

## Graded evaluation and application of physical asset management in provincial grid companies

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**Abstract.** The evaluation of asset management by provincial power companies of the local municipal power supply companies under their jurisdiction is an important part of the evaluation of the physical assets of the grid. By studying the physical asset management of local municipalities, it is possible to provide more micro-level suggestions for improving the level of physical asset management. The traditional analysis of local municipalities' physical assets evaluation does not consider the indirect impact of local municipalities' macroeconomic and social development factors on grid operation, nor does it consider the progress or regression of local municipalities' management levels over a period of time, making the traditional analysis of local municipalities' physical assets evaluation less objective and accurate. Based on this, this paper selects suitable evaluation indicators from three aspects: the scale of the number of equipment and the value of physical assets, the level of physical asset management performance, and the macroeconomic and social development of local municipalities, and combines hierarchical analysis and expert scoring methods to build a comprehensive index system for the grading evaluation of physical asset management. The system analyses the degree of influence of macroeconomic and social development factors on the operation of the grid, and the progress or regression of the management level of each municipality over a period of time. Finally, based on the results of the analysis, countermeasures are proposed to improve the management of the physical assets of the grid.

**Keywords:** Physical assets; Level of performance; Local and municipal macro factors; Comprehensive evaluation; Hierarchical.

### 1. Introduction

The asset management evaluation of local and municipal companies by provincial companies is an important part of the evaluation of the physical assets of the power grid. The asset management evaluation of local and municipal companies is a more detailed study of the physical asset management of local and municipal companies, starting from the more microscopic object of study, and is an important supplement to the evaluation of the physical asset management of provincial companies, thus analyzing and evaluating the physical assets of provincial companies from the whole to the local and from the surface to the point. Through quantitative analysis, the management level of local and municipal companies is comprehensively evaluated in order to grasp the current asset management situation of local and municipal companies, identify problems in the current asset management of local and municipal companies, promote the improvement of asset management of local and municipal companies, and provide scientific basis for local and municipal companies to improve their management methods and formulate more scientific management strategies.

However, due to the differences in external factors such as regional economy and population, these factors will indirectly have an impact on the power grid operation of local municipalities and ultimately affect the provincial company's comprehensive evaluation of local municipalities, thus not accurately reflecting the actual management level of local municipalities and making the evaluation results lose fairness and reasonableness. Therefore, how to judge the degree of influence of external factors and eliminate this influence, more objective and accurate to measure the management level of local municipalities is an urgent problem to be solved. In addition, as the scale of physical assets and

the level of management of local municipalities vary from city to city, a horizontal comparative analysis of physical assets alone may overlook the progress or regression in the level of management of physical assets of local municipalities, thus not accurately reflecting the actual level of management of local municipalities. Therefore, a longitudinal comparative study and analysis of the asset management of local municipalities in different years is also an important element of the evaluation of the physical assets of local municipalities.

## 2. Review of Research

The existing evaluation system of power grid physical asset management is mainly based on the continuous development of power grid construction, the scale of power grid equipment quantity and physical asset value is getting bigger and bigger, its operation and maintenance, renewal and transformation tasks are getting heavier and heavier, the traditional rough power equipment asset management mode has certain shortcomings based on the current situation of power grid equipment quantity scale and physical asset value, applying a scientific comprehensive evaluation model of Results. Wei Pu et al. established a comprehensive evaluation index system based on the whole life cycle theory of assets, using hierarchical analysis method and based on the characteristics of physical assets of power grids. You Fei et al. established a comprehensive analysis and evaluation model of the physical assets of power grids through the set-pair analysis method to achieve quantitative evaluation and specific analysis. Zhang Zhengkai et al.'s research on the analysis and evaluation system of physical assets of power grids based on a big data platform successfully controlled the overall condition of physical assets as well as external development trends, and realized statistics, analysis and prediction of the value scale and decommissioning of physical assets based on big data calculation, enabling managers to plan, manage and use asset equipment in a more efficient and convenient manner. Li Zhiwei et al. A kind of physical asset analysis and evaluation system based on big data thinking and ID-CROSS algorithm, using the principle of data parsing link to realize the index system, analysis dimension, data source, processing process and presentation of physical asset analysis and evaluation. Liu Lu et al. for the comprehensive value of physical assets of power grids, firstly, selected 17 indicators from four aspects of scale structure, health level, utilization efficiency and management efficiency, and constructed a comprehensive value evaluation index system of physical assets of power grids, followed by the use of grey correlation and ideal solution method to establish a comprehensive value evaluation model of physical assets of power grids. Cui Yongtao conducted an in-depth study from different dimensions such as asset scale, asset structure, asset utilization efficiency, asset health level and asset retirement, selected multi-level and all-round evaluation indicators, established a power grid enterprise physical asset index evaluation system, and gave the direction of physical asset evaluation and management improvement measures based on the prediction of power grid enterprise technical reform investment. The above scholars have launched a study on the application of comprehensive evaluation methods in power grid asset management, which has promoted the progress of power grid asset management methods.

