Problems Existing in the Process of Investment Execution of Distribution Network Infrastructure Projects and Their Improvement Paths

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Abstract. By constructing a real and accurate data set and a collaborative and efficient management mechanism, lean management of State Grid Investment lays a foundation for the company to mine the value of data and promote the implementation of the new concept of data-driven management. Focus on 10 kV and below power grid infrastructure projects, build a data index system, monitor the matching, integrity, accuracy and compliance of the key links of project initiation, start and production information, in-depth analysis of the existing management problems, and put forward relevant suggestions.

Keywords: Power grid infrastructure projects · Investment execution · Indicator improvement

1 Introduction

As the scale of power grid enterprises continues to expand, the total amount and types of power grid assets continue to expand. Among them, power grid infrastructure equipment of 10 kV and below, as the last link connecting the main transmission network and power users in the power grid, plays a crucial role in realizing the development of power enterprises and meeting the needs of power users [1]. In order to implement the requirements for precise management and control of infrastructure project investment execution process management, Hubei Company focuses on site construction and functional management requirements, and establishes an investment execution process monitoring index system based on relevant requirements of State Grid Company. And through the analysis of the early warning problems of the power grid infrastructure projects of equipment specialty 10 kV and below, the causes of the problems are classified and summarized, and the standardized index improvement method is put forward to standardize the project management requirements.

S. Kadry et al. (Eds.): BDEIM 2022, AEBMR 233, pp. 11–21, 2023.
https://doi.org/10.2991/978-94-6463-124-1_3

2 Indicator Monitoring System

In the process of asset management, State Grid Corporation shall, in accordance with the new requirements of its own asset management and the international standard ISO 55000, establish a management system adapted to its own characteristics, namely the Measures for the Statistical Management of Fixed Asset Investment. At the same time, companies in each province are constantly trying to optimize and improve the system, establish an institutionalized, systematic and systematic asset management framework, adjust the content of the asset management manual, and further standardize the system construction and operation of each unit [2].

Considering the matching, integrity, accuracy and compliance of data in the investment execution process of power grid infrastructure projects of 10kV and below, the whole process data supervision is carried out from the three links of "early management, start-up management and production management", and the investment implementation monitoring indicators and evaluation rules are determined.

2.1 Construction of Investment Execution Process Monitoring Index System

The construction of the execution analysis index takes the key links of the investment execution process as the main line, and the management requirements, related systems and business management experience of each professional department as the basis [3]. The construction framework of the investment execution analysis index is determined centering on the analysis and evaluation of the investment execution risk and the efficient solution of problems (Table 1).

Table 1. Investment implementation process monitoring index system framework

Process	Investment execution key links	Evaluation standard
Early management	Initial link: construction scale, total investment, construction period	Integrity, Accuracy
	Examination and approval link: feasibility examination and approval, initial examination and approval	Integrity, Accuracy
	Project construction link: network grid plan list, ERP project construction, ERP project construction	matching
Start-up management	Project start time, Compliance of project commencement	Matching, Compliance
Production management	Project production time, Compliance of project completion, No delay of project	Matching, Compliance

2.2 Investment Execution Analysis Index Evaluation Standards

2.2.1 The Evaluation Standard of Matching

According to the process of power grid infrastructure project, after the project list is issued by the investment plan, the project construction in ERP system will enter the construction management stage and be managed in PMS system. Therefore, the matching rate index is set. First, it is to judge whether the project list issued by the investment plan matches each other with the ERP construction project and the PMS construction project, so as to analyze the start-up situation of the projects issued by the investment plan. The second is to judge whether the projects scheduled to be started this year in the list of projects issued by the investment plan match the projects started this year by PMS; The third is to judge whether the projects scheduled to be put into production this year in the list of projects issued by the investment plan match the projects put into production this year by PMS.

2.2.2 The Evaluation Standard of Integrity

Considering that the missing key information data of the project construction engineering will have a great impact on the project construction engineering, the integrity rate index is set [4]. The first is to judge whether the information of the project construction is complete, including the initial approval time and the complete information of the project construction scale; The second is to judge the integrity of the construction information of the single project, in which the single project refers to the multiple single projects separated from a project, including the complete information of the initial total investment of the single project, the planned start time of the single project, the actual start time of the single project, and the actual completion time of the single project.

