# Study on The Cost Attribution Method of Power Grid Equipment Maintenance under Multi-dimensional Lean Management Model

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**Abstract**—The current conventional cost manage- ment model of power grid operation has the problem of single cost apportionment standard, which leads to the poor attribution accuracy. In this regard, the cost attribution method of grid equipment maintenance cost under multi-dimensional lean management mode is proposed. The whole life cycle cost of grid equipment operation is analyzed, and the total cost of grid equipment asset operation and maintenance is calculated, and finally, the operation cost method is used to construct the cost attribution model of maintenance cost. The analysis of the experimental results shows that when the proposed method is used to attribute the maintenance cost cost, the attribution error value of the method is low and has a more desirable cost attribution effect.

## 1. INTRODUCTION

Grid operation and maintenance cost is the cost of resources consumed by the grid enterprise to maintain the normal operation and production of the grid, including material costs, repair costs, labor costs and other operating costs. The use of operation cost management theory can effectively establish different indirect cost sets and accurately allocate product costs, which is important for enterprise management. The traditional costing method cannot accurately allocate the indirect costs. The cost collection is a collection of various indirect costs of different nature, and the brief costs need a more scientific and reasonable allocation method[1-2]. Multidimensional lean management is an innovative management system proposed by the power grid company to meet the current internal and external management needs. It promotes a multidimensional and lean management concept. Through multidimensional lean management changes, power companies can effectively integrate data scattered in various businesses and links to unleash synergistic value advantages.

Therefore, this paper constructs a multi-dimensional lean management model for power grid production and operation standard cost prediction. By studying the direct costs, indirect costs and other related costs incurred in the whole life cycle of assets and equipment, we standardize the collection of grid equipment overhaul costs, realize the statistics of the whole life cycle cost of grid equipment, and provide an aid for decision making in grid planning and design, equipment procurement and evaluation of the whole life cycle cost management of assets.

## 2. WHOLE LIFE CYCLE COST ANALYSIS OF GRID EQUIPMENT IN A MULTI-DIMENSIONAL LEAN MANAGEMENT MODEL

The multidimensional lean management model consists of three parts: optimization of the accounting system, business-financial integration and establishment of a multidimensional cost reflection system[3-4]. In the multidimensional lean management mode, if the cost of power grid equipment maintenance cost is collected and processed, the whole life cycle cost of power grid equipment should be analyzed first. According to the stage of asset lifecycle management, the lifecycle cost is divided into five cost items: initial investment cost (CI), technical transformation cost (CR), operation and maintenance cost (CM), fault disposal cost (CF) and decommissioning cost (CD), taking into account the cost characteristics and application scenarios. The cost information comes from the development of each business activity, and the relevant business includes five business modules of engineering financial management, equipment maintenance management, production project management, storage and distribution management and asset management, as shown in the following calculation formula[5].

$$LCC = CI + CR + CM + CF + CD \quad (1)$$

The whole life cycle cost is related to the whole life

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cycle management process. The cost of construction and safety works is taken from the cost of construction and installation works of the corresponding transferred assets in the final project account. The specific formula is shown below[6-7].

$$S_{CI} = LCC_E + LCC_J + LCC_O \quad (2)$$

Where, $S_{CI}$ represents the initial investment cost, $LCC_E$ represents the purchase cost of grid operation equipment, $LCC_J$ represents the cost of grid construction and safety works, and $LCC_O$ represents other costs. The above steps can complete the analysis of the whole life cycle cost of grid equipment operation, calculate the initial investment cost, and provide help for the subsequent cost attribution of maintenance expenses.

## 3. GRID EQUIPMENT ASSET O&M COSTING

The operating cycle of power grid equipment is generally long, and the cost of maintenance and operation is an important factor affecting the whole life cycle cost of assets and daily equipment management. However, there are major problems in the attribution of overhaul O&M costs[8-10]. Therefore, this paper firstly calculates the operation and maintenance costs of grid equipment assets.