The differences in external factors that exist in each municipality and their indirect impact on the evaluation of physical assets in the municipality have become a challenge for the evaluation of physical assets in the municipality, and such external factors need to be dealt with in a reasonable analytical manner. Yan Qingyou et al. proposed the scope of external environmental impact factors of power grid assets based on the characteristics of the whole life cycle management of the assets of the State Grid Corporation constructed an improved TOPSIS environmental impact identification model based on transfer entropy, wrote a MATLAB toolbox to calculate, analyze and identify the degree of comprehensive impact of external environmental factors on assets and introduced transfer entropy to determine the weights of each evaluation expert. The treatment of external factors in other fields for local municipalities also has significant implications for this study. When Li Yuning and others studied the comprehensive evaluation of the operating efficiency of various telecommunication enterprise group companies to provincial companies and provincial companies to local municipalities,

in order to reflect the operating results achieved by each company through internal efforts, the influence of external factors needed to be eliminated in order to ensure the fairness and reasonableness of the comprehensive evaluation, and the external factors were scientifically analyzed and simplified through principal component analysis to arrive at the degree of their influence and The influence of external factors is scientifically analyzed and simplified through principal component analysis to determine the degree of influence and eliminate it. Chen Yubao et al. used a three-stage DEA model to remove the influence of environmental and random factors to measure and analyze the efficiency of science and technology innovation in 16 provinces of high-tech industries in the central and eastern regions of China.

Throughout the existing literature, a relatively mature research methodology has been developed and fruitful research results have been achieved regarding the evaluation and analysis of physical assets of power grids, but there is a lack of research on the combination of macroeconomic and social development factors in local municipalities and the vertical analysis of the management level of physical assets of local municipal companies. Based on this, this paper selects suitable evaluation indicators from three aspects, namely, the scale of power grid equipment and physical asset value, the level of physical asset management performance, and the macroeconomic and social development of local municipalities, and combines analytic hierarchy process [10] and expert scoring method to build a set of comprehensive evaluation index system for the physical assets of local municipalities. The evaluation system is used to analyze the degree of influence of macroeconomic and social development factors on the operation of the grid and the progress or regression of the management level of each municipality over a period of time. Finally, the results of the comprehensive evaluation provide recommendations to guide the management of physical assets in the region.

### **3. Construction of a comprehensive evaluation index system for the physical assets of local municipalities**

#### **3.1 Selection of indicators**

The comprehensive evaluation indicators of physical assets of local municipalities consist of the scale of the number of electrical network equipment and the value of physical assets, the level of performance of physical assets management, the macroeconomic and social development of local municipalities evaluation indicators.

##### **3.1.1 Grid equipment quantity size and physical asset value evaluation indicators**

Number size and physical asset value of grid equipment Evaluation indicators include four aspects: original asset value, net asset value, number of assets, and technical size of assets

##### **3.1.2 Indicators for evaluating the level of performance of physical asset management**

The level of performance of grid physical assets management reflects the operation of grid equipment, and briefly illustrates the level of grid physical assets. The three secondary indicators, namely Electricity supply reliability rate, voltage qualification rate and transmission availability factor, reflecting the quality of grid physical assets, the average annual load factor of main transformers reflecting the efficiency of grid physical assets, and the indicator of electricity sales reflecting the efficiency of grid physical assets, together form a large category of asset management performance indicators.

###### **3.1.2.1 Electricity supply reliability rate**

Reliability of electricity supply rate refers to the situation in the statistical period in order to disregard and the need to limit electricity supply due to insufficient system power supply. It directly reflects the power supply capacity of power supply enterprises to power users, and also reflects the degree to which the power industry meets the demand for electrical energy of the national economy, and is a comprehensive reflection of the quality and management level of power supply enterprises

in terms of planning, design, infrastructure, construction, equipment manufacturing and production operation.

