Research on Efficiency And Benefit Evaluation of Newly-Added Investment Assets of Power Grid Company After Investment Interface Extension

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Abstract. Evaluating the efficiency and benefit of the newly added investment assets after the extension of the investment interface of the power grid company not only helps to know whether the expected target of the newly increased investment has been achieved and whether the main efficiency and benefit indicators have been achieved, but also helps to sum up experience and lessons for It provides important support for scientific decision-making of new investment in the future. Through literature research and expert consultation, a list of efficiency and benefit evaluation indicators for newly added investment assets after the extension of the investment interface of power grid companies is established. Then, using the questionnaire survey and quantitative statistics method, the indicators were screened, and the newly added investment assets efficiency and benefit evaluation indicator system was formed. The expert evaluation method and the fuzzy comprehensive evaluation method are used to establish the EEM-FUZZY model for the efficiency and benefit evaluation of the newly added investment assets. The efficiency and effectiveness of the invested assets are accurately evaluated, respectively. At the end of the paper, an empirical study is carried out, and the research shows that the EEM-FUZZY model is reliable, simple and practical, and easy to implement by computer, which improves the effectiveness and timeliness of the newly added investment assets evaluation.

Keywords: newly added investment assets, investment interface extension, EEM—FUZZY model, efficiency and benefit evaluation

1 Introduction

In recent years, Power Grid Corporation of China has actively changed its development strategy, innovated traditional management mode, and vigorously promoted the extension of investment interface based on customer demand[1]. Through the extension of the investment interface, the power grid company has promoted the development of marketing strategies and business expansion projects from the aspects of services and infrastructure, while improving customer satisfaction, optimizing the investment environment, and effectively promoting the development of social economy[2].

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With the expansion of the newly increased investment scale after the extension of the investment interface of power grid companies, the newly added investment assets are increasing year by year, which makes the newly added investment face great challenges. While focusing on the quality and progress of the newly added investment projects, how to improve the management level of the newly increased investment decision-making has become a major content of investment management[3]. Evaluating the efficiency and benefit of the newly added investment assets after the investment interface extension of the power grid company not only helps to know whether the expected target of the newly increased investment has been achieved and whether the main efficiency and benefit indicators have been achieved, but also helps to sum up experience and lessons, and provides important support for scientific decision-making of new investment in the future[4].

At present, China Power Grid Corporation has realized the importance of evaluating the newly added investment assets. Provincial power grid companies have successively evaluated the newly added investment assets after the extension of the investment interface, but the following deficiencies exist in the evaluation[5-6]: First, the evaluation of the newly added investment assets is not well understood; Second, the evaluation indicators are relatively single, not scientific enough; Third, the evaluation method is more subjective and less objective. Based on this, this paper uses literature research, expert consultation method, questionnaire survey and quantitative statistics method to reconstruct the evaluation indicator of newly added investment assets. Then, the EEM-FUZZY model is established by combining expert evaluation method (EEM for short) and fuzzy comparative evaluation method (FUZZY for short), and an empirical study is carried out. Research shows that the model can not only reflect the overall efficiency and benefit of newly added investment assets, but also accurately evaluate the efficiency and benefit of newly added investment assets respectively.

2 Indicator system of newly added investment assets

2.1 Construction principles of evaluation indicator system

After the extension of the investment interface, it is a complicated task to construct the evaluation indicator system of the newly added investment assets, which requires that the designed indicators can accurately, comprehensively and effectively reflect the efficiency or benefit of the newly added investment assets. Therefore, various factors should be comprehensively considered when constructing the newly added evaluation indicator system of investment assets. At the same time, it is necessary to follow the corresponding principles to ensure that the evaluation indicator system is scientific and comprehensive.

(1) The principle of systematism. When constructing the indicator system, the balance and coordination between multiple factors should be considered comprehensively, so that the indicator system must be able to comprehensively and objectively reflect the efficiency and benefit of newly added investment assets.

(2) The principle of conciseness and scientificity. The evaluation indicators should not be too many or too detailed, nor too few or too coarse. When constructing the indicator system, strive to be complete and keep an appropriate balance between simplicity and complexity.

(3) The principle of mutual independence. Indicators in the indicator system, especially at the

same level, should be relatively independent and not cross-related, otherwise duplication will occur, directly affecting the objectivity of the evaluation results.

