Hindawi
Mobile Information Systems
Volume 2022, Article ID 1375331, 11 pages
https://doi.org/10.1155/2022/1375331

Research Article

Management of Power Marketing Audit Work Based on Tobit Model and Big Data Technology

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Received 17 June 2022; Revised 12 July 2022; Accepted 16 July 2022; Published 8 August 2022

Academic Editor: Chi Lin

In order to improve the management effect of power marketing audit work, this paper combines big data technology to carry out related data processing, changes the management mode of traditional power marketing audit work, analyzes the overall process and characteristics of the current power marketing audit case selection, and designs an audit system. Moreover, this paper builds a data warehouse based on data mining technology and realizes the process of automatic generation of the index system. In addition, this paper chooses the Tobit model proposed by Tobin, which is a restricted dependent variable model and can be better applied to the relevant analysis of power marketing audit indicators. Finally, this paper evaluates the effects of the method and system designed in this paper through simulation experiments. The experimental research results show that the power marketing audit management system based on big data technology can play an important role in power audits.

1. Introduction

The so-called power marketing audit mainly refers to the use of effective means and methods to carry out feasible and controllable quality audit and supervision of the marketing process of power enterprises. At present, the marketing audit of the electric power industry has become the most critical part of the marketing process of China's power supply enterprises, and it is also an effective measure to control risks in the professional operation of electric power marketing. In fact, the power marketing audit management work can be regarded as a key point in the entire power marketing process, and it is extremely important in the power marketing management work. The specific work it carries out will often directly affect the basic image and fundamental interests of power companies and, at the same time, will have a more important impact on the interests of electricity customers in the electricity market. There are many links in the processing of various electric power business operations, and problems in any one link may cause huge losses to the electric power company [1]. Therefore, the essence of power marketing audit management is a supervision process of management, cooperation, and operation of various links. This is a means implemented in order to maximize the protection of the power companies' own interests and the fundamental interests of electricity customers. This method can avoid the errors that may occur or exist in the various business of power marketing and prevent the occurrence of losses [2].

Many foreign countries have established energy regulatory agencies specifically responsible for economic regulation of energy (electricity). These regulatory agencies are responsible for the investigation and handling of violations of laws and regulations, dispute resolution, and handling of complaints and reports [3]. After long-term practical exploration, foreign regulatory agencies have gradually formed some mature practices and characteristics in the legal system, organizational system, and working procedures of the marketing audit business. It not only ensures the smooth development of the audit work, but also puts forward opinions on the rules and systems of the electricity market and promotes the reform of the national electricity market,

which is worthy of our reference. In the development of marketing audit informatization, the power informatization level of the United States, Japan, and Germany is the best. As early as 2003, the US Department of Energy held a high-level seminar on the future of the US power system and formed the long-term goal of the Grid2030 plan. At present, almost 100% of US electric power companies have basically realized system integration work and realized the use of information technology to conduct auxiliary analysis and audit monitoring of electric power marketing work [4]. The main purpose of power audits in the UK power market, which has achieved the separation of transmission and distribution, is to monitor and evaluate the operational efficiency of the power grid and improve the quality of power supply. For example, the detection of market power demand includes the prediction of the power demand of the whole society on the user side and the expected load growth of the power grid. Among them, the demand forecast on the user side includes power load and power, customer satisfaction, and power supply reliability. In further detail, it also includes power demand forecasts within the jurisdiction of different power companies.

The so-called power marketing audit mainly refers to the use of effective means and methods to carry out feasible and controllable quality audit and supervision of the marketing process of power enterprises. At present, the marketing audit of the electric power industry has become the most critical part of the marketing process of China's power supply enterprises, and it is also an effective measure to control risks in the professional operation of electric power marketing.

This article combines big data technology to construct a power audit work management system, which improves the efficiency of power audit while further improving work efficiency, and provides a theoretical reference for the further development of subsequent power audit work.

2. Related Work

The United Kingdom is the first country in the world to carry out electricity market reforms. The Office of Gas and Electricity Markets in the United Kingdom is an organization independent of the government, and the electricity regulatory agency supervises both electricity and natural gas markets in the United Kingdom [5]. The Competition Policy and Law Enforcement Department is set up under this regulatory agency. Its main task is to be responsible for the audit business of the electricity market and maintain the stable operation of the electricity market. Australia's electricity marketization is also relatively high. The main responsibility of the Australian Energy Regulatory Agency (AER) is to manage the national electricity market, formulate relevant laws and regulations, and promote the reform of the national electricity market. Moreover, AER also includes audit departments, which mainly carry out audit work within the scope of the power market in various regions of the country [6]. The United States has a high degree of electricity marketization. As a federal country, state-level government departments enjoy a high and independent status [7]. Therefore, the United States has formed a federal and state regulatory system in the electricity market. The Federal Energy Regulatory Commission (FERC) is responsible for state-level power economic regulation, and the State Public Utilities Regulatory Commission (PUC) is responsible for state power regulation. FERC and PUC include the departments that deal with complaints and reports, the departments that mediate disputes, and the departments responsible for administrative penalties [8].

Among the institutions set up within FERC, the three offices, the Law Enforcement Office, the Administrative Litigation Office, and the Administrative Judge's Office, are directly in charge of the inspection work. Based on years of auditing practices, the Law Enforcement Office, Administrative Litigation Office, and Administrative Judge's Office coordinated and cooperated with each other to form a complete audit system and process system. The three offices perform their duties, complement each other, and supervise each other [9]. For example, the Audit Department of the Law Enforcement Office regulates and manages the operation and management of relevant electric power companies according to a certain time frame. The inspection department performs investigation duties and is responsible for handling violations reported by the audit department or other institutions that have been ruled by the committee; if the punished person disagrees with the law enforcement, the office's investigation conclusion can exercise the right to appeal. The Administrative Litigation Office accepts its appeal or adopts other effective methods to resolve incidents and disputes to ensure the speed and fairness of the litigation process and ensure that the case resolution complies with FERC regulations [10]. In order to protect the legitimate rights and interests of clients, the Office of the Administrative Judge needs to conduct detailed investigations and fair punishments of violators or adopt mediation to solve problems. Through the accumulation of long-term practical experience, the US Energy Regulatory Agency has gradually formed a sound system in terms of handling appeals and reporting, coordinating disputes and punishing non-compliance with laws and regulations, and investigating the inspection work [11].

