Research on Fixed Asset Management System for Power Grid Based on Whole Life Cycle

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Abstract. Power companies are asset intensive enterprises, and currently face various problems such as low asset lifespan, rapid asset growth, and chaotic management. In this context, transforming asset management methods has become an inevitable choice for power companies. Introducing new management methods and adopting full lifecycle management methods for asset management has become an important means of cost control for enterprises. Utilizing the power information system platform ERP system to achieve full lifecycle management is the optimal implementation method.

Keywords: State Grid Corporation of China, fixed assets, full lifecycle management

1 Introduction

As a fundamental resource for socio-economic development, electricity has long been under the basic control of the state. However, with the continuous promotion of market economy reform, the electricity market should also adapt to the development trend of the market economy, gradually breaking the monopoly development pattern, which is the goal and direction of power enterprise reform. In the four stages of power generation, transmission, transformation, and sales in the electricity market, according to the reform principle of "separation of power plants and networks, bidding for grid connection", the power generation stage has taken the lead in achieving market-oriented operation [1-3].

To meet the development needs of the market economy, various power companies need to carry out cost control and management, and improve their core competitiveness [4-6]. As an asset intensive enterprise, fixed assets are an important component of the value statement of power enterprises, accounting for a considerable proportion of the total assets of the enterprise. Power companies involve a wide variety of asset types, extensive content, significant asset growth rate, and high asset value, which enhance the difficulty of fixed asset management [7-8]. Therefore, promoting effective fixed asset management methods is one of the challenges that power enterprises must face.

The theory of full lifecycle management of fixed assets in enterprises originated from full lifecycle cost management, which can be traced back to the railway system in Sweden. At the end of the 20th century, the IEC organization released the international standard IEC60300-3-

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3, and eight years later, a revised version of the standard was released. In the power equipment manufacturing industry, many well-known multinational companies have also conducted LCC research on their research and development products, in order to improve the market competitiveness of their products and enhance the long-term development momentum of the enterprise [9-10]. In the LCC model, when conducting cost analysis on equipment, costs are decomposed into five aspects, namely input, operation, maintenance, failure, and abandonment costs [12]. Lai Jiadong, Yang Xiutai, and others divided the fixed asset lifecycle cost of the power industry into operation and maintenance costs and one-time inputs. However, the distribution model of operation and maintenance costs has no regularity in the cost distribution. They proposed a cost distribution model based on grayscale correlation analysis and applied this method to the equipment comprehensive automation project of substations, Using the relative comparison between real data and analytical model data to evaluate the applicability of formal models [11-13].

On the basis of studying the achievements of fixed asset full lifecycle management both domestically and internationally, combined with the current situation and characteristics of fixed asset management in power enterprises, this article analyzes the inherent deficiencies in current management work, proposes targeted methods for full lifecycle management, and integrates management methods with ERP systems. This electronic information operation platform integrates equipment management, material management, budget management The various functions of process task management and fixed asset management provide a scientific solution for the fixed asset management of power enterprises.

2 Basic knowledge of fixed assets

2.1 Overview of fixed asset management

Generally speaking, fixed assets are one of the most important production factors for enterprises to produce and add value to their products. The proportion of fixed assets in the intangible and tangible total assets of enterprises is quite high, which is an important factor affecting the scale effect and production effect of enterprises. Therefore, in asset management, the position and role of fixed asset management are very important. In practical management work, the types and quantities of fixed assets are very large, so there is still a long way to go for orderly and efficient asset management work. Throughout the entire lifecycle of fixed asset management, it involves six asset states, including planning, bidding and purchasing, construction, production and reuse, scrapping, and cleaning. The work content and business management types involved in fixed asset management include three, namely accounting, technology, and item management. Below, we will introduce these three types of business management separately.

Technical management considers asset management and maintenance from the perspective of equipment technology, while the business types involved in technical management cover multiple aspects such as the selection, evaluation, and selection and definition of technical solutions and strategies. Specifically, the work content of this management includes the development of maintenance operation plans for assets and their supporting kits, as well as the formulation of strategies for emergency troubleshooting and repair, the regulation of technical parameters for the normal operation of assets, the viewing of historical inspection records, as

well as the selection of asset types in the early stages of project initiation and the scrapping verification at the end of asset lifecycle.