2.2.3 The Evaluation Standard of Accuracy

From the perspective of business practice, project needs to check the accuracy between initial data, feasibility data, and planning data. Early management also need to improve precision at the same time, reduce the feasibility and initial data error [5]. The following requirements must be met:

① The initial total investment of the project must be accurate, and the specific requirements are:

$$|\mathrm{ITI} - \mathrm{FTI}|/\mathrm{FTI} <= 20\% \text{ and } |\mathrm{ITI} - \mathrm{PTI}|/\mathrm{PTI} <= 10\% \tag{1}$$

ITI: Initial total investment; FTI: Feasibility total investment; PTI: planning total investment;

② The variable capacity of the project must be accurate, and the specific requirement is:

$$\mathrm{IVC} = \mathrm{FVC} = \mathrm{PVC} \tag{2}$$

IVC: Initial variable capacity; FVC: Feasibility variable capacity; PVC: planning variable capacity;

③ The line length of the project needs to be accurate, and the specific requirements are:

$$|\text{ILL} - \text{FLL}|/\text{FLL} <= 20\% \text{ and } |\text{ILL} - \text{PLL}|/\text{PLL} <= 10\% \quad (3)$$

ILL: Initial line length; FLL: Feasibility line length; PLL: planning line length;

2.2.4 The Evaluation Standard of Compliance

As the Regulations on Project Management of State Grid Distribution Network Project clearly stipulates the commencement and commissioning time of the project, compliance indicators are introduced. The following requirements must be met:

① The earliest start time of a single project in the PMS system must be compliant, and the specific requirements are:

$$|\text{EST in PMS} - \text{EST in WSP}| <= 7 \text{ days} \quad (4)$$

EST in PMS: The earliest start time of a single project in the PMS system; EST in WSP: The earliest start time of a project item in the work-start reports;

Besides, the commencement of the PMS system project shall not be earlier than the execution time of the construction contract.

②The latest production time of a single project in the PMS system must be compliant, and the specific requirements are:

$$|\text{LPT in PMS} - \text{PT in CAR}| >= 7 \text{ days} \quad (5)$$

LPT in PMS: The latest production time of a single project in the PMS system; PT in CAR: The production time of the project in the completion acceptance report;

Besides, the latest production time in PMS system should be earlier than the latest operation time of the PMS equipment ledger.

③No delay of project requirements are:

$$|\text{CT} - \text{AST}| <= 12 \text{ months} \quad (6)$$

CT: The current time; ART: Actual start time;

3 10 kV and Below Power Grid Construction Project Investment Problems that Exist in the Implementation Process

Taking the investment execution data of a power company's power grid infrastructure project of 10 kV and below as of June 30, 2022 as an example, this paper applies monitoring indicators and evaluation principles to monitor the problems in distribution network management.

Sample data range: 3189 large market projects of 10 kV plan, 2258 projects officially issued by investment plan, 2025 ERP projects, 2163 PMS projects, 6323 PMS individual projects.

Monitoring results: A total of 2163 PMS construction projects were monitored, and 672 problematic projects were found in the early stage, accounting for 31.1%. A total of 658 problematic projects were found in the construction phase, accounting for 30.4%; A total of 379 problematic projects were found in the production stage, accounting for 17.5% (Table 2).

Table 2. Data required for monitoring indicators and data sources

Data list	Key fields	System
The projects of 10 kV plan	PTI; FVC; FLL	Net power grid system
The projects of 10 kV investment plan	PTI; PVC; PLL	Net power grid system
The projects in ERP	Accumulated amount recorded	ERP system
The projects in PMS	ITI; IVC; ILL	PMS system
The individual projects in PMS	EST; LPT; AST	PMS system

Table 3. Example of incomplete construction scale and initial examination and approval of project

Problem classification	**Incomplete construction scale**					**Incomplete approval projects**
index	**The number of distribution transformer**	**Distribution transformer capacity**	**The length of overhead line**	**The length of cable line**	**The length of low-voltage line**	**The time of initial examination and approval**
NO.XXX1	0	0	0	0	0	null

3.1 Early Management

The main objective of the early management is to ensure the smooth start of the project, focus on the push of basic information of project feasibility research, carry out the preparation, review and approval of the initial project, and maintain the initial project information. A total of 2163 PMS construction projects were monitored, and 672 problematic projects were found in the early stage, accounting for 31.1%.

3.1.1 The Project Construction Scale and Initial Examination and Approval are Incomplete

After monitoring, 447 such problems were found, accounting for 20.8%.

Among them, 38 projects with incomplete construction scale accounted for 1.7%. Characteristics of main problems: the information of project construction scale in the PMS system, namely, the number of distribution transformer, distribution transformer capacity, length of overhead line, length of cable line, and length of low-voltage line, has no data.

The number of incomplete approval projects was 426, accounting for 19.7%. Main problem features: no data on the initial approval time (Table 3).