It can be seen from the investigation of relevant literature that there is relatively little research in this field at home and abroad regarding the risk of the marketing business of the power supply company. The more mature research is the power market risk in the process of or after the reform of the western power market. And most of them are related to the financial aspect. Among them, the representative research results are presented in the following. Literature [12] studied the risk management in the competitive power market environment and established the VAR model and its improved CVAR model; literature [13] showed that the utility function and the VAR model are mainly used for the risks that users generate when purchasing electric energy. Literature [14] studies the impact of relevant laws, regulations, and policies on the benefits and risks of power companies in the government's deregulated electricity market;

literature [15] studied the risk assessment of load forecasting errors, combined the differential autoregressive moving average model with the artificial neural network model, predicted the load curve, and then calculated the variance of the load change value.

3. Power Marketing Audit Management Algorithm Based on Big Data Technology

The so-called data mining is to extract effective and available resources and knowledge from the ocean of large amounts of information. There is a large amount of basic data in government and enterprises, and this information is often messy and unrelated, and valuable information may be hidden in it. The conventional analysis tools of this information cannot be expressed. Only through data mining can the hidden information and knowledge be extracted, and the knowledge can be used to guide the work planning and research direction of the government and enterprises. The core step of data mining is the process of knowledge discovery in database (KDD), that is, the step of obtaining the required knowledge module by a specific algorithm in KDD; and the result of its operation directly affects the reliability of the discovered knowledge.

At present, knowledge mining is mainly divided into three stages, and the process is shown in Figure 1 [16].

What data mining needs is to use different methods to take relevant tests for different data to complete different tasks. At present, the more common data mining methods include genetic algorithms, artificial neural networks, and other methods. Although each method has its pros and cons, there is still no general data mining method. More often, different methods are combined and connected in a certain way to make a data mining model, so as to solve some specific problems in a targeted manner [17].

Through the existing different known data, the prediction model can predict the future. Although it cannot provide a very detailed prediction for the entire model, it at least provides a raw data, such as the annual turnover of a restaurant and so on. In this way, these relatively primitive data can provide a more valuable and meaningful reference value for future power marketing and other related fields.

The descriptive model is to classify and summarize the relationships and related rules of some related categories in the data. Moreover, compared to the predictive model, the descriptive model is a more advanced model with more variables. The main classification of the two models is well reflected in the figure below, and the difference between the two is also very well represented in Figure 2 [18].

At present, data mining mainly has the following common analysis and prediction methods:

(1) Linear regression analysis method: for tax-related problems with linear characteristics, linear regression forecasting is the main analysis method. Based on the influence factors of the variable in time, it is divided into two methods: unary linear regression analysis and multiple linear regression.

(2) Nonlinear regression prediction method: exponential curve predictive analysis method and quadratic curve predictive analysis method are commonly used methods to deal with nonlinear power marketing problems. For the electricity marketing problem that continues to grow at a steady rate, the corresponding exponential curve model forecasting model can be established through the exponential curve forecasting method to estimate. If there is a quadratic function relationship between power marketing and a certain macroeconomic variable of the country, the quadratic curve model can better explain it.

(3) Association analysis: association mining algorithms can effectively identify the inherent association relationships between different fields in the data. The more classic algorithm is the Apriori algorithm. At present, the association mining algorithm is mainly used to mine the interrelationships of commodities involved in the massive business operations of enterprises and, on this basis, to measure the consumption behavior of potential customers.

(4) Neural network prediction method: for explained variables with many influencing factors, neural network prediction method is the most suitable predictive analysis method. In addition, compared with other analysis methods, the neural network prediction method effectively avoids the process of defining whether the model is linear in the modeling stage and greatly simplifies the construction and operation of the model.

(5) Classification analysis: the classification method is a kind of guided learning, the category must be clear, and there must be a certain amount of data that has been obtained the classification results to create a classification model (the most commonly used are decision trees, neural networks, etc.), and then it can be used. This classification model classifies new data and is often used to classify customer groups and adopt different marketing methods for customers belonging to different categories.

(6) Cluster analysis: the core idea of cluster analysis is data classification; that is, target data is classified according to different similarities, similar data have similar designated characteristics, and different types of data are different from each other. Cluster analysis is similar to association analysis and has the characteristic of exploring the correlation of data attributes. Among them, the dissimilarity of clusters is calculated based on the attribute value of the description object, and the distance is a frequently used measurement method.

(7) Sequence mode analysis: as the name implies, the sequence mode is used to predict a sequence of actions in a chronological order. For example, in a shopping transaction database, it may be found that the user will purchase a printer for a period of time after purchasing a computer. This is a rule. For another example,

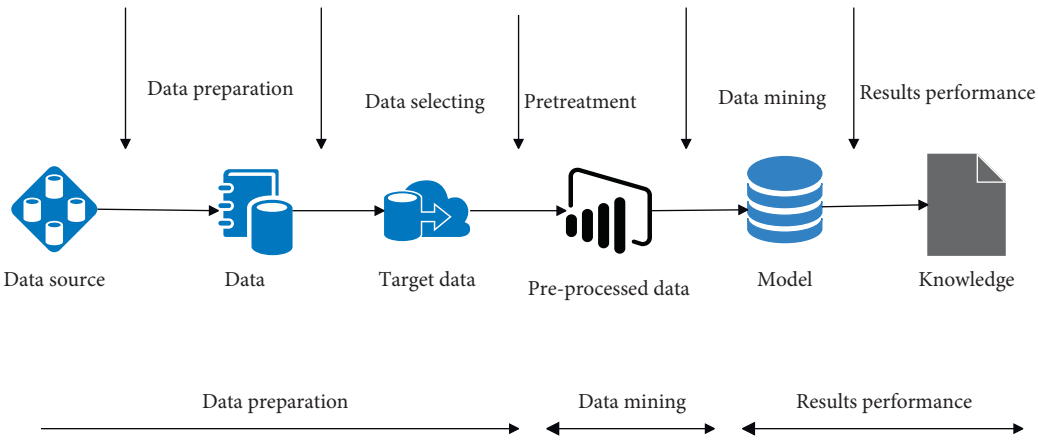

Figure 1: The steps of knowledge mining.

