Research on evaluation and strategy of competitiveness of Grid Sales Corporation based on grey fuzzy method

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Abstract

A new round of power system reform has led to fierce competition in the electricity sales market. As one of the main competitors, how to evaluate and enhance the core competitiveness determines its position and influence for Grid Sales Corporation in the industry. This paper first analyzes the status of the competition in the electricity sales market, and then uses grey fuzzy comprehensive evaluation method to evaluate the competitiveness of Grids Sales Corporation. Finally, according to the evaluation results, it is concluded that, in order to adapt to new market changes, Grids Sales Corporation should further improve service capabilities such as energy-saving services, differentiated services, and energy Internet services while maintaining its competitive advantages.

Keywords

Grid Sales Corporation; competitiveness evaluation; grey fuzzy method; service strategy.

1. Introduction

With the in-depth development of a new round of power system reform, many power sales companies have entered the sales side. Under the background of new mechanisms and multiple market entities, grid sales corporations have entered the fierce market competition with their financial advantages, huge talent advantages, and strong technical platform advantages [1].However, in the open sales market, they are also facing enormous challenges.

According to foreign reform experience, the biggest threat to the grid sales corporation comes from power generation companies [2].Under the new system of electricity sales, the power generation companies will rapidly cut into the market. Because they have price advantages, so they can seize large and medium-sized industrial customers, and quickly occupy the market share. In addition, some high-tech industrial parks, public service industries, and energy-saving service companies may be more professional in the power service market. They are able to provide packaged services, customized services, etc. Other power sellers will use their own advantages and will also occupy a part of the market. Especially for some Internet companies, their flexibility, user groups, online sales channels and service quality make them potential competitors. Therefore, if Grid Sales Corporation wants to adapt to new market changes, they need to make an in-depth evaluation of their competitiveness, find out the space for further development and enhance their competitiveness.

For the evaluation of the market competitiveness of the grid sales corporation, both domestic and foreign scholars have conducted extensive research. Tsutsui M et al. (2009) used the SBM measurement model to evaluate the U.S. power company's multi-level energy efficiency [3]. Jia Z et al. (2011) used information entropy theory to determine the objective weights of evaluation indicators, and applied fuzzy comprehensive evaluation method to establish an assessment model for operating capability of regional grid company [4]. Li W et al.(2012) evaluated the power service quality of power supply companies based on grey relational comprehensive evaluation model [5].You Y Q et al.(2016) evaluated the operational performance of 31 power supply companies using a dynamic network model [6]. After the implementation of a new round of power system reforms in China, scholars have less evaluation for the competitiveness of various types of power selling entities. But they are rich in the construction system and evaluation methods. Benchao Li (2015) has studied the service evaluation

system for power supply companies and it has a good guiding significance for the establishing an evaluation index system in this paper [7]. Yongxiu He (2011) systematically expounded the comprehensive evaluation method and its application in the power industry [8]. Juan Liu (2010) used entropy method to evaluate the competitiveness of power supply companies [9]. Wenya Liu et al. (2016) used the fuzzy evaluation method to compare the competitiveness of the six major power sellers after the electricity reform [10].

Through combing the literature, it is found that most of the studies above use a single model to evaluate the competitiveness. In order to further resolve the uncertainty in the competitiveness evaluation system, and take into account subjective and objective factors, this paper combines the grey and fuzzy evaluations. It can provide a reference for accurately evaluating the competitiveness of Grid Sales Corporation and propose corresponding optimization strategies based on the evaluation results.

2. Competitiveness Evaluation Index System and Model of Grids sales corporation

2.1 Build a competitiveness evaluation index system

In addition to the power-selling business such as non-different power sales and electricity billing, high-quality power supply and service is the core of competition in the power sales market [11]. Based on the reference of related literature, this paper constructs an evaluation index system for the competitiveness of Grids Sales Corporation. The specific indicator system is shown in Table 1.

