The Research of Electric Meter Site Inspection Data Mining

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Abstract: In recent years, with the constant improvement of Power Supply Information Collection System, the data mining of power information has been deepened. Site inspection is one of the most important way to obtain the operating status of the meter. Data collected by Site inspection, which have wide coverage and strong periodicity, can accurately reflect the error of electric meters, user load, operating environment etc. Therefore, it`s necessary to include electric meters site inspection data into the source of power information mining. In this paper, the big data mining strategy of site inspection data is discussed preliminarily, which is helpful to analyse the running status of electric meters and user's electricity consumption more accurately , give full play to the role of site inspection in the operation and maintenance of the electric meter.

1 INTRODUCTION

"The Technical Administrative Code of Electric Metering" divides electric metering devices into five categories based on the voltage level, and sets the site inspection cycle to 6/12/24 months for I/II/III category of electric metering devices. Detailed operation data of the electric meter, which includes appearance, operating errors, operating environment and user load, can be obtained in site inspection. In recent years, the number of I/II/III category power users increased significantly. At the same time, the amount of data obtained by site inspection also shows a blowout.

At present, the electric meter site inspection focus on the operating fault and the error excess , but lack of overall and deep mining analysis for the mass site inspection data, which reflects the detailed operating situation of electric metering devices. In recent years, because of the analysis methodology developments and the widely usage of application, the data mining in power system has drawn more and more attention from all parties. As the uniform electric meter spreads across the country, and site inspection is highly informative and digitized, site inspection data is more truthful, reliable, comprehensive and standardized. It lays a good foundation for the site inspection data mining, analysis and application.

2 ANALYSIS OF DATA TYPES IN SITE INSPECTION OF ELECTRIC METER

The site inspection of the electric meter is mainly aimed at the operating error, including: general check, wiring check, secondary side voltage drop measurement on the related voltage transformer, the electric meter operating error measurement, timing error test, the combination error of meter reading, etc. At the site of the inspection, the inspector can obtain relative operation data of electric meter, including timing, appearance, environment, user load, etc. The site inspection data can be roughly divided into numerical and non-numerical classes. The data collected from the user site have high reliability. Moreover, the period of site inspection data acquisition is fixed. Therefore, the value of the analysis on the site inspection data cannot be ignored.

2.1 Numerical class data

The data from site inspection are mostly numerical. In addition to the metering error (γ) of the electric meter, the site inspection can also get the clock error (Δt) by comparing the clock, the reading meter error (δ) by obtaining the time-sharing electricity quantity,

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the user's instantaneous load (*p*) by calculating voltage (U) and current (I) value, and the user's total electricity quantity (W) at the inspection point. The above data can be obtained in the site inspection and can be conveniently stored, processed and analysed.

2.2 Non-Numerical Class Data

The appearance of electric meter, operating environments, etc. difficult to measure by value, can be expressed in a non-numerical way. The data is categorized in detail when obtained in order to maintain the objectivity, as shown in Table 1
.

Table 1 Non-Numerical Data of Site Inspection

Data	Status	Corresponding Detailed Information
Appearance	Good	no dirt and oil pollution on the electric meter surface/ complete and no damage of the shell/ LCD screen display clarity/ good button function/ complete seal
	Mediocre	ash or oil on the electric meter surface/ surface lightly damaged/ key sensitivity reduced
	Alert	serious ash or oil pollution on the electric meter surface，surface damaged/ LCD screen display blur，button insensitive
Environment	Good	appropriative power distribution room/ controllable room temperature/ dust-proof, moisture-proof, rodent control measures/ equipped with a professional electrician
	Mediocre	appropriative power distribution room/ electrician patrol/ general protective measure in power distribution room/ ash accumulating in power distribution room
	Alert	no power distribution room/ outside electric meter without protective measures/ power distribution room without electrician patrol or protective measures

By organizing data and especially combing non-numerical data, site inspection data can be normalized to maintain data accuracy and objectivity, thereby preparing for data analysis and mining.

3 ELECTRIC METER SITE INSPECTION DATA MINING

Electric meter site inspection data includes not only the energy meter running information, but also contains the relevant user information. The site inspection data is not independently, but there is a potential contact and influence between each other, and this connection and influence is multi-dimensional, non-linear。Therefore, it is necessary to fully excavate and analyse the data from the site inspection to explore the inherent relationship between the meter data. The result of data mining can be used to analyse and predict various phenomena and situation that may occur in the operating of electric meter.