Electricity supply reliability rate calculation formula.

Electricity supply reliability rate = (1 - average time of customer outage / time of statistical period) \* 100%.

The statistics of Electricity supply reliability rate are the basis for the technical management of power supply enterprises and an important part of the modern management of the power industry. With the development of social production and the increasing modernization of people's living standards, the reliance on electricity is becoming greater and greater. The reliability rate indicators of power supply enterprises' ability to supply electricity to customers on a continuous basis have become equally important as the quality indicators of power supply such as voltage, perimeter waves and harmonics. Practice has shown that a sudden interruption of power supply in a city, especially a modern large or medium-sized city, will directly affect social stability. Therefore, it has become an urgent task for power supply enterprises to improve the reliability rate of power supply in the distribution network.

### 3.1.2.2 Voltage compliance rate

The voltage compliance rate is the percentage of time in a month that the voltage at a monitoring point is within the compliance range in relation to the total monthly voltage monitoring time in grid operation.

The supply reliability rate and the voltage qualification rate in urban areas and rural areas are generally separated, and the prescribed standards for the two are also different. In urban areas, the supply reliability rate is not less than 99.90%, and the voltage qualification rate for residential customers is not less than 96%; in rural areas, the supply reliability rate and the voltage qualification rate for residential customers are approved by the State Grid Corporation, and the commitment indicators are published by the electricity companies of each province (autonomous region and municipality directly under the Central Government)

### 3.1.2.3 Transmission and substation availability factor

The transmission and substation availability factor is one of the indicators in the transmission facility time category, which reflects the probability of availability of the transmission facility. It is calculated as the ratio of the number of hours the facility is available during the statistical period to the number of hours in the statistical period.

### 3.1.2.4 Average annual load factor of main transformer

The average annual load factor of the main transformer is an evaluation indicator of the efficiency of the asset. There are three main transformer sizes in Anhui 220kV, 110kV and 35kV

The average annual load factor of the main transformer is the average load factor of a single station calculated for the substation. As the N-1 rule load is currently used in practice, it is not yet possible to carry out a direct statistical analysis of the average load factor of a single main substation. Therefore, according to the management requirements, the average annual load factor of a single station is the average annual active power of a single main substation, the average annual available time of a single main substation, the average rated capacity of a single main substation and the power factor. By combining the annual average load factor with the maximum load for load analysis, an evaluation of the safety level and the economic level of the grid can be achieved.

Average annual load factor of main transformer calculated by

$$Tlr = \frac{W}{t \times q \times r} \times 100\%$$

$Tlr$  is the average annual load factor of the main substation,  $W$  is the average annual active power of a single station,  $t$  is the average annual availability of the main substation of a single station,  $q$  is the average rated capacity of the main substation of a single station and  $r$  is the power factor.

### 3.1.2.5 Electricity sales

Electricity sales are an evaluation indicator of asset efficiency. Electricity sales are the amount of electricity sold to customers (including wholesale customers) and the amount of electricity supplied to the enterprise for use in non-electricity production, capital construction, overhaul and non-production departments (such as canteens and dormitories).

### 3.1.3 Evaluation indicators for macroeconomic and social development of local municipalities

**Table 1.** Macroeconomic and social development of Anhui municipalities Evaluation indicators

Indicators	Description
GDP	Grid operations are closely related to economic development, and GDP is the most intuitive indicator of the economic development of a region, the higher the regional GDP, the more important the management of grid assets
Resident population	The purpose of grid operations is to provide essential public services to the people, and the larger the population of the area, the more important the management of grid assets
Share of secondary sector	The higher the proportion of secondary industries in a region, the more important the management of grid assets
Urbanization rate	The urban grid is more complex than in rural areas, and the higher the Urbanization rate, the greater the need for high levels of asset management
Number of industrial enterprises above scale	Industrial enterprises above a certain size are often large consumers of electricity, and the greater the number of such enterprises in a given municipality, the greater the pressure on grid operations and the more important the management of grid assets