Table 1 evaluation index system of Grids Sales Corporation

First-level indicators A_i	Secondary indicators A_{ij}
A_1 Business Hall Service	A_{11} The convenience of business outlets
	A_{12} Timeliness of business acceptance
	A_{13} Salesperson business level
	A_{14} Salesperson service attitude
A_2 Field Service	A_{21} Completion time
	A_{22} Timely and accurate meter reading
	A_{23} Timely repair response
	A_{24} Timely and accurate issue bills
A_3 Phone service	A_{31} Telephone connection
	A_{32} Attendant business level
	A_{33} Attendant service attitude
A_4 Power quality	A_{41} Power stability
	A_{42} Power reliability
	A_{43} Power security
A_5 Other service	A_{51} Energy-saving Service
	A_{52} Differentiated Services
	A_{53} Energy internet Service

2.2 Determine index weights

In this paper, we use analytic hierarchy process to calculate indicator weights. According to the steps of the analytic hierarchy process, the expert group conducts complementarity comparisons to determine the relative importance of each element in the hierarchy. After determining the overall

order of importance of each element, the weight vector, characteristic root, and consistency can be calculated. Assume that the weight of the first-level indicator is $\mu_1, \mu_2,...\mu_i,...\mu_n$, Secondary indicators is $\mu_{i1},\mu_{i2},...\mu_{ii},...,\mu_{ij},i=1,2,...,m$. The calculation results are shown in Table 2. Since the AHP is a widely used method, the calculation process in this paper is not repeated here.

Table 2 the weight of each indicator

First-level indicators A_i	weight μ_i	Secondary indicators A_{ij}	weight μ_{ij}
A_1 Business Hall Service	0.211	A_{11} The convenience of business outlets	0.121
		A_{12} Timeliness of business acceptance	0.241
		A_{13} Salesperson business level	0.315
		A_{14} Salesperson service attitude	0.323
A_2 Field Service	0.215	A_{21} Completion time	0.304
		A_{22} Timely and accurate meter reading	0.191
		A_{23} Timely repair response	0.334
		A_{24} Timely and accurate issue bills	0.171
A_3 Phone service	0.154	A_{31} Telephone connection	0.311
		A_{32} Attendant business level	0.333
		A_{33} Attendant service attitude	0.356
A_4 Power quality	0.199	A_{41} Power stability	0.305
		A_{42} Power reliability	0.306
		A_{43} Power security	0.389
A_5 Other service	0.221	A_{51} Energy-saving Service	0.451
		A_{52} Differentiated Services	0.437
		A_{53} Energy internet Service	0.112

2.3 Grey Fuzzy Comprehensive Evaluation Method

2.3.1 Determine the comment set and sample matrix

The comment set of competitiveness evaluation include low, medium and high. In general, the evaluation coefficient that belongs to (0.1, 0.3) is low, belongs to (0.3, 0.7) is medium, and belongs to (0.7, 0.9) is high. After determining the comment set, M experts are invited to assess the indicator layer according to evaluation criteria. Then we can determine the sample matrix.

2.3.2 Determining the Evaluation Grey Class and its Whitening Weight Function

According to grey evaluation of triangular whitening weight function, we can establish whitening weight function. Set J indexes, whitening weight functions of k (k =1, 2, 3) grey class is

$$f_j^k(x)=\begin{Bmatrix} 0 & x\notin\left[x_j^{k-1},x_j^{k+2}\right] \\ \dfrac{x-x_j^{k-1}}{\lambda_j^k-x_j^{k-1}} & x\in\left[x_j^{k-1},\lambda_j^k\right] \\ \dfrac{x_j^{k+2}-x}{x_j^{k+2}-\lambda_j^k} & x\in\left[\lambda_j^k,x_j^{k+2}\right] \end{Bmatrix} \quad (1)$$

We extend the range of indexes to $x_j^0 = 0, x_j^5 = 1$. $x_j^1, x_j^2, x_j^3, x_j^4$ correspond to the threshold of three grey classes include "low evaluation", "medium evaluation", "high evaluation", that is $x_j^1 = 0.1, x_j^2 = 0.3, x_j^3 = 0.7, x_j^4 = 0.9$. λ_j^k is the average value of the x_j^k and x_j^{k+1}, that is

$$\lambda_j^1 = \frac{1}{2}(x_j^1 + x_j^2) = \frac{1}{2}(0.1+0.3) = 0.2;$$

$$\lambda_j^2 = \frac{1}{2}(x_j^2 + x_j^3) = \frac{1}{2}(0.3+0.7) = 0.5;$$

$$\lambda_j^3 = \frac{1}{2}(x_j^3 + x_j^4) = \frac{1}{2}(0.7+0.9) = 0.8;$$

We substitute specific values into function (1), then we can know the triangular whitening weight function of J.