Table 4. Example of inaccurate construction scale and initial examination and approval of project

Problem classification	**Inaccurate construction scale**						**Inaccurate initial examination and approval**		
Key fields	**Variable capacity**			**Line length**			**Initial examination and approval**		
index	**IVC**	**PVC**	**FVC**	**ILL**	**PLL**	**FLL**	**ITI**	**PTI**	**FTI**
NO.XXX2	100	100	500	1	1	2.75	92.86	92.86	35.67

Through investigation and research, the main reasons for this kind of problem include: First, the operation error of information entry system, there is information omission; Second, there are missing items in the approval documents based on information input, and the information of project construction scale is missing.

3.1.2 The Project Construction Scale and Initial Examination and Approval are not Accurate

After monitoring, the number of such problems was found to be 346, accounting for 16.0%.

Among them, there were 319 projects with inaccurate construction scale, accounting for 14.7%. Main problem characteristics: the initial variable capacity and line length of the project are consistent with the planned data, but the value of the initial variable capacity and line length of the project is quite different from that of the feasibility variable capacity and line length.

The number of inaccurately initial examination and approval of PMS project was 194, accounting for 9.0%. Main problem characteristics: $|ITI\text{-}FTI|/FTI > 20\%$ (Table 4).

Through investigation and research, the main reasons for this kind of problems are limited by the incomplete information obtained from the preliminary research of infrastructure projects, the underestimation of the project scope, the incomplete consideration of various functions and other problems, which lead to the inaccurate compilation and evaluation, and thus the inaccurate investment estimation.

3.1.3 The Projects of ERP and PMS Does not Match

After monitoring, 142 such problems were found, accounting for 6.6%. Main problem characteristics: Compared with the planned release list of the development department, there was a mismatch between the ERP construction project list and the PMS construction project list.

Through investigation and research, the main reasons for this kind of problem are as follows: First, the ERP project construction and PMS system do not release the list of projects in time according to the development plan, which leads to the mismatch with the list issued by the development plan and the omission of projects; Second, there is non-compliance in process management, resulting in a mismatch with the list issued by the development department, appearing in redundant projects (Table 5).

Table 5. Example of project mismatch between ERP and PMS

Project code	The ERP construction project list	The PMS construction project list
NO.XXX3	Yes	No
NO.XXX4	No	Yes

Table 6. Examples of projects with start-up management problems

Problem classification	Project code	EST in Net power grid system	EST in PMS	EST in WSP	The execution time of the construction contract
Unmatched	**NO.XXX5**	1900/1/0	2022/7/15	2022/7/15	2022/7/15
	NO.XXX6	2021/12/30	2022/3/4	2022/3/4	2022/3/4
	NO.XXX7	2022/7/27	1900/1/0	2022/7/27	2022/7/27
Non compliance	**NO.XXX8**	2022/3/15	2022/3/15	2022/3/1	2022/3/15
	NO.XXX9	2022/4/1	2022/4/1	2022/4/1	2022/4/2

3.2 Start-Up Management

At the Start-up management stage, the construction management unit shall organize the construction project Department and the project supervision Department to complete the construction application and review process synchronously according to the provincial company side of the infrastructure platform. A total of 2163 PMS construction projects were monitored, and 658 problematic projects were found in the construction phase, accounting for 30.4% (Table 6).

3.2.1 The Projects Started This Year Do not Match

After monitoring, 658 such problems were found, accounting for 30.4%. Main problem features: There is a mismatch between the project submitted by the PMS system and the net power grid system.

Through investigation and research, the main reasons for this kind of problem are as follows: First, the PMS system and the net power grid system do not cooperate together, the work-start report and other supporting documents are not uploaded in time, and there is a time difference between the two systems in submitting the start time. Second, the accuracy of the work-start reports by the PMS construction end and the net power grid system has not been checked, and there is inconsistency between the two systems in data entry.

3.2.2 The Projects Started Without Compliance

After monitoring, two problems of this kind were found. Main problem characteristics: the earliest start time of each individual project in the PMS system is not compliant. Firstly, the interval of the earliest start time between the PMS and the WSP is more than 7 days; secondly, it is earlier than the signing time of the construction contract, which does not conform to the time stipulated in the distribution network management method.

Through investigation and research, the main reasons for this kind of problems are as follows: First, the management of the project is not standard in the early stage, and the project is delayed, which leads to the actual start time later than the planned start time; Second, the management of the bidding and procurement procedure is not strict, and the signing time of the construction contract is later than the plan. A few projects advance the actual start time to the signing of the construction contract in order to meet the project plan nodes, which seriously violates the relevant requirements of the distribution network management method.

3.3 Production Management

At the production management, the construction management unit shall organize the owner, supervision department and construction project department to complete the start-up and production process simultaneously in the provincial company of infrastructure platform. Monitoring sample PMS construction projects 2163, found a total of 379 problems in the production stage, accounting for 17.5% (Table 7).

