Research and Application of "Transparency" System for Sampling Inspection of Power Materials

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Abstract—Aiming at the problem of insufficient transparency in the process of sampling inspection of power materials, the research and application of transparency system for sampling inspection of power materials are proposed. Based on the browser / server mode, the "transparent" system architecture of power material sampling inspection is designed. This article is based on the working principle of the B/S architecture server. This paper analyzes the working mode of the power material sampling server, designs the power material sampling server, and completes the hardware design of the system. Based on the corresponding power material time weight and power material sampling data, this paper analyzes the historical quality of the system. According to the correlation between independent variables and dependent variables, the quality pass rate of power materials is predicted by calculating the sum of residual squares. Combined with the design of power material sampling process, the software design of the system is completed, and the power material sampling is realized. The test results show that the proposed "transparent" system has better sampling effect in the maximum completion time and the non sampling rate of the deadline.

1. Introduction
Power material quality is an important condition for the stable operation of power systems and power networks, and also an important guarantee for power system security and people's property security. Therefore, the spot check of power material quality is an important work in power management [1]. The power industry must unify the management of power materials and establish a sound power material supervision system. Fundamentally strengthen the supervision of power material procurement and product quality. Improve the operating efficiency of power enterprises, and ensure the quality and safety of power supplies. This can ensure the stability and operating quality of the entire grid system [2]. With the rapid development of China's economy, the demand for electricity is growing, and the competition in the market of power materials is increasingly fierce. In the bidding procurement of power materials, some suppliers reduce the cost in order to achieve the goal of winning the bid. The problem of producing substandard power materials is increasing gradually. Therefore, the power enterprises must do a good job in the quality supervision of transparent power supplies sampling inspection, assume the social responsibility for the supply of safe power supplies [3]. The differential sampling strategy is an effective means to improve the quality management of power materials. But the existing material sampling inspection generally uses manual sampling inspection, which has consumed an amount of time and energy, the sampling rate is not high.

In response to this problem, there have been related studies. Reference [4] proposed an artificial intelligence-based power material sampling system. Based on the intelligent reasoning engine algorithm, according to the knowledge graph structure, construct the supplier sampling strategy rule library to
realize the intellectual output of the sampling inspection. Reference [5] According to the business needs of electric power materials sampling inspection, using the Internet of Things and flexible testing technology, build an intelligent flexible detection framework and integrated data processing platform for electric power materials, and improve the quality control system of material sampling inspection.

Drawing lessons from the design ideas of the above research system using intelligent computer technology, this paper designs a "transparency" system for random inspection of electric power materials. In the hardware design, AJAX technology and Browser/Server architecture are used to design a "transparent" server for power material sampling. In software design, a polynomial regression model is used to design the electric power material sampling process, calculate the residual square sum, predict the quality qualification rate of the powder material, and complete the system's transparent identification of power materials.

Different from the existing power material sampling inspection system, the hardware design of this article realizes the automatic identification of materials and the automatic collection of management data. The software design in this paper ensures the standardization and accuracy of material quality management data. The experimental results prove that the system designed in this paper solves the problems of traditional manual sampling and testing. This system improves the effect of power material sampling and testing from the perspective of time and sampling rate.

2. Hardware design of "transparency" system for electric power material sampling inspection

2.1. "Transparency" System Architecture Design for Power Material Sampling Inspection

The "transparency" system of electric power material sampling inspection is a supervision system for the overall management of the quality of purchased electric power materials. The so-called "transparency" not only means that the quality of power supplies is transparent to the sampling inspection party, but also that the enterprise can obtain the sampling inspection process and sampling results in real time by accessing the server terminal. Therefore, the power material sampling inspection system is also designed from these two aspects.

Using AJAX technology [6], the client data is collected and sent to the database server through the Browser/Server architecture. At the same time, sample sampling is performed on the collected data through the database server, and obvious sampling results are obtained through analysis, to achieve "transparency" in the sampling of materials. Figure 1 shows the "transparency" system architecture for electric power material sampling inspection.

In Figure 1, the database server cloud application is mainly for data integrity management and data security management, with big data storage, collection and analysis functions. Among them, the
database server cloud mainly uses the associated database and client information data to completely and securely store the relevant data of power material management in the supervision system[7].

