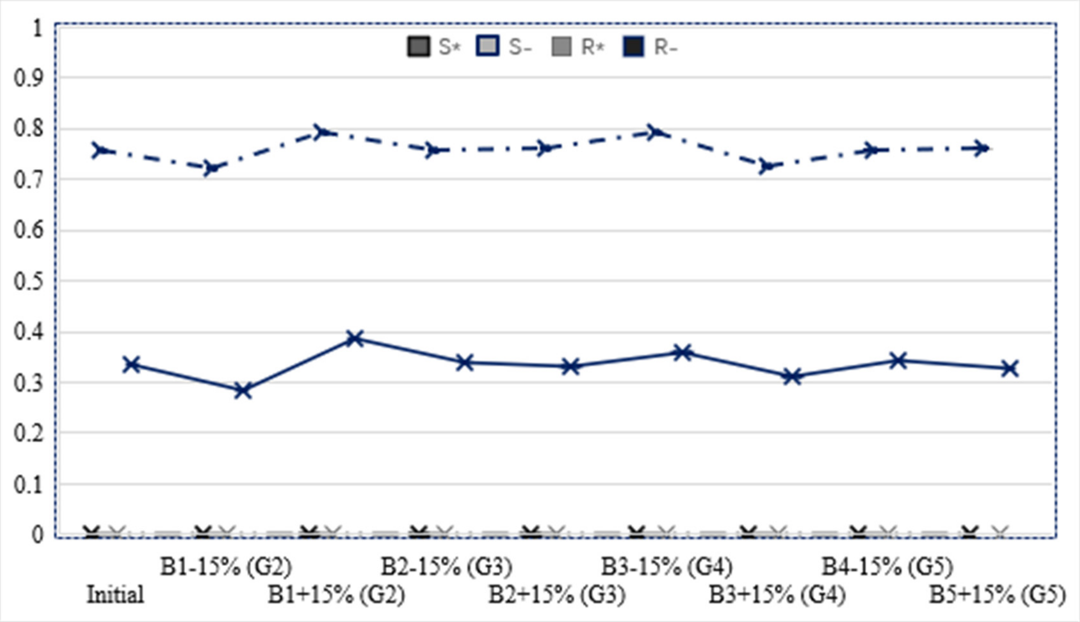

Figure 1. Results under indicator changes

At the same time, it can be seen from the evaluation index weight results that using BWM method to determine the index weight is helpful to transform the fuzzy and uncertain weight importance information into clear and definite weight values, which is convenient for further comprehensive evaluation. Based on the weight calculation results, the following conclusions can be drawn: 1) the weights of the primary indicators such as the comprehensive system dimension (B_1), the key node dimension (B_2), the subject contribution dimension (B_3) and the resource endowment dimension (B_4) are 0.4913, 0.0664, 0.3061 and 0.1362 respectively, so attention should be paid to the contribution efficiency of the comprehensive system and each main body in the offshore wind power value chain;2) the most direct factors affecting the synergy of the offshore wind power value chain in the comprehensive system dimension (B_1) are the synergy ability of the offshore wind power system and the development ability of the offshore wind power project, and the former has the greatest synergy effect on the offshore wind power value chain among all the secondary indicators;3) the synergy performance of the key node dimension is comprehensively affected by the power supply efficiency, the operation efficiency of the power transmission node and the demand response ability of the power consumption node; 4) The importance of the project's direct economic benefit index ranks second, which directly affects the contribution of multi-entity participation in the offshore wind power value chain, and also focuses on the design, installation, operation and maintenance and grid-connection costs of offshore wind power projects;5) When conducting collaborative evaluation on the offshore wind power value chain, it is necessary to consider not only the wind energy resource endowment, but also the information flow, logistics and energy flow resources of the value chain.

6. Conclusion

The healthy development of offshore wind power value chain is inseparable from complex and dynamic multi-party coordination and operation. In order to study the collaborative evaluation of Guangxi offshore wind power value chain, this paper constructs an evaluation index system of offshore wind power value chain, and uses BWM-FVIKOR model alternatives to carry out comprehensive evaluation analysis on the basis of expert scoring method, verifying the applicability of the evaluation index system and the effectiveness of the evaluation model. The results show that Guangxi offshore wind power value chain synergy needs to consider the multiple effects of comprehensive system dimension, key node dimension, subject contribution dimension and resource endowment dimension, and should focus on the performance of offshore wind power system synergy ability, offshore wind power project development ability, project direct economic benefit, offshore wind power resource endowment, value chain information flow, logistics and energy flow resources.

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