IOP Conference Series: Earth and Environmental Science

PAPER • **OPEN ACCESS**

Research on Multi-Dimensional Closed-Loop Management and Control Mode of Schedule Investment for Power Grid Infrastructure Projects

To cite this article: Jian Zhang *et al* 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **295** 042013

View the article online for updates and enhancements.

This content was downloaded from IP address 59.127.168.43 on 10/10/2019 at 04:12

Research on Multi-Dimensional Closed-Loop Management and Control Mode of Schedule Investment for Power Grid Infrastructure Projects

Jian Zhang[1], Xianing Jin[2], Yi Song[2], Weihong Yang[2], Mingli Zhang[3], Jing Gao[3], Bo Yang[3], Zhanjun Li[3] and Yihe Wang[3]

[1]State Grid Corporation of China CO. LTD., Beijing, Beijing, 100000, China

[2]State Grid Economic and Technological Research Institute CO., LTD., Beijing, Beijing, 100000, China

[3]State Grid Liaoning Electric Power Co., Ltd. Economic and Technical Research Institute, Liaoning, Shenyang, 110000, China

[*]Corresponding author's e-mail: jessicacau@163.com

Abstract. With the deepening of external power transmission and distribution price reform and other policies, the work program of "optimize operation and management strategy, promote quality and efficiency development" within the power grid company has put forward clear requirements for the coordination of multiple majors, such as planning, construction, transportation and inspection, and materials. Starting from the actual management demand of investment chain, we build collaborative control standards of investment, standard control model, the innovative power grid construction project investment in multi-dimensional closed-loop control mode, and apply it to the investment management process, in order to extend investment value management to business terminals, constantly improve the management of scientific, validity and accuracy, and assist the company in multi-dimensional lean management and control.

1. Investment Management Status of Power Grid Infrastructure Projects

Currently, there are still many problems in the investment management of power grid infrastructure projects, such as:

(1) We lack a strong grasp in the whole process control of power grid infrastructure project. Currently, there is a lack of effective quantitative tools for the implementation analysis of power grid investment plan, mid-year plan adjustment, project capital arrangement, etc., as well as insufficient analysis depth and lack of grasp for project process control.

(2) The rationality and normative evaluation of investment plan execution are lack of basis. At present, the investment management personnel of grassroots units to judge the rationality and normative evaluation of the implementation of the project investment plan is lack of effective management basis, which cannot be closely related to the construction department's project site situation, and the closed-loop feedback mechanism of investment cannot be effectively implemented.

(3) Cross-professional communication is not smooth. Power grid project management chain is long, involving multiple functional departments. Meanwhile, business data and financial data are scattered

Content from this work may be used under the terms of the Creative Commons Attribution 3.0 licence. Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.
Published under licence by IOP Publishing Ltd

in each functional module of its professional system, resulting in difficulties in data acquisition and low efficiency.

Therefore, it is urgent to change the investment management mode of power grid infrastructure projects to improve the lean investment management level of power grid company.

2. Connotation and Main Practice of Closed Loop Management and Control Mode of Multi-Dimensional Schedule Investment in Power Grid Infrastructure Projects

In order to solve the problems existing in the investment management of power grid infrastructure projects, we innovatively put forward the multi-dimensional closed-loop management and control mode of schedule investment of power grid infrastructure projects to facilitate lean management of project investment. The specific connotation of the model is as follows:

Multidimensional investment progress closed-loop control mode refers to all kinds of engineering project investment plan management as the breakthrough point, in order to reduce multiple dimensions of project assets, such as investment plan implementation deviation index as the goal, to whole process engineering development, finance, construction, material big data as the foundation, to project schedule, cost, capital payment schedule and net investment completed progress between four gripper matching rate for control of a set of “standardization, quantifiable, integration” project lean controls the whole process of solution. Specific measures are summarized as “a set of standards, a set of models and three types of curves”:

“One set of standards”: we develop a set of milestone plan, investment plan and investment budget coordinated control standards based on the integration of industry and finance;

“A set of models”: we build a standard time series quantitative model with four indicators of construction progress, cost, capital and investment completed;

“Three types of curves”: we use a set of models to generate standard curve, experience curve and actual curve (" three types of curves ") to build a multi-dimensional integrated monitoring platform for the project, which can scan the past, warn the present and predict the future of the project in an all-round and multi-angle way in real time.