Object management refers to the management of asset business content during different stages of the asset management process. Specifically, the content of transaction management includes the application and approval of multiple links such as asset increase, maintenance, change, renovation, scrapping, and cleaning in asset management, data changes after asset information changes, the formulation, printing, and pasting of asset labels, and periodic asset inventory.

2.2 Definition of full cycle cost management

The management of Life Cycle Cost (LCC) of equipment will inevitably evolve into the management of cost control for assets throughout their entire lifecycle after a certain degree and time of development. We refer to this stage of cost control management as Life Cycle Asset Management (LCAM), and the relationship between the two is based on the relationship between the foundation and high-rise buildings, After inheriting the advantages of LCC theory and undergoing appropriate development, LCAM theory is gradually applied to companies and enterprises with dense asset distribution. The main entry point of LCC theory is to measure the economic expenditure of equipment throughout its lifecycle. Its ultimate goal and core content is to make important judgments and decisions for the cost analysis of equipment or equipment systems throughout their lifecycle. It is a new asset management concept and way of thinking for power grid enterprises to calculate the minimum operating cost in asset lifecycle management work under the premise of meeting normal production activities and safety.At present, LCC full cycle cost management has become an important management method for equipment economic cost control in large enterprises worldwide, and the composition of its economic cost is shown in Figure 1.

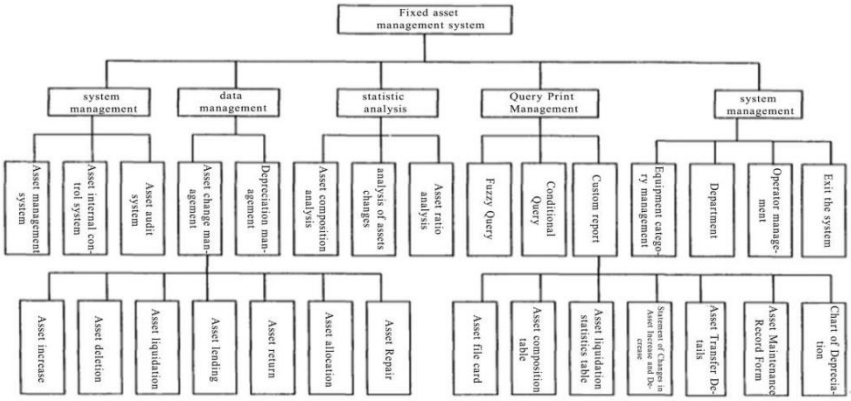

Fig. 1. Overall structure diagram.

The input cost here mainly refers to the procurement value cost of the equipment, including equipment costs, transportation costs, initial installation costs, and commissioning and network access costs, etc. The cost incurred before the equipment is put into operation and generates value-added. The operating cost refers to the expenses required for daily operation

of the equipment after it is connected and connected to the network, mainly divided into daily equipment inspection and maintenance, equipment environmental monitoring and maintenance, performance experiment turnover costs, etc. The maintenance cost mainly includes the cost of regular inspection of equipment operation, replacement of worn or warning equipment components, and preventive equipment experimental expenses, which can also be divided into three types: labor cost, equipment component cost, and experimental cost. The cost of failure includes two parts: maintenance costs caused by equipment failure and electricity consumption losses caused by power interruption or shortage caused by this failure. The latter is further divided into two types: direct and indirect losses. Direct losses mainly refer to the electricity collection losses caused by power supply interruption caused by power outage, while indirect losses are based on the perspective of users, Due to the power interruption caused by this fault, the power company should provide certain compensation for indirect losses to the electricity consuming enterprises or individuals according to the situation. Scrap cost refers to the cost of dismantling, cleaning, and destroying equipment or assets that have entered the network beyond their service life and service life. The consumption of labor, transportation, and material resources generated in this process is an important component of scrap cost, and the effective recovery of some equipment and panels is added to the scrap cost in a negative form.