2.2. Design of Server for Sampling Inspection of Electric Power Materials

The Browser/Server (B/S) structure is the structure of the browser and the server. It is an improvement of the C/S structure based on Internet technology. It is a new type of server structure [8]. The working principle of the B/S structure server is as follows as shown in Figure 2.

Fig.2 B/S architecture server working principle diagram

The B/S architecture server obtains the database transmission protocol in the TCP/IP model, the front end accesses the client through the WWW browser, and part of the transaction logic is implemented in the front end Browser. The back-end uses client software to access the database, and the main transaction logic is implemented on the server side, which effectively guarantees the accuracy of big data sampling. The local area network establishes a B/S network system, and extracts and uses the database in the Internet mode, which effectively simplifies the client computer load, reduces the cost and workload of maintenance and upgrades, and can also ensure the integrity and security of the data [9]. The power material sampling server in this paper is designed based on the Browser/Server (B/S) structure.

The Net framework technology is used to develop the electric power material sampling inspection server to realize the compatibility of the sampling inspection system with the existing operating system[10], and to realize the transparent operation of the database sampling inspection. The working mode is shown in Figure 3.

Fig.3 Sampling server working mode
This paper uses a B/S architecture server, through the SQL Server Native Client 11 server. This paper uses clients inside and outside the local area network to access the electric power material sampling inspection system to become more convenient, faster and more efficient. For the client, as long as there is a network inside the enterprise, it can access the server terminal. Any browser can use the system. Not only can it be accessed by the outside world in the local area network, but the user side can also use the system at any time, giving full play to the advantages of the transparent structure of the B/S architecture server.

Based on the browser/server model, a “transparency” system architecture for electric power material sampling inspection is designed. We analyzed the working model of the power material sampling server based on the working principle of the B/S architecture server. In this paper, the power material sampling server is designed, and the hardware design of the system is realized.

3. "Transparency" System Software Design for Power Material Sampling Inspection

3.1. System software overall design ideas
Electricity materials are a continuously produced product, and continuous fluctuations often occur in quality control. The quality of electric materials can be predicted through "transparency" sampling software design.

The development of the "transparency" of the power material sampling inspection system has allowed us to realize the long-awaited automatic identification of materials and the acquisition of power material management data in the power energy system. This also provides a guarantee for the standardization and preparation of the material quality management data. However, the system must have the function of automatically generating a monthly sampling table through sampling indicators and power supply progress. This process needs to be based on historical data. Using a polynomial regression model, using residuals and iterative formulas to calculate the correlation between independent variables and dependent variables, predict the quality qualification rate of power supplies, and optimize the sampling inspection process of power supplies.

3.2. Detailed design of system software

3.2.1. Iterative calculation of quality qualification rate
The historical data of the quality of power materials will have a certain impact on the results of the modeling, and the historical data can be assigned time weights according to the time sequence. To predict the quality of power materials in the current cycle, we need to learn from the power material quality data of the previous \( m \) cycles. The time sequence is \( V^{*}_{t-1} > V^{*}_{t-2} > \cdots > V^{*}_{t-m} \), and \( V^{*}_{t} \) is more important than \( V^{*}_{t-1} \). After calculation, the time weight corresponding to power materials should be \( \omega^{*}_{t-1} > \omega^{*}_{t-2} > \cdots > \omega^{*}_{t-m} \).

According to the historical quality sampling data of power materials, the quality of power materials in the \( t \) period is predicted. Assuming that the first \( m \) periods are \( t_1, t_2, \ldots, t_m \), the qualified rate of power material supplier \( i \) corresponding to the quality of power materials is \( G_{i1}, G_{i2}, \ldots, G_{im} \). A polynomial regression model is used to analyze the correlation between the independent variable and the dependent variable, namely:

\[
\hat{G}_i = f(t_i) = \beta_0 + \beta_1 t_i + \beta_2 t_i^2 + \cdots + \beta_l t_i^l + \varepsilon
\]  

In equation (1), \( \varepsilon \) represents the random deviation of power material quality prediction, and \( (\beta_0, \beta_1, \ldots, \beta_l) \) represents the regression coefficient.