(4) The principle of measurability. The data of evaluation Indicators should be easily collected and simple to calculate. If the data of evaluation indicators is difficult to collect, it will affect the evaluation efficiency and evaluation results.

2.2 Construction process of evaluation indicator system

2.2.1 Establishing the list of evaluation indicators

At present, many scholars at home and abroad have studied the efficiency evaluation indicators of power grid investment projects[7-8]. Meanwhile, many scholars have studied the benefit evaluation indicators of power grid investment projects[9-10]. With the help of these literatures[11-14], a list of efficiency and benefit evaluation indicators of newly added investment assets of power grid company is established preliminarily. Then, according to the literature[15], the preliminary list of indicators was revised; On this basis, 9 project evaluation experts and 7 project managers of power grid enterprises were consulted, and the indicators were revised again according to their opinions, thus forming a formal list of evaluation indicators.

2.2.2 Conducting the questionnaire survey

The "Questionnaire on the Importance of Efficiency and Benefit Evaluation Indicators of newly added investment Assets of Power Grid Company" is designed, and the importance of evaluation indicators is divided into five levels: unimportant, somewhat important, important, very important, and extremely important. A total of 15 experts in related fields are invited to rate the importance of each evaluation indicator.

2.2.3 Screening the evaluation indicators

Making statistics on the scoring of the importance of each evaluation indicator, and then the quantitative statistical method is used to screen the evaluation indicators. When it comes to the importance of the *j-th* evaluation indicator, assuming there are a_1, a_2, a_3, a_4, and a_5 experts respectively rating this indicator as unimportant, somewhat important, important, very important, and extremely important accordingly, which means that the proportion of this indicator considered unimportant, somewhat important, important, very important, and extremely important is $a_1/15$, $a_2/15$, $a_3/15$, $a_4/15$, and $a_5/15$ respectively. a_1, a_2, a_3, a_4, and a_5 are hired to represent the number of experts, and the sum of them is 15. Then, with 67% as the threshold, if the cumulative proportion of the indicator considered important, unimportant, or particularly important is less than 67%, it will be deleted, otherwise, it will be retained.

2.2.4 Categorizing the evaluation indicators

According to the nature of evaluation indicators, the selected evaluation indicators are classified into two categories: efficiency indicators and benefit indicators. Among them, efficiency indicators are used to reflect the effectiveness and adequacy of asset utilization, and benefit indicators are used to reflect the value generated by assets, including economic value and social value.

2.3 Construction result of evaluation indicator system

Following the principles and process of constructing the indicators of newly added investment assets, the evaluation indicator system of the newly added investment assets is finally formed. The indicator system includes two primary indicators, namely the efficiency of newly increased investment assets and the benefit of newly increased investment assets. The indicator system includes 15 secondary indicators, which are the N-1 passing rate of power grid equipment, the capacity-to-load ratio of power grid, the Average load rate of newly added lines, the average load rate of newly added main transformers, the accident rate of newly added lines and equipment, voltage qualification rate, market share, composite line loss rate, annual electricity sales, overall labor productivity and so on. These indicators are described in Table 1.

Table 1. Efficiency and benefit evaluation indicator system of newly added assets of power grid company

Target	Primary indicators	Secondary indicators
Efficiency and benefit evaluation of newly added assets of power grid company	Efficiency of newly added investment assets	N-1 passing rate of power grid equipment x_{11}
		Capacity-to-load ratio of power grid x_{12}
		Average load rate of newly added lines x_{13}
		Average load rate of newly added main transformers x_{14}
		Accident rate of newly added lines and equipment x_{15}
		Voltage qualification rate x_{16}
		Market share x_{17}
		Composite line loss rate x_{18}
		Proportion of electric energy in terminal energy consumption x_{19}
	Benefit of newly added investment assets	Annual electricity sales x_{21}
		Additional electricity supply per unit of newly added investment x_{22}
		Overall labor productivity x_{23}
		Return on equity x_{24}
		Rate of return on total assets x_{25}
		Socio-economic contribution rate x_{26}

3 EEM-FUZZY model for efficiency and benefit evaluation of newly added investment assets

Combined expert evaluation method (EEM) and fuzzy method (FUZZY), the EEM-FUZZY model for efficiency and benefit evaluation of newly added investment assets is established. Specifically, in this model, the EEM is adopted to determine the weights of evaluation indicators first, and then the FUZZY is adopted to evaluate the newly added investment assets.

