Construction and Application of Hebei Electric Power Digital Demonstration Evaluation System

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Abstract—In the era of digital economy, digital transformation is the inevitable choice for the development of enterprises in the future. In this context, Hebei electric power grid to promote enterprise digital transformation, select 10 units to carry out digital demonstration, we will promote the production, operation and management of digital power grids, customer service, and load reduction and efficiency enhancement at the grass-roots leve. At the same time, in order to select a number of practical and replicable digital transformation templates, this paper adopts the methods of Brainstorming, entropy weight, fuzzy comprehensive evaluation, etc. , build the digital model evaluation system and carry out the application, and finally determine 3 model units, for other units to provide reference experience of digital transformation.

Keywords- Digital Transformation; digital demonstration; evaluation system; model of transformation

1. Introduction

At present, domestic and foreign power grid enterprises have not carried out enterprise digital transformation assessment. Foreign experts and scholars generally believe that the digital transformation of enterprises has three significant characteristics: ① digital technology can play its advantages as a means and method to promote digital transformation, and the upgrading of digital technology can significantly reduce the economic cost of enterprise information use[1]; ② It is the process that enterprises or industries use digital technology to improve value creation and respond to external changes[2]; ③ Its purpose is to improve major businesses to improve customers' feelings, facilitate processes and reshape business models. In this process, create new customer experience and effectively promote the quality and efficiency of enterprises.

In this paper, the experts are invited to discuss the evaluation indicators by Brainstorming, and finally decide to construct a digital model evaluation system from the three dimensions of “Organizational guarantee, process guarantee and effectiveness guarantee” [3], as shown in Figure 1. In the aspect of organizational security, it determines whether the division of work is clear, whether the objectives of work are clear, and whether the control mechanism is sound, etc. , from the regular meeting, weekly report, monthly report, progress and other indicators to

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determine whether the regular meeting mechanism of the Model Unit is sound, weekly report, monthly report, whether the implementation of the content of serious, and so on; From the work effectiveness, other work effectiveness, typical experience, publicity reports and other indicators to determine the overall effectiveness of the demonstration unit.

Serial number	Model home
1	State Grid Xiongan New Area Power Supply Company
2	State Grid Zhengding County Power Supply Company
3	State Grid Shijiazhuang County Power Supply Company
4	State Grid Shenzhou County Power Supply Company
5	State Grid, new Dingzhou power supply
6	State Grid Taocheng District Zhaoquan Park Power Supply Station
7	State Grid, Bohai Sea New Area Power Supply Company
8	State Grid Longyao County Yamaguchi Power Station
9	State Grid Xian County Nanhetou power supply station
10	State Grid Luquan Miyama power supply

Serial number	Evaluation dimension	Assessment indicators
1	Organization protection	Division of duties
		Work Plan
		Control the organization
2	Process protection	Regular meetings
		Weekly report
		Monthly report
		Progress
3	Effectiveness protection	Effectiveness
		Other results
		Typical experience
		Publicity reports

Fig. 1 Details of demonstration units and assessment indicators

After the establishment of the evaluation system, experts are invited to mark the indexes of 10 demonstration units, and the final scores of each demonstration unit are determined by means of entropy weight method and fuzzy comprehensive evaluation, etc. , as shown in Figure 2. Based on the scores, three demonstration units were selected: China National Grid Zhengding County Power Supply Company, China National Grid Xiong' an New Area Power Supply Company, and China National Grid Shijiazhuang Power Supply Company.