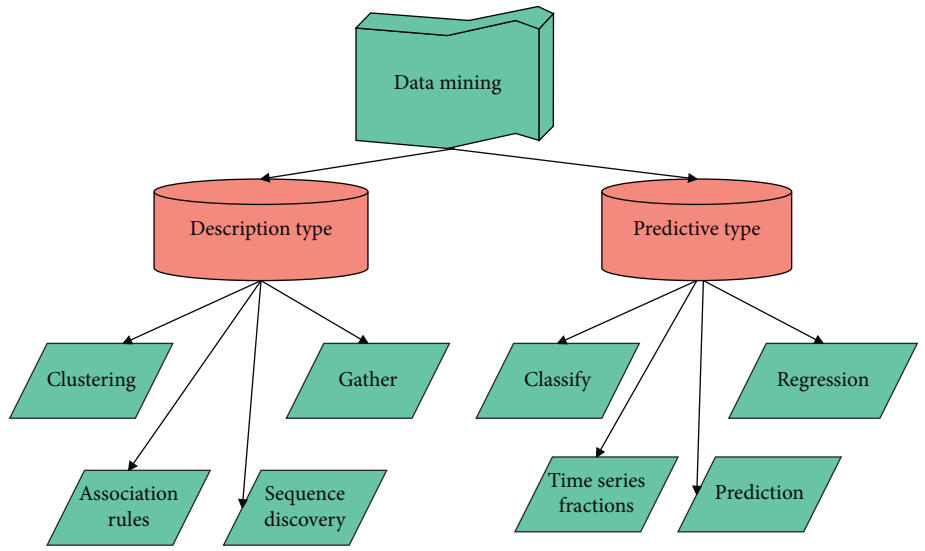

Figure 2: Analysis method of data mining.

through web log analysis, we can find that website viewers usually have a special page flow when browsing pages. Finding such a rule will help the website further provide more user-friendly services.

The various forecasting methods and methods listed above can be classified into two main categories: one is explanatory forecasting methods, which means that some special values are found from different variables or influencing factors. Some specific things establish a very complete linear regression model; the other is a time series analysis method; this method is mainly a systematic and purposeful and targeted research, analysis, and induction of various past data so as to find out the rules and provide relevant suggestions for future decision-making [18].

Data mining technology has broad prospects in the field of electric power marketing audit due to its intuitive, concise, and efficient characteristics. Some experts and scholars at home and abroad have put forward many viewpoints in this regard. The main direction of their research is to mine unknown information through different data mining algorithms from the built data warehouse and apply it to the intelligent selection of audits. After that, by mining the basic information of electric power marketers and analyzing electric power marketing behaviors, the source of the cases that may have problems is screened.

Tobit model: its main form is as follows: it sets a certain electricity expenditure as the explained variable y_i and the corresponding explanatory variable as X_i. Then, we can know that there are only two results for the electricity expenditure level y_i: one is greater than y_0, which represents the minimum expenditure level of the electricity, and the other is directly zero. Therefore, under the research assumption that the model is linear, the relationship between power expenditure y_i and explanatory variable X_i is [19]

$$y_i = \begin{cases} \beta^T X_i + e_i, & \text{if } \beta^T X_i + e_i > y_0 \\ 0, & \text{other} \end{cases}, \quad e_i \sim N\left(0, \sigma^2\right), i = 1, 2, \ldots, n. \tag{1}$$

Among them, Xi is the (k+1)-dimensional explanatory variable vector, and β is the (k+1)-dimensional unknown parameter vector. This model is called a censored regression model. We deform the above model and subtract y_0 from both sides of the equation under the premise that y_0 is known. In the resulting model, the constant term is equal to the original constant minus y_0. The form of this model is called the Tobit model [20].

$$y_i = \begin{cases} \beta^T X_i + e_i, & \text{if } \beta^T X_i + e_i > y_0 \\ 0, & \text{other} \end{cases}, \quad e_i \sim N\left(0, \sigma^2\right), i = 1, 2, ..., n. \tag{2}$$

The Tobit model can also be expressed as

$$y_i = \max\left\{\beta^T X_i + e_i, 0\right\}, \quad fdghjk. \tag{3}$$

or

$$y_i = \beta^T X_i + e_i, \quad y_i = \begin{cases} y_i, & \text{if } y_i > 0, \\ 0, & \text{if } y_i \le 0. \end{cases} \tag{4}$$

For the Tobit model, the explanatory variable Xi is observable (that is, Xi takes the actual observation value), and the explained variable y_i cannot be directly obtained, but is observed in a restricted way. When $y_i^* > 0$, $y_i = y_i^* > 0$, y_i at this time is the "unrestricted" observation value. When $y_i^* \le 0$, $y_i = 0$, at this time y_i is the "restricted" observation value. Obviously, "restricted" observations are all truncated to 0, and "unrestricted" observations are taken as actual observations.

For the analysis of the Tobit model, the core idea is to measure the estimated values of β and σ^2 based on n (n> k) observations of y_i and X_i. When using the model, we assume that when $y_i = 0$, the observed value is n_0, and when $y_i > 0$, the observed value is n_1; then the total amount is $n = n_0 + n_1$.

