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Risk Analysis and Prevention and Control of Electric Power Enterprise Operation Management

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Abstract: This article examines the analysis, prevention, and control of risks in electric power enterprise operation management. It provides an in-depth exploration of risk factors, including market, policy, societal, personnel, technological, business, and other influences. Recognizing the potential threats these risks pose to the operation of electric power enterprises, the study conducts a preliminary investigation from four perspectives: major risks, large risks, general risks, and other risks.

Keywords: Electric power enterprise; Operation management; Risk; Prevention and control

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1. Introduction

As the cornerstone of modern society, the stable operation of power enterprises is essential. Nevertheless, these enterprises face numerous risks in their operations and management. Such risks can impact not only economic performance but also the stability and safety of power supply systems [1]. Accordingly, conducting an in-depth analysis of the operational and managerial risks in electric power enterprises and devising effective prevention and control measures hold significant practical importance.

2. Analysis of risk factors in the operation and management of electric power enterprises

2.1. Market factors

Traditional electric power enterprises, such as China's South Grid, have historically operated within regional contexts where competition among enterprises was minimal [2]. However, with the advent of electricity market reforms, numerous listed companies have entered the market, increasing customer options for power purchases and, consequently, intensifying competition. Furthermore, the instability of customer bases has significantly heightened operational risks for electric power enterprises.

In addition, the conventional methods of electricity purchase and settlement, which often involve payment delays or overdue bills, present challenges. Customers accustomed to deferring payments or settling arrears exacerbate financial risks for these enterprises.

Finally, electric power enterprises must maintain a delicate balance between electricity purchases and sales to maximize efficiency and profitability. Oversupply leads to energy wastage and increased costs, while undersupply disrupts production and daily life. Any imbalance between power supply and demand introduces considerable operational risks [3].

2.2. Policy factors

The "Basic Rules for the Operation of the Electricity Market" specify that market participants include operating entities, institutions, and power grid enterprises [4]. Operating entities encompass power generation companies, electricity sales companies, power users, and new market entrants, all of which are required to register and adhere to legal regulations prohibiting violations and promoting fair competition.

For power generation enterprises, the rules establish their role as market entities. These entities must complete registration procedures, comply with standardized trading processes, and avoid practices such as collusion, price manipulation, and abuse of market dominance [5]. By fostering compliance and efficiency, these measures encourage enterprises to gain competitive advantages through cost reduction and improved power generation performance.

For electricity sales enterprises, the regulations clarify their market roles and trading guidelines, enabling them to operate within a standardized framework. This structure helps these enterprises improve service quality and attract customers, reducing risks associated with unfair competition while promoting sustainable growth [6].

For power grid enterprises, the requirements include establishing and maintaining electricity measurement databases and publishing relevant data. While this increases operational costs and data management responsibilities, it also enhances transparency and credibility in their operations.

For the electric power industry as a whole, regulatory oversight by bodies such as the National Development and Reform Commission and the National Energy Administration ensures stable electricity market prices [7]. By mitigating adverse effects caused by price fluctuations and fostering a fair competition environment, these regulations provide a secure business environment. Prohibitions against illegal interventions further encourage enterprises to rely on their capabilities and services to compete, thus promoting overall industry development and innovation.

2.3. Social factors

The operations of electric power enterprises are often influenced by external factors that introduce complexities [8]. Political and economic conditions, industry policies, and national macroeconomic regulations can shape the strategic direction and planning of these enterprises. During unfavorable economic conditions, electricity customers may face financial challenges such as poor capital turnover, diminished profits, or disrupted cash flow. These issues may lead to delayed payments or unsettled electricity bills, resulting in financial strain for power enterprises.

Additionally, the decision by some electricity customers to temporarily halt factory operations or retain idle workers can cause a significant reduction in electricity consumption. This decline negatively affects electricity sales targets for specific periods, further increasing operational challenges [9].

Special circumstances, such as domestic and international epidemics, have exacerbated these difficulties. Business closures, factory shutdowns, and reduced production have directly contributed to substantial decreases in electricity sales. Even customers who maintain operations may struggle to pay electricity bills on time due to financial strain, complicating the recovery of outstanding charges.