Serial number	Evaluation dimension	Assessment indicators	Weight
1	Organization protection	Division of duties	0.1
		Work Plan	0.1
		Control the organization	0.1
2	Process protection	Regular meetings	0.08
		Weekly report	0.06
		Monthly report	0.06
		Progress	0.1
3	Effectiveness protection	Effectiveness	0.4
		Other results	Plus points
		Typical experience	Plus points
		Publicity reports	Plus points

Serial number	Model home	Score
1	State Grid Xiongan New Area Power Supply Company	98
2	State Grid Zhengding County Power Supply Company	95
3	State Grid Shijiazhuang County Power Supply Company	94
4	State Grid Shenzhou County Power Supply Company	89
5	State Grid, new Dingzhou power supply	87
6	State Grid Taocheng District Zhaoquan Park Power Supply Station	86
7	State Grid, Bohai Sea New Area Power Supply Company	84
8	State Grid Longyao County Yamaguchi Power Station	83
9	State Grid Xian County Nanhetou power supply station	81
10	State Grid Luquan Miyama power supply	79

Fig. 2 The weight of evaluation index and the score of each unit

2. Related work

In order to construct and apply the digital model assessment system, this paper adopts the expert Brainstorming to determine the assessment indicators and the entropy weight method to determine the weights of the indicators[4], third, Fuzzy Comprehensive Evaluation method is used to evaluate the demonstration units[5].

In terms of evaluation indicators, since the digitized demonstration was first carried out by Hebei electric power of the state grid and there was no previous relevant experience, experts were organized to brainstorm, in order to give full play to each expert's expertise, draw on the evaluation experience of other projects, cover more indicators, and achieve more reasonable evaluation indicators.

In the aspect of index weight, the entropy method is used to ensure that the index weight is more objective and less subjective. Compared with other evaluation work, the entropy weight method can deeply reflect the distinguishing ability of the index and determine the better weight.

As for the evaluation of the demonstration units, compared with other evaluation work, the fuzzy comprehensive evaluation method can deal with the fuzzy evaluation objects by precise digital means, the second is that the evaluation result is a vector, not a point value, which contains abundant information, and the second is that the evaluation result is a vector, not a point value, it can not only describe the evaluated object accurately, but also further process and get reference information.

3. Method

3.1. Brain storming method

(1) Introduction to the method

Brain storming is a method pioneered by Alex Osborne of the American advertising agency BBDO. The method consists of discussions and talks in the form of meetings between value engineering teams in a normal and unrestricted atmosphere, where people think outside the box, think positively, speak freely and express their views fully.

(2) Success Points

Free Talk: participants should not be subject to any rules and regulations, to relax the mind, let the mind free gallop. From different angles, different levels, different directions, boldly expand imagination, as far as possible landmarks innovative, distinctive, original ideas.

Delayed judgement: The brainstorming process must adhere to the principle of not evaluating any ideas on the spot. It is important not to confirm an idea, nor to reject it, nor to comment on it. All evaluations and judgements must be deferred until the end of the session. This is partly to prevent judgements from restraining the active thinking of the participants and spoiling the favourable atmosphere for free and open discussion, and partly to concentrate on developing ideas first and to avoid bringing forward work that should be done at a later stage, which could affect the production of a large number of creative ideas.

No criticism: The absolute prohibition of criticism is an important principle to be followed in brainstorming. No one participating in a brainstorming session should criticise anyone else's ideas, as criticism can certainly have a dampening effect on creative thinking. Self-criticism by the speakers is also forbidden. Some people have a tendency to use self-effacing remarks that are also self-critical in nature, which can spoil the atmosphere and affect the free flow of ideas.

Aim for quantity: The goal of a brainstorming session is to get as many ideas as possible, and aiming for quantity is its priority. Everyone in the session should take the time to think and come up with as many ideas as possible. The quality of the ideas can be left to the post-conference idea processing phase. In a sense, the quality of ideas is closely linked to the quantity, and the more ideas that are generated, the more creative ideas are likely to be included.

3.2. entropy weight method

(1) Introduction to the method

Entropy weighting, a physical term, is explained by the basic principles of information theory, where information is a measure of the degree of order in a system and entropy is a measure of the degree of disorder in a system; according to the definition of information entropy, for a certain indicator, the entropy value can be used to determine the degree of dispersion of a certain indicator, the smaller the value of its information entropy, the greater the degree of dispersion of the indicator, the greater the influence (i.e. weight) of the indicator on the comprehensive evaluation, and if the values of a certain indicator If all the values of an indicator are equal, the indicator does not play a role in the comprehensive evaluation. Therefore, information entropy can be used as a tool to calculate the weight of each indicator and provide a basis for the comprehensive evaluation of multiple indicators.