If the observation value n_0 at $y_i = 0$ is ignored, then the remaining n_1 observation values are complete observation values (yi > 0), and β can be estimated by the least square method in the calculation. However, the least squares estimate in this range is biased and inconsistent. Then, the conditional expectation of the observation value y_i at $y_i > 0$ is [21]

$$E\left(e_i | y_i > 0\right) = E\left(e_1 | e_i > -\beta^T X_i\right) = \sigma \cdot \frac{f_i}{F_i}. \tag{5}$$

Therefore,

$$Y_i = \beta^T X_i + e_i = \beta^T X_i + \sigma \cdot \frac{f_i}{F_i} + u_i. \tag{6}$$

Among them, f_i and F_i are, respectively, the probability density function and the distribution function of the standard normal distribution under the condition $(\beta^T X_i/\sigma)$. Since the least squares estimator does not calculate the item $\sigma f_i/F_i$ that is not independent of Xi, the least squares estimator is biased and inconsistent. Since $e_i \sim N(0, \sigma^2)$,

$$E\left(e_i | y_i > 0\right) = \sigma \cdot \frac{f_i}{F_i} > 0. \tag{7}$$

That is, the least squares estimator of β is biased.

If $n = n0+n1$ observations are taken into consideration, the unconditional expectation of yi is $E(y_i) = F_i \cdot (\beta^T X_i) + \sigma \cdot f_i$.

Therefore, even if the least squares method is applied to all n observations, the unbiased and consistent estimators of the Tobit model are difficult to obtain. In summary, the maximum likelihood estimators of β and σ^2 are consistent estimators, and the maximum likelihood estimation method is the preferred method for calculating the estimator of the Tobit model.

The core of this research design is to extract appropriate data from the huge power marketing audit management system to establish indicators. This involves the storage and extraction of power marketing data and the process of data mining. At this stage, the establishment of a special audit data warehouse is the development trend of electric power marketing. This chapter will discuss the related concepts of the data warehouse, design the construction process of the data warehouse, and give the Tobit regression analysis steps based on the discriminant method.

Because of the continuous extension and broadening of its concept, the data warehouse itself has continued to develop and expand. As far as we can conclude, the entire data warehouse has the following characteristics:

(1) Subject-orientation: an abstract theme is mainly used to show how different customers are concerned about the analysis of different data. Each topic is a field of data analysis, and the topics are independent of each other.

(2) Integration: the data in the data warehouse is formed by extracting, processing, and analyzing data from different data sources. In this process, the data in each data source should be consistent in order to achieve effective extraction, processing, and analysis from each other.

(3) Relative stability: it refers to the phenomenon that once the data in the data warehouse is loaded or used, it will be stored for a long time and the data will rarely be modified such as changes and deletions.

(4) Reflecting history: the data in the warehouse obviously represents a certain period of time in the past. It stores a certain period of historical data. The choice of time point is mainly to meet the needs of decision support analysis.

(5) Dynamic data: the data in the warehouse is not completely static. In order to meet the needs of decision-making, the latest data must be frequently loaded into the data warehouse, and from the perspective of operational efficiency, the data beyond the scope of statistical analysis must be archived to tape, or it is also nonstatic to make some appropriate corrections to the data in the warehouse, such as on the CD-ROM.

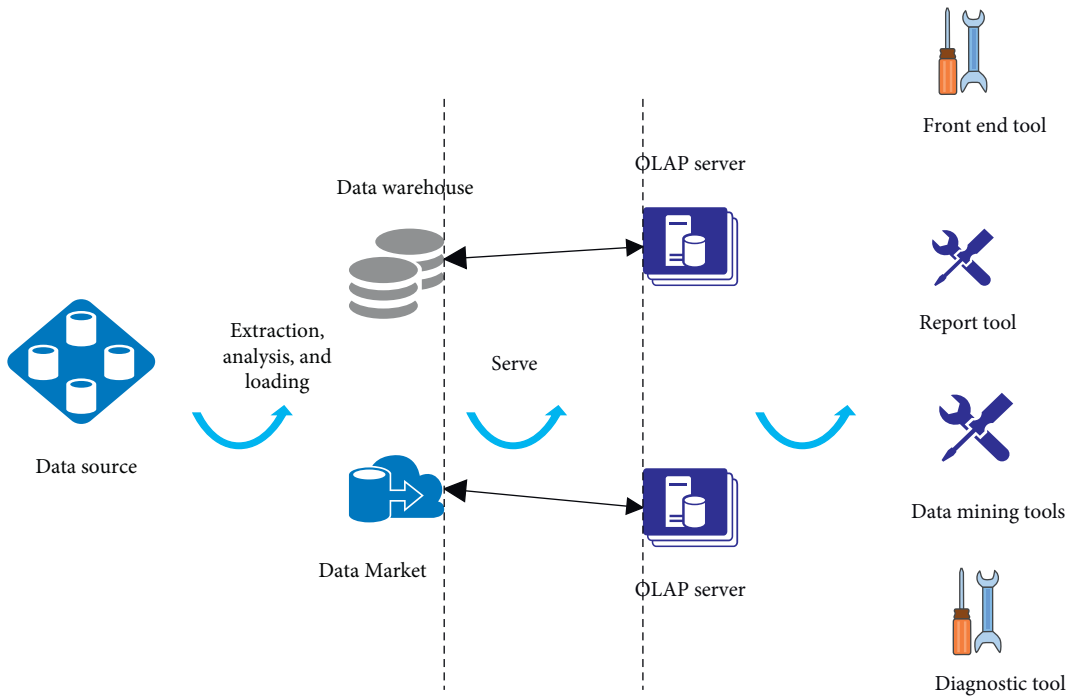

Figure 3: System structure of data warehouse.

