Study on Investment Impact Factors of Overhead Line Engineering Based on Big Data Statistics

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Abstract. Overhead line project is one of the key points of the investment and construction of power grid enterprises. Therefore, how to effectively carry out the statistical analysis of the big data of the project cost, and further improve the scientific nature and the accuracy of the project investment estimation, has become one of the key points and difficulties in the operation and development of power grid enterprises. This paper analyzes the statistical analysis of big data, from the perspective of the overall investment level, the investment structure composition, the investment difference of feasibility study, excavates the main factors affecting the engineering cost, and provides the reference for the investment calculation and investment estimation.

Keywords: overhead line engineering, cost big data, influencing factors, statistical analysis

1 Introduction

It is an important work of power grid enterprises to strengthen the lean management of overhead line project cost and reasonably control the level of power grid project cost.

Literature [1] put forward the method of power grid engineering cost impact factor analysis based on hierarchical analysis method, and verified the proposed method of power grid engineering cost impact factor analysis through simulation experiment accuracy. Document [2] was based on the national power grid projects put into operation in recent years, the statistical analysis of the final accounts of transformation and line projects. The results showed that the probability distribution of the final account unit cost of the substation project was similar to the normal distribution, and it was also similar to the normal distribution. Based on the paradox case in the current power grid project cost data analysis report, through the analysis and extraction of specific case data characteristics, and the use of simple data model, it expounded the causes of Simpson's paradox in the analysis of power grid project cost data, and puts forward the solution of data grouping research. Document [4] first analyzed the power grid engineering cost system, and on this basis, the power grid engineering cost storage system

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was constructed. Then, based on the big data environment, the data management process and management framework of power grid project cost were put forward, hoping to strengthen the management and control of power grid project cost. Document [5] studied the problems existing in Chinese power grid project cost valuation management; the influence of economic and environmental factors on power grid project cost; the control of power grid engineering construction stage; the basic practice of reasonable determination and effective control of power project cost.

To sum up, the analysis of the above experts and scholars on the influencing factors of the cost of power grid engineering is mostly more qualitative, which is not combined with the actual analysis results of engineering big data. Therefore, the scientific nature of the research conclusions needs to be further improved.

2 Statistical analysis of big data of investment of overhead line sample projects

2.1 Basic information of the Sample Engineering

This paper collects a total of 114 overhead line projects approved by GX Provincial Power Grid Company in a certain year, with a total length of 1554km (1400km for a single circuit, 154km for a double circuit) and a static investment of 1.87 billion yuan, of which: 220kV is 24, the length is 530.63km, and the static investment 881 million yuan; 110kV is 30, the total length is 350.25km, and the static investment is 510 million yuan; 35kV is 59, the total length is 672.44km, and the static investment is 479 million yuan.

2.2 Analysis of the main design conditions of the sample engineering

(1) Distribution of meteorological conditions of sample projects

Engineering design wind speed of different voltage levels is shown in the figure below:

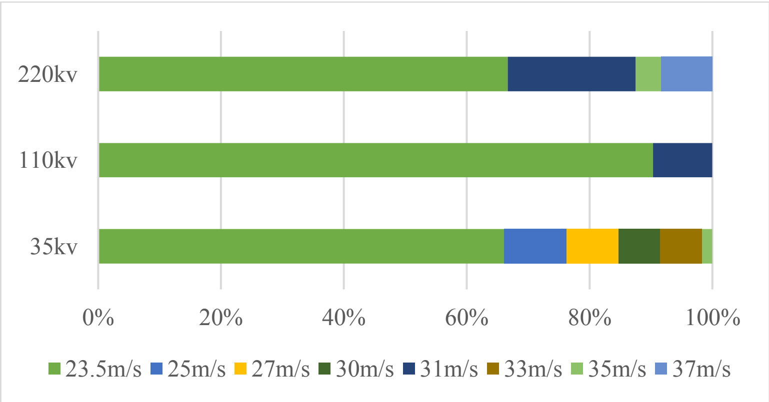

Fig. 1. Design wind speed of samples with different voltage levels.

It can be seen from the figure that the wind speed of overhead lines of all voltage grade in GX region is mainly 23.5m/s. In addition to using the 23.5m/s as the main design wind speed, the 35kV sample also involved multiple different design wind speeds between 25 m/s and 37 m/s.

The ice coating situation of engineering samples of different voltage levels is shown in the figure below:

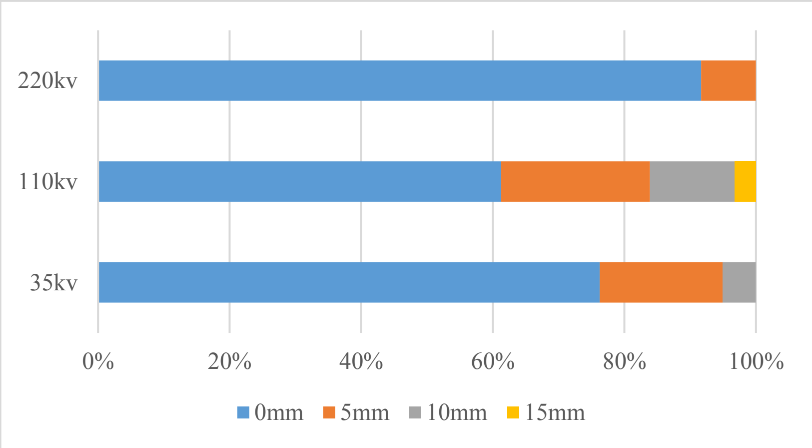

Fig. 2. Ice distribution of each voltage level.

