Research on Efficient Collection Method of Blackout Data in Distribution Network

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Abstract. Based on the power supply management needs of power supply companies, this paper adopts a big data-driven power outage data collection method to build a scientific customer outage time key indicator around the power grid comprehensive customer service system, establish a customer outage time indicator responsibility system, and establish a customer outage process monitoring platform to form a data-driven customer power outage analysis system to effectively handle customer power outages.

1. Introduction

At present, the data related to power outages in the distribution network come from many business systems, such as the electricity consumption information collection system, and are centrally stored in the public data resource pool, which contains a large amount of structured data, unstructured data, massive historical quasi real-time data, and geographic information data. The data of each business system is not integrated, but there is a lack of correlation between different business data. For the analysis of these blackout data, the lack of automated means and low work efficiency are not conducive to the further development of business analysis and data value mining. It is necessary to develop a large-scale blackout data collection platform to solve the problem of data collection efficiency and data analysis. With the construction of public data resource pools and big data platforms for power companies and the application of related technologies, there is a certain foundation in data storage, monitoring, and display. Therefore, it can be based on the data of public data resource pools and big data platforms, with the help of big data technology to efficiently collect, analyze and display distribution network outage data to improve the management level of distribution network outage data [1].

2. Collection of customer power failure event data

2.1. Data acquisition

2.1.1 Low-voltage data acquisition. The mobile electricity monitor uses a sub-line and segmented real-time online monitoring method. It is installed on a telephone pole and uses open-type current transformers to sample data. It has the characteristics of easy disassembly and can be dismantled and used repeatedly. Equipped with a GPRS communication interface, supporting the communication protocol of the negative control terminal of the power grid, which can remotely read the meter and
access the metering automation master station. Realized functions include: real-time monitoring of voltage, current, load power and data; real-time monitoring of voltage quality, calculation of pass rate; real-time reporting of power outages and calls to the master station, as shown in Figure 1.

**Figure 1.** Low-voltage information collection function diagram

2.1.2 *System data collection.* The data collection function and storage of the power failure information of the metering automation system are realized through the power failure information collection function as shown in Table 1. Every morning, the metering automation system will make up for the 15-minute frozen operating curve data at the system's main station and perform a logic analysis of the power outage information.

| NO. | data item                        | source    | Description                                                                 |
|-----|----------------------------------|-----------|-----------------------------------------------------------------------------|
| 1   | Terminal power outage or call    | terminal  | Moment of power outage or call                                              |
|     | event record                     |           | By convention, 1440 minutes is the data when no power outage occurs every day, and less than 1440 minutes is the data after the power outage occurs. |
| 2   | Daily running time               | terminal  | By convention, zero is the data when there is no power outage on the day, and zero is the data after the power outage. |
|     | Cumulative time of the day's     | terminal  | The terminal's auxiliary judgment for power failure is to freeze one piece of operating data including voltage and current every 900 seconds. |
|     | power failure                    |           |                                                                             |
| 3   | 900 seconds of running data      | terminal  |                                                                             |

2.2. *Analysis of customer power failure data*

The principle of the metering automation system to count the power outage time is to establish an automatic statistical model based on 900 seconds of running data, the day's total power outage, and the day's running time. According to the actual situation, a rule base of logic judgment methods for outage time should be established. There are two cases to measure the power outage time of the automated system to automatically make statistics: there are terminal outages reported with power outages or incoming call alerts, and outages with no power outages or incoming call alert events [2].

2.3. *Automatic comparison of power failure data*

The power failure data was quickly restored to the power system, the distribution intensive system and the distribution network production management system, and sorted out and intelligently screened. An
analysis of the blackout record was obtained. Then, it is paired with the outage data intercepted by the metering automation system. The metering automation system sends the intercepted blackout data to the marketing system through a preset program interface, and the marketing system performs a second matching based on the first blackout record to obtain the final announced blackout event, as shown in picture 2.

![Figure 2. Automatic collection of customer power failure information](image)

The automatic comparison of power failure information is set to select automatic or manual startup. Where the conditions are mature, automatic matching can be performed on a regular basis every day. If conditions do not exist, manual matching can be started (matching will be manually started after the marketing management information system manually enters a power outage). The application of the cooperative rapid power recovery system is mainly to transfer the collected data to the rapid power recovery system, and then the rapid power recovery system and other power outages obtained in the marketing system, the 0.4kV power outage event of the distribution network, and the rapid power outage event. Compare and analyze the low-voltage blackout data. Do a deduplication job for the same event from multiple sources, and interface with the mobile APP application to form a fault repairing work order, and the accuracy and completeness of the power failure event record.