According to the above, we can find that the data warehouse is actually a kind of dynamic, can reflect a certain reality very quickly, and can provide relevant decision makers or leaders with very effective data and information in a short time., So as to help them realize an important tool for decision-making. In addition, the data warehouse is therefore regarded by many people as a system and structure and can provide systematic research and analysis.

Data mining technology is based on massive amounts of raw data. In the same way, the use of data mining technology in the power marketing system must rely on a powerful power marketing information platform. The emergence of data warehouses effectively solves this difficulty and provides a strong guarantee for power marketing agencies to implement data mining.

The construction of the data warehouse is based on a large amount of existing business data, as shown in Figure 3. Moreover, the construction of a good data warehouse often requires a lot of manpower and money, and the relevant personnel need to have very good qualities and related technologies, and they must be very careful in the data entry process. Therefore, it is very difficult to build a data warehouse.

The data source is the basic element of the data warehouse. The key to a data warehouse is to store and manage data, conduct targeted information extraction, cleaning, and integration for different business systems, and organize them according to themes. According to the coverage of data, data warehouses can be divided into enterprise-level data warehouses and department-level data warehouses.

Data storage and management are the core of the entire data warehouse system. The main components are ROLAP, MOLAP, and HOLAP. The basic data and aggregated data of ROLAP are stored in RDBMS. The basic data and aggregated data of MOLAP are stored in a multidimensional database. The basic data of HOLAP is stored in RDBMS, and the aggregated data is stored in a multidimensional database.

The OLAP server can effectively integrate the required data and combine them in a certain structure for extraction, processing, and analysis and to find out effective information.

The front-end tools mainly include three stages: various reporting tools, query tools, data warehouse planning, and analysis phase; data warehouse design and implementation phase; and data warehouse use and maintenance. These three stages are a continuous cycle and an improvement process. Under normal circumstances, the data warehouse system cannot be completed in one cycle, but after many cycles of development, each cycle will add new functions to the system, so that the application of the data warehouse will be improved.

The development of everything has its own unique and complete life cycle, and so does the data warehouse. Generally speaking, the development and application cycle of a data warehouse can be divided into the stages shown in Figure 4.

In view of the cyclical principle of its operation and development, when we apply it to the development of the power marketing system platform, we compare its analysis, implementation, and maintenance in the three stages shown in Figure 5.

After establishing the power marketing audit selection data warehouse and the corresponding data mining algorithm, the key step of the research is to filter the appropriate indicator system from the excavated audit information, thereby establishing a Tobit regression model to evaluate the

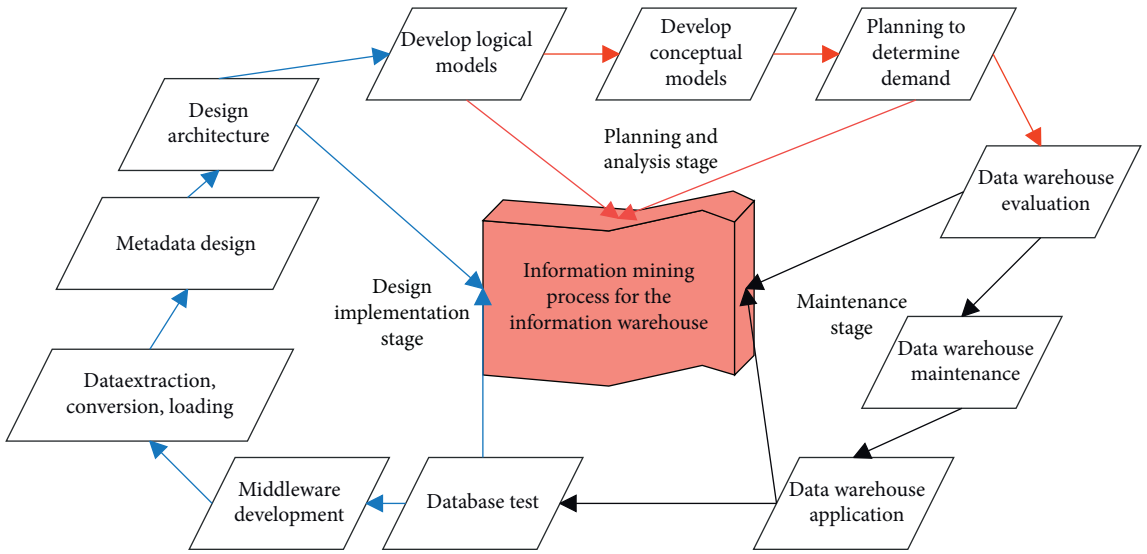

Figure 4: The information development process of the data warehouse.

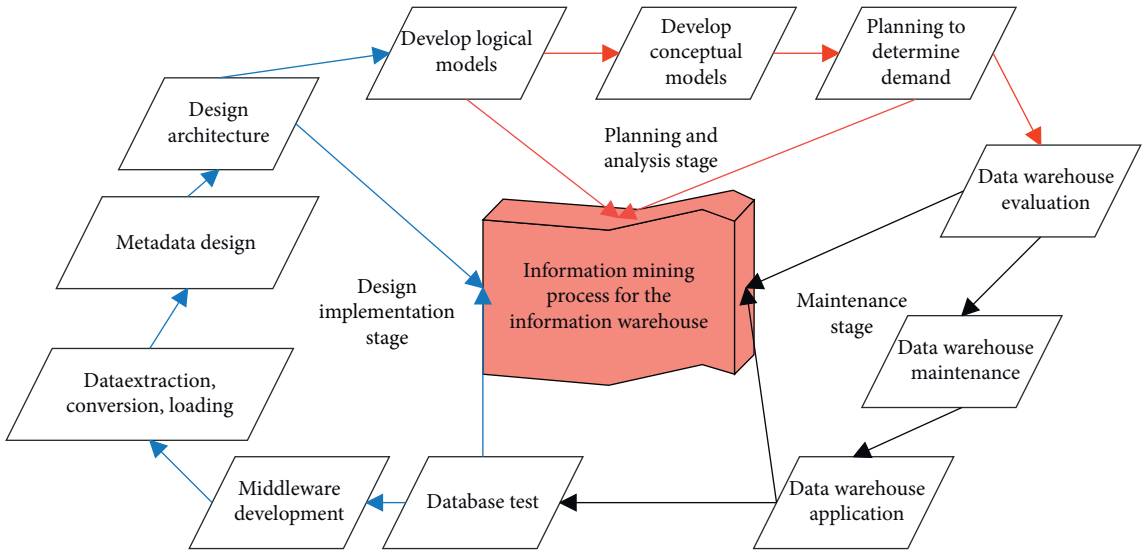

Figure 5: Application model of data warehouse for audit case selection.