3.1 Overview of relevant methods

3.1.1 Expert evaluation method

Expert evaluation method (EEM) is the most common method in statistics, which features simple, practical and easy to calculate[16]. The steps to determine the weights of evaluation indicators using the EEM are as follows.

First, a number of experts are invited to rate the importance of the first-level indicators to the evaluation object; At the same time, the importance of the second-level indicator to the first-level indicator is scored, with the scoring range ranging from 1 to 10 points (the higher the score of an indicator, the more important it is.)

Second, the average score of the expert scores for each first-level indicator is calculated and the average scores of all first-level indicators are normalized. As a result, the normalized value is the weight of the first-level indicator correspondingly.

Third, similarly, the average score of each second-level indicator under each first-level indicator is calculated and normalized. The normalized value correspondingly is the weight of the second-level indicator under the first-level indicator.

Fourth, the comprehensive weights of all second-level indicators can be obtained by multiplying the weights of the first-level indicators by their corresponding second-level indicators.

3.1.2 Fuzzy comparative evaluation method

In 1965, L.A. Zadeh proposed the concept of Fuzzy Sets, which used mathematical methods to express the fuzziness and uncertainty of transactions[17]. Subsequently, many scholars have applied fuzzy sets to the evaluation of problems that are difficult to quantify, and formed the fuzzy evaluation method[18]. The main steps of the fuzzy comprehensive evaluation method are as follows:

First, determine the factor set of the evaluated object, $U = \{u_1, u_2, \cdots, u_n\}$.At the same time, determine the grade set of the evaluated object, $V = \{v_1, v_2, \cdots, v_m\}$.

Second, determine the weight of each factor of the evaluated object to obtain a factor weight set, $A = \{a_1, a_2, \cdots, a_n\}$. a_i represents the weight of the factor u_i, i=1, 2,…, n.

Third, construct the comprehensive evaluation matrix between the evaluation factor set and the grade set. The comprehensive evaluation matrix is denoted by R.

$$R = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1m} \\ r_{21} & r_{22} & \cdots & r_{2m} \\ \vdots & \vdots & & \vdots \\ r_{n1} & r_{n2} & \cdots & r_{nm} \end{bmatrix} \quad . \tag{1}$$

Where, $r_{ij} = \eta(u_i, v_j)$ $(0 \leqslant r_{ij} \leqslant 1)$, indicating the degree of membership of the factor u_i evaluated as v_j; In the matrix, the ith row $R_i=(r_{i1}, r_{i2},..., r_{in})$ is a single factor evaluation of the i-th evaluation factor u_i, which is a fuzzy subset on V.

Fourth, comprehensive evaluation. Calculate $B = A \circ R$, then make a judgment based on the principle of maximum membership.

3.2 Establishing the EEM-FUZZY model

The EEM-FUZZY model for efficiency and benefit evaluation of newly added assets is established as follows by combining EEM and FUZZY methods. The model is constructed as follows.

(1) Establishing the efficiency and benefit evaluation indicator system of the newly added assets of power grid company, and adopting the EEM to determine the evaluation indicators' weights.

(2) Determining the evaluation grades of the efficiency and benefit of the newly added investment assets and constructing the set of comments (evaluation grades).

(3) Applying the membership function to calculate the membership degree between the actual value of each indicator and the comment set, which constitutes the fuzzy comprehensive evaluation matrix.

(4) Determining the evaluation indicator weight vector, and calculating the corresponding fuzzy vector according to the indicator weight vector and fuzzy comprehensive evaluation matrix.

(5) Determining the evaluation level of each first-level indicator and the comprehensive level of the evaluation object according to the principle of maximum membership degree.

4 Empirical study

ZY Company is held by SC Provincial Power Company, whose main businesses are grid planning, construction, operation and power supply. The company now has 7 functional departments, 3 business support and implementation agencies, 15 township power supply stations. At present, the company has a total of 792 employees, a supply area of 1,563.5 square kilometers, and a service population of about 1.02 million. In recent years, ZY company has actively carried out the work of investment interface extension. In 2020, 13 new investment projects have been added and more than 80 million yuan has been added to the investment. The EEM-FUZZY model was used to evaluate the efficiency and benefit of ZY's newly increased investment assets in 2020.