As can be seen from the figure, the 220kV samples were mainly 0mm, not above 10mm, and 0mm and 5mm ice accounted for 92% and 8%. The ice-covered area is mainly concentrated in Hechi.

As can be seen from the figure, the 220kV samples were mainly 0mm, not above 10mm, and 0mm and 5mm ice accounted for 92% and 8%. The ice-covered area is mainly concentrated in Hechi.

At 110kV, 0mm, 0mm, 5mm, 10mm and 15mm were 61%, 23%, 13% and 3%. The ice-covering area is mainly concentrated in Liuzhou and Hechi.

The ice covering of 35kV samples was dominated by 0mm, without 15mm or above, 5mm and 10mm for 76% of 0 m m, 19% and 5%.

(2) Topographic and geological distribution of sample projects

The topographic distribution of each voltage samples is shown in the following table:

Table 1. topographic distribution of sample engineering

Topography / voltage	level the land	hills	mountainous region	mire	alp	steep mountain	hydrographic net
220kV	27%	48%	18%	5%	2%	0%	0%
110kV	32%	42%	19%	3%	1%	0%	3%

35kV	35%	41%	16%	3%	4%	0%	0%
amount to	32%	43%	18%	3%	3%	0%	1%

On the whole, the comprehensive terrain of the whole region is mainly flat land (32%), hilly land (43%) and mountainous land (18%). The engineering terrain conditions of 220kV, 110kV and 35kV samples are mainly hilly and followed by flat land.

The engineering geological distribution of each voltage grade sample is shown in the following table:

Table 2. Distribution of sample engineering geology

soil / voltage	Ordinary soil	hard soil	Pine sand	Puddle	Mudwater pit	Flow sand pit	Rock
220kV	24%	22%	22%	0%	8%	0%	14%
110kV	24%	26%	23%	0%	7%	0%	16%
35kV	29%	28%	18%	1%	6%	0	16%
Total	28%	26%	21%	1%	7%	0%	17%

The comprehensive geology of the sample engineering is mainly ordinary soil (28%), solid soil (26%), pine sand and stone (21%), rock (17%), mud water (7%), and puddle (1%).

2.3 Analysis of sample project investment

(1) Analysis of the overall cost level and cost composition

According to the formation of corner steel tower and steel pipe rod, the cost composition of single-loop overhead lines approved in 2021 is calculated respectively, and compared with the feasibility study indicators, as shown in the following tables:

Table 3. Investment composition of single-loop frame line works (Angle Steel Tower).

Voltage level	Conductor cross section (mm^2)	Ontology investment	proportion	Compilation base period spread	Proportion	Miscellaneous expenses	Proportion (%)	Static investment (10,000 yuan)
220kV	1×240mm^2	1860	67%	268	10%	530	19%	2781
	2×300mm^2	4270	73%	672	12%	882	15%	5824
	2×400mm^2	25158	71%	3440	10%	7017	20%	35615

	2×630mm2	48093	72%	5860	9%	12470	19%	66423
	subtotal	79381	72%	10240	9%	20899	19%	110643
	Feasibility indicators		73%		6%		21%	
110kV	1×240mm2	1068	71%	136	9%	290	19%	1494
	1×300mm2	33528	74%	4796	11%	6708	15%	45032
	subtotal	34596	74%	4932	11%	6998	15%	46526
	Feasibility indicators		75%		9%		16%	
35kV	1×150mm2	7112	68%	1313	12%	2080	20%	10505
	1×185mm2	7326	75%	978	10%	1511	15%	9815
	1×240mm2	14176	71%	2472	12%	3338	17%	19986
	subtotal	28614	71%	4763	12%	6929	17%	40306
	Feasibility indicators		72%		10%		18%	

It can be seen from the table that the ontology investment, the preparation of the benchmark period price difference and other cost ratio of different voltage sample projects are basically consistent with the feasibility study index.

(2) Comparison with the sample investment level of the previous year

Compared with the samples analyzed in the previous year, the number of sample projects in this year has increased. The comparison of the number of sample projects, path lengths, and investment in each year is shown in the following table:

In terms of investment level, the investment level of this year's samples has increased compared with the previous year, ranging from 3% to 15%. The main reasons are: ①The price of steel and other materials has risen; ②The number of projects with large cross-sections has increased; ③The path situation Complex projects increase.

