

Application exploration of power grid project management based on big data analysis technology

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Abstract. With the rapid advance of the digital transformation of the power grid, the power system is and will enter the digital era. Relying on advanced measurement, transmission and storage technologies, power grid project management will generate massive data in all aspects, and show a blowout growth trend. This paper analyzes the typical application scenarios of big data analysis technology in power grid project management, and proposes an effective solution for power grid project management based on the effective mining of data value by big data analysis technology. The proposal of this paper is of great significance for improving the intelligent level of power grid project management and further effectively supporting the construction of power grid projects.

Keywords: Big data analysis, power grid project management, intelligence, risk prediction.

1. Introduction

With the increasing global energy demand and the increasing complexity of power system, the project management of power grid engineering is facing unprecedented challenges. As an important part of national critical infrastructure, the safe and stable operation of power grid is directly related to the sustainable development of national economy and the normal order of people's life. During the "14th Five-Year Plan" period, the overall power grid construction of the Southern Power grid Company plan to invest about 670 billion yuan to accelerate the construction of digital power grids and promote the construction of new power systems with new energy as the main body. In the process of such large-scale power grid construction, the importance of power grid project management is self-evident. Therefore, it has become a problem which need to effectively improve the safety management level of power grid engineering.

The traditional means of power grid project management as a whole can be described as a system that is relatively dependent on manual operation and limited technical resources. Power grid project management mainly focuses on planning, communication and coordination, risk management, quality control, cost management, document management, technology and innovation, etc. Under traditional means, although some basic project management software will be used to improve work efficiency, overall, project management methods and tools are relatively backward. With the development of informatization and digitalization, more and more power grid engineering projects have begun to explore and apply modern project management methods based on advanced technologies such as big data, cloud computing, and the Internet of Things to improve the efficiency and level of project management. Big data technology, with its powerful data collection, storage, processing and analysis capabilities, has brought revolutionary changes to power grid project management. Through big data analysis technology, the risk assessment and prediction of each link of power grid engineering can be realized, so as to effectively carry out emergency response and decision support, and ensure the efficiency and accuracy of power grid project management. This paper aims to explore how big data analysis technology can help power grid project management, improve management energy efficiency, and promote the development of power grid construction and safety production.

2. Typical application scenarios of power grid project management

The traditional typical application scenarios of power grid project management mainly focus on project planning, design, construction, quality control, safety management and schedule management.

Power grid project management usually adopts a hierarchical organizational structure, in which the project manager is responsible for the overall project planning, implementation and monitoring, and each functional department is responsible for specific work. In the project start-up stage, set up the project management team, clarify the responsibilities and permissions of each member, and ensure the orderly progress of the project.

In terms of project planning and schedule management, Gantt chart, milestone plan and other tools are used to plan the project schedule, regularly hold project meetings, track the project progress, and adjust the plan in time to deal with deviations. At the beginning of the project, develop a detailed project plan, including the timing of each phase, the assignment of tasks, and the expected results. During the construction process, the progress is continuously monitored to ensure that the project is on schedule.

In terms of project quality control and safety management, through the formulation of quality standards and safety norms, the establishment of quality control points and safety checkpoints, regular and irregular inspections to ensure project quality and construction safety.

In the construction process, the construction is carried out in strict accordance with quality standards and safety norms, regular quality inspection and safety inspection are organized, and problems are found and rectified in time.

In terms of communication, coordination and information management, internal and external communication and coordination of projects are traditionally carried out through meetings, documents, telephone calls, etc., and project information is collected, sorted out and analyzed to provide support for decision-making. Throughout the project, regular project meetings are held to discuss project progress, problems and solutions. At the same time, the project information management system is established to collect, sort out and analyze project-related information to provide basis for project management and decision-making.

In terms of risk management, identify the risk factors that the project may face, assess the impact degree and possibility of risks, and formulate risk response strategies and plans. At the initial stage of the project, a comprehensive risk assessment is carried out based on the experience of the project manager to identify potential risk factors. In the construction process, continue to pay attention to risk changes, timely adjust risk response strategies and plans.

3. Power grid project management solution based on big data analysis technology

The application of big data analysis technology in power grid project management is multi-dimensional. Through in-depth data analysis, real-time monitoring and predictive modeling, the risk warning and response ability of project management can be effectively improved. The following is the solution realization path of big data technology in power grid project management.