(2) Calculation steps

1) Constructing the original data matrix

Suppose there are M evaluation objects, each M corresponds to N evaluation indicators, build out the original data matrix $A = (a_{ij})_{m \times n}$, a_{ij} denotes the value of the j th indicator under the i th evaluation object.

2) Normalising raw matrix data

In performance evaluation, evaluation indicators are generally divided into two main categories, which are benefit-type indicators and cost-type indicators. For different indicators, the corresponding types of data standardization should be carried out to obtain the normalized matrix $B = (b_{ij})_{m \times n}$, where：

For positive indicators (benefit-based indicators)：

$$b_{ij} = \frac{a_{ij} - a_j^{\min}}{a_j^{\max} - a_j^{\min}} \tag{1}$$

For negative indicators (cost-based indicators)：

$$b_{ij} = \frac{a_j^{\max} - a_{ij}}{a_j^{\max} - a_j^{\min}} \tag{2}$$

(Note: To ensure that the values are valid, a further valid value of 0.0001 is added to each value after dimensionlessisation)

3) Calculate the contribution of the i th unit under the j th indicator under the entropy weighting method:

$$p_{ij} = \frac{b_{ij}}{\sum_{i=1}^{n} b_{ij}} \tag{3}$$

4) Calculate the entropy value of the j th indicator under the entropy weighting method:

$$e_j = -\frac{1}{\ln n} \sum_{i=1}^{n} p_{ij} \ln p_{ij} \tag{4}$$

5) Calculation of the variability factor under the entropy method: $g_j = 1 - e_j$

6) Determining the weights of evaluation indicators under the entropy weighting method ω_j:

$$\omega_j = \frac{g_j}{\sum_{j=1}^{m} g_j} \tag{5}$$

3.3. Fuzzy integrated evaluation method

(1) Introduction to the method

The fuzzy comprehensive evaluation method is based on fuzzy mathematics and uses the principle of synthesis of fuzzy relationships to quantify factors that are difficult to quantify and to make a comprehensive evaluation of the subordinate rank status of the thing being evaluated.

(2) Calculation steps

1) Determining the set of evaluation indicators, evaluation set

Indicator set $U = \{U_1, U_2, ..., U_m\}$ (m is the number of evaluation indicators)

Evaluation set $V = \{V_1, V_2, ..., V_n\}$ (n is the number of evaluation levels)

2) Determine the weighting of each indicator

Set of indicator weights for each dimension

$$W = \{w_1, w_2, ..., w_m\}, \sum_{i=1}^{m} w_i = 1$$

3) Constructing a fuzzy relationship matrix of evaluation indicators

$$R_i = (r_{ij}), i = 1, 2, ..., m; j = 1, 2, ..., n; \sum_{j=1}^{n} r_{ij} = 1 \quad (6)$$

$$R = \begin{pmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{pmatrix} \quad (7)$$

4) Calculating the fuzzy integrated evaluation set

Fuzzy integrated evaluation set $B = W \times R = (b_1, b_2, ..., b_n)$

5) Calculating indicator evaluation values

For the evaluation set B De-fuzzy calculation, evaluation value of each indicator $E = B \times H$ (H For the evaluation set V Points for each level) .

4. Experiments

4.1. Indicator weights

(1) Expert scoring

Five experts were invited to score the indicators of each demonstration unit, and the average score of each indicator of each demonstration unit was calculated, as shown in Table 1.