“Seven applications”: multidimensional investment progress closed-loop control mode can support the annual investment plan (budget) precise preparation, project cost schedule and money rolling forecasts, investment plan (budget) process control, executive deviation dynamic real-time warning, dynamic process control, accurate adjustment daily with years, interdisciplinary professional applications such as monitoring indicator statistics and dynamic monitoring. It also achieves the budget of the investment, the investment plan and project construction progress together lean controls, accurate connection between annual investment plan (budget) and monthly project investment arrangement, and effectively improve the efficiency and effectiveness of project investment planning (budget) management and control.

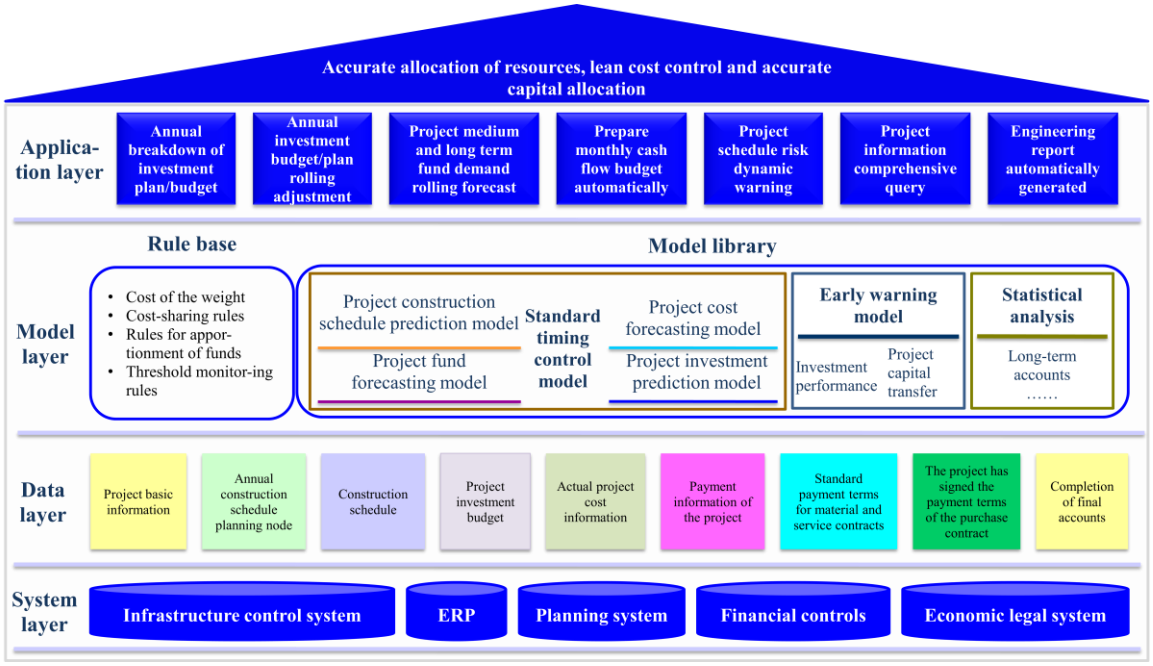


Figure 1. Business framework of multi-dimensional schedule investment closed-loop control mode for power grid infrastructure projects

2.1. Establish A Standard System for Coordinated Investment Control

Project image schedule, cost schedule, capital schedule and investment schedule are respectively the core indicators to control investment projects of construction, finance, development department. Through in-depth exploration of the internal relationship between project image progress, accounting costs, fund payments, and investment completion, according to the cost details of engineering WBS elements, we establish rationalization rules during the whole life cycle of the project, and formulate collaborative project management and control standards of various professional departments, which served as the basis for accurate preparation of investment plans and investment budgets.