Some calculation formulas used by power companies in fixed asset management. These formulas can help power companies better manage their fixed assets, improve asset utilization efficiency, and reduce maintenance costs. The following are some commonly used fixed asset management formulas for power companies:

$$X^* * (1 - Y^*)/Z^* = R^* \tag{1}$$

Formula 1 is the fixed asset depreciation formula, where X^* is the original value of the fixed asset, Y^* is the estimated net residual value rate, Z^* is the estimated useful life, and R^* is the annual depreciation amount.

$$X^* - L - T = V \tag{2}$$

Formula 2 is the fixed asset net value formula, where L is cumulative depreciation, T is impairment provision, and V is the fixed asset net value.

$$R^*/A^* * 100\% = S \tag{3}$$

Formula 3: Fixed asset utilization rate formula, where R^* is the actual usage area, A^* is the total area, and S is the fixed asset utilization rate.

$$W^*/(A + 1) = S^* \tag{4}$$

Formula 4 is the fixed asset maintenance cost formula, where W^* is the total maintenance cost, A is the number of repairs, and S^* is the cost of each repair.

3 Design of fixed asset management system for power grid based on full lifecycle

According to the characteristics of the development of power enterprises, traditional asset management methods are obviously no longer able to meet the requirements of refined

management. Improving and transforming asset management methods is currently one of the urgent problems that power enterprises need to solve. As the core management of all subsidiaries, State Grid Corporation of China takes a global system perspective, comprehensively analyzes the business process needs of the planning and design stage, procurement and construction stage, operation and maintenance stage, and technical renovation and scrapping stage, controls and implements strategies for all links, and achieves system optimization. This is also an important measure for current management reform.

3.1 Fixed asset management module

The fixed asset management module includes: fixed asset increase module, fixed asset decrease module, asset management module, engineering management module, report management module, comprehensive query module, and key indicator module. This will be explained separately here.

Fixed asset enhancement module: This module implements the approval process and card creation management business for new fixed assets from different sources. According to the different sources of assets, they are divided into: new construction fixed assets, zero purchase fixed assets, allocated fixed assets, and inventory surplus fixed assets. Different sources of fixed assets require different fixed asset enhancement processes and related business operations.

The engineering management specialist submits the asset delivery list associated with the project after the project settlement. Users enter physical information, financial information, ancillary equipment, and other information of assets in different processes, and finally establish fixed asset cards through the new project to fixed asset conversion process.

Zero purchase fixed asset increase: Implement the input and approval management function for enterprise zero purchase fixed asset increase fixed asset. Users submit a list of zero purchase to fixed asset conversion based on the zero purchase plan, and enter financial information, physical information, and ancillary equipment information at different stages of the process. After completing the zero purchase to fixed asset conversion approval process, a fixed asset card is finally established.

3.2 Database system design

A database system is a repository for managing and storing information. At present, the mainstream database vendors and products in the market are related to IBM DB2, MS SQL Server 2000, ORACLE 9i, Sybase, etc. They each have their own characteristics and advantages, and have played a huge role in different application fields. DB2 is a product of IBM, originating from SystemR and SystemR *, supporting platforms from PC to Unix, from small to large machines, and from IBM to non IBM products; Sybase is a high-performance and highly reliable relational database management system for online transaction processing.

Due to the wide variety and large amount of data involved in this system, we used multiple tables to differentiate data with different functions when designing the database system. The design of the database is shown in table 1.

Table 1. Database table design.

Entity Name	Entity Description	Entity attributes	Entity Name
Unit information	Record detailed information	Contact person, email, address, phone number	Unit information
Personal information	Record basic information	User ID, username, user ID	Personal information
Role	Record character information	Role ID, User ID, Number	Role
Authority	Record functional information	ID number, function name, affiliation	Authority

3.3 System experiment

To verify the effectiveness and feasibility of the system, we conducted a series of experiments. The experimental results are shown in table 2:

Table 2. Asset Category Table.

Number	Experimental steps	Observing phenomena	Data record
1	User login	The user is able to successfully log in	Success
2	Asset Information Management	Information can be successfully added	Success
3	Asset acquisition management	Claim information can successfully added	Success
4	Asset scrapping management	Scrap information can successfully added	Success
5	Asset maintenance management	Repair information can successfully added	Success

Logic functional testing is used to test the logic of a system, mainly targeting the business logic and operational logic of the system. The operation logic check mainly includes: page link check, relevance check, checking whether the function of the button is correct, information duplication, checking deletion function, etc. Taking system login testing as an example, as shown in table 3, describe the functional testing process of this system.

Table 3. Functional testing.