3 Combing the influencing factors of overhead line engineering investment based on SD model

3.1 Basic principle of the S D model

System dynamics (SD) was founded by Professor Jay W. Forrester of MIT in 1956. It is an interdisciplinary and comprehensive subject specializing in understanding systems and solving system problems. The basic tool of system dynamics is the causality diagram, which connects multiple factors with arrows labeled causality to form a causal chain. The causality has positive causality and negative causality, which are represented by "+" and "-" on the arrows respectively, which means that the increase of the cause will promote or inhibit the result. Two or more causal relationship chains are connected end to end to form a causal loop. When a certain element in the loop is strengthened, the causal relationship of the entire loop can be strengthened, which is called a positive causal loop, otherwise it is called a negative causal loop. When the nature of variables and the inflow and outflow directions of system energy are relatively clear, the flow direction of system energy can be identified in the diagram to clarify the feedback form and control law of the system. This kind of diagram is called a flow diagram.

Power transmission and transformation projects have the characteristics of large investment, long construction period, and many units and departments involved. The factors affecting the project cost can be regarded as a complex system, which is suitable for analysis by using the system dynamics model to establish a relatively complete influencing factor system.

3.2 Analysis of the investment influence factors of overhead line engineering based on SD model

Based on the statistical analysis of the big data of overhead line engineering investment in Section 2, combined with the cost composition of overhead line engineering project, this paper sorts out the influencing factors of the investment of overhead line project from multiple aspects, etc., such as "natural environment, engineering technology, market factors, policy standards and management norms".

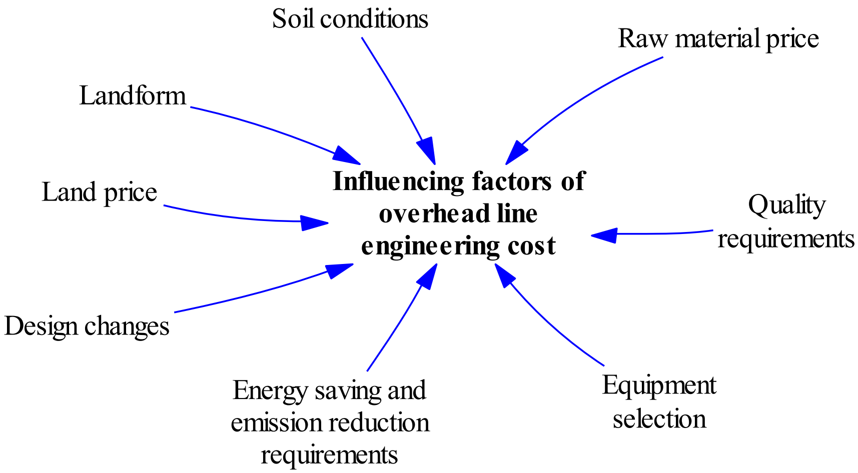

Fig. 3. Combing of the influencing factors of investment in overhead line engineering based on SD model.

The factors affecting the investment level of the overhead line project include many aspects. Conventional external factors include the proportion of the project terrain, design wind speed, ice covering, site transportation, etc. At the same time, limited by the project terrain conditions and path direction, the proportion of the project tension tolerance will also have a direct impact on the investment level of the line project. In addition, special construction measures such as ropeway transportation, the main materials (such as steel) price rise and fall will also have a certain impact on the investment level of overhead line projects.

4 Suggestions on project cost control

(1) Precise analysis of feasibility study to estimate the reasons for over-control indicators to achieve lean management and control of project cost

Accurate analysis of the reasons for estimating over-control indicators in feasibility studies is conducive to effective cost control, and is conducive to improving the lean management and control of engineering project cost. Strictly analyzing the reasons for the over-control indicators estimated in the feasibility study can also provide a supplementary basis for the preparation of the investment control indicators in the next year's feasibility study.

(2) Standardize the feasibility study investment analysis process to achieve efficient improvement of feasibility study analysis work efficiency

By building a smart data platform, it can update, store, and manage data online. On this basis, a dedicated system for feasibility study investment analysis is established to standardize the feasibility study investment analysis process. The standardized feasibility study investment analysis process is conducive to the improvement of work efficiency, the accuracy of investment analysis data processing, and the reduction of labor costs.

(3) Mining individual influencing factors to improve the reference value of equipment and material price information

Combined with the statistical analysis results of the proportion of sub-item costs in the investment analysis, it can be seen that the purchase cost of distribution network engineering equipment and the cost of installation materials account for a large proportion of the total cost. The driving influence of various internal and external factors such as policies shows the characteristics of large fluctuations and different fluctuation trends. Therefore, it is necessary to correctly grasp the changing trend of equipment and materials prices, and strengthen the analysis and forecasting of equipment and materials prices, so as to help rationalize the price of equipment and materials. Control the cost of distribution network projects, optimize investment strategies, and reduce project investment risks.

5 Conclusion

Based on the analysis of the statistical analysis of the big data of overhead line engineering investment of GX provincial power grid company, combined with the basic principle of SD model, this paper systematically analyzes the factors affecting the investment of overhead line engineering, providing reference and guidance for power grid enterprises to improve the investment control level of overhead line engineering. In the future, power grid enterprises should continue to increase the accumulation of big data for project investment on the one hand; On the other hand, power grid enterprises should combine the research results of this paper to formulate effective cost control measures, so as to continuously improve the level of cost control of transmission line projects.

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