**Table 2.** Macroeconomic and social development in Anhui cities in 2021

City	GDP (billion yuan)	Resident population (10,000)	Share of secondary sector (%)	Urbanization rate	Number of industrial enterprises above scale (in units)
Huabei City	1223.0	197.4	42.0	64.78%	699
Tongling	1165.6	130.6	46.1	66.30%	554
Xuancheng City	1833.9	248.7	46.8	61.75%	1638
Wuhu City	4302.6	367.2	47.6	72.99%	1867
Fuyang	3071.5	817.1	37.5	42.74%	1695
Bozhou	1972.7	498.6	34.5	43.20%	665
Huainan	1451.7	304.0	40.8	61.91%	763
Chuzhou	3362.1	399.0	48.9	62.90%	2045
Chizhou	1004.2	133.1	46.0	60.10%	586
Huangshan City	957.4	133.2	35.8	59.25%	570
Anqing	2656.9	417.1	43.8	56.17%	1722
Bengbu	1989.0	331.7	33.9	56.90%	1722
Lu'an City	1923.5	440.5	38.8	49.46%	1088
Hefei	11412.8	946.5	36.5	84.04%	2219
Ma'anshan	2439.3	215.7	49.4	72.39%	1201
Suzhou	2167.7	532.5	35.5	45.03%	1060

This study has referred to relevant materials, combined with the knowledge of industrial economics and the theoretical basis related to the operation of power grids, taking Anhui as an example, from the various indicators of macroeconomic and social development of each city, the evaluation indicators that need to be considered in conducting the evaluation study of the physical assets of power grids were selected, the selected evaluation indicators and their descriptions are

shown in Table 1, 2021 macroeconomic and social development of each city in Anhui as shown in Table 2.

### 3.2 Determination of weights

Once the indicators were determined, the hierarchical analysis was used to determine the weights of the indicators. In this study, the construction of the hierarchical analysis method and the calculation of the specific weights were carried out by means of the software yaahp.

Firstly, the hierarchical model of the comprehensive evaluation indicators of physical assets of local municipalities was constructed through yaahp software. After determining the hierarchical model, a two-by-two comparison was made based on the importance for the evaluation of physical assets, and a consistency test was conducted to finally determine the weights of each indicator in the evaluation system.

**Table 3.** Results of weighting of indicators for comprehensive evaluation of physical assets in local municipalities

Indicator content	Tier 1 indicators	Secondary indicators	Weighting
Grid physical asset indicators	Number size and physical asset value of grid equipment	Total original value	0.0393
		Total net value	0.0393
		Total number	0.0393
		Total technical scale	0.0393
	Asset management performance levels	Electricity supply reliability rate	0.0834
		Voltage compliance rate	0.0834
		Transmission and transformation availability factor	0.0834
		Average annual load factor of main transformer	0.1474
		Electricity sales	0.1960
		GDP	0.0273
Municipalities Macroeconomic and social development Indicators	Local market macro factors	Resident population	0.0459
		Share of secondary sector	0.0796
		Urbanization rate	0.0170
		Number of industrial enterprises above scale	0.0796

According to the theory of physical asset management, among the primary indicators, the indicator of the level of physical asset management performance is more important than the indicator of macroeconomic and social development of local municipalities, and the indicator of macroeconomic and social development of local municipalities is more important than the indicator of the scale of the number of grid equipment and the value of physical assets. Therefore, the weighting coefficients of the indicators of the level of performance of physical asset management are higher than those of the indicators of macroeconomic and social development of local municipalities, and the weighting coefficients of the indicators of macroeconomic and social development of local municipalities are higher than those of the indicators of the quantity scale of grid equipment and value of physical assets.

The secondary indicators for the quantitative scale of grid equipment and the value of physical assets, i.e. original asset value, net asset value, number of assets and technical scale of assets are of equal importance and therefore have the same weighting coefficients. Among the asset management performance level indicators, asset effectiveness is more important than asset efficiency, and asset efficiency is more important than asset quality, and the size of the weighting coefficient is in line with the level of importance. Among the indicators of macroeconomic and social development of local municipalities, the two indicators of the share of secondary industry and the number of industrial enterprises above the scale have the same importance and higher importance than other indicators,

the importance of resident population is higher than GDP, the importance of GDP is higher than Urbanization rate, and the size of the weight coefficient is consistent with the high importance.

After a two-by-two comparison and consistency test based on the above guidelines for the importance of primary and secondary indicators, the results of the comprehensive evaluation indicator weights for physical assets of local municipalities are shown in Table 3.