3.1 Electric meter Operation Reliability Prediction

Meter as a measure of electrical energy, strictly speaking, during the operation does not allow the process of maintenance situation. However, due to various factors, it is difficult to avoid various faults during the actual operation of the electric meter. Most failures occur not by chance, but as a result of a combination of various factors. At present, it is difficult to conduct real-time monitoring on the operating parameters of the electric meter in operation. Therefore, the mastery of operating conditions is mainly based on the site inspection data. The operating status of the electric meter is excavated in the site inspection data, and the reliability of the electric meter is evaluated. Next, the two most common failures, including the error excess of electric meter and the voltage/current loss are analysed.

3.1.1 Electric meter Operating Error

In the operation of the meter, the failure of operating error excess accounts for the most. In addition to the quality of the product and the running time, the factors that affect the error of the electric meter include the environmental factors such as the load, temperature and humidity of the user. The operating error of the electric meter can be analysed preliminarily from the existing site inspection data.

(1) Electric meter manufacturing level

Because of the different manufacturing levels, the operating errors of electric meters from different manufacturers, models and batches often have great

differences. Take the 2017 site inspection data as an example: the site inspection operating error of 5 batches electric meter with similar running time is compared, and the average absolute value and standard deviation are analysed. As shown in Figure 1, the operating error size and dispersion of different batches of electric meter are different. According to the error average absolute value and standard deviation, the different batches of electric meters can be divided into two categories, A and B, with 0.5‰ as the dividing line, which indicates the influence of the electric meter manufacturing level on the error.

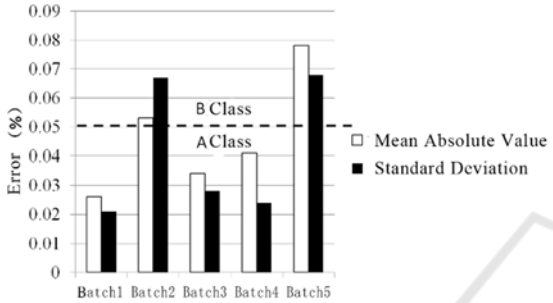

Fig 1 Comparison of Mean Absolute Value and Standard Deviation of Electric meter Error

(2) Electric meter running time

With the increase of running time, the error excess rate of the electric meter increased obviously. The error excess rate of the different running time of 3 batches of the electric meter is shown in Figure 2. The batch 3 whose operation period expires and fails to be changed in time reaches 0.71‰, far more than the other batches. The batch 3, which runs more than 5 years, is divided into B class, with 0.5‰ as the dividing line, according to the operating error excess.

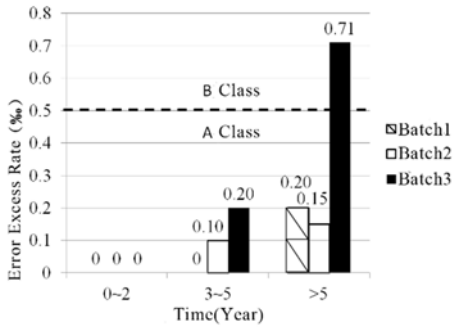

Fig 2 Comparison of Error Excess Rate of Different Electric meter Running Time

(3) User Maintenance

The error of 10 electric meter operating errors found in the first quarter of 2017 is analysed. The 10 users cover industrial, commercial and administrative institutions, and the user's power distribution facilities are properly maintained. Therefore, from the existing site inspection data analysis, the operation error of the electric meter is less related to the external environmental factors, such as the maintenance of the user.

Based on the existing site inspection data, the operating error of the electric meter is mainly related to the product batch (difference in manufacturing level) and running time. The results of the analysis can be used to predict the performance of the electric meter. According to the division of the above A and B class, the operation error of the Double-B class electric meter should be paid attention to in the site inspection. If the corresponding batch has expired the operation period, it is necessary to speed up changing the meter to reduce the operation error excess of the electric meter.

3.1.2 Voltage/Current Loss

The loss of voltage and current caused by fuse burn-out in voltage and current transformer is one of the most frequent faults that affect the accuracy of measurement. There are many factors that lead to fuse burn-out. It is not only related to the quality of fuse, but also related to the external factors such as the operating environment. It is generally believed that lightning is one of the important reasons for fuse burn-out or damage. After fuse burn-out, the electric meter can record the time of failure. Taking the fuse burn-out fault data found in site inspection in 2016 and 2017 in a certain area as an example, August~ November is a high failure period, which is about 2 times of that in other months, as shown in Figure 3. July ~September is the high incidence of lightning in the region. A part of the fuse has not been fused directly after a lightning strike, but it can continue to run for a period of time in the case of damage. Therefore, November ~ November is still a period of high incidence of voltage and current loss caused by fuse burn-out.