$$f_j^1(x) = \begin{cases} 0 & x \notin [0,0.7] \\ \dfrac{x}{0.2} & x \in [0,0.2] \\ \dfrac{0.7-x}{0.5} & x \in [0.2,0.7] \end{cases} \tag{2}$$

$$f_j^2(x) = \begin{cases} 0 & x \notin [0.1,0.9] \\ \dfrac{x-0.1}{0.4} & x \in [0.1,0.5] \\ \dfrac{0.9-x}{0.4} & x \in [0.5,0.9] \end{cases} \tag{3}$$

$$f_j^3(x) = \begin{cases} 0 & x \notin [0.3,1] \\ \dfrac{x-0.3}{0.5} & x \in [0.3,0.8] \\ \dfrac{1-x}{0.2} & x \in [0.8,1] \end{cases} \tag{4}$$

Function (2) belongs to whitening weight function of low evaluation. Function (3) belongs to whitening weight function of medium evaluation. Function (4) belongs to whitening weight function of high evaluation.

2.3.3 Construct fuzzy membership matrix

We construct the fuzzy membership matrix of factor I, that is

$$\sigma_i = \left(\sigma_i^k\right) = \begin{bmatrix} \sigma_1^1 & \sigma_1^2 & \ldots & \sigma_1^s \\ \sigma_2^1 & \sigma_2^2 & \ldots & \sigma_2^s \\ \ldots & \ldots & \ldots & \ldots \\ \sigma_n^1 & \sigma_n^2 & \ldots & \sigma_n^s \end{bmatrix} \tag{5}$$

σ_i^k is comprehensive clustering coefficient of object i that belongs to k grey class：

$\sigma_i^k = \sum_{j=1}^{m} f_j^k(x_{ij}) \cdot \eta_j^k$, $\eta_j^k = \dfrac{\lambda_j^k}{\sum_{j=1}^{m} \lambda_j^k}$.

2.3.4 Grey comprehensive evaluation of factor i

We assess the factor i: $A_i = [a_{i1} \quad a_{i2} \quad a_{i3}] = [\mu_{i1} \quad \mu_{i2} \quad \ldots \quad \mu_{in}] \cdot \sigma_i$

Then we can judge the factor i belongs to grey class k^* according to the formula $\max_{1 \le k \le s} \{\sigma_i^k\} = \sigma_i^{k^*}$.

3. Example analysis

This paper takes a grid sales corporation in S province for example. Experts participating in competitiveness evaluation have 30 persons. These people include 6 from Grid Corporation, 7 from power generation companies, 7 from power sales companies, and 10 from research institutions. These experts selected the evaluation set of each indicator based on their own experience and the company's situation. The selection is shown in Table 3.

Table3 Expert scoring table

First-level indicators A_i	Secondary indicators A_{ij}	high	medium	low
A_1	A_{11}	16	12	2
	A_{12}	14	11	5
	A_{13}	17	14	5
	A_{14}	13	12	5
A_2	A_{21}	17	9	4
	A_{22}	16	12	2
	A_{23}	15	10	5
	A_{24}	13	10	7
A_3	A_{31}	19	9	2
	A_{32}	16	13	1
	A_{33}	13	10	7
A_4	A_{41}	12	11	7
	A_{42}	14	10	6
	A_{43}	13	12	5
A_5	A_{51}	9	14	7
	A_{52}	11	13	6
	A_{53}	14	13	3

According to the selection of experts, the fuzzy matrix of the evaluation set of each index can be obtained as shown in Table 4.

Table4 fuzzy evaluation matrix

First-level indicators A_i	Secondary indicators A_{ij}	high	medium	low
A_1	A_{11}	0.533	0.400	0.067
	A_{12}	0.467	0.367	0.167
	A_{13}	0.472	0.389	0.139
	A_{14}	0.433	0.400	0.167
A_2	A_{21}	0.567	0.300	0.133
	A_{22}	0.533	0.400	0.067
	A_{23}	0.500	0.333	0.167
	A_{24}	0.433	0.333	0.233
A_3	A_{31}	0.633	0.300	0.067

	A_{32}	0.533	0.433	0.033
	A_{33}	0.433	0.333	0.233
A_4	A_{41}	0.400	0.367	0.233
	A_{42}	0.467	0.333	0.200
	A_{43}	0.433	0.400	0.167
A_5	A_{51}	0.300	0.467	0.233
	A_{52}	0.367	0.433	0.200
	A_{53}	0.467	0.433	0.500