The power outage management platform will establish an automatic power outage comparison module. The main principle of this model is: the metering automation system sends the intercepted power outage data to the marketing system, and the marketing system performs a second intelligent matching based on the first power outage record. When the customer's electricity number, metering device code, blackout start time, blackout end time, and line are consistent, the system will automatically determine that it belongs to a blackout record and release correct blackout event information to the outside. When there is any inconsistency in the power outage information of the two systems (that is, the data pairing fails between the two systems), the system will form an abnormal record (false positive difference table, false negative difference table, and blackout time difference table) [3]. The staff of the branch office's business team will collect such abnormal record data every day, and perform manual check and confirmation to reasonably make up for the lack of outage statistics due to system errors. The automatic comparison module processing flowchart is shown in Figure 3.
3. Calculate customer power outage time
In general, there are two kinds of statistical standards for the reliability of power supply in international standards: one is the statistics that exclude the effects of special natural disasters or exceed the blackout setting value, and the other is the statistics that include the impact of special circumstances. International advanced power grid companies do not attach the highest importance to power supply reliability indicators. They are accustomed to statistics such as the average customer power outage time and the number of power outages. After practice verification, the results of the above two caliber statistical indicators are quite different [4]. Excluding events exceeding the set value of power outages will have a significant impact on the statistics of power outages in some areas. The calculation method for the average customer power outage time (SAIDI) is:

$$SAIDI = \frac{\sum_{i=1}^{N_D} T_{Ci}}{N_D}$$

Among them, SAIDI is the average outage time of customers in the IEEE-1366 standard, $N_D$ is the number of customers, and $T_{Ci}$ is the outage time of the a customer. At present, because advanced countries / regions have abundant technical means and basic management are in place, they can accurately count the number of customers connected on each line. Therefore, the statistics of power outages are based on a real power customer, regardless of voltage level. The cause of power outages can be specified as grid faults and natural disasters. Power outages caused by this cause can be excluded, but power outages caused by transformer failures in distribution networks must be counted.

4. Distribution network blackout data collection system

4.1. Model Construction
The influencing factors such as equipment outage loss with the highest correlation are selected, and a power outage analysis model for the distribution network is constructed using a particle swarm optimization algorithm, and an optimal solution is given. The big data source of the model comes from the big data platform. The big data platform collects business data such as power outages, faults,
uninterrupted operations from distribution management systems such as production management systems, marketing systems, scheduling systems, and GIS systems. The calculation tool spark performs filtering and processing to realize the basic data of model calculation, that is, X of the above model [5].

Data centre data flow can be divided into three types of scenarios: data sharing, analysis mining, and vertical cascading. According to the characteristics of data use and conversion requirements, the three types of scenarios are used in business systems, data centre content and analysis applications Circulation between.

4.2. Business Architecture Design
It mainly includes two modules, daily monitoring and monthly analysis, to monitor and display frequent power outages in the distribution network. The daily monitoring module mainly counts the number of power outages in each distribution transformer that has a power outage within 30 days, and monitors the distribution transformers that have experienced two or more power outages. The monthly analysis module mainly counts all power outage distribution transformers this month. Calculate the number of power outages of a single distribution transformer, and monitor the distribution transformers that have experienced two or more power outages within a month. As shown in Figure 4.

4.3. Data Flow Diagram

![Figure 4. Statistics and Collection System for Power Outages](image)

5. System realization effect

5.1. Realization of cross-business correlation analysis and deep mining of power outage data
Clean and reconstruct the data of the connected power consumption information collection system, marketing business system, GIS system, etc., and further enrich the data monitoring rules according to the power outage business management of the distribution network. According to the two dimensions of the provincial and municipal companies, the daily monitoring module and monthly analysis module are used to monitor and display power outages in the distribution network from dimensions such as the overall situation, feeder correlation analysis, power failure cause analysis, and complaint correlation analysis. Real-time online monitoring of the province's power outages and timely detection of changes [6].
5.2. Optimized data access and computing efficiency

Based on the original data monitoring, intelligent algorithms are used to take the economic optimization, reliability, and workload balance of the planned power outage joint optimization as the objective function, and combine the actual needs of power outage management to build an optimization model for power outages in the distribution network. The big data computing framework performs real-time calculations. Based on the big data platform, the data access efficiency of the power consumption information collection system, production management system, and marketing system is optimized, and the efficiency of digital-analogy construction is improved.

6. Conclusion

The application of a data management platform for power outages based on big data analysis improves the efficiency of data collection for power outages, improves work efficiency, provides data support for statistical analysis of low-voltage reliability, and provides auxiliary decision-making for enterprise production activities. Played a positive role.

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