power marketing situation and determine the scope of the case selection, as shown in Figure 6. Since the selection methods and principles of the index system have been systematically explained above, the corresponding power marketing analysis model can be simulated in combination with the research data under this research idea.

4. System Construction

The power marketing audit and monitoring system is designed to be centrally deployed at the provincial level, but is independent of the marketing business system; that is, the application release of the two systems does not affect each other. The systems realize application access through the integrated integration platform according to standard interfaces and business services encapsulated by models, call functions to obtain information from each other, and return results in real time. The designed application integration deployment logic diagram is shown in Figure 7.

In order to realize the seamless connection of process authority between the marketing business application system and the marketing audit monitoring system, this paper integrates the organizational authority, work flow of the audit monitoring system, and the marketing business application system to achieve the integration of the organizational authority of the two. At the same time, the data interaction between the production management system and other peripheral systems and the marketing audit monitoring system can also be implemented through the integrated platform. The process integration diagram is shown in Figure 8.

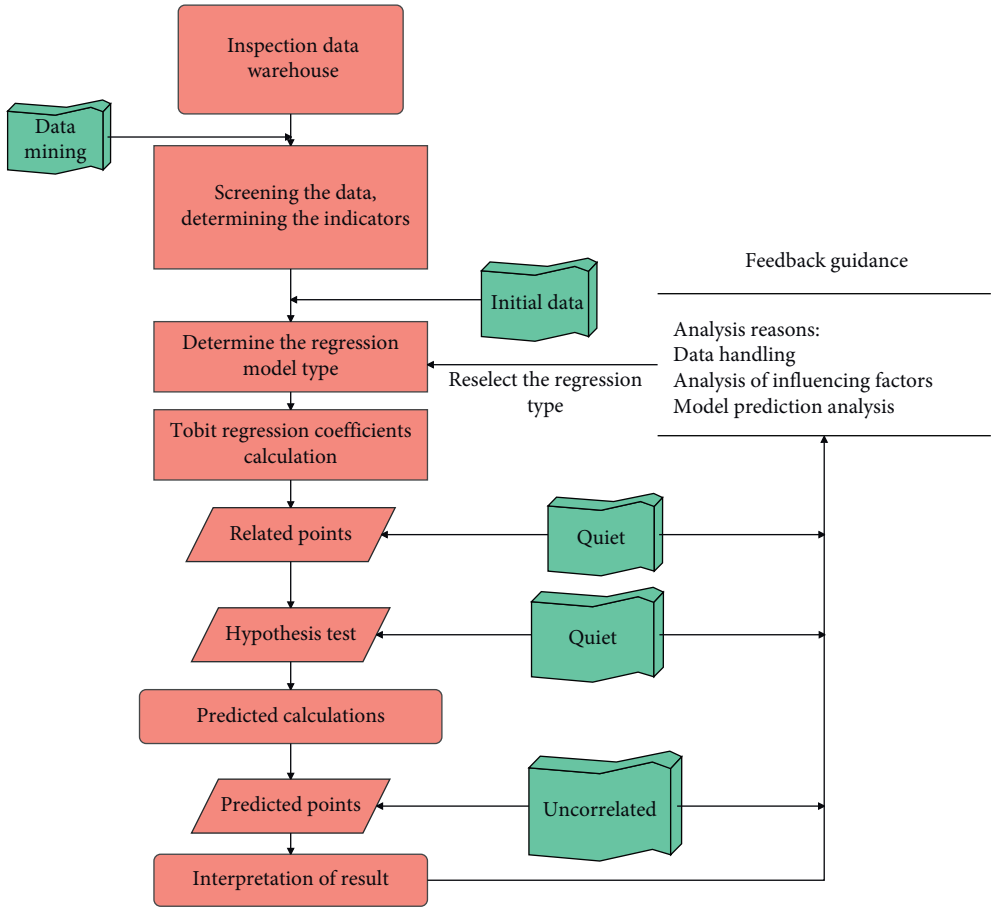

Figure 6: Tobit regression model establishment steps.