(1) Clear the construction schedule life cycle prediction rules

The construction progress of the project is the key calculation basis for predicting the construction cost and installation cost of engineering cost, capital, investment completed of the investment. Through the research construction department, clarify the actual project construction progress calculation method. That is, according to the completion progress of each unit of the project, multiply by the weight of the project cost of each milestone node, bottom-up accumulation to get the progress of the project construction.

(2) Define cost life cycle forecasting criteria

According to the composition of cost WBS elements, the milestone phase corresponding to the expense occurrence and the occurrence rules within the phase can be determined. The apportionment rules of cost in the whole life cycle is determined by combining the theory occurrence time and history occurrence rules.

The first is to determine the milestone stage of expense business with the expense centralized management department. According to the principle of accrual basis set the key points of the milestone plan corresponding to each detailed expense business (such as initial bidding, material bidding, civil construction, installation, debugging, commissioning, etc.). We coordinate the construction, materials and other costs to the management department to jointly determine the theoretical allocation principle of various costs at all stages of the project. The second is to calculate the law of its staged occurrence according to the historical data of other expenses. We select the historical completion projects of different voltage levels, correspond the occurrence time of each detail cost with the milestone planning node, and calculate the actual proportion of such cost in each

milestone node interval. The third is to determine the reasonable allocation rules after appropriate adjustment based on the theoretical occurrence time of various expenses and the calculation rules of historical projects. Compare and analyze the differences between the theoretical occurrence period of each detailed expense and the calculation time period of historical projects. At the same time, combine the accounting and financial management requirements, eliminate the unreasonable historical factors, and scientifically formulate the allocation rules for different types of individual projects and the detailed cost.

(3) Identify investment lifecycle prediction rules

The determination methods of investment life-cycle prediction rules and cost prediction rules are basically the same, but the difference lies in that the starting point and ending point of investment prediction are different from the cost prediction rules, and the investment prediction rules start from the project commencement and end from the project commissioning.

(4) Make clear the prediction rules of the whole life cycle of capital

Cooperate with the ministry of construction and the ministry of materials to analysis the actual payment characteristics and rules of materials and service funds. And based on the contract terms and fund payment management requirements, formulate the payment terms, payment time and payment proportion rules and standards for various expenses.

2.2. Construct the Standard Time Sequence Quantitative Control Model

With standard rules based on the above specified index system, we use multidimensional standard control model of the power grid infrastructure project, and monitor dynamically the "schedule, cost, capital, investment" four management indicators of the project. Three display dimensions from the project type layer, the single engineering layer, and the four expenses layer, we draw standard time series curves, actual curves and experience curves on a monthly basis, which constitute the whole process of multidimensional management control curve community of the whole life cycle of a project. With this tool, we can intuitively see the annual, cumulative investment budget and the implementation of investment plan of the project and the relationship between the data, dynamically monitor, warn and control the image progress, cost and capital expenditure of the project, and realize the coordination, online and visualization of the investment budget control of the project. The actual implementation of the four curves can reflect, analyze and evaluate the compilation accuracy of the investment budget (investment plan) and the problems in the implementation process, and provide dynamic feedback to the front-end link, and form a closed loop of the standard multi-dimensional control of the whole engineering process.

Generation method and curve diagram of the standard control curve, the actual curve, the cost experience curve of the four key control indicators in the whole process of construction progress, cost, capital and investment are shown in figure 2:

The first is to construct construction schedule standard and actual curve model. Decompose the construction schedule of the construction department into each month of the whole project life cycle according to the natural day schedule, and calculate the monthly completion schedule of each milestone node plan. In the order of “unit engineering -> milestone plan node -> monolithic engineering ->project”, multiply by the cost weight of substation, overhead and cable etc. different types set in the infrastructure management and control system. Then, summary from bottom to top in turn the predicted milestone nodes, monomer project and the schedule of completion project months plan, and then draw the construction progress standard curve. Based on the actual construction progress of each unit at each milestone node of the infrastructure management and control system multiplied by its corresponding cost weight standard, we can obtain the actual construction progress curve of each individual monthly and project layer.

