Research on Comprehensive Evaluation Method of Power Grid Efficiency

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Abstract. Power Grid Efficiency directly affects the development level of the company and is an important embodiment of the company's comprehensive strength and market competitiveness. Different from the previous single cause analysis, this paper uses the earned value method to evaluate the project progress objectively and systematically, and establishes the relevant evaluation index system, so as to have certain reference value for the company's decision-making adjustment.

Keywords: Project execution efficiency; power grid engineering; comprehensive evaluation; earned value method.

1. Introduction
In order to ensure the steady and continuous growth of the national economy, it is necessary to optimize and control the capital input of power grid project construction, optimize the industrial pattern, strictly control the project risk, control the project progress, and accelerate the investment and construction of various power grid projects. Power grid project has the characteristics of large scale, complex technology and changeable construction environment. In addition, with the acceleration of China's power market reform, the competition among all kinds of power grid project construction and investment becomes increasingly fierce, which inevitably faces huge competition and challenges. The low execution efficiency of power grid project will affect the industry transformation and development of power grid companies in the context of a new round of power reform. The establishment of the evaluation system of project execution efficiency is helpful to optimize the power grid project from the aspects of cost, safety and schedule, so as to create new profit points for the power grid company.

2. Evaluation of project cost management efficiency
2.1. Cost management efficiency theory method
The cost management efficiency of the project is mainly to ensure the quality and timely completion of the project under the approved budget conditions, which mainly includes: Resource Planning: to determine the types and quantities of various resources (manpower, equipment and materials) used for the project work. Cost estimation: Estimating the Cost of resources needed to complete project work. Cost budget (Cost Budgeting): to estimate the Cost of the assigned to each work of the project.
Control: Control the change of project budget. The specific process of cost control is shown in the figure below:

![Fig. 1 Schematic diagram of cost management process](image_url)

In the process of cost control, this section USES the Earned Value method to evaluate projects. The earned value theory introduces an intermediate variable earned value to establish the relationship between schedule and cost, so as to help the project management team to analyze the linkage between project schedule and cost, so as to comprehensively analyze and manage project schedule and cost.

2.2. Establishment of cost management efficiency evaluation index system
The earned value technique is a method to control the project progress and cost synchronously, and realize the synchronic management of the progress and cost by monetizing the project amount. The earned value can objectively and systematically evaluate the progress of the project, which is an effective performance scale to measure the project status, realize the comprehensive dynamic management of the project, and effectively realize the pre-planning, in-process control and post-event prediction in the project management process.

Specific indicators include:
1) Planning cost refers to the accumulated amount of investment required for the work to be completed by a certain point according to the approved progress plan and budget. Its calculation formula is as follows:

$$BCWS = PW \times BQ$$  \hspace{1cm} (1)

Among them, BCWS is Budgeted Cost of Work Scheduled, PW is the planned workload, and BQ is the budget quota.

2) Earned value refers to the accumulated amount of investment required for the work completed by a certain point according to the approved budget. The calculation formula is as follows:

$$BCWP = FW \times BQ$$  \hspace{1cm} (2)

Among them, BCWP is Budgeted Cost of Work Performed, FW is the Finished work, and BQ is the budget quota.

3) The actual cost is the cumulative value of the actual cost of completing the work at a given point in time.

4) In the earned value method, CV refers to the difference between the budgeted cost of executed work BCWP and the actual cost of executed work ACWP during the inspection period. Its calculation formula is as follows:
3. Evaluation of project cost management efficiency

3.1. Theoretical method of risk safety management efficiency

Project production safety management refers to a series of activities including planning, analysis, decision-making and control centering on safety issues in project production activities in order to achieve specific safety objectives. The connotation of enterprise production safety management mainly includes planning, organization, personnel, command, coordination and report. For power grid enterprises, production safety management is a series of management work to make production activities in a good and controllable production environment and work order, to eliminate personal and equipment accidents, to ensure the continuous operation of the power grid and reliable power supply. Production safety management, as an organized, purposeful, ideological and defined management activity in the production and operation of enterprises, is conducive to comprehensively improving the level of production safety and management of enterprises.

3.2. Establishment of risk safety management efficiency evaluation index system

| Table 1. Project safety production management evaluation system |
|-------------------|-------------------|-------------------|
| First grade       | Second grade       | Third grade       |
| Company safety production management | Number of major accidents | General accidents below the number of accidents |
|                    | Ability to prepare and revise plans | After the accident plan execution |
| Safety accidents   | Main transformer unplanned shut down the frequency | Main transformer unplanned outage time |
| Emergency management | Frequency of unplanned line outage | Line unplanned downtime |
| Total number of trips | Relay protection and safe device misoperation | The total number of trips not caused by insulation |
| Line fault         | Other              |                   |

The evaluation system of production safety management can be established according to the influence of the evaluation index on the evaluation objective. In actual work, the influencing factors of the overall objective problem of production safety management are decomposed layer by layer, and the characteristic variables of the company's production safety management are gradually refined according to the size of the influence and the severity of the consequence of each factor, and finally a tree-shaped hierarchical structure is formed. The details are shown in the table.

(1) Safety accidents. In order to standardize the enterprise work safety accident emergency management and emergency response procedures, improve the ability to deal with work safety accidents. In the event of an accident, can quickly, effectively and orderly implementation of emergency rescue
work, minimize casualties and property losses, to prepare a series of measures.