Data collection and integration: Power grid project management relies on comprehensive data collection and integration, including equipment operation data, environmental monitoring data, personnel operation records and other sources of data. With its efficient data processing ability, big data analysis technology can integrate massive heterogeneous data and provide a comprehensive project execution view for power grid project managers. Through the real-time data stream processing capability based on Spark or flink, abnormal situations can be quickly identified and responded to, so as to ensure the real-time and initiative of project safety management.

Risk assessment and prediction: The application of big data analysis technology makes it possible to evaluate and predict the security risks of power grid projects. On the one hand, it can conduct comprehensive analysis of historical accident data, equipment usage and environmental factors to effectively identify safety risks under different operating conditions; On the other hand, combining real-time monitoring data and using machine learning algorithms for information mining, potential project management security problems can be predicted and effective preventive measures can be

taken in time. This method can effectively provide scientific basis for security management decisions and help managers to formulate more effective security strategies. The overall process is as follows:

- 1) Historical data analysis: Mining historical accident data, identifying accident patterns and causes, and providing historical reference for risk assessment.
- 2) Real-time risk monitoring: Combined with real-time data monitoring, dynamic assessment of power grid engineering security risks to achieve real-time risk monitoring and management.
- 3) Prediction model construction: Machine learning and other advanced technologies are applied to build prediction models to warn potential safety problems in advance and reduce accidents.

Emergency response and decision support: In the management of power grid engineering projects, how to quickly and accurately carry out emergency response is crucial to reduce the impact of accidents. Big data analysis technology can quickly analyze the causes and provide solutions when problems occur in project promotion, and effectively provide decision support. At the same time, with the application of real-time data analysis and visualization tools, managers can quickly understand the accident situation and make decisions, which can greatly improve the speed and quality of emergency response of project management. In-depth mining of accident data helps to optimize the emergency response process and improve the efficiency and effect of accident handling. The overall process is as follows:

- 1) Abnormal rapid analysis: When an anomaly occurs, the cause and scope of impact are quickly analyzed to provide accurate information for emergency response.
- 2) Decision support system: Through visual tools and data analysis, to assist managers to make scientific decisions quickly and improve the efficiency of emergency response.
- 3) Process optimization: Continuously optimize the emergency response process based on in-depth analysis of big data to improve the professionalism and effectiveness of accident handling.

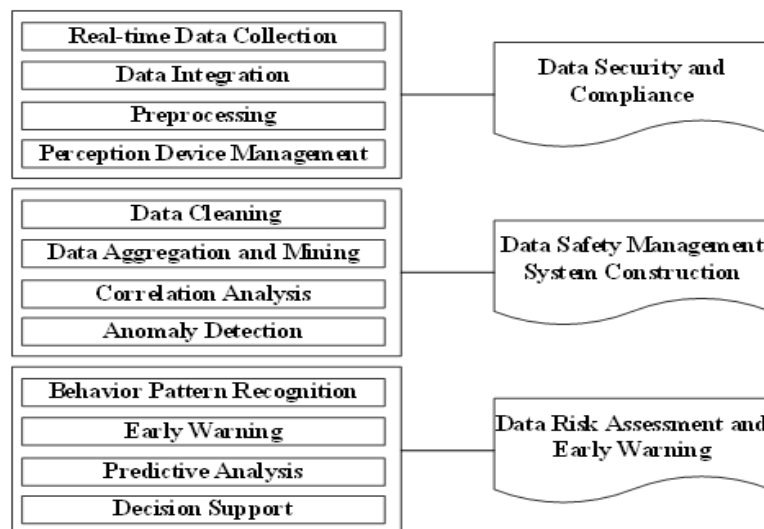


Figure 1. Electric Power Grid Project Management Big Data Platform

As depicted in Figure 1, the structure of the application scenarios for the project management of power grid engineering based on big data analysis technology is comprehensive, integrating various functionalities to ensure robust data security and risk management.