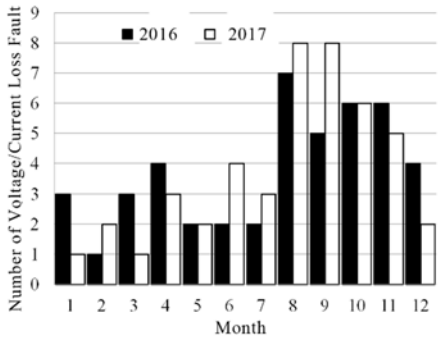

Fig 3 Time Distribution of Voltage/Current Loss

In view of the seasonal characteristics of voltage and current loss caused by fuse burn-out, effective preventive measures and investigation methods should be taken, such as checking fuse before thunderstorm season. In addition, with the continuous improvement of the Power Supply Information Collection System, online trouble-shooting and timely repair can be made to reduce the metering errors caused by the failure.

In summary, the analysis of field test data can extract the characteristics of all kinds of electric meter on-site fault, and it is of great significance to predict the running stability of the electric meter. At the same time, with the continuous application of new devices, all kinds of operating status are changing. Based on real-time updating of site inspection data, it can better track all kinds of state variables and develop more perfect inspection strategies.

3.2 Analysis of User's Electricity Consumption Behaviour

With the establishment of Power Supply Information Collection System, the collection of user power data is more comprehensive and perfect, which is the important data source of current power big data analysis. However, besides voltage, current and power, the site inspection data contains many peculiar non-electrical data, which can provide a more comprehensive description of user electricity consumption behaviour.

3.2.1 Maintenance of user equipment

According to the site inspection data, the equipment maintenance of different properties power user is quite different. Table 2 shows the maintenance of different properties power user measurement devices in a certain area. The maintenance evaluation criterion is based on table 1.

Table 2 Operation and Maintenance of Different Properties Power Users Facilities

Users Properties	Appearance			Environment		
	Good	Mediocre	Alert	Good	Mediocre	Alert
Large industry	93.1%	6.9%	0.0%	89.7%	10.3%	0.0%
Government agency	98.0%	2.0%	0.0%	98.0%	2.0%	0.0%
School & Hospital	95.7%	4.3%	0.0%	93.5%	6.5%	0.0%
Small industry	76.0%	14.8%	9.2%	67.3%	12.8%	19.9%
Commercial property	73.2%	17.1%	9.3%	67.9%	22.7%	9.4%

According to the appearance of the user's power equipment and the operating environment, the maintenance of the power equipment can be judged. Large industrial, government agencies, schools, banks, hospitals have strict electric equipment management system. The power distribution environment of those users is better, and the distribution personnel are more fixed and professional. Therefore, equipment failure can be detected in time. And overall, the small industry, commercial property and other power users are equipped with low professional technicians, and the maintenance of power equipment is not enough.

In view of the differences in the maintenance of the user equipment, the power supply enterprise should formulate the differential measures to guide users to maintain the electrical equipment and reduce the failure of the equipment.

3.2.2 Peripheral Data Acquisition in Big Data Analysis

With the establishment and application of the Power Supply Information Collection System, the analysis of the user's electrical behaviour can be extended to the big data analysis of the full sample. The Power Supply Information Collection System is able to collect real-time information, includes user's voltage, current, power, electricity amount and so on, as well as the inherent user electrical properties, address and so on. Through the full sample data mining, the user behaviour can be analysed and predicted.

The information contained in the site inspection data is irreplaceable, such as user geographic environment information, user nature of centralized area, etc., and it is a supplement data of the Power Supply Information Collection System. The user address information in the Power Supply Information Collection System is only a single address, and lacks relevant geographical environment information. For example, the user address is on the sea or near the river. When the address information is wrong, it can be corrected by site inspection data immediately. The Power Supply Information Collection System treat each power user as a separate data, lack of integrity. However, site inspection can classify power user according to the same properties, and treat the users as a whole, such as large industrial area, commercial street users, high tech park etc. Through the combination of the Power Supply Information Collection System and the site inspection, the user's electrical data will be more perfect and comprehensive, and the data mining will be more detailed and deeper.

4 CONCLUSIONS

The electric meter site inspection can get the electrical and non-electrical data of user metering equipment, and has the advantage of data channel`s uniqueness. The data has the characteristic of full coverage, and has a certain real-time performance. The operating statues of the electric meter can be predicted preliminarily, and the user's electricity behaviour can be excavated, with the help of the mining in site inspection data. Combined with the Power Supply Information Collection System, site inspection data will play its unique advantages and provide effective information in big data analysis to making data mining more in-depth.

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