Despite these challenges, power enterprises are expected to fulfill their social responsibilities. For example, they may offer solutions such as online payment channels and ensure the continuity of power supply to customers facing financial difficulties to support normal production and daily life. While these measures demonstrate corporate responsibility, they also increase the financial burden on power enterprises [10].

Table 1 illustrates the summarized risk indicators associated with the operation and management of electric power enterprises.

Table 1. Summarized risk indicators associated with the operation and management of electric power enterprises

Risk indicator	Level 1 risk index layer	Level 2 risk index layer
Operation and management (A)	Market factor risks (A1)	Industry competition (A11)
		Buying and selling method (A12)
		Supply and demand imbalance (A13)
	Policy factor risks (A2)	Power policy adjustment (A21)
		Industrial policy adjustment (A22)
	Social factor risks (A3)	Force majeure and emergencies (A31)
		Corporate social responsibility (A32)
	Personnel factor risks (A4)	Staff position adjustment (A41)
		Staff skills (A42)
		Staff ethics (A43)
	Technical factor risks (A5)	Power supply quality (A51)
		Power metering device fault (A52)
		Abnormalities in the power information acquisition system (A53)
		Operating system instability (A54)
		Information security (A55)
	Business factor risks (A6)	Customer service (A61)
		Electricity bill recovery (A62)
		Electricity supply cost (A63)

2.4. Technical factors

Technical factors are critical to the efficient operation and safeguarding of electric power enterprises. Technologies such as data collection systems, operating systems, and information security frameworks form the backbone of power system functionality [11]. However, technical issues, when they arise, can be challenging to resolve and may lead to significant operational disruptions.

(1) Collection system problems: The functionality of automatic meter reading systems, electricity information collection systems, and equipment monitoring systems is essential for ensuring seamless

operations. A failure in any component of these systems can result in interruptions or delays in data transmission, slowing automatic meter reading processes and affecting power measurement accuracy.

(2) Operating system issues: Reliable operating systems are indispensable for the smooth functioning of electric power enterprise operations [12]. While these systems streamline power personnel management, they also introduce operational risks. Problems such as database abnormalities, data interaction delays, server congestion, and packet loss can hinder operational outcomes and reduce efficiency.

(3) Information security issues: In power systems, critical information about electricity customers and the operational safety of electric power enterprises must be protected. Cyberattacks or unauthorized intrusions can lead to system crashes, data tampering, or the exposure of sensitive customer information. Such incidents can severely disrupt the normal operation and management of electric power enterprises [13].

Table 2. Total risk categories in electric power enterprise operation management

Primary evaluation index	Weight	Secondary evaluation index	Weight	Total weight	Total sort
Market factor risks (A1)	0.145	Industry competition (A11)	0.297	0.043	9
		Buying and selling method (A12)	0.163	0.024	14
		Supply and demand imbalance (A13)	0.540	0.078	4
Policy factor risks (A2)	0.041	Power policy adjustment (A21)	0.750	0.031	11
		Industrial policy adjustment (A22)	0.250	0.010	18
Social factor risks (A3)	0.079	Force majeure and emergencies (A31)	0.667	0.053	7
		Corporate social responsibility (A32)	0.333	0.026	12
Personnel factor risks (A4)	0.108	Staff position adjustment (A41)	0.230	0.025	13
		Staff skills (A42)	0.648	0.070	5
		Staff ethics (A43)	0.122	0.013	16
Technical factor risks (A5)	0.229	Power supply quality (A51)	0.177	0.041	10
		Power metering device fault (A52)	0.056	0.013	17
		Abnormalities in the power information acquisition system (A53)	0.420	0.096	3
		Operating system instability (A54)	0.269	0.062	6
		Information security (A55)	0.078	0.018	15
Business factor risks (A6)	0.398	Customer service (A61)	0.309	0.123	2
		Electricity bill recovery (A62)	0.582	0.231	1
		Electricity supply cost (A63)	0.109	0.044	8

3. The electric power enterprise operation management risk prevention and control strategy

3.1. Prevention and control measures and suggestions for major risks

In the context of risk prevention and control, market and business risks represent significant challenges. Among

these, customer service, electricity recovery, and supply-demand imbalances are the most prominent secondary risk indicators. Based on these classifications, the following strategies are proposed for addressing major risks.