ID	20110607004	Name	System Login
Use case description	System login Enter the system with a valid username and password Page information includes: Page background display User name and password input interface, login system interface after inputting data		
Use case entry	Open IE and enter the corresponding address in the address bar to enter the login page of the system		
Test Case ID	Scene	Testing procedure	Expected results
TC1	Initial page display	Enter from the entrance of the use case	Design consistency
TC2	User name input verification	Enter an existing user	Admin input successful
TC3	Password entry	Enter data associated with username	Input successful
TC4	System login	Click the login button	Successfully logged into the system

The performance of the system is verified by calculating the asset utilization rate of subordinate organizations, which is derived from the total asset utilization rate of each organization, as illustrated in the figure 2 below.

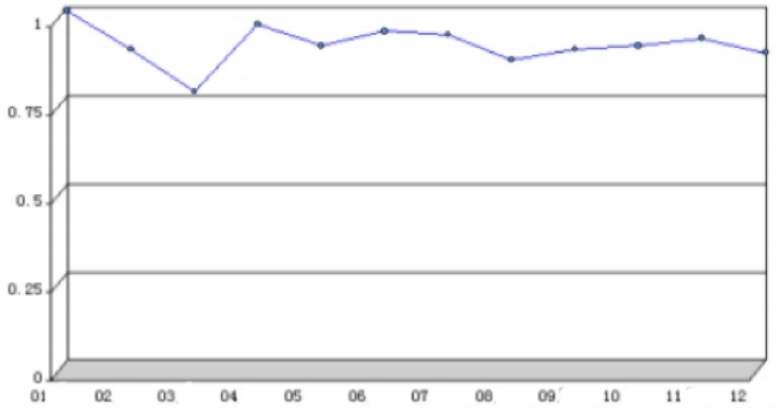

Fig. 2. Monthly Asset Ratio Curve.

The performance metrics for a workflow management system include whether the workflow model meets performance requirements, throughput, average turnaround time, resource utilization, and more. The system was performance-tested using LoadRunner 7.6.0.5, and the results are shown in the figure 3 below:

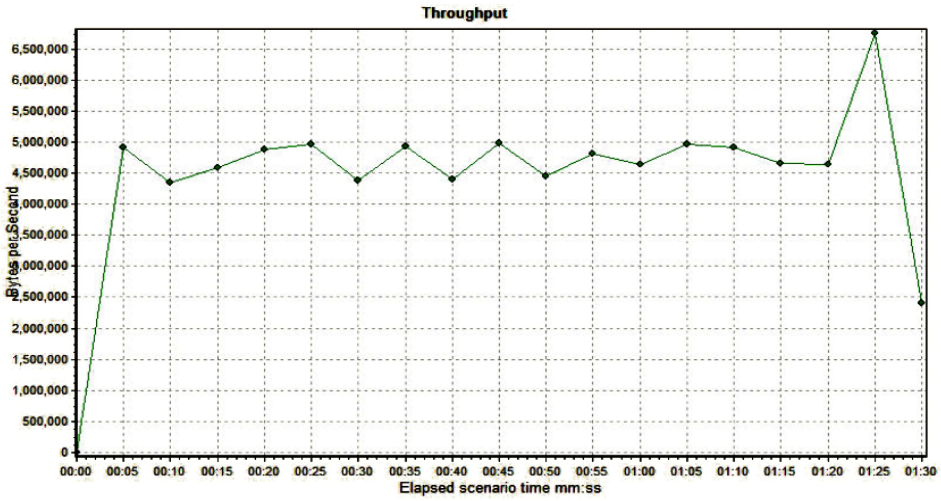

Fig. 3. Performance test result chart.

The above test results show that the stability of this system can effectively manage power asset management.

4 Conclusion

This article analyzes the current situation and prominent problems of fixed asset management in power enterprises, and explores the ideas and methods for establishing a comprehensive management information system for fixed assets in power enterprises. On the basis of a detailed analysis of the business requirements for fixed asset management in power enterprises, this paper uses application development tools to design and develop a software system that integrates fixed asset system management, data management, institutional management, statistical analysis, query and printing functions. This system has achieved standardized, modern, and information-based management of fixed assets in power enterprises, improving the quality and efficiency of fixed asset management in power enterprises.

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