In the production process of power materials, the quality of power materials obeys a normal distribution, which will cause random errors. Equation (1) cannot pass the power material sampling data
points, that is to say, $\hat{G}_{ji}^*$ and $G_{ji}^*$ are not necessarily equal, and there is a residual error between the two:

$$\gamma_j = G_{ji}^* - \hat{G}_{ji}^*$$  \hspace{1cm} (2)

According to the calculation result of the residual $\gamma_j$, the sum of squares of the residual is calculated as:

$$G_j = \sum_{k=1}^{n} [G_{ji}^* - (\beta_0 + \beta_1 t_j + \beta_2 t_j^2 + \cdots + \beta t_j^t + \varepsilon)]^2$$  \hspace{1cm} (3)

When the sum of squares of the residual $\gamma_j$ is closer to 0, it indicates that the fitting effect is better. After the calculation formula of the residual sum of squares is fitted, iterative calculations can be carried out in the $t = t_{m+1}$ period to predict the quality qualification rate of power supplies.

According to the time weights corresponding to power supplies, a polynomial regression model is used to analyze the correlation between independent variables and dependent variables. Using the iterative calculation of the residual sum to predict the quality qualification rate of power supplies.

### 3.2.2. Optimize the electric power material sampling inspection process

The optimized sampling inspection process of electric power materials in this study is shown in Figure 4.

![Flow chart of electric power material sampling inspection](image)

In Figure 4, relevant departments can download it as needed.

### 3.3. Database design and implementation

At the same time, this "transparency" system provides an information storage platform, which can also realize functions such as automatic reading, processing reports, early warning, and recycling. And
promptly issue early warning information, verify and deal with bad behavior. In addition, the "transparency" system for sampling inspection of electric power materials can also check conditions such as material inspection date, sampling batch, and material code. This system realizes the fast query and statistical functions of quality sampling information. This "transparency" system can also provide a reliable basis for bidding for electric power materials. The specific method is expressed in the query, statistics, analysis, etc. of big data information technology and the generation of charts or images. In addition, the “transparency” system for electric power material sampling inspection has technologies such as data encryption, identity authentication, and authority management. Which play a great auxiliary role in improving the security of material quality supervision and management data. In addition, the risk control of power material quality information data management, and the hidden dangers of safety have also been greatly reduced.

In summary, this article is based on the time weight corresponding to the power material. And based on the historical quality sampling data of power materials, it analyzes the correlation between the independent variable and the dependent variable. This article predicts the qualified rate of power materials by calculating the sum of squared residuals. In this process, combined with the design of the electric power material sampling inspection process, the software design of the system is realized.

4. System test
In order to verify that the "transparency" system of power material sampling inspection proposed in this paper has better performance, the "transparency" system of power material sampling inspection in reference [4] and the "transparency" system of power material sampling inspection in reference [5] is used for comparison. From the three aspects of maximum completion time, non-sampling inspection rate by the deadline, and false inspection rate of electric power materials, the results of electric power materials sampling inspection are analyzed.

The test result of the maximum completion time of the electric power material sampling inspection is shown in Figure 5.

![Fig 5. Test results of the maximum completion time of electric power material sampling](image-url)

It can be seen from the results in Figure 5 that with the increase in the amount of power material sampling, the maximum completion time of the three power material sampling "transparency" systems is getting longer and longer. Reference [5] and Reference [4] have the problem of slow convergence in the “transparency” system of electric power material sampling inspection, which leads to a long maximum completion time. The “transparency” system proposed in this paper for power material sampling
inspection plans the shortest time that customers need to wait, the level of power material load balance, and the cost of sampling inspection tasks to complete as a single evaluation function, and has achieved a relatively good sampling inspection effect.

The cut-off time non-sampling rate test results of electric power materials sampling inspection are shown in Figure 6.

![Fig. 6. The cut-off time of power supplies sampling inspection results of non-sampling rate test](image)

It can be seen from the results in Figure 6. Compared with the other two methods, the method in this paper increases with the sampling amount of power materials. The non-sampling rate of the “transparency” system proposed in this paper for the random inspection of power supplies is the lowest, which is less than 5%. This is because the other two systems regard the deadline as a constraint, and the lack of "transparency" in the random inspection of electric power materials affects the final random inspection effect.

5. Conclusion
This paper puts forward the research and application of the “transparency” system of electric power material sampling inspection. Through the hardware design and software design of the “transparency” system of electric power material sampling inspection, the random inspection of electric power materials is realized. The results show that the proposed “transparency” system for power material sampling inspection has a better sampling effect.

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