Power companies can establish a credit rating mechanism for electricity charges, factoring in the total electricity consumption, payment history, and credit investigation status of enterprises or individuals. Different management approaches can be applied based on credit levels. Customers with good credit can be offered value-added services, while those with poor credit require heightened monitoring and fee collection efforts. For customers with significant payment delays or abnormalities, risk control measures in accordance with legal provisions may be necessary. For customers nearing bankruptcy, deploying specialized personnel to ensure timely liquidation is recommended.

Additionally, power companies should actively promote online payment methods. Leveraging diverse media channels to guide customers toward online transactions can reduce reliance on offline payment options. In cases of overdue payments, timely alert messages should be sent to customers, allowing them to prepare for payment deadlines. Furthermore, incentives such as gifts or value-added services can encourage electricity conservation [14]. Awareness campaigns in schools, communities, and residential areas can enhance understanding of the importance of safe and economical electricity use, thereby addressing payment-related challenges.

3.2. Prevention and control measures and suggestions for larger risks

Technical factors, identified as higher-level risks in the weighted order of secondary indicators, have a significant impact on electricity information acquisition systems and operating systems. To mitigate these risks, the following measures can be adopted during the electricity information collection process.

During the installation and debugging of acquisition terminals, strict adherence to work standards and procedures is essential. Post-installation, all equipment should be inspected to ensure proper functioning. Debugging processes must address both uplink and downward communication issues.

For uplink communication debugging, staff should perform the “seven confirmations,” including verifying that the collection terminal equipment indicators are functioning, external antennas are properly installed, SIM card services are activated, communication module indicators are operational, equipment configurations align with main files, communication parameters are accurate via handheld tools, and that terminal equipment maintains consistent communication with the main system.

For downward communication debugging, workers should complete “two confirmations”: ensuring that the acquisition terminal lines are functional and that the terminal startup process is operating correctly. These measures are critical to minimizing technical risks and ensuring system reliability.

3.3. Prevention and control measures and suggestions for general risks

Among the various factors influencing the operation and management of electric power enterprises, staff ethics, position adjustments, and skills are categorized as moderate risks. These elements play a pivotal role in ensuring smooth enterprise operations and reducing the likelihood of errors in management processes. As information systems are upgraded and business processes optimized, electric power enterprises should emphasize enhancing the comprehensive abilities of their employees.

Organizing diverse training programs can expose employees to new systems, equipment, and business models, enabling them to adapt to the evolving needs of modern enterprise operations. Furthermore, integrating

modern management theories into operational strategies can facilitate the establishment of a total quality management model [15]. This approach emphasizes total quality, full participation, and comprehensive coverage of all processes to maintain high standards of work quality.

During quality monitoring, any identified issues should prompt targeted business and skills training for employees. This proactive approach can significantly improve the overall operational capabilities of the workforce, ensuring the efficiency and reliability of the enterprise.

3.4. Prevention and control measures and suggestions for other risks

Other risk factors, such as policy and social risks, represent external challenges with relatively low probabilities but significant impacts. These risks, often categorized as force majeure, require specific strategies to mitigate their effects.

To address policy-related risks, enterprises can enhance the provisions of power supply and consumption contracts by clearly stipulating response measures for emergencies and force majeure events. Regular negotiations with power supply entities or individuals can establish fixed online payment modes through scheduled deductions from designated accounts.

From a social responsibility perspective, electric power enterprises should actively engage with electricity customers, identifying and addressing potential problems to formulate mutually beneficial solutions. For example, when customers face financial difficulties, enterprises can collaborate with banks to offer specialized electricity loans. This strategy not only alleviates financial pressure on customers but also facilitates risk transfer, ensuring the stability of the enterprise's operations.

4. Concluding remarks

In summary, the risks associated with the operation and management of electric power enterprises are diverse and complex, necessitating significant attention and proactive responses. By conducting precise risk analyses and implementing effective prevention and control measures, power enterprises can enhance their resilience against risks and ensure stable, sustainable operations.

This approach enables enterprises to maintain a competitive advantage in the dynamic market environment while delivering reliable and high-quality power services to society. Such efforts contribute significantly to economic development and the improvement of people's livelihoods.

Disclosure statement

The author declares no conflict of interest.

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