### 3.3 Guidelines for assigning scores and scoring methods for evaluation indicators

#### 3.3.1 Theoretical approach

The expert scoring method means that the opinions of relevant experts are solicited anonymously, and their opinions are counted, processed, analyzed and summarized to objectively combine the experience of most experts with subjective judgement, and to make reasonable estimates of a large number of factors that are difficult to analyze quantitatively using technical methods.

#### 3.3.2 Assignment guidelines

The scores are assessed according to the specific indicators of the municipalities' comprehensive physical assets evaluation index system, using the expert scoring method. Due to the different types of indicators, the method of scoring is also different. For the indicators of the physical assets of the electricity network itself, the scoring principle is followed from low to high, with the higher the value, the higher the score. The range of scores is from 1 to 16. The macroeconomic and social development indicators of local municipalities are scored on a high to low scale, with the higher the value, the lower the score. The range of scores is from 1 to 16.

#### 3.3.3 Scoring Methodology

After obtaining the corresponding score for each indicator and combining the weights obtained from the hierarchical analysis method, a weighted sum is obtained to arrive at the total evaluation score.

## 4. Results of the comprehensive evaluation of the physical assets of the local municipalities

### 4.1 Results of the cross-sectional comparative evaluation analysis of municipalities in 2021

**Table 4.** Evaluation results of physical asset indicators of power grids in Anhui cities in 2021

City	Total grid score	Ranking	Value of scale score	Ranking	Performance Score	Ranking
Suzhou	12.8658	1	12	5	12.3942	1
Wuhu City	12.72148	2	8.75	8	12.3776	2
Hefei	12.0194	3	16	1	11.3906	3
Xuancheng City	11.5502	4	10	7	11.1572	4
Chuzhou	11.48288	5	10.75	6	11.0604	5
Fuyang	11.13408	6	14.75	2	10.5544	6
Lu'an City	10.94628	7	12.75	4	10.4452	7
Huainan	10.54705	8	6.5	11	10.2916	8
Bozhou	10.49518	9	7.75	9	10.1906	9
Ma'anshan	9.530925	10	5.25	12	9.3246	10
Huangshan City	9.1969	11	3	14	9.079	11
Anqing	8.089775	12	13.75	3	7.5494	14
Chizhou	8.0746	13	4	13	7.9174	12
Bengbu	7.838775	14	7.75	9	7.5342	15
Tongling	7.788575	15	1.75	15	7.7198	13
Huaibei City	5.161925	16	1.25	16	5.1128	16

Taking the Anhui power grid as an example, the evaluation results of the physical asset indicators of the power grid, the evaluation results of the macroeconomic and social development of local municipalities and the comprehensive evaluation results were calculated through the scoring method

of the comprehensive evaluation index system, as shown in Tables 4 to 6. Table 5 shows the results of the evaluation of macroeconomic and social development of Anhui municipalities in 2021, and Table 6 shows the results of the comprehensive evaluation of physical assets of Anhui municipalities in 2021. Based on the three scoring results, a cross-sectional comparative analysis between municipalities was conducted.

**Table 5.** Evaluation results of macroeconomic and social development in Anhui cities in 2021

City	Total Local Municipality Score	Ranking
Huangshan City	3.4782	1
Bozhou	2.9131	2
Tongling	2.8562	3
Chizhou	2.843	4
Huaibei City	2.6286	5
Huainan	2.4976	6
Suzhou	2.4772	7
Bengbu	2.4105	8
Lu'an City	2.2359	9
Fuyang	1.8262	10
Xuancheng City	1.8168	11
Anqing	1.4915	12
Ma'anshan	1.482	13
Hefei	1.125	14
Wuhu City	0.9334	15
Chuzhou	0.8236	16

**Table 6.** 2021 Results of comprehensive evaluation of physical assets across Anhui municipalities

City	Total combined score	Ranking
Suzhou	15.343	1
Wuhu City	13.65488	2
Bozhou	13.40828	3
Xuancheng City	13.367	4
Lu'an City	13.18218	5
Hefei	13.1444	6
Huainan	13.04465	7
Fuyang	12.96028	8
Huangshan City	12.6751	9
Chuzhou	12.30648	10
Ma'anshan	11.01293	11
Chizhou	10.9176	12
Tongling	10.64478	13
Bengbu	10.24928	14
Anqing	9.581275	15
Huaibei City	7.790525	16