(2) Emergency handling. In order to standardize the enterprise work safety accident emergency management and emergency response procedures, improve the ability to deal with work safety accidents. In the event of an accident, can quickly, effectively and orderly implementation of emergency rescue work, minimize casualties and property losses, to prepare a series of measures.

(3) Main change. The production site is an important place for production, and also the place where the front-line employees work every day. For some potential safety hazards and emergencies on the site, timely investigation and active prevention should be taken to ensure the normal production order and personal health and safety.

(4) Line. Work safety should be people-oriented, adhere to the safety development, adhere to the principle of safety first, prevention first and comprehensive treatment, and strengthen the implementation of the main responsibility.

(5) Other risks. The development of safety activities refers to the corresponding safety training activities according to the safety policy, so as to effectively improve the safety skills of employees and promote safe and civilized construction and production.

4. Evaluation of project time management efficiency

Time schedule management, also known as project period management or project schedule management, is an important measure to ensure the timely completion of engineering projects, reasonably arrange the supply of resources, and save the cost of engineering projects. The evaluation of project management efficiency can help the company to better control the project progress, so as to ensure the completion of the project in the expected time or without affecting the quality of the project.

4.1. Time schedule management efficiency theory method

In terms of engineering projects, critical path method is usually used to manage the project schedule. The critical path method works as follows: calculate the duration for each minimum task unit, define the earliest start and end dates, the latest start and end dates, form a sequence of logical network diagrams according to the relationship of activities, and find the longest path that is necessary, that is, the critical path. Reasonable time to obtain the overall time, the staff can use this data to determine the duration.

4.2. Establish the evaluation index system of time progress management efficiency

In the critical path method, there are generally the following time parameters:

(1) The earliest start time ES refers to that the earliest start time of an activity is determined by the last earliest end time of all the leading activities. The calculation formula is as follows:

\[ ES = \max\{\text{Tight front work EF}\} \] (7)

(2) The earliest end time EF refers to the earliest end time of an activity determined by the earliest start time of the activity plus its duration. Its calculation formula is as follows:

\[ EF = ES + t \] (8)

Among them, \( t \) is Working duration.

(3) The LF is the latest time an activity can start without delaying the end time of the entire project. It is equal to the earliest and the latest start time of all the tight jobs. Its calculation formula is as follows:

\[ LF = \min\{\text{Tight after work LS}\} \] (9)

(4) LS is the earliest time an activity can start without delaying the end of the project. It is equal to the latest end time of the activity minus the duration of the activity. Its calculation formula is as follows:

\[ LS = LF - t \] (10)

(5) Total time lag TF is the maximum time fluctuation for an activity without affecting the overall planned duration. Its calculation formula is as follows:

\[ TF = LF - EF = LS - ES \] (11)

(6) Free jet lag FF refers to the time at which an activity can float without affecting the earliest start time of its tight work. Its calculation formula is as follows:
\[ FF = \min \{ ES(\text{Tight after work}) \} - ES - t \] (12)

(7) Earliest start time \( \triangle E1 \) refers to the time between the earliest start time and the earliest end time. Its calculation formula is as follows:

\[ \triangle E1 = ES - EF \] (13)

(8) \( \triangle E2 \) refers to the time between the earliest start time and the earliest end time. Its calculation formula is as follows:

\[ \triangle E2 = ES - EF \] (14)

(9) \( \triangle L1 \) represents the time between the earliest start time and the earliest end time. Its calculation formula is as follows:

\[ \triangle L1 = FS - FF \] (15)

(10) \( \triangle L2 \) is the length of time between the earliest start time and the earliest end time. Its calculation formula is as follows:

\[ \triangle L2 = FS - FF \] (16)

5. Conclusion

Aiming at the comprehensive evaluation system of project execution efficiency, this chapter mainly analyzes the efficiency of project fund management, project risk and safety management and project schedule management. In terms of project cost management, project cost includes resource planning, cost estimation, cost budget and cost control. Through cost control, real-time monitoring of the use of funds and expenses of power grid projects, revision of cost estimates, budget update and corrective measures. By using the principle of earned value method, the project progress is evaluated objectively and systematically, and the related evaluation index system is established. In terms of project risk and safety management, according to the theory of production safety management, a hierarchical index evaluation system was established by combining the analytic hierarchy process (AHP) with comprehensive consideration of planning, organization, personnel, command, coordination and other aspects. In the aspect of project time schedule management, critical route method is used to manage the project time schedule, and an evaluation index system is established.

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References

[1] Vassilis K. Bouras. A Method for the Evaluation of Project Management Efficiency in the Case of Industrial Projects Execution[J]. Procedia - Social and Behavioral Sciences,2013,74.

[2] K. Chandrashekhar Iyer, Partha S. Banerjee. Measuring and benchmarking managerial efficiency of project execution schedule performance[J]. International Journal of Project Management, 2016, 34(2).

[3] Keim, B., Black, L.G. Signal Mountain Cement-a success story in project execution and technological efficiency[P]. Cement Industry Technical Conference, 2003. Conference Record. IEEE-IAS/PCA 2003, 2003.

[4] Amme, W., Dalton, N., Frohlich, P.H., Haldar, V., Housel, P.S., von Ronne, J., Stork, C.H., Zhenochin, S., Franz, M. Project TRANSPROSE: reconciling mobile-code security with execution efficiency[P]. DARPA Information Survivability Conference & Exposition II, 2001. DISCEX '01. Proceedings, 2001.

[5] Hussain Shahid. A Study on Measuring the Impact of Project Delay on Local Community-Community Participation in Public Projects[D]. Dalian university of technology, 2018.