Analysis of Operation Cost and Control of Communication Operator Data Center Park

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Abstract. This paper focuses on the operating costs of the data center. Firstly, the calculation model of the operation cost is proposed for the construction and operation conditions of the data center, which can provide the calculation method for the feasibility study of the data center projects. Secondly, it gives suggestions to reduce operating costs from various perspectives.

Keywords: Data center · Operating costs · Power cost · Water bill · Labor cost

1 Introduction

In March 2020, the Central Economic Conference formally put forward the concept of "new infrastructure", which set new infrastructure such as data centers, 5G, industrial Internet and the Internet of Things as new drivers of economic growth [1]. The state actively guides social capital to participate in the construction of data centers. With the continuous enrichment of market entities and the fierce market competition, it has become the consensus of the data center industry at the present stage to reduce costs and increase efficiency through various ways.

In the era of operators, independent scale data center parks are rare and precious, and have certain pricing power for rack leasing. The operation management and operation cost control of the park mainly come from the operators' own experience. With all kinds of capital entering the data center industry, all kinds of market entities, including traditional operators, begin to pay attention to the control of operating costs, and are trying to improve the market competitiveness through the control of operating costs. By analyzing the operation cost of the data center park, this paper puts forward the corresponding optimization suggestions and measures.

2 Analysis of the Operation Cost Calculation Model of the Data Center Park

TCO is usually used when considering the total cost of ownership in the data center park [2] Method analysis, namely, the study of the whole life cycle cost of the data center park. In the statistical calculation, the total cost of ownership is divided into two main aspects.

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One is the investment of fixed assets, namely the construction cost CAPEX (Capital Expenditure), and the other is the operation cost, namely OPEX (Operating Expense), which mainly includes the energy consumption cost of the park and the maintenance and the management cost. The research object of this paper is the rental data center park, with the total cost excluding the input of server and the operation cost of server.

2.1 The Assumed Conditions of the Model

After the completion of the long-term operation state, the cost invested during the normal operation of the equipment shall be regarded as the operating cost. The operating cost calculation model is discussed here mainly to provide a reliable estimate for the early investment decision. In order to estimate the values closer to the actual situation, the various conditions need to be limited. And this paper tries to detail the various operation and maintenance costs in the early consultation stage of various estimation methods and considerations.

In order to simplify the calculation, the operating costs are divided into electricity costs, water costs, labor costs and maintenance costs. The electricity bill includes the electricity used for the IT equipment and the various systems serving the IT equipment. The data center park generally measures the electricity bill according to the whole building or the whole floor. At present, water cooling is still one of the mainstream forms of air conditioning in data centers. Considering the high cost of water charges in some areas, this paper takes water charges as a factor for consideration. Labor cost mainly refers to the operation and maintenance cost of the park (for the environmental infrastructure of the equipment room), including power operation and maintenance, air conditioning operation and maintenance, network operation and maintenance, intelligent operation and maintenance, property allocation in the park, elevator operation and maintenance, etc. Usually, the lessee is responsible for the operation and maintenance of IT equipment and the corresponding system and data management. Maintenance cost refers to sporadic repair, diesel oil and daily maintenance accessories, excluding the replacement and upgrading of large equipment.

This article does not include depreciation and amortization in operating costs.

2.2 Computational Model

Power cost calculation model.

After the national formulation of the dual-carbon target, energy consumption has become an unprecedented hot topic. Due to the high energy consumption characteristics of the data center itself, how to achieve the carbon peak and carbon neutrality of the data center itself has attracted much attention. Projected in the park management, reducing power costs and the policy itself have a strong convergence. At present, traditional operators, third parties and Internet giants have frequently expressed their determination to achieve the dual-carbon goal, emphasizing the energy-saving transformation of existing data centers and the use of new technologies in new parks to reduce the power ratio [3] (ratio of electricity consumption of data centers). Therefore, it is extremely important to reduce the power ratio through the overall technical framework planning of the data

center in the early stage. At present, liquid cooling is the most effective. Here can lead to a power cost calculation method: electricity ratio calculation method [4]

$$C_{EO} = E_{\mathrm{O}} * HEP \tag{1}$$

In formula:

C_{EO} C_{EO}—— Actual operating value of the annual data center power cost;
E_{O}—— The annual power consumption of the data center is KWH;
HEP—— hourly electricity price;

Introduce the energy ratio calculation announcement in GB40879-2021 <Data Center Energy Efficiency Limit Value and Energy Efficiency Grade>

$$R_D = \frac{E_D}{E_{DIT}} \tag{2}$$

In formula:

R_D—— Design value of data center electric energy ratio;
E_{DIT}—— The planning and design value of the power consumption of the information equipment, the unit is KWH;

The design value of the power ratio is usually calculated by the design team according to different technical architectures. It must be emphasized here that the design value of the data center power ratio is used in the publicity (2), and this paper introduces the actual value of the power ratio in order to obtain the power cost during the operation period. In fact, the electric energy is more complex than the design value than the actual value of the design value. It has many influencing factors, such as shelf rate, management mode, operation and maintenance method, climate, customer requirements, etc., which has particularity and changes with time, so:

$$R_{O\mathrm{t}} = \gamma_t * R_D \tag{3}$$

γ_t—— The electric energy ratio factor of a data center at t time point is estimated by empirical value;
$R_{O\mathrm{t}}$—— The electric energy ratio of a data center at the t-time point;

It can be obtained by converting the form of publicity (2):

$$E_D = R_D * E_{DIT} \tag{4}$$

The most important factor affecting the actual value of the total power cost is the actual power consumption of the information equipment,It is more accurate to calculate the actual total power cost by using the actual operating value of the power consumption of the information equipment.This paper simplifies this, because the power consumption of information equipment in the planning stage is usually proposed by the customer or the user, which is closely related to the business pricing in the contract and is also the most important delivery requirement, so the change is relatively small and little deviation in the actual data center project. However, in the actual operation, the power consumption

of the information equipment cannot always run according to the planned and designed value, and according to the actual business, the power consumption of the information equipment will have different decreases. For example, the cloud computing business is about 80% ~ 95% of the planned and designed value. Therefore, the reduction coefficient of power consumption of information equipment β_x is introduced here:

$$E_{OIT} = \beta_x * E_{DIT} \tag{5}$$

In formula:

β_x—— The reduction coefficient of the power consumption of the information equipment, x refers to the type of equipment with different power;

Put the publicity (3)–(5) into the publicity (1):

$$C_{EO} = \sum_{t=0}^{n} \sum_{x=1}^{l} \gamma_t * \beta_x * R_D * E_{DIT} * HEP/8760 \tag{6}$$

HEP is the hourly electricity price, the current electricity price is changing from policy pricing to market pricing, different power generation methods such as thermal, solar, wind, nuclear, hydro, tidal and other costs vary, seasonal climate changes also affect the electricity price. However, China's power supply is reliable, the price is reasonable which change range is small and the overall predictable.

Water bill calculation model.

Data center park water use [4] is usually divided into production water use, domestic water use [5]. It is difficult to unify the water consumption of air conditioning production is affected by air conditioning type, local climate conditions and operation and maintenance mode, and it is difficult to calculate accurately. Taking the traditional cold water-cooled air conditioning system as an example, the main source of water consumption can be summarized in the following aspects.