3.3.1 The Projects Put into Production This Year Do not Match

After monitoring, 379 such problems were found, accounting for 17.5%. Main problem features: There is a mismatch between the projects put into production this year submitted by the PMS system and the net power grid system.

Through investigation and research, the main reasons for this kind of problem are as follows: First, the completion acceptance report and other supporting documents are

Table 7. Examples of projects with production management problems

Problem classification	Project code	LPT in Net power grid system	LPT in PMS	PT in CAR	LPT in PMS equipment ledger	CT	AST
Unmatched	**NO.XX10**	1900/1/0	2022/6/25	2022/6/25	2022/6/25	2022/6/30	2022/3/1
	NO.XX11	2022/6/1	1900/1/0	2022/6/1	2022/6/1	2022/6/30	2022/3/1
	NO.XX12	2022/6/29	2021/12/16	2022/6/29	2022/6/29	2022/6/30	2022/3/1
Non compliance	**NO.XX13**	2022/5/15	2022/5/15	2022/5/1	2022/5/15	2022/6/30	2022/1/1
	NO.XX14	2022/4/1	2022/4/1	2022/4/1	2022/4/10	2022/6/30	2022/1/1
	NO.XX15	2022/4/30	2022/4/30	2022/4/30	2022/4/30	2022/6/30	2021/6/1

not uploaded in time. Second, the accuracy of the completion acceptance report by the PMS construction end and the net power grid system has not been checked.

3.3.2 The Projects Put into Production Without Compliance

After monitoring, two problems of this kind were found. Main problem characteristics: First, the interval of the latest production time between the PMS and the WSP is more than 7 days; second, the latest production time in PMS system is not earlier than the latest operation time of the equipment ledger.

Through investigation and research, the main reason for this kind of problems is as follows: The project process management is not standardized, and the project progress lags behind, resulting in the actual production time later than the planned production time.

3.3.3 There is Delay in the Project

After monitoring, 1 such problem was found, and the performance of this index was good. Main problem characteristics: $|CT\text{-}AST| > 12$ months.

Through investigation and research, the main reasons for this kind of problem are as follows: First, the project is suspended or canceled due to reasons after the establishment, and the project is not cleared in time; Second, the project process management is not standard, the project progress lag leads to the actual project delay.

4 Suggestions for Promotion

4.1 Deepen Project Feasibility Study and Preliminary Document Review, and Check the Consistency of Scale Information

The company development department and the power distribution Department (network reform Office) of each city should respectively do a good job in the early management of feasibility study review and initial review depth, to ensure the consistency of construction scale information; At the same time, the development department shall timely input the line length, distribution capacity and other information into the net power grid to ensure the integrity and accuracy of the information; The power distribution Department timely inputs the scale information such as line length and distribution capacity in the PMS to ensure that the information is complete and accurate.

4.2 Standardize the Project Construction Work Issued from the Plan to Ensure the Timely and Accurate Construction

The power distribution department to strengthen the coordination with the development department, organize various units in receives the development plan issued after project approval, and input the project list synchronously in ERP and PMS according to the planned project list, narrowing the difference between the project approval time and the planned release time, Improve the matching between those different systems.

4.3 Verify the Commencement and Production of the Project to Ensure the Accuracy and Compliance of the Commencement and Production

It is suggested that the power distribution Department and the Development Department formulate a joint action plan, list the projects with differences, and supervise each unit to check the actual construction situation of the projects in time. For projects inconsistent with the actual construction situation, combined with relevant supporting materials, check the authenticity of the project commencement and production; For the projects consistent with the actual construction situation, timely supervise all units in the relevant system maintenance project start time and production time, to ensure the consistency between different systems.

4.4 Regularly Carry Out Data Governance Work, and Strongly Promote the Rectification of Problem Projects

Each unit shall carry out monthly data check and supplement of PMS and ERP system, strengthen monthly indicator monitoring, and timely cooperate with relevant departments to rectify the key indicators of the project according to the problem projects. Improve the relevant regulations and norms of data governance, and ensure that the monitoring indicators in the process of investment implementation meet the control requirements of the State Grid company.

5 Conclusion

This paper takes power grid infrastructure projects of 10kV and below as the research object, considering the matching, integrity, accuracy and compliance of data in the process of project investment implementation. Through monitoring samples, it is found that projects with management problems in the early management account for about 31.1%, projects with Start-up management problems account for about about 30.4%, and projects with production management problems account for about 17.5%. It is suggested that in the future management work, we should deepen the review of documents in the early stage of the project and check the consistency of information. Standardize and issue investment plans to ensure timely and accurate construction projects; Verify the commencement and production of the project to ensure the accuracy and compliance of the commencement and production. Through the normalization of data governance work, promote the construction of real and accurate data sets and collaborative and efficient management mechanism, to help the overall development of the power industry.

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