The second is to construct cost standard, actual curve and experience curve model. Based on the calculation of project outline (estimation) excluding taxes and the standard of internal control coefficient, calculate the internal control target. According to the project construction cost and installation cost, relying on the construction progress prediction model to predict the project

construction schedule. And the completion percentage method is adopted to divide project cost control objectives in the project life cycle each year. Equipment purchase expense and other fees based on the corresponding relationship of expense type and milestone plan node determine the starting time of all kinds of cost-sharing. We adopt appropriate allocation method based on cost characteristics, decompose the total budget to each year and month during the start time, and map the project standard cost control curve. Draw the actual cost curve according to the actual monthly cost data of ERP system.

The third is to construct project capital expenditure standard and the actual curve model. On the basis of the standard cost timing curve model, combining with the detailed expense payment proportion and payment time point rules, and according to the "cost forecast + payment commitment period", we construct the standard control curve of capital expenditure. According to the actual monthly project capital expenditure data, draw the actual capital curve.

The fourth is to construct investment standard and actual curve model. Based on the construction progress prediction model and the cost standard control curve rules, the investment standard control curve is drawn on the basis of tax-inclusive budget estimates. According to the actual monthly investment completion data reported by the planning system, draw the actual investment completion curve.

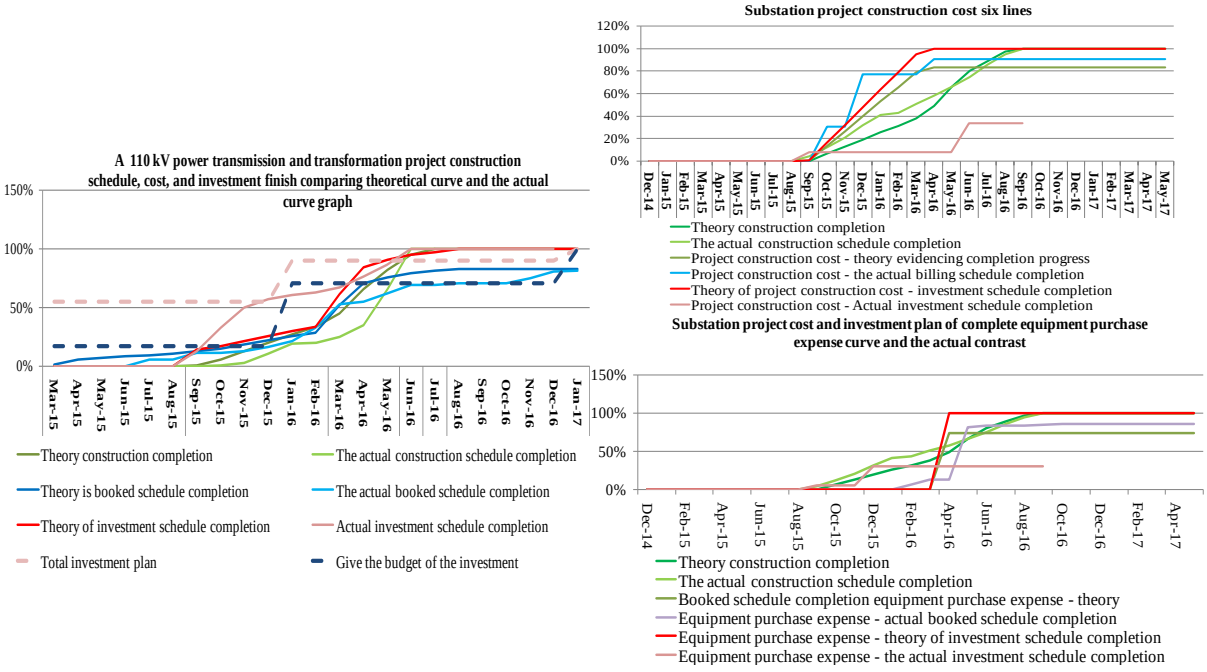


Figure 2. Comprehensive display diagram of model curves

3. Integrated Application of Multi-dimensional Closed-loop Management and Control Mode of Investment Schedule for Power Grid Infrastructure Projects