Based on the function (2) (3) (4) above, we can calculate the gray statistics of each index firstly. Then we can get the fuzzy membership matrix of each index according to equation (5). Finally, it is calculated that fuzzy membership matrix of first-level indicators of the competitiveness evaluation for grid sales corporation in S province.

$$\sigma_1 = \begin{bmatrix} 0.2485 & 0.1500 & 0.0621 \\ 0.1781 & 0.1335 & 0.0445 \\ 0.1835 & 0.1445 & 0.0459 \\ 0.1419 & 0.1500 & 0.0355 \end{bmatrix}$$

$$\sigma_2 = \begin{bmatrix} 0.2848 & 0.1000 & 0.0712 \\ 0.2485 & 0.1500 & 0.0621 \\ 0.2133 & 0.1165 & 0.0533 \\ 0.1419 & 0.1165 & 0.0355 \end{bmatrix}$$

$$\sigma_3 = \begin{bmatrix} 0.3552 & 0.1000 & 0.0888 \\ 0.2485 & 0.1665 & 0.0621 \\ 0.1419 & 0.1165 & 0.0355 \end{bmatrix}$$

$$\sigma_4 = \begin{bmatrix} 0.1067 & 0.1355 & 0.0267 \\ 0.1781 & 0.1165 & 0.0445 \\ 0.1419 & 0.1500 & 0.0355 \end{bmatrix}$$

$$\sigma_5 = \begin{bmatrix} 0 & 0.1835 & 0 \\ 0.0715 & 0 & 0.0179 \\ 0.0715 & 0.1835 & 0.0179 \end{bmatrix}$$

Then we can further calculate the fuzzy comprehensive evaluation matrix:

$$A_1 = (\mu_{11}, \mu_{12}, \mu_{13}, \mu_{14}) \cdot \sigma_1$$

$$= (0.121, \quad 0.241, \quad 0.315, \quad 0.323) \cdot \begin{bmatrix} 0.2485 & 0.1500 & 0.0621 \\ 0.1781 & 0.1335 & 0.0445 \\ 0.1835 & 0.1445 & 0.0459 \\ 0.1419 & 0.1500 & 0.0355 \end{bmatrix}$$

$$= (0.1766, \quad 0.1443, \quad 0.0442)$$

Similarly, the fuzzy comprehensive evaluation vector of other first-level indicators can be obtained.

$$A_2 = (\mu_{21}, \mu_{22}, \mu_{23}, \mu_{24}) \cdot \sigma_2 = (0.2295, \quad 0.1179, \quad 0.0574)$$

$$A_3 = (\mu_{31}, \mu_{32}, \mu_{33}, \mu_{34}) \cdot \sigma_3 = (0.2437, \quad 0.1280, \quad 0.0609)$$
$$A_4 = (\mu_{41}, \mu_{42}, \mu_{43}, \mu_{44}) \cdot \sigma_4 = (0.1422, \quad 0.1347, \quad 0.0356)$$
$$A_5 = (\mu_{51}, \mu_{52}, \mu_{53}, \mu_{54}) \cdot \sigma_5 = (0.0393, \quad 0.1033, \quad 0.0098)$$

So the total fuzzy evaluation matrix is

$$R = \begin{bmatrix} 0.1766 & 0.1443 & 0.0442 \\ 0.2295 & 0.1179 & 0.0574 \\ 0.2437 & 0.1280 & 0.0609 \\ 0.1422 & 0.1347 & 0.0356 \\ 0.0393 & 0.1033 & 0.0098 \end{bmatrix}$$

Therefore, we can know the comprehensive evaluation vector of the competitiveness for Grid Sales Corporation in S province:

$$A = (\mu_1, \quad \mu_2, \quad \mu_3, \quad \mu_4, \quad \mu_5) \cdot R$$
$$= (0.211, \quad 0.215, \quad 0.154, \quad 0.199, \quad 0.211) \cdot \begin{bmatrix} 0.1766 & 0.1443 & 0.0442 \\ 0.2295 & 0.1179 & 0.0574 \\ 0.2437 & 0.1280 & 0.0609 \\ 0.1422 & 0.1347 & 0.0356 \\ 0.0393 & 0.1033 & 0.0098 \end{bmatrix}$$
$$= (0.1611, \quad 0.1251, \quad 0.0403)$$

Then we normalize vector A: $A = (0.4934, \quad 0.3822, \quad 0.1234)$

According to the results of the final comprehensive evaluation vector, among the three degrees of membership, the high evaluation is 0.4934, the medium evaluation is 0.3822, and the low evaluation is 0.1234. Based on the principle of maximum degree of membership, the comprehensive membership value is 0.4934, which is evaluated as “high”. Therefore, in general, Grid Sales Corporation in S province is more competitive in the power sales market.