4. Design of big data analysis platform for power grid project management

The big data analysis platform for power grid project management is a comprehensive system that integrates data collection, storage, processing, analysis and visualization. The platform aims at deep mining and analysis of massive data in power grid engineering projects through big data analysis technology, including but not limited to the data generated by various links such as project design, construction, operation and maintenance, as well as external environment such as meteorological, geological and other related data. This method can effectively realize the fine management of the

whole life cycle of the power grid project, improve the efficiency of project management, reduce the operating cost, and provide strong support for decision-making. The design of power grid engineering safety management platform based on big data analysis technology mainly includes the following key components:

4.1. Data Collection and Perception Module

The data acquisition and perception module is the basis of the big data analysis platform, which is responsible for obtaining data from various sources and realizing real-time collection of all kinds of data in the power grid project. Through data acquisition interface and network transmission equipment, the module effectively guarantees real-time monitoring of power grid status and provides original data support for subsequent data processing and analysis.

1) Real-time data acquisition: collect project site status data and related parameters through data acquisition interface.

2) Multi-source data integration: information from different data sources is integrated to form a unified data flow.

3) Data preprocessing: The data is cleaned, formatted and standardized to facilitate subsequent processing.

4) Sensing equipment management: monitor and manage the operating status of the sensing system to ensure the accuracy and continuity of data collection.

4.2. Data Processing and Analysis Module

The data processing and analysis module is the core of the power grid project management big data platform, which is mainly responsible for cleaning, converting, aggregating and mining the collected original data. Utilize big data technologies such as Hadoop and Spark to efficiently process and analyze large-scale data sets and extract valuable information and data. At the same time, the module also includes functions such as multidimensional association analysis, anomaly detection and threat analysis, which helps to identify potential risks and threats in power grid operation and provide scientific basis for security management.

1) Data cleaning and conversion: Remove invalid or incorrect data and convert the data into a format suitable for analysis.

2) Data aggregation and mining: Aggregate large-scale data sets and use data mining technology to extract in-depth information.

3) Correlation analysis: Analyze the correlation between data to find potential problems and rules in power grid operation.

4) Anomaly detection: the algorithm can effectively monitor the anomalies in the data pattern to provide a basis for security risk assessment.

4.3. Intelligent Early Warning and Decision Support Module

The intelligent early-warning decision support module uses machine learning algorithms to conduct in-depth analysis of power grid big data to achieve prediction and early warning of potential risks.

The module can define the behavior pattern or user access capability according to the user's historical behavior and database usage pattern, and can effectively detect the user's abnormal behavior intelligently without setting a fixed threshold in advance. At the same time, through continuous monitoring and analysis of power grid data, the module can timely detect abnormal behaviors and issue early warnings to assist decision makers to take preventive measures, so as to improve the initiative and effectiveness of power grid security management.

1) Behavior pattern recognition: Define the behavior patterns of users and systems based on historical data for abnormal behavior detection.

2) Real-time monitoring and early warning: continuous monitoring of power grid data, timely warning of potential risks and abnormal behaviors.

3) Predictive analytics: Using machine learning algorithms to predict grid security risks and future trends.

4) Decision Support: Provide decision-makers with data-driven insights and recommendations to assist in the development of security policies and responses.

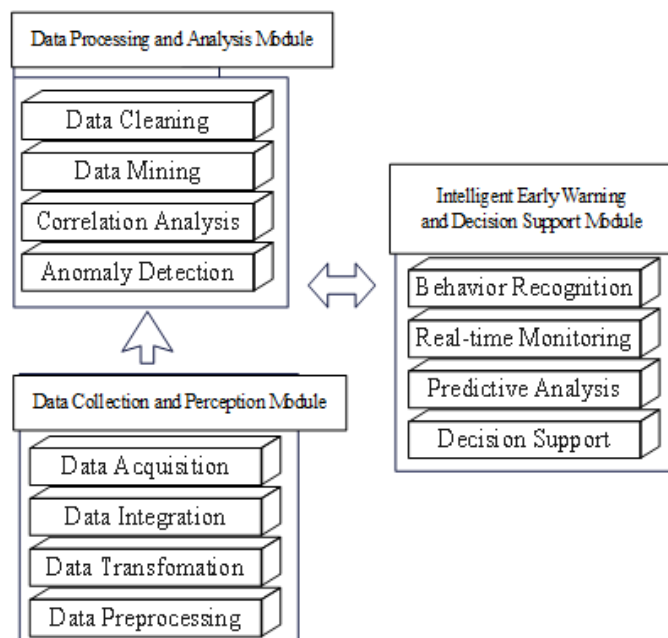


Figure 2. Electric Power Grid Safety Management Big Data Platform Design.