The above comprehensive evaluation ranking results do not fully reflect the level of physical asset management of local and municipal companies. With reference to the data from the comprehensive ranking, a more practically meaningful result can be obtained by using qualitative analysis to compare the level of macroeconomic development of local municipalities and the gap between the quantity and scale of grid equipment and the value of physical assets, based on the level of asset management performance. Based on the ranking of the evaluation results in the above tables, the results are divided into three evaluation levels: high, medium and low. The results of the evaluation of the number and

scale of grid equipment and the value of physical assets are 1-5 for high level, 6-10 for medium level and 11-16 for low level. The evaluation results of the asset management performance level are 1-5 as high, 6-10 as medium and 11-16 as low. The macroeconomic development indicators of local municipalities correspond to the requirements of grid asset management, 1-5 as low, 6-10 as medium and 11-16 as high. Asset management performance directly reflects the level of asset management. At the same level of asset management performance, the number size of grid equipment and the value of physical assets are rated lower than the management requirements, indicating a better level of asset management. The results of the qualitative analysis are shown in Table 7.

**Table 7.** Results of the qualitative analysis of physical assets across Anhui municipalities in 2021

City	Management requirements	Grid value and scale	Asset Management Performance	levels of asset management
Wuhu City	High	Moderate	High	High
Xuancheng City	High	Moderate	High	High
Chuzhou	High	Moderate	High	High
Hefei	High	High	High	High
Suzhou	Moderate	High	High	High
Ma'anshan	High	relatively low	Moderate	Moderate
Huainan	Moderate	relatively low	Moderate	Moderate
Bozhou	relatively low	Moderate	Moderate	Moderate
Lu'an City	Moderate	High	Moderate	Moderate
Fuyang	Moderate	High	Moderate	Moderate
Huangshan City	relatively low	relatively low	relatively low	relatively low
Chizhou	relatively low	relatively low	relatively low	relatively low
Tongling	relatively low	relatively low	relatively low	relatively low
Huaibei City	relatively low	relatively low	relatively low	relatively low
Bengbu	Moderate	Moderate	relatively low	relatively low
Anqing	High	High	relatively low	relatively low

Wuhu City, Xuancheng City, Chuzhou City, Hefei City and Chuzhou City have a high level of asset management for their power grids. All five municipalities had a high level of asset management performance. Among them, Wuhu City, Xuancheng City and Chuzhou City responded to the higher level of grid physical asset management requirements with a medium level of grid equipment quantity size and physical asset value, indicating that the management level was higher in the high school. Hefei City has responded to the higher level of grid physical asset management requirements with a higher level of grid equipment quantity size and physical asset value. and have a slightly lower level of management than Wuhu City, Xuancheng City and Chuzhou City. Cebu City has responded to the medium level of grid physical asset management requirements with a higher level of grid equipment quantity size and physical asset value, and the management level is slightly lower than that of Hefei City.

Ma'anshan City, Huainan City, Bozhou City, Liu'an City, Fuyang City The level of asset management of the power grid is moderate. All five municipalities have a medium level of asset management performance. Among them, Maanshan City has the highest level of management among the medium ones, as it has a lower level of grid equipment and physical asset value to cope with the higher level of grid physical asset management requirements. Huainan City is second only to Ma'anshan City in terms of the scale of the number of equipment and the value of the physical assets of the grid at a lower level to cope with the requirements of the physical asset management of the grid at the Middle East level. Bozhou, Liu'an and Fuyang have a higher level of grid equipment and physical asset value than their cities and therefore have a lower level of management than Huainan.

Huangshan City, Chizhou City, Tongling City, Huaibei City, Bengbu City and Anqing City have low levels of physical asset management for power grids. The level of asset management performance in all five cities was low. Among them, Huangshan City, Chizhou City, Tongling City, and Huaibei City, have lower quantitative scale of power grid equipment and physical asset value levels and power grid physical asset management requirements, probably due to the limited scale of macroeconomic

development, which is an inherent deficiency. The number size of grid equipment and the value class of physical assets and grid physical asset management requirements in Bengbu are medium. Anqing has a high quantitative size of grid equipment and physical asset value class and grid physical asset management requirements. The problem in these two cities should be a specific management problem.

