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Risk assessment of urban network planning in china based on the matter-element model and extension analysis

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ABSTRACT

The practice of urban power network planning in China is facing more and more complex risks. The nature of the risks themselves is unclear and uncertain. In order to ensure that urban power networks are planned in a scientific manner, a reasonable risk assessment needs to be performed. Based on extension analysis and the matter-element extension theory, a model of risk evaluation designed to be applied to urban power network planning is put forward in this paper. This model has the advantage that it conveniently quantifies the qualitative indices. At the same time, it also overcomes the main limitation of the matter-element method, namely, that if the risk index exceeds the risk grading standard, it can not be calculated using the correlation function. Finally, taking a specific urban power network as an example, the empirical analysis results show that this model is credible and practical.

1. Introduction

Recently, with the development of the market economy, great changes have taken place in the investment environment and conditions. The power grid project in China has many problems such as long cycle, many uncertainty factors, great economic and technical risks, and serious impact on the ecological environment. Urban power network planning has faced more and more risks, especially due to snow, earthquakes and other natural disasters. Also, the impact on the grid from the uncertainty factors that are difficult to control is very complicated. So people began to recognize the importance of risk management in urban power supply. Therefore, the use of certain models and methods to assess the risks of network planning is particularly important.

Many models have been used in order to evaluate risks, such as the investigation and expert evaluation methods, the sensitivity analysis method [1], the Dempster–Shafer theory [2], the hierarchy fuzzy method [3], the Monte Carlo simulation method [4], the fuzzy decision support system [5], the fault tree analysis [6], the Bayesian inference [7], the grey theory and fuzzy mathematics [8], the genetic algorithms and neural network approaches [9] and so on. Many studies have also been conducted on the risks of the power system. A risk analysis of the bulk power system was performed based on the power flow simulation model and stakeholder input in [10]. The mean-semivariance (MSV) risk measure was applied in spatial energy market risk analysis in [11]. Transaction costs and other practical constraints were also included. In addition, the advantage of MSV over semivariance (SV) was that it provided a more logical measure. A new approach to risk analysis in power networks by combining the results of reliability studies with the input data (failure rate of components and repair time) was introduced in [12]. After line faulted, the substation protection and trip operations were modeled by the event trees. And different event trees and states were simulated by the power system dynamic analysis program. A simple deterministic frequency stability model was developed in order to evaluate the risks involved in the operation of protective equipments in [13]. However, there are not many methods of risk assessment used in urban power network planning. In addition, according to the researches mentioned above, these methods fail to consider the risks' characteristics of uncertainty and fuzziness. In addition, the attributes of the uncertain risk indices are different. Therefore, this problem requires further research, namely, into how to establish a comprehensive method for the evaluation of urban power network planning.

In 1983, the extension theory was established by Chinese scholars Cai Wen et al. Based on the formalize logic tools, the rules and methods required to solve the contradiction problem can be analysed qualitatively and quantitatively. The theoretical pillars are the matter-element method and the extension set theory, and the logical cell is the matter-element theory. The matter-element model is composed of objects, characteristics and values based on certain characteristics. Therefore, the content and the relationship between the quality and the quantity of the comprehensive

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