(1) Cooling water evaporation When the cooling water is made by the cooling tower, the heat in the data center is mainly distributed to the atmospheric environment by the evaporation of the cooling water, and the water evaporation loss is the main part of the water resource consumption in the data center.
(2) Generally, the operating water temperature of the cooling water system in the data center is 32 °C/37 °C, which is easy to breed bacteria, which is suitable for the growth of algae and dirt and the step on the pipe wall, and the temperature needs to control the concentration of dosing through the discharge of cooling water. This process will also produce water consumption
(3) Humidifying water in IT room In winter, especially in northern China, the relative humidity of the outdoor environment is low. If the humidity in the machine room is affected by this, the humidity requirements in the machine room should be maintained through the humidification system, and the humidifying water needs to be consumed.
(4) The water softening equipment with water freezing water and humidification water will cause some losses due to leakage and drainage during operation. In order to

ensure the operation safety and system pressure, it is necessary to supplement the softening water in time, and supplement the municipal water softening equipment to the system.

(5) Water for equipment maintenance During the operation of the system, water needed for flushing and pipeline pressure test.

(6) Water for operation and maintenance of the diesel system This part is water for smoke exhaust and purification and cooling of the diesel unit, and the water consumption accounts for a small proportion. In addition, the proportion of water used in the data center will change significantly in different seasons.

The concept of WUE is introduced here. WUE is about the parameter of water resource utilization efficiency of IT equipment in the data center. Usually, HVAC engineers can give the WUE in the ideal situation when considering the climate factors in the selection of air conditioning system.

WUE = Water consumption of the data center/electricity consumption of the data center IT equipment

However, under the actual operation and maintenance state, due to the influence of climate change and the change of electricity consumption of IT equipment, the actual water consumption is different from the ideal design state.

$$V_{PWO} = Wue * \sigma * E_{OIT} \tag{7}$$

In formula:

V_{PWO}—— Actual operation and maintenance value of the annual production water in the data center;
Wue *Wue*—— Water resources utilization rate under the ideal state;
σ—— Climate change coefficient, can be valued according to the change of climate conditions;

Domestic water is usually calculated according to the water supply and drainage specifications, but there is a large gap in the actual operation and maintenance. When the overall domestic water consumption is estimated according to the number of operation and maintenance in the park, the water saving coefficient is used to adjust the domestic water consumption according to the operation and maintenance experience. The actual water habits of each park are different, so the water-saving coefficient should be determined according to long-term statistical data.

$$V_{IWO} = \psi_{iWO} * 50 * P * T \tag{8}$$

In formula:

V_{IWO}——Actual value of operation and maintenance of domestic water annually;
ψ_{iWO}——Water-saving coefficient of domestic water use;
P—— operation and maintenance number;

$$C_{WO} = (V_{PWO} + V_{IWO}) * 10^{-3} * PRW \tag{9}$$

In formula:

C_{WO}—— Actual operation and maintenance value of the annual total water cost;

PRW—— Water rate unit price, yuan/ton;

Labor cost calculation model.

After the completion of the data center, it will be transferred from the construction team to the operation and maintenance team. The compensation and the daily training expenses of the whole operation and maintenance team form the labor cost. The data center has a huge and complex system, with various types of equipment, professional crossover, and high requirements for operation and maintenance personnel. The survey of the American data center standards organization and the third-party certification agency Uptime Institute found that about 50% of the computer room risks were found by the monitoring system, and another 50% were found by the operation and maintenance personnel during inspection. Therefore, the operation and maintenance team is very important to the data center. The number and quality of the operation and maintenance team affect the quality of operation and maintenance, but also affect the operation and maintenance cost of the park.

Before planning, the operation and maintenance team should take inventory of all kinds of equipment in the data center, calculate the maintenance time according to the type and quantity of equipment, so as to determine the number of operation and maintenance team. According to different specialties, the equipment is divided into the following categories: network operation and maintenance, high and low voltage power distribution equipment, HVAC equipment, diesel generator equipment, uninterruptible power supply equipment, and moving ring monitoring equipment. In addition, it should also include the park property, elevator operation and maintenance.

$$C_{LO} = C_1 + C_2 + \sum_{m=1}^{6} \sum_{n=1}^{i} \lambda_{mn} \mu_{mn} L_{mn} \tag{10}$$

In formula:

"M" refers to the types of equipment, divided into 6 types; "n" refers to various types of equipment, such as HVAC equipment: air conditioning host, chilled water circulating pump, cooling water circulating pump, plate heat exchanger, cold storage tank, etc.;

C_1—— Annual operation and maintenance cost of the park property;
C_2—— Annual operation and maintenance cost of elevators;
λ_{mn}—— Number of equipment;
μ_{mn}—— Number of operation and maintenance required by a single equipment;
L_{mn}—— Labor unit price, yuan/year, including salary and welfare;

Often, the accuracy of the statistical equipment cannot be achieved in the preliminary demonstration stage of the project, and the operation and maintenance personnel required according to the IT power consumption or the number of racks are also allowed [6].

3 The Operator Data Center Operation Cost Control Suggestions

Data center operation and maintenance is a huge and complex system of professional activities with multi-professional participation, including the management of the building environment and all kinds of unique equipment [7]. The operation and maintenance

cost of the data center of basic telecom operators mainly includes power cost, water cost, labor cost, maintenance cost, etc. Therefore, the control cost needs to be started from multiple perspectives [8].

(1) Optimize the operation and maintenance personnel configuration: the personnel configuration of the data center can be graded or fixed or fixed regularly. In addition, data centers can use outsourcing and mobile work to reduce the personnel resource cost inherent in center operation and maintenance.
(2) Adopt automatic operation and maintenance tools: automate the operation and maintenance tasks as much as possible, reduce manual intervention, and reduce the error rate. For example, you can use the automated open interface of the data center to monitor the overall status and automatically identify the fault point. At the same time, resource utilization can be optimized by implementing automatic capacity expansion and migration measures, improve system availability, fault tolerance, and reduce maintenance costs.
(3) Implement energy management measures: overall planning, centralized monitoring and management of energy consumption in the data center. Reduce energy consumption in data centers through energy management technology and power-saving measures. For example, a detailed temperature control strategy and efficient temperature control equipment are adopted to realize the automatic energy consumption management of the data center.
(4) Optimize the equipment maintenance strategy: adopt the standardization of equipment ordering, configuration and maintenance, promote the management mode of the whole life cycle, carry out comprehensive maintenance of the equipment, and improve its service life. Reasonably adopt new technology and equipment, reduce operating cost, improve equipment management effect and productivity level.
(5) Adopt virtualization technology: realize server resource sharing through virtualization technology, reduce the number of servers and reduce the cost of power supply and heat dissipation, and improve the use efficiency of data center. At the same time, the simulators and each server are optimized to the maximum through resource pooling and automated management techniques.

In addition to controlling the cost from the perspective of technology, it can also reduce the operation and maintenance cost from the perspective of organizing management innovation and technology innovation. Such as the introduction of contract energy management. Energy contract management refers to that an enterprise signs a contract with a professional service agency to reach a cooperation agreement, and the professional team of the latter carries out energy saving transformation and management for the former, so as to achieve the purpose of achieving energy saving, reducing energy consumption and reducing energy cost [9].

4 Conclusions

According to the current situation of the existing data center of the operator, this paper divides the operation cost into power cost, water cost, labor cost and operation and maintenance cost, gives the calculation ideas of various costs, and establishes a scientific calculation model, which well solves the problem of predicting the operation

cost in the early stage of the project. Since the maintenance cost is usually estimated according to the fixed proportion of fixed assets, which is quite different from the actual cost, it is suggested that different maintenance cost should be analyzed and calculated specifically. The calculation method of this paper has distinct characteristics, which is mainly applicable to the professional data centers of telecom operators, and also has certain reference significance for other types of data center parks. Finally, this paper gives the suggestions on the operation cost control of the data center from the technical and organizational management innovation: optimizing the operation and maintenance personnel allocation, adopting automatic operation and maintenance tools, implementing energy management measures, optimizing equipment maintenance strategies, adopting virtualization technology, and introducing contract energy management [10].

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