Multidimensional schedule closed loop control pattern of the power grid infrastructure project based on a standard control model, is applied to the whole process of power grid infrastructure project investment, support the applications across departments, such as the investment plan (budget) closed loop management, the annual investment plan (budget) precise preparation, real-time early warning of execution deviation, dynamic control of execution process, accurate adjustment during the budget year. We realize the investment plan, investment budget and construction coordination, lean, closed loop control. See figure 3 for the specific application process:

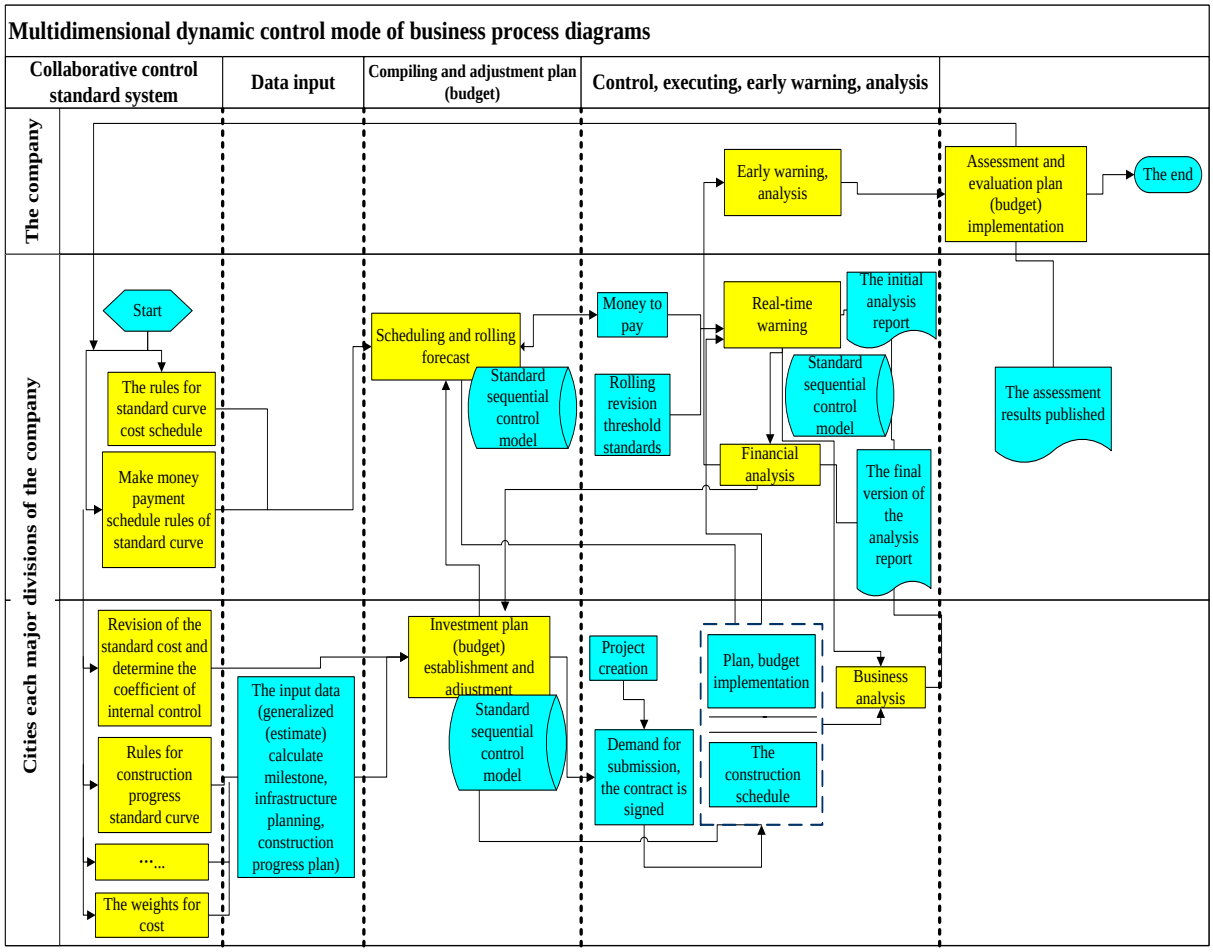


Figure 3. Flow chart of multi-dimensional target dynamic control business

(1) Investment plan (budget) preparation stage

Based on the established standard timing control model of investment and cost, we can decompose the total investment of the project plan to each month of the whole life cycle of the project, summarize the annual investment plan (budget), and support the accurate preparation of annual investment plan and investment budget.

(2) Investment planning (budgeting) process control

The process control of investment plan (budget) mainly includes the control, warning and analysis of the implementation. We make full use of the established standard timing control model curve to realize the control, warning and analysis of execution. We take the generated standard timing control model of investment and cost as the control objectives of the monthly implementation of investment plan and investment budget respectively, and control the deviation of the implementation from the control objectives. At the same time, we cross-compare and verify the multi-dimensional standard time series control curves of construction, cost, investment, capital, etc., and give early warning for projects that exceed the reasonable threshold interval. We conduct business and financial analysis on the generated early warning project list, and generate analysis reports as the basis for subsequent assessment and evaluation.

(3) Investment plan (budget) midyear adjustment

Based on the deviation warning results, we have preliminarily determined the list of investment plan (budget) adjustment projects. Based on the established standard time series management and control model of investment and cost, with the progress of project construction, by rolling updating model parameters, we realize the accurate management and control of investment plan and budget standard time series. At the same time, we compare the forecast investment (budget) of the remaining

period with the actual surplus investment plan (budget) to determine the amount of adjustment projects in the middle of the year and guide the precise adjustment of power grid infrastructure projects in the middle of the year.