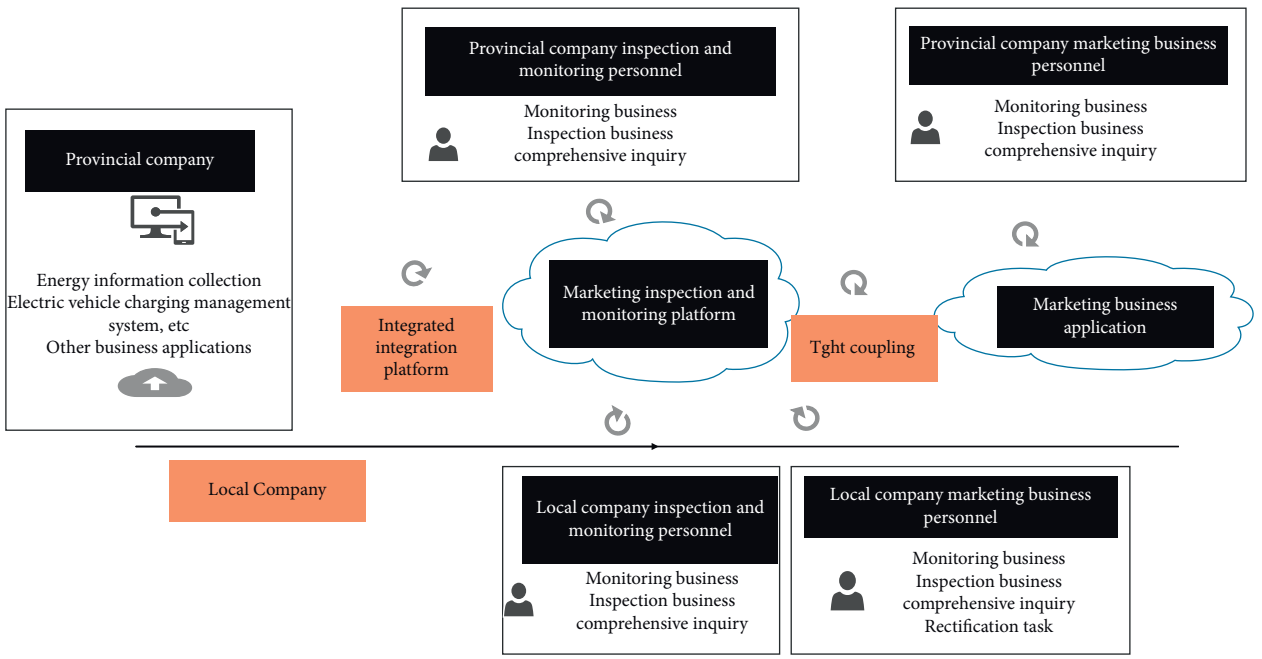

Figure 7: Logic diagram of application integration deployment.

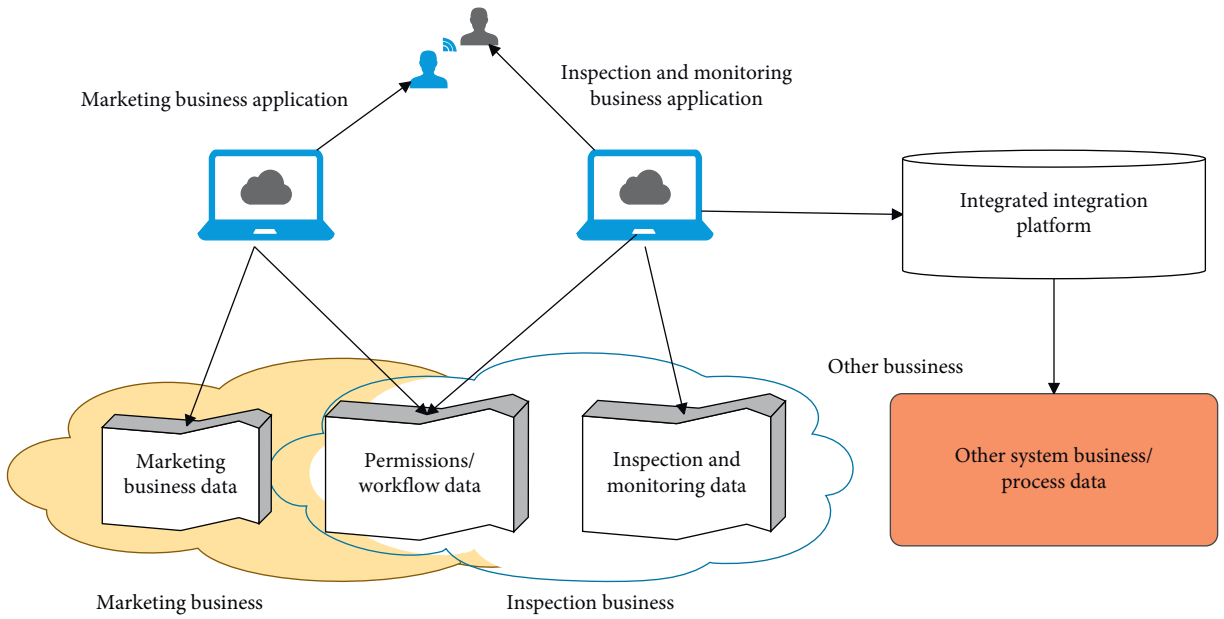

Figure 8: Schematic diagram of process integration.

