Research on Cooperative Mode of Power Engineering Investment Based on Modern Supply Chain

Chen Zhang [1a*], Tianqi Hua [2b], zhuo Zhang[2c], Haochen Huang [2d], Guanglong Xie [1e], Yuwei Xiong [1f]

{zhangchen@sgeri.sgcc.com.cn [a], huatianqi@sgm.sgcc.com.cn [b], zhangzhuo@sgm.sgcc.com.cn [c], huanghaochen@sgm.sgcc.com.cn [d], xieguanglong@sgeri.sgcc.com.cn [e], xiongyuwei@sgeri.sgcc.com.cn [f]}

[1.]State Grid Energy Research Institute Co., Ltd
[2.] State Grid Materials Co., Ltd.

Abstract. The coordinated management of material planning and integrated planning is an important measure for making precision investments and building modern smart supply chain in the new era. This paper focuses on studying the coordinated management strategy of modern smart supply chain and precision investments in power grid. It analyzes the data structures and management systems of material planning and integrated planning, proposes to improve and enhance them by supporting business coordination through data sharing, and provides the principle and key measures of coordinated management from the perspective of system management to promote efficient coordination between material planning and integrated planning. The ultimate goal is to enhance the level of precision investments and promote the high-quality development of power grid.

Keywords: Modern smart supply chain; Precision investments in power grid; Coordinated management

1. Introduction

Power grid investment management and material management play an important role in whole-