#### 4.2 Three-year longitudinal comparison results

Based on the above comprehensive evaluation index system and scoring method, this paper evaluates and analyses the physical assets of various cities in Anhui in the past three years. Based on the comprehensive evaluation results of physical assets in the past three years, a longitudinal analysis is conducted to analyze the changes in the management level of physical assets in the past three years in various cities in Anhui. The longitudinal analysis does not consider the macro factors of local municipalities. 2019-2021 The ranking of the evaluation results of physical asset indicators of power grids of various cities in Anhui is shown in Table 8.

**Table 8.** Ranking of the evaluation results of physical asset indicators of power grids in Anhui cities in 2019-2021

City	2019	2020	2021
Suzhou	8	3	1
Wuhu City	1	1	2
Hefei	7	10	3
Xuancheng City	4	6	4
Chuzhou	3	5	5
Fuyang	10	15	6
Lu'an City	2	2	7
Huainan	5	7	8
Bozhou	6	8	9
Ma'anshan	9	4	10
Huangshan City	15	11	11
Anqing	12	12	12
Chizhou	14	13	13
Bengbu	11	9	14
Tongling	13	14	15
Huabei City	16	16	16

The results of the longitudinal analysis and evaluation of the physical assets of the grid over the last three years show that the relative position of the value scale of the physical assets of the grid has basically not changed much. Only the three municipalities with smaller values and totals have changed. The performance level of grid asset management has changed considerably in many cities, but the overall change has been modest, with only a few low cities showing significant improvement in the level of grid asset management, while many have not made significant progress, while some have regressed somewhat because they have made less or no progress. Overall, the level of physical asset management in Anhui municipalities has not changed significantly in the last three years.

#### 5. Conclusions and recommendations

The findings of this paper can provide some guidance on the management of physical assets in the region, the main conclusions of the study are.

(1) The level of physical asset management in the local municipalities of the grid company is highly correlated with the macro external economic and social environment of the local municipalities. Comparing the evaluation results of physical assets of power grids, the evaluation results of macro factors of local municipalities and the comprehensive evaluation results, we can see that the macro factors of local municipalities have a greater or lesser impact on the level of physical assets

management. In the case of Anhui Grid, for example, Chuzhou City and Maanshan City are ranked at the bottom of their respective series in terms of the size of the number of grid equipment and the value of physical assets and the level of asset management performance, but a comparison of the municipal macro factors shows that the level of asset management in Chuzhou City and Maanshan City would like to be higher than the level reflected by the level of performance management. The city of Suzhou ranks highest in terms of asset management performance, but a comparison of local macro factors shows that the level of asset management in the city is lower than that reflected in the level of performance management.

(2) The level of asset management is not high in places where the number of grid equipment and the value of physical assets are low. All municipalities with lower levels of grid equipment quantity size and physical asset value have at best a medium level of asset management. Grid equipment quantity size and physical asset value are essential for a high level of asset management, and increasing investment in grid equipment quantity size and physical asset value is a necessary measure to improve the level of physical assets in the grid.

Based on the results of the analysis of this paper, the following recommendations are made for the physical assets of grid companies.

Grid planning requires consideration of various factors. Studies have shown that the current scale of the number of equipment and the value of physical assets in the grid is largely in line with the population of each municipality, while there is little correlation with the total local economy, industrial structure and Urbanization rate. The value and scale of physical assets lags behind the level of macro socio-economic development of the municipality in some localities. Therefore, more factors should be considered in the process of grid construction for investment and construction.

Improving the efficiency of equipment utilization is key to development. Unlike the reliability rate of power supply, the voltage compliance rate and the transmission and substation availability factor, which reflect the quality of assets. The annual average load factor of main transformers of different sizes varies greatly from city to city, indirectly reflecting that there are certain differences in the efficiency of the use of physical assets in different places. Improving the efficiency of equipment utilization is the key to improving the management of physical assets.

Accurate forecasting is as important as regular inspections. Research shows that power supply companies in cities with large populations or industrial enterprises above a certain size are more likely to have overloaded power grid equipment. It is necessary to accurately predict whether power grid equipment is working under high load or even overload, which is not conducive to good operation of power grid equipment, based on various factors such as the city's population, economic scale and industrial structure. The power to reduce the potential crisis of the grid, to ensure safe and reliable operation of the grid.

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