4.1 Determining the weights of indicators with the EEM

The expert evaluation method (EEM) was adopted to determine the weights of indicators for the efficiency and benefit evaluation of the newly added investment assets of power grid company. The specific process is as follows.

Fifteen experts in related fields were invited to rate the importance of the primary indicators in Table 1; At the same time, the importance of secondary indicators to primary indicators was scored, with the scoring range between 1 and 10 points. The evaluation results of experts were collected, and the weight vectors of evaluation indicators were calculated using the expert evaluation method. The weight vectors of evaluation indicators are shown in Table 2.

Table 2. Weight vectors of indicators

Weight vector of first-level indicators	$W = (0.5026 \ \ 0.4974)$
Weight vector of efficiency indicators of newly added investment assets	$W_1 = (0.1397 \ \ 0.1213 \ \ 0.1195 \ \ 0.1195 \ \ 0.1176 \ \ 0.1066 \ \ 0.1048 \ \ 0.0919 \ \ 0.0790)$
Weight vector of benefit indicators of newly added investment assets	$W_2 = (0.1288 \ \ 0.1564 \ \ 0.1748 \ \ 0.1626 \ \ 0.1810 \ \ 0.1963)$

4.2 Efficiency and benefit evaluation of newly added assets

4.2.1 Classifying the evaluation grades of the newly added assets

The efficiency and benefit evaluation grades of newly added investment assets of power grid company were divided into five levels[19], which are: excellent (A), good (B), medium (C), low (D), and poor (E). Here, they are taken as the comments set V for efficiency and benefit evaluation, then $V = \{A, B, C, D, E\} = \{excellent, \ good, \ medium, low, \ poor\}$. Scores of efficiency and benefit evaluation indicators of newly added investment assets of the power grid company are given by experts, and the scoring criteria corresponding with the comments set V are shown in Table 3. For example, if an expert rates the evaluation indicator x_{ij} as grade A, then this indicator will be scored between 90 and 100. The higher the score of an evaluation indicator, the greater its contribution to the efficiency and benefit of the newly added assets.

Table 3. Grading of evaluation indicators

Evaluation grades V	**A**	**B**	**C**	**D**	**E**
Scoring interval	(90,100]	(80,90]	(70,80]	(60,70]	[0,60]

4.2.2 Calculating the membership degree of second-level indicators

The actual data of the efficiency and benefit evaluation indicators of investment assets newly added by ZY Company in 2020 was collected and 10 experts in related fields were invited to score the efficiency and benefit evaluation indicator x_{ij} of investment assets newly added by ZY Company in 2020 by referring to the average value of indicator x_{ij} of the power grid industry in recent three years. Based on expert scoring results, the frequency of evaluation indicator x_{ij} at different evaluation grades was obtained, as shown in Table 4.

Table 4. Efficiency and benefit evaluation indicators of newly added investment assets of ZY company and membership degree

First-level indicators	**Second-level indicators**	**Excellent (A)**	**Good (B)**	**Medium (C)**	**Low (D)**	**Poor (E)**
Efficiency of newly added investment assets	x_{11}	2	6	2	0	0
	x_{12}	2	5	3	0	0
	x_{13}	1	4	5	0	0
	x_{14}	1	3	4	2	0

	x_{15}	0	4	4	1	1
	x_{16}	6	3	1	0	0
	x_{17}	3	5	1	1	0
	x_{18}	3	4	2	1	0
	x_{19}	3	5	1	1	0
Benefit of newly added investment assets	x_{21}	2	6	1	1	0
	x_{22}	1	5	3	1	0
	x_{23}	0	1	3	5	1
	x_{24}	1	1	5	2	1
	x_{25}	1	1	6	1	1
	x_{26}	3	3	2	2	0

The values in Table 4 are frequency distribution values. For example, "1, 1, 6, 1, 1" in the "rate of return on total assets" (indicator x_{25}) respectively means that one of the 10 experts who participated in the scoring gave this indicator more than 90 points, one expert scored it between 80 and 90 points, six experts scored it between 70 and 80 points, one expert scored it between 60 and 70 points, and one expert scored it below 60 points.