Judging from the result of the degree of membership of the first-level indicators, Grid Sales Corporation has a high level in the business hall service, field service, phone service, and power quality. But the capabilities of energy-saving services, differentiated services and energy internet service are relatively weak. Therefore, Grid Sales Corporation should further strengthen three capabilities above to enhance market competitiveness.

4. Competitive optimization strategy of Grid Sales Corporation

4.1 Optimization strategy of energy-saving service

Energy-saving services mean that power sales companies use various means to help users save energy in order to promote the sustainable development of electricity.

First of all, Grid Sales Corporation can analyze the user's power consumption characteristics based on the user power information provided by the cloud platform and big data. And they can provide customers with services such as energy-saving diagnosis and solution to guide the user's power consumption behavior.

Second, the power sales company should strengthen research and development of energy-saving technologies, increase the supply of energy-saving electrical equipment, and provide customers with corresponding maintenance equipment and operations management services.

In addition, Grid Sales Corporation can use a variety of service tools to encourage users to save energy. For example, a graph such as a smile or a sad face is printed on the user's bill to promote customer’s

energy-saving behavior; Collaboration with social platforms like Wechat to introduce the power bill into the social element, enabling the user to see rank in the social circle to stimulate their energy-saving power.

4.2 Optimization strategy of differentiated services

The difference strategy means that the company provides different services according to the specific needs of different users, in order to improve customer satisfaction and loyalty, and to bring value to the enterprise.

Firstly, Grid Sales Corporation can divide the consumers into household consumption and large electricity customer and so on. And they can propose corresponding service strategies for different customers. For large customers, their needs are positioned to reduce energy costs, promote energy conservation, configure reliability facilities and reduce customer investment costs, etc. So they should provide customers with a variety of power price options and electrical equipment program optimization. For the household customers, their needs are comfortable, economy and safety. So the corresponding service strategy is to actively promote some high-efficiency electrical products such as intelligent electrical appliances and energy-saving water heaters.

Secondly, Grid Sales Corporation can also provide customized services according to the user's special needs. Based on the user's power characteristics and power consumption information, it can recommend the service package that suits the user.

Moreover, Grid Sales Corporation can also develop energy detection platform, carry out energy detection service, and track the user's personalized needs and the implementation effect of the scheme.

4.3 Optimization strategy of energy internet service

The energy Internet service means that the power sales companies use the cloud platform, combined big data and information management techniques, to dig and analyze the users' information in depth. In this way, they can grasp the diversified energy demands of users and provide users with energy services suitable for their life and production mode.

First of all, through the launch of the mobile account management application app, Grid Sales Corporation enables customers to conveniently manage their own electricity bills, access electricity data, and various prices to improve the user experience.

Secondly, by introducing the Internet information publishing platform, Grid Sales Corporation can provide customers with dynamic information and price fluctuations of power, coal, oil, natural gas and other energy sources, so that users can have a clear view of the important dynamics of the related industries.

Furthermore, Grid Sales Corporation can cooperate with other platforms to provide convenient network services. For example, cooperation with payment platforms such as Alipay or mobile banking clients to achieve the user "one click payment"; cooperation with Baidu and Gaode map clients, letting users query the address of business hall, gas station, charging pile anytime and anywhere to facilitate users to travel.

5. Conclusion

The new round of power system reform has triggered fierce competition. As one of the main competitive bodies, it is critical to scientifically evaluate and enhance the core competitiveness for Grid Sales Corporation. This paper uses grey fuzzy comprehensive method to estimate the competitiveness of Grid Sales Corporation. According to the evaluation results, it is concluded that the Grid Sales Corporation are generally competitive, but their service capabilities such as energy-saving services, differentiated services and energy internet are relatively weak. Therefore, in order to adapt to new market changes, Grid Sales Corporation should further improve its service capabilities such as energy-saving services, differentiated services, and energy internet services while maintaining its competitive advantages.

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