Research on Multi-dimensional Sensitivity Economic Evaluation Method of Digital Technology in Power Grid Enterprises

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Abstract. The participation of power grid enterprises is essential to meet the requirements of new energy reform for carbon neutralization. Aiming at the multi-dimensional sensitivity of power grid enterprises, this paper proposes a digital technical and economic analysis model for power business needs and a digital benefit technical and economic evaluation method based on multi-dimensional index sensitivity analysis, which can meet the requirements of safe and stable operation of power grid, intelligent operation management of enterprises, construction of energy Internet ecosystem, economic accounting of energy Internet industry Driving the demand for the benefit evaluation of digital construction from the aspects of integration economic impact, innovating the production mode of power grid enterprises and the construction of energy Internet service system has important practical significance to improve the economic benefits of power grid enterprises, so as to provide an economic evaluation method for realizing carbon peak.

Keywords: Economic evaluation · Sensitivity analysis · Digital technology

1 Introduction

The digital platform will play a great role in the future energy system. The automatic control system, management system, market system, settlement system and operating system of "net + grid + net" and "source network load storage integration" of smart energy in the future will change the existing digital mode. The establishment of the new system requires strong enterprise informatization and digital platform cooperation, as well as the establishment of new digital system, data platform and mathematical model. However, at present, the research on technical and economic evaluation of digital construction benefits of power grid enterprises is still blank. In recent years, companies in the global power industry are undergoing digital transformation. At present, there are many research work related to digital construction, but the technical and economic evaluation research on the benefits of digital construction of power grid enterprises has not been carried out. There is no targeted, quantifiable and systematic benefit evaluation

L. C. Jain et al. (Eds.): ICWCA 2021, SIST 307, pp. 60–67, 2022.
https://doi.org/10.1007/978-981-19-3486-5_7

method and technical and economic evaluation model. There is no forward-looking research on quantifiable technical and economic evaluation of the digital construction effect of power grid enterprises to adapt to different application scenarios, no scientific and complete benefit evaluation index system required for the benefit evaluation of enterprise digital construction has been established, and there is a lack of quantifiable dynamic evaluation control methods.

Therefore, based on the research on the economic benefit optimization of power grid digital construction project, this paper introduces the design idea of technical and economic evaluation methods such as sensitivity analysis and quantitative control, comprehensively considers various factors such as digital system and cross domain data reuse, establishes the index system of enterprise digital economic benefit evaluation, and constructs the digital economic benefit evaluation model and analysis model, Further, under the constraints of enterprise digital architecture, the dynamic theory of quantitative control is introduced to establish an intelligent quantitative control analysis model.

2 Digital Technical and Economic Analysis Model for Power Business Demand

2.1 Multi Source Correlation Method for Digital Development of Power Enterprises

Firstly, it analyzes the demand of social development for digital development from the aspects of basic resource operation, power data value-added service and digital platform ecological construction. According to the construction principles of digital architecture flexibility, applicability and sustainability, it designs the hierarchical division mechanism of enterprise level digital architecture, and uses brainstorming method Delphi method creates a multi-source association table between business requirement scenarios and digital architecture [1].

Brainstorming. Use collective thinking to guide everyone participating in the meeting to speak widely around the central topic and stimulate inspiration. Each new idea can arouse the association of others, produce a series of new ideas, produce chain reactions, and form a pile of new ideas, which provides more possibilities for creative problem-solving and give full play to their creative thinking ability to the greatest extent, Express independent opinions freely and collect typical business demand scenarios of digital construction as far as possible.

Delphi Method. Eliminate the influence of authority in a back-to-back way, consult the prediction opinions of the expert group members, after several rounds of consultation, make the prediction opinions of the expert group tend to be concentrated, finally make a prediction conclusion in line with the future development trend, and analyze and build a typical business demand scenario of digital construction facing the new industry, new business form and new business model of energy Internet, The requirement tracking matrix method is used to construct the technical association table of typical business requirement scenarios.