(4) Assessment and evaluation

Assess and evaluate the implementation of the investment plan (budget), and feedback the assessment results to the front end of the business to form a closed loop of investment management, supervise and urge the business rectification, and improve the overall business management level.

4. Conclusion

In this article, we put forward the multidimensional control model for the core of multi-dimensional investment target dynamic closed loop control mode, which provides the project lean controls the whole process of "standardization, quantifiable and integration" solutions, and achieves the investment plan (budget) compiled "basis", the investment process control "tool", and "gripper" collaborative business department. We deeply explore the construction schedule, cost progress, investment progress and the relationship between the capital, open the project the whole chain management of each major department a "black box", unearth many application scenarios of the investment management chain. Then, wide cooperate with professional departments of construction, development and materials could timely find and solve management difficulties and blockage problems, promote the management level of all related professional departments in the whole chain of project investment management to jointly improve, and facilitate the high-quality development of power grid company.

Acknowledgements

This research was financially supported by State Grid Liaoning Electric Power Co., Ltd.'s "Research on multi-target sequence prediction model and dynamic warning for power grid infrastructure projects" (Grant No. B3441318K001).

Corresponding author: Xianing Jin, at Power Economic Research Institute of State Grid Electric Power Company. Tel: (+86)010-66602386; Fax: (+86)010-66602377; E-mail: jessicacau@163.com. Address: B515 State Grid at Future Science Park, ChangPing District, Beijing, China.

References

[1] Ge W, Zhang H 2017 The practice and thinking of closed-loop management in the whole-process closed-loop management of project budget J. Chinese market (2017)12

[2] Wang D 2014 A brief analysis of the comprehensive coordinated management and control of project budget closed-loop management J. China chief accountant (2014)11

[3] Wang L 2015 Discussion on the innovation of infrastructure budget management of electric power enterprises. J. Financial supervision (2015)35

[4] Xing J.F, Yuan H.Q, Zhang J, Kang, Z.Z, Xing N.N 2015 Application of closed-loop management in project management of power grid enterprises J. Project management technology (2015)06

[5] Sun X.H 2014 A brief discussion on the closed-loop management of fixed asset investment in coal enterprises J. Economic research guide (2014)15