The asset operation and maintenance cost attribution model is shown in equation (3). For a single job involving multiple assets, the cost is apportioned according to the proportion of man-hours consumed in the asset at the time of the job. For defect handling jobs, the job cost is attributed to where the final defect occurs.

$$C_m = \sum_{i=1}^{n} K_i m \cdot Mc_i \quad (3)$$

Where, $C_m$ is the O&M cost of asset m, $K_i$ is the apportionment factor of asset m in the cost of job i, and $c_i$ is the cost of job i, calculated as the proportion of job time spent on asset m jobs in the actual job.

## 4. GRID EQUIPMENT MAINTENANCE COST ATTRIBUTION MODEL CONSTRUCTION

In this paper, we choose the job costing method to construct a cost attribution model for power grid equipment maintenance costs. Under the job costing method, a cost allocation process system needs to be established first, which is from the initial cost occurrence, job type, job motive to the final allocation to the secondary unit. The cost drivers and allocation proportion of the secondary operation center are shown in Table 1.

**Table1** Secondary operation center cost drivers and share ratio

| First-class operation center | Secondary operation center | Operation Motivation | Share ratio |
|---|---|---|---|
| Control Operations | Control Operations | Complexity of the project program process, planning Workload of program implementation and monitoring | Collected by grid size to provincial grid companies |
| | Strategic Planning | Project investment amount | Collected by the amount of headquarters technology projects to Provincial Power Grid Company |
| | Innovation Management | Asset size of member companies | Collected by grid size to provincial grid companies |
| | Production Technology | Operating income of member enterprises | Collected by grid size to provincial grid companies |
| | Marketing | Asset size of member companies | By procurement scale |
| | Infrastructure development | Business complexity of member enterprises, negotiation Number of times, number of contracts | By data size |
| | Supply Chain Management | The degree of informationization of the enterprise, the acceptance of information technology The extent or number of information technology services | Collected by grid size to provincial grid companies |
| | Digitalization | Asset size of member enterprises | Percentage by number of workers |
| | Safety Supervision | Number of employees in member companies | By number of units |

According to the different service objects, the headquarter costs that should be included in the scope of transmission and distribution price accounting can be transferred to provincial power supply units or special projects, and the apportionment principle is as follows: the headquarter costs of transmission and distribution services directly related to special transmission projects are included in the pricing of special projects, and the headquarter costs of other transmission and distribution services are included in provincial power grids for diversion. Therefore, the cost sharing of headquarters is divided into three parts, firstly, the cost of the general transfer (power dispatch control center) is directly transferred to each provincial grid company according to the service contract, secondly, the cost identified as "service for special project" within the special cost is transferred to the special project, and for other costs that cannot be strictly distinguished from the boundary, the cost sharing rate of cost drivers is applied. Finally, the costs collected by each secondary operation center are apportioned among UHV and provincial grid companies according to the apportionment rate. By analyzing the above-mentioned cost links, the whole-life-cycle cost allocation model based on the asset-level equipment of the power grid is established, and the principles and apportionment methods of specific items are clarified, as shown in Table 2.

**Table 2** Life-cycle cost attribution model for grid equipment

| Cost attribution items | | | Explanation of values |
|---|---|---|---|
| Initial investment cost | | | Derived from the original value of the fixed initial asset card |
| Technology improvement cost | | | Derived from the increase in the original value of fixed assets due to technological transformation |
| Routine maintenance costs | Project category | Periodic Overhaul | Project settlement amount (the asset level equipment must be checked at the time of project establishment. through the equipment can be associated with the relevant project information, the settlement according to the proportion of the original value of the asset is apportioned) the relevant project information, the settlement according to the The proportion of the original value of the asset is apportioned) |
| | | Daily Maintenance | Project settlement amount (asset level equipment must be checked at the time of project creation. through the equipment can be associated with the relevant project information, the settlement according to the proportional share of the original value of the asset) |
| | Non-Project Category | Regular Inspection | Associated with asset level equipment through work order, enter people, machines and materials, the system will automatically apportion according to the standard the standard |
| | | Elimination of defects | When asset-level equipment is associated with a work order, and people, machines and materials are entered, the system will automatically apportion When asset-level equipment is associated with a work order, and people, machines and materials are entered, the system will automatically |
| | | Inspection | The system will automatically apportion the cost according to the standard by associating the asset-level equipment with the work order (you can check The system will automatically apportion the cost according to the standard by associating the asset-level equipment with the work order (you can check the asset-level equipment by category), and the loser, machine and material. |