4.2.3 Constructing the fuzzy evaluation matrices of first-level indicators

The ratio of the frequency to the number of experts was taken as the membership degree of indicator x_{ij} to grade V_t. Based on the data in Table 4, the fuzzy evaluation matrices of the first-level indicators were constructed.

The fuzzy matrix of first-level indicators of the efficiency of newly added assets was constructed as:

$$R_1 = \begin{pmatrix} 0.2 & 0.6 & 0.2 & 0.0 & 0.0 \\ 0.2 & 0.5 & 0.3 & 0.0 & 0.0 \\ 0.1 & 0.4 & 0.5 & 0.0 & 0.0 \\ 0.1 & 0.3 & 0.4 & 0.2 & 0.0 \\ 0.0 & 0.4 & 0.4 & 0.1 & 0.1 \\ 0.6 & 0.3 & 0.1 & 0.0 & 0.0 \\ 0.3 & 0.5 & 0.1 & 0.1 & 0.0 \\ 0.3 & 0.4 & 0.2 & 0.1 & 0.0 \\ 0.3 & 0.5 & 0.1 & 0.1 & 0.0 \end{pmatrix} \tag{2}$$

The fuzzy matrix of first-level benefit indicators of the benefit of newly added investment assets was constructed as:

$$R_2 = \begin{pmatrix} 0.2 & 0.6 & 0.1 & 0.1 & 0.0 \\ 0.1 & 0.5 & 0.3 & 0.1 & 0.0 \\ 0.0 & 0.1 & 0.3 & 0.5 & 0.1 \\ 0.1 & 0.1 & 0.5 & 0.2 & 0.1 \\ 0.1 & 0.1 & 0.6 & 0.1 & 0.1 \\ 0.3 & 0.3 & 0.2 & 0.2 & 0.0 \end{pmatrix}. \quad (3)$$

4.2.4 Conducting Fuzzy comparative evaluation

In the above paper, the EEM was adopted to obtain the weight vectors of second-level indicators of the newly added investment assets efficiency and benefit of ZY Company respectively as:

$$W_1 = (0.1397 \quad 0.1213 \quad 0.1195 \quad 0.1195 \quad 0.1176 \quad 0.1066 \quad 0.1048 \quad 0.0919 \quad 0.0790) \quad (4)$$

$$W_2 = (0.1288 \quad 0.1564 \quad 0.1748 \quad 0.1626 \quad 0.1810 \quad 0.1963) \quad (5)$$

Then, the fuzzy evaluation vectors of newly added investment assets efficiency and benefit were as follows orderly:

$$B_1 = W_1 * R_1 = (0.2228 \quad 0.4358 \quad 0.2663 \quad 0.0632 \quad 0.0118) \quad (6)$$

$$B_2 = W_2 * R_2 = (0.1347 \quad 0.2662 \quad 0.3414 \quad 0.2058 \quad 0.0518) \quad (7)$$

In accordance with the principle of maximum membership, it can be seen that the evaluation grade of the newly added investment assets efficiency of ZY Company is “good” and the evaluation grade of the newly added investment assets benefit of ZY Company is “medium”.

After evaluating the two first-level evaluation indicators of the newly added investment assets of ZY company, the comprehensive evaluation matrix $A = (B_1, B_2)^T$ was obtained. Let W be the weight vector of the two first-level evaluation indicators of the newly added investment assets of ZY Company, which can be calculated as $W = (0.5026, 0.4974)$ by using the EEM above. Then the efficiency and benefit comprehensive evaluation result of the newly added investment assets in ZY Company was as:

$$\begin{aligned} H = W * A &= (0.5026 \quad 0.4974) * \begin{pmatrix} 0.2228 & 0.4358 & 0.2663 & 0.0632 & 0.0118 \\ 0.1347 & 0.2662 & 0.3414 & 0.2058 & 0.0518 \end{pmatrix} \\ &= (0.1789 \quad 0.3514 \quad 0.3037 \quad 0.1341 \quad 0.0317) \end{aligned} \quad (8)$$

By the principle of maximum membership, it can be seen that the evaluation grade is “good”, that is, the comprehensive efficiency and benefit of the newly added investment assets of ZY Company is at grade B.