Table 1 Average scores for each indicator for each demonstration unit

Serial number	Demonstration units	Division of responsibilities	Work Plan	Management and control organization	Regular meetings	Weekly Newsletter	Monthly Report	Progress	Work effectiveness
1	State Grid Zhengding County Power Supply Company	92	90	90	92	91	92	94	92
2	State Grid Xiongan New Area Power	89	88	92	89	89	89	90	90

Serial number	Demonstration units	Division of responsibilities	Work Plan	Management and control organization	Regular meetings	Weekly Newsletter	Monthly Report	Progress	Work effectiveness
	Supply Company								
3	State Grid Shijiazhuang Power Supply Company	89	89	88	91	89	89	87	87
4	State Grid Shenzhou Power Supply Company	83	86	85	83	86	86	84	83
5	State Grid Dingzhou Xinli Power Supply Station	80	87	82	85	80	83	82	82
6	State Grid Taocheng District Zhaohuan Park Power Supply Office	81	85	80	81	82	82	80	83
7	State Grid Bohai New Area Power Supply Company	81	82	80	81	82	82	80	82
8	State Grid Longyao County Shankou Power Supply Station	83	79	80	81	78	80	82	79
9	State Grid Xian County Nanhetou Power Supply Office	79	75	77	80	77	75	76	78
10	State Grid Luquan City Hai Shan Power Supply Station	75	74	79	72	75	75	75	74

(2) Calculation of weights

Based on the scores of each indicator of each demonstration unit, the entropy weighting method was used to calculate the weight of each indicator, and the results are shown in Table 2.

Table 2 Weighting of each indicator

Serial number	Assessment indicators	Weighting
1	Division of responsibilities	0.1
2	Work Plan	0.1
3	Management and control organization	0.1
4	Regular meetings	0.08
5	Weekly Newsletter	0.06
6	Monthly Report	0.06
7	Progress	0.1
8	Work effectiveness	0.4

4.2. Application of the assessment system

(1) Final score for each demonstration unit

Based on the weighting of the indicators and the scores of each indicator of each demonstrationunit, the overall score of each demonstration unit was calculated, as shown in Table 3. And three model pacesetters were identified based on the ranking of the scores of each unit.

Table 3 Final score for each demonstration unit

Indicators	Zhengding	Xiongnu	Shijiazhuang	Shenzhou	Dingzhou	Park House	Bohai	Yamaguchi-sho	South River Head Office	Hai Shan Institute
Division of responsibilities	92	89	89	83	80	81	81	83	79	75
Work Plan	90	88	89	86	87	85	82	79	75	74
Management and control organization	90	92	88	85	82	80	80	80	77	79
Regular meetings	92	89	91	83	85	81	81	81	80	72
Weekly Newsletter	91	89	89	86	80	82	82	78	77	75
Monthly Report	92	89	89	86	83	82	82	80	75	75
Progress	94	90	87	84	82	80	80	82	76	75
Work effectiveness	92	90	87	83	82	83	82	79	78	74
Other results	2	2	2	1	2	2	1	1	2	1
Typical experience	2	2	1	1	1	1	1	1	1	1
Publicity	2	1	2	2	1	1	1	1	1	2
Final score	98	95	94	89	87	86	84	83	81	79

(2) Model pacesetter units

Based on the score ranking of each demonstration unit, State Grid Zhengding County Power Supply Company, State Grid Xiongan New Area Power Supply Company and State Grid Shijiazhuang Power Supply Company were finally identified as the model pacesetters.

5. Conclusion

In order to promote the digital transformation of power grid enterprises, State Grid Hebei Power selected 10 units to carry out digital demonstration in accordance with the overall requirements of the State Grid Corporation, aiming to select a number of practical and effective, replicable and replicable digital transformation models. In this paper, by constructing a digital demonstration evaluation system and carrying out application, three demonstration pacesetters were finally identified, providing reference experience for digital transformation of other units.

To carry out the application of digital demonstration evaluation system, first, quantify the value of the achievements of each demonstration unit, and provide direction for determining the digital transformation of power grid enterprises; The second is to select excellent demonstration units, promote typical practices and improve the overall digital level of power grid enterprises.

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