Through the above steps, a full life-cycle cost sharing and collection model of assets related to power grid equipment overhaul costs is established, forming an asset-level equipment collection unit and a project and work order-based overhaul cost collection mechanism, collecting asset cost collection information through fixed asset cards and overhaul business activities, and then providing accurate and timely information for power grid planning and design, technical and economic comparison of investment projects, equipment procurement, and full life-cycle asset cost management evaluation. This provides timely and accurate information on the cost of power grid equipment maintenance through fixed asset cards and maintenance activities. This completes the design of the cost collection method for grid equipment overhaul in a multidimensional lean management model.

## 5. TESTING AND ANALYSIS

### 5.1. Test Preparation

In order to prove that the cost attribution effect of the proposed multi-dimensional lean management model of the grid equipment overhaul cost attribution method is better than that of the conventional grid equipment overhaul cost attribution method, an experimental session is constructed to verify the actual attribution effect of the grid equipment overhaul cost attribution method after the theoretical part is designed. In order to improve the reliability of the experimental results, two conventional methods are selected for comparison, and the experimental results of the three methods are compared to prove the effectiveness of the method. The conventional methods selected for this experiment are DRG-based and big data-based methods for cost attribution of grid equipment overhaul costs.

In this experiment, a large-scale power grid project in a certain region is selected as the experimental object, and the advantages and disadvantages of the three methods are compared through the cost of the power grid equipment to be overhauled under the project. The experiments include planned maintenance, temporary maintenance and unplanned maintenance. 20 groups of grid equipment are selected for maintenance, and the equipment is conditioned, faulted and improved, and then the three methods are used to collect the cost of maintenance and compare the accuracy of the methods.

### 5.2. Analysis of test results

The evaluation index selected for this experiment is the imputation accuracy of the method, and the specific comparison index is the error value between the imputation result and the actual situation, the lower the value, the higher the imputation accuracy of the method, and the specific experimental results are shown in Figure 1.

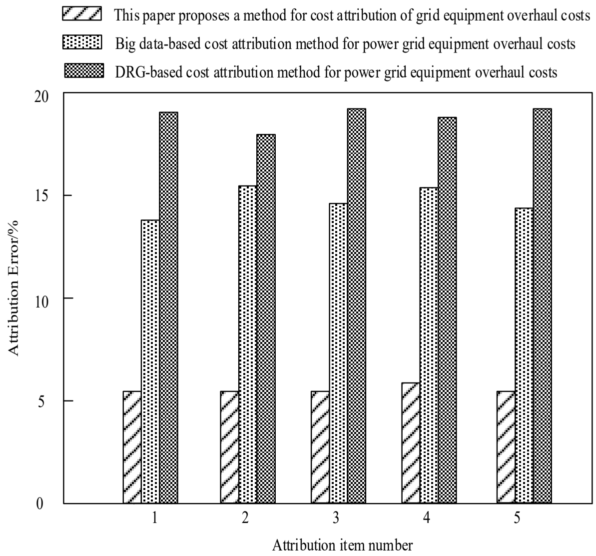


**Figure 1** Comparison results of imputation error

Analysis of Figure 1 shows that there are also differences in the attribution errors of different methods when attributing the cost of grid equipment overhaul. The numerical comparison clearly shows that the cost aggregation error of the proposed multidimensional lean management model is low, with an average value of 8.0% or less, while the aggregation error of the two conventional cost aggregation methods is significantly worse, with an average value of 12.5% or more. It can be proved that the cost attribution results of the proposed cost attribution method are closer to the real situation, which is helpful to provide reliable help for the apportionment of overhaul costs.

## 6. CONCLUSION

In this paper, we propose a multi-dimensional lean management model for the cost of grid equipment overhaul. By adopting the job costing method, we adopt an asset life-cycle cost sharing and collection model to form an asset-level equipment collection unit and a project and work order-based overhaul cost collection mechanism. It helps to build a cost management system for power grid operation and promote intensive financial management.

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