As depicted in Figure 2, the key components of the power grid engineering safety management big data platform design are illustrated, showcasing the integrated system architecture that supports the comprehensive management and analysis of safety data within the power grid.

5. Characteristics Of Power Grid Engineering Safety Management Application Based On Big Data Technology

The application characteristics of power grid engineering safety management based on big data technology are mainly reflected in the following aspects:

Application of big data mining and collection technology: In the supervision process of smart grid, big data mining and data collection technology can effectively improve the effectiveness of data processing, ensure that security management decisions are made according to the latest information, and thus ensure the response speed and accuracy of management decisions. For example, through integrated data mining, the management of the power grid effectively includes the integration of data from various sources and types, and data analysis effectively provides a comprehensive view of the operating status of the power grid, including equipment status, operating logs, and environmental factors. These features facilitate the use of historical and real-time data to build predictive models that predict potential security risks, so that preventive measures can be taken in advance to avoid losses.

Application of heterogeneous data source processing technology: Smart grid involves many aspects such as power generation, distribution station, transmission and transformation, and needs to process a large number of heterogeneous data. The use of big data isomer data source technology can unify the management and analysis of various types of data, build a data service platform, and ensure the normal operation of smart grid solutions.

Application of new database management technology: In the big data application of smart grid, parallel database technology is an important support. This technology can control power engineering in parallel at all kinds of solution connection points and perform various tasks in the database, further improving the overall performance and ease of use of the database.

Application of big data visualization technology: Smart grid contains a large amount of data, how to effectively and quickly display these data through the display screen in an intuitive way is the main application of big data visualization technology. Through visual perception data and data analysis and processing, it can help technicians accurately grasp the diversity in the smart grid environment and find the regularity of power grid operation, so as to optimize the power grid setting and system partitioning, and improve the safety and operation efficiency of the power grid. At the same time, by using artificial intelligence algorithms to automatically identify and analyze data patterns, and dynamically adjust data collection, processing and analysis strategies according to changes in power grid operation and external environment, intelligent management suggestions are provided. Promote information exchange and collaborative work through data sharing and collaboration across departments and teams to improve management efficiency. When handling sensitive data, encryption and anonymization techniques are used to maintain security and ensure data security and privacy protection. Compliance Reduces legal risk by complying with laws, regulations and industry standards to ensure lawful and compliant use of data.

These application features not only improve the safety management efficiency of power grid engineering, but also provide important support for the stable operation and optimization of power grid through data analysis and visualization.

Table 1. Characteristics of Power Grid Engineering Safety Management Application Based on Big Data Technology.

Characteristics	Description
Real-time	Real-time data collection and processing ensure that safety management decisions are based on the most current information, enhancing response speed and accuracy.
Comprehensive	Integration of data from various sources and types provides a holistic view of the power grid's operational status, including equipment status, operation logs, and environmental factors.
Predictive	The use of historical and real-time data to build predictive models that anticipate potential safety risks and allow for preventive measures to be taken in advance.
Intelligent	Machine learning and artificial intelligence algorithms are used for automatic identification and analysis of data patterns, offering intelligent management suggestions.
Adaptive	The ability to dynamically adjust data collection, processing, and analysis strategies in response to changes in power grid operations and external environments.
Scalable	The technology's capacity to expand its data processing capabilities to meet increasing management demands as the power grid scale grows and data volumes increase.
Visual	Data visualization tools transform complex data information into intuitive charts and reports to assist in decision-making.
Collaborative	Support for data sharing and collaboration across departments and teams, promoting information exchange and cooperative work to enhance management efficiency.
Secure	Encryption and anonymization techniques are employed when handling sensitive data to ensure data security and privacy protection.
Compliant	Adherence to legal regulations and industry standards to ensure the legal and compliant use of data, reducing legal risks.

6. Conclusion

The purpose of this paper is to analyze the application scenarios of big data technology in the safety management of power grid engineering and to explore how big data technology can assist in the intelligent and precise management of power grid safety. By constructing a safety management plan for power grid engineering based on big data technology, this paper provides a new approach and method for safety management in the electric power industry.

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