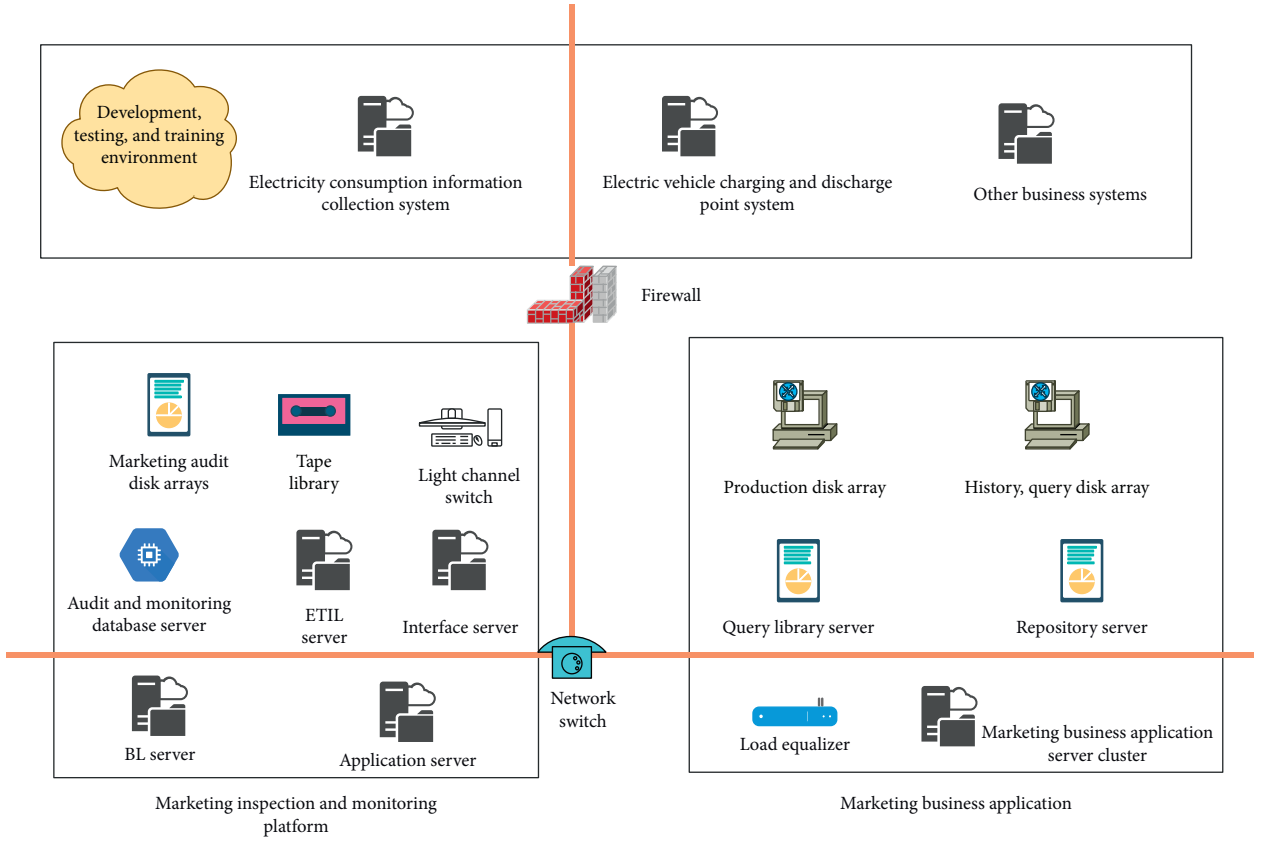

Figure 9: The physical architecture deployment diagram of the electric power marketing audit and monitoring system.

There are roughly two ideas for the design of the marketing audit monitoring platform. The first is to design the monitoring platform as an independent system that can maintain normal communication with related business systems. The second is to deploy the monitoring platform in the existing power marketing system. The two systems share the infrastructure such as the computer room, information security, and backup equipment. The second idea is used in the design of this paper. The physical architecture of the specific monitoring platform is shown in Figure 9.

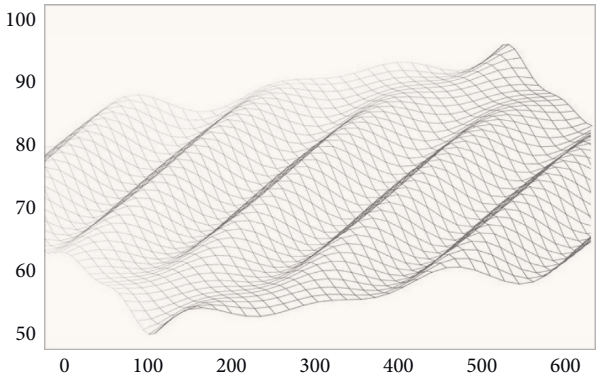

Figure 10: Data mining effect of power marketing audit management system based on big data technology.

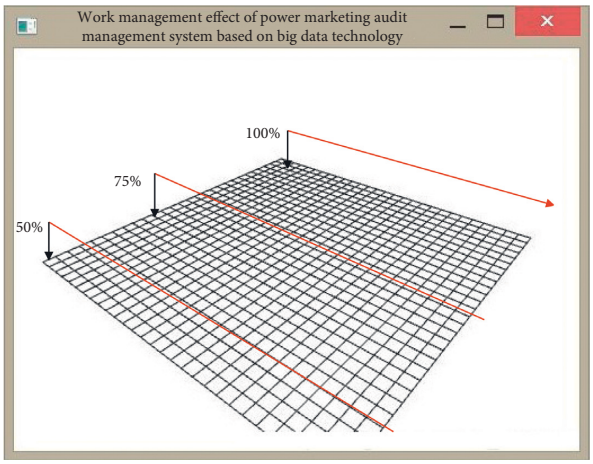

Figure 11: Work management effect of power marketing audit management system based on big data technology.

On the basis of the above research, this paper verifies the power audit data mining effect of the algorithm model proposed in this paper and builds a database based on historical data. Moreover, this paper uses the system proposed in this paper to perform data mining simulation, and the results are shown in Figure 10.

From the perspective of data mining simulation, the power marketing audit management system proposed in this paper can play an important role in power marketing audit data analysis. On this basis, this paper explores the effect of power marketing audit management system on the management effect of power marketing audit work, and the results obtained through simulation are shown in Figure 11.

From the above research, it can be seen that the power marketing audit management system based on big data technology can play an important role in power audits.

5. Conclusion

Power marketing audit management can be regarded as a key point in the entire power marketing process, and it is extremely important in power marketing management. The specific work it carries out will often directly affect the basic image and fundamental interests of power companies and, at the same time, will have a more important impact on the interests of electricity customers in the electricity market. Since there are many links in the processing of various electric power business operations, problems in any one link may cause huge losses to the electric power company. Therefore, the essence of power marketing audit management is a supervision process of management, cooperation, and operation of various links. This is a means implemented in order to maximize the protection of the power companies' own interests and the fundamental interests of electricity customers. In addition, this method is used to avoid errors that may occur or exist in the progress of various power marketing businesses and to prevent losses. This article combines big data technology to construct a power audit work management system, which improves the efficiency of power audit while further improving work efficiency, and provides a theoretical reference for the further development of subsequent power audit work.

Data Availability

The data used to support the findings of this study are included within the article.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding this work.

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