5 Conclusions

In this paper, the EEM and FUZZY methods are combined to establish the EEM-FUZZY model. The EEM-FUZZY model has the following characteristics:

(1) This model can reflect the state of efficiency and benefit of newly added investment assets of power companies, and can objectively conduct a comprehensive evaluation of the efficiency and benefit of newly added investment assets of power grid companies.

(2) The numerical values of the parameters required by the model are easy to collect, and the calculation is concise and convenient for practical operation. The calculation process of this model is easy to be realized on the computer, so as to improve the efficiency of the evaluation of the newly added investment assets of power grid companies.

(3) This model can not only provide a decision-making reference for ZY Company to add new investments, but also provide guidance for other power companies to evaluate investment projects.

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References

[1] Lin X.: Optimization of business expansion workflow. China Power Enterprise Management. (29), pp. 82-83 (2019).
[2] Guo M.: Deepening the application of the whole process of business expansion to help optimize the power business environment. Popular Utilization of Electricity. 34(10), pp. 11-12 (2019).
[3] Lin X.: Analysis of existing problems and countermeasures in the management of power expansion project under the background of modernization. Science and Informatization. (34), pp. 137-139 (2017)
[4] Chen K.: Analysis of existing problems and countermeasures in power expansion project management. Science and Informatization. (21), pp. 174-179 (2018)
[5] Lu X, and Li S.: Research on service management optimization of power marketing industry expansion. Popular Utilization of Electricity. 34(10), pp. 13-14 (2019).
[6] Ni X.: Problems and countermeasures in the expansion project of power key customers. Technology and Economic Guide. (17), pp. 77-78 (2021).
[7] Mandelli Stefano, Colombo Emanuela, Redondi Andrea, et al.: A small-hydro plant model for feasibility analysis of electrification projects in Rural Tanzania. Proceedings of the 3rd IEEE Global Humanitarian Technology Conference. pp. 11-16(2013).
[8]Verdelho M.I.R.F., Carvalho P.M.S., Santana J.J.E., Ferreira L.A.F.M.: Practical implementation of scenario generation-based risk analysis of electrical grids investment projects. International Journal of Risk Assessment and Management. 19 (4) , pp.331-345(2016).
[9] Yang H, Li T, Xiong N, Zhang Y, and Ling Z.: A new post-evaluation system for urban distribution network construction projects based on whole process control. Journal of Nanchang University (Natural Science). 42(3), pp. 283-288 (2018).
[10] Dong S, Li B, Chen D, and Zhao M.: Key points of post-evaluation on environmental benefit of medium and low voltage distribution network projects. Rural Electrification. (12), pp. 22-23 (2018).

[11] Hu W, Zhong B, and Fang Z.: Establishment of post-investment evaluation system for low-voltage industry expansion supporting projects. Power and Energy. 41(2), pp. 271-275 (2020).
[12] P. Bahramian, Glenn P. Jenkins, and F. Milne.: A stakeholder analysis of investments in wind power electricity generation in Ontario. Energy Economics. 103, pp. 1-9 (2021).
[13] Fang X, Liu P, and He H.: Research on risk investment evaluation indicators of emerging projects: based on fuzzy comprehensive evaluation method. Science and Technology Management Research. 40(15), pp. 65-70 (2020).
[14]Hinestroza Olascuaga LM, Carvalho PMS, de Jesus CMSC: Lowering risk intolerance to unlock private investments in renewable energy-based rural electrification. Energy for Sustainable Development. Vol. 74, pp. 258-268(2023).
[15] STATE GRID Corporation of China.: Management regulations for post-evaluation of fixed asset investment projects of State Grid Corporation of China. http://www.sgcc.com.cn/html/sgcc_main/.
[16] Li X, and Liu X.: Applied Statistics. Publishing House of Electronics Industry. China (2018).
[17] Li B.: Research on financial risk evaluation of real estate Company A based on fuzzy comprehensive evaluation method. Master's degree thesis. Xi'an Shiyou University, China (2020).
[18] Li X, Zhu X, Liao Q, and Sun H.: Evaluation of power transmission and transformation projects using fuzzy multi-layer models. International Journal of Simulation: Systems, Science and Technology. 17(47), pp. 211-216 (2016).
[19] Yao Y.: Research on performance evaluation of distribution network investment projects of power grid enterprises: a case study of R city distribution network project. Master's degree thesis. Capital University of Economics and Business, China (2020).