Secondly, based on the abstract expression of enterprise business process and digital system facilities, the enterprise level digital architecture scheme is designed by combining work breakdown structure and business process reengineering method according to the needs of enterprise digital socio-economic development, industry and enterprise under the new industry, new business format and new business flow of energy Internet. Then, the value engineering method is used to complete the preliminary screening of digital planning scheme, the digital project economic benefit evaluation technology based on sensitivity analysis is used to complete the financial test of digital planning scheme, and the digital benefit technical and economic evaluation model based on multi-dimensional index sensitivity analysis is used to complete the comprehensive evaluation of digital planning scheme [2]. The model realizes business demand scenario - Technical and economic analysis rules - Technical and economic evaluation model - new industry, new business form, new business model variable factors - digital technical and economic evaluation model information integration and fusion technology.

2.2 Technical and Economic Analysis Flow of Multi-source Correlation Between Power Business Demand Scenario and Digital Architecture

Based on the abstract description of enterprise business process and digital system facilities, the enterprise level digital architecture scheme is designed by combining work breakdown structure and business process reengineering method according to the needs of enterprise digital socio-economic development, industry and enterprise under the new industry, new business format and new business model of energy Internet for carbon neutralization. Then, the value engineering method is used to complete the preliminary screening of digital planning scheme, the digital project economic benefit evaluation technology based on sensitivity analysis is used to complete the financial test of digital planning scheme, and the digital benefit technical and economic evaluation model based on multi-dimensional index sensitivity analysis is used to complete the comprehensive evaluation of digital planning scheme. The model realizes the business demand scenario - Technical and economic analysis rules - Technical and economic evaluation model - new industry, new format, new business model variable factors - digital technical and economic evaluation model information integration technology, and uses the model to carry out technical and economic analysis [3].

The process of technical and economic analysis method of digital project associated with economic business demand scenario and digital architecture is shown in Fig. 1.

The technical and economic analysis method of digital project with multi-source correlation between business demand scenario and digital architecture proposed in this paper innovatively studies the correlation between business demand scenario - Technical and economic analysis rules - Enterprise Digital Architecture - digital planning, and constructs a digital benefit analysis model with multi-source correlation between business demand scenario and digital architecture based on variable factor integration According to different business scenarios such as power data value-added service and digital platform ecological construction, dynamic adjustment of technical and economic evaluation indicators and weights can more accurately complete the digital economic benefit evaluation of power grid enterprises [4].

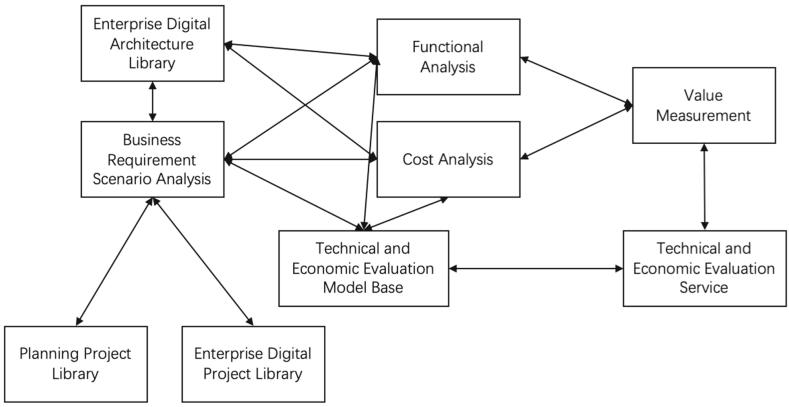

Fig. 1. Flow chart of technical and economic analysis method of digital project related to business demand scenario and digital architecture.

3 Technical and Economic Evaluation Method of Digital Benefits Based on Multi-dimensional Index Sensitivity Analysis

3.1 Multidimensional Index Sensitivity Analysis

Sensitivity analysis refers to the analysis of the impact on financial or economic evaluation indicators when the main uncertain factors of power grid construction projects change, the calculation of sensitivity coefficient and critical point, the identification of sensitive factors, the determination of their sensitivity, and the analysis of the project's bearing capacity when the factor reaches the critical value. It can be divided into single factor sensitivity analysis and multi factor sensitivity analysis [5].

Single Factor Sensitivity Analysis. The so-called single factor sensitivity analysis method refers to the analysis of the impact of the change of a single uncertain factor on the economic effect of the scheme. The general steps are as follows: determine the sensitivity analysis index. Select the uncertain factors to be analyzed. Analyze the fluctuation degree of each uncertain factor and its possible increase or decrease to the analysis index. Identify sensitivity factors. Calculate the critical point of variation factor. Scheme selection.

Multivariate Sensitivity Analysis. Multi factor sensitivity analysis method is to calculate and analyze the impact of two or more uncertain factors on the economic benefit value of the project under the assumption that other uncertain factors remain unchanged, and determine the sensitivity factors and their limit values. Multi factor sensitivity analysis is generally conducted on the basis of single factor sensitivity analysis, and the basic principle of analysis is roughly the same as that of single factor sensitivity analysis. However, it should be noted that multi factor sensitivity analysis must further assume that several factors that change at the same time are independent of each other, and the probability of change of each factor is the same [6].

3.2 Data Basis of Power Grid Digital Technical and Economic Evaluation Model

On the basis of fully collecting massive historical data such as investment amount, performance, technology, function points, economic benefits, data scale, social benefits and environmental benefits of power grid digitization projects, this paper understands the digitization development trend and demand of power grid enterprises, calculates the weight value of evaluation indexes by using subjective and objective weight methods, and obtains the weight range of each index, Then, the Monte Carlo simulation method is used to randomly generate the weight value of the evaluation index, obtain the multi index weight sample set, and realize the optimal decision-making of the digital project according to the sensitivity of the project evaluation results to the weight, so as to complete the construction of the digital technical and economic evaluation model based on multi-dimensional index sensitivity analysis [7].

3.3 Technical and Economic Analysis Model of Multi-source Correlation Between Business Demand Scenario and Digital Architecture

Based on the comprehensive and in-depth analysis of the impact of new energy Internet industries, new business formats and new business models on the enterprise level digital architecture, the hierarchical division mechanism of enterprise level digital architecture is designed, the support planning scheme for the development needs of the digital system construction foundation of power grid enterprises is created, and the value engineering method and the digital project economic benefit evaluation technology based on sensitivity analysis are applied The technical and economic evaluation model of digital benefits based on multi-dimensional index sensitivity analysis completes the construction of technical and economic analysis model related to business demand scenario and digital architecture.

3.4 Technical and Economic Evaluation Method of Digital Benefits Based on Multi-dimensional Index Sensitivity Analysis

Based on the data of digital technology of power grid enterprises, this paper analyzes the functional and technical composition of digital system and identifies the cost-effectiveness of digital system. This paper studies the correlation between digital system and projects in multiple application scenarios, identifies project constraints and judgment standards, and constructs the scheme of power grid digital system and the financial evaluation model of the project, Complete the technical and economic analysis of digital economic benefits of power grid enterprises, carry out the sensitivity analysis of the impact of uncertain factors on the economic benefits of digital projects, and establish the economic benefit evaluation technology of digital projects based on sensitivity analysis.

Firstly, through investigation and interview, system decomposition and intelligent mining technology, this paper analyzes the functional and technical composition of the digital system of power grid enterprises, and comprehensively combs the existing digital system. The system decomposition method is used to refine and decompose the composition of power grid digital system from multi-dimensional, and the support vector

machine and particle swarm optimization algorithm are used to accurately mine the function points of each part. Then, by consulting the software quota, using the functional cost method, service charge price calculation and cost decomposition, the preliminary identification of cost-benefit is completed. Secondly, identify the technical, scale and quality requirements of infrastructure, enterprise platform, business application, value ecology, safety protection and operation guarantee, form the development parameters of digital projects, analyze the independent, interdependent, mutually exclusive and complementary relationship between digital projects, and analyze the financial flow according to the input of digital projects, Formulate project feasibility judgment criteria. Complete the financial evaluation according to the steps of identifying financial costs and benefits, estimating financial costs and benefits, preparing financial statements, calculating financial indicators, etc. For different project types, financial evaluation indicators are selected for analysis and demonstration [8].

Finally, a digital evaluation model based on two-dimensional normal cloud is designed [9], which is used to deal with the uncertain transformation between qualitative concept and quantitative description. Let u be the quantitative domain of the advantages and disadvantages of the benefit evaluation index expressed by accurate numerical value, that is, C is the fuzzy description on u, that is, the primary, intermediate and advanced evaluation of the digital benefit level. If one of the scores x is a random realization in the score U of the overall level of digital benefit, and X is the random number of the stable tendency of C, then x can be called cloud drop, and the distribution of X in the quantitative domain is cloud. The reverse cloud generator is used to realize the transformation from the evaluation score obtained by the evaluation index to the grade division of the evaluation index, and the steps are as follows:

As a cloud drop, the index value of each evaluation index is divided into quantitative value x_i, its membership degree is y_i, and then the expression mode of a cloud drop is (x_i, y_i).

If there are n indicators for evaluation,, calculate the sample mean (1), first-order sample absolute central moment (2) and sample variance (3) of the index score of each evaluation index.

$$\overline{X} = \frac{1}{n}\sum_{i=1}^{n} x_i \tag{1}$$

$$\frac{1}{n}\sum_{i=1}^{n} \left|x_i - \overline{X}\right| \tag{2}$$

$$s^2 = \frac{1}{n-1}\sum_{i=1}^{n} \left(x_i - \overline{X}\right)^2 \tag{3}$$

The sample mean is the expected value E_x, which is the most typical sample from qualitative to quantitative evaluation index.

In combination with the sample mean value, the entropy E_n is obtained by the formula difference (4). Entropy represents the degree of dispersion of index scores, and its value also reflects the value range of index scores that can be accepted by concepts in the universe space.

$$E_n = \left(\frac{\pi}{2}\right)^{\frac{1}{2}} \times \frac{1}{n}\sum_{i=1}^{n}\left|x_i - \overline{X}\right| \tag{4}$$

From the above sample variance and entropy, the super entropy H_e is obtained through formula (5). the greater the super entropy, the greater the dispersion of the evaluation index, and the randomness of the membership degree also increases.

$$H_e = \sqrt{s^2 - E_n^2} \tag{5}$$

The technical and economic analysis and evaluation method of digital economic benefits of power grid enterprises applies the single factor sensitivity analysis and multi factor sensitivity analysis methods to calculate the critical value and sensitivity coefficient of each uncertain factor, analyze and demonstrate the tolerance of digital projects to uncertain factors, Finally, the digital evaluation model based on two-dimensional normal cloud design is used to analyze the super entropy of the influence of uncertain index factors (such as function, technical method, data integration, security protection, performance, infrastructure, construction objectives, operation guarantee, etc.) on the dispersion of digital projects (such as investment, cost, income, life cycle, etc.).

4 Summary

The traditional economic benefits are often based on the economic analysis module of cost and income. Facing the digital economic benefit evaluation scenario of power grid enterprises, this paper studies the digital new technology, new industry, new business form, new business, economy and technology innovation based on fuzzy theory and sensitivity analysis Social coupling relationship and digital economic benefit evaluation method based on multi-dimensional index sensitivity analysis. Compared with the existing technology, the quantitative evaluation model of digital benefits of power grid enterprises based on multi-dimensional index sensitivity analysis in this paper can more accurately complete the economic benefit evaluation of digital technology of power grid enterprises, and provide the methodological basis of economic evaluation for future energy carbon neutralization.

Acknowledgments. This paper was supported by the Science and Technology project in State Grid Corporation of China, which name is 'Research on the evaluation system and technology tools of digital technology and economy of enterprises, No. 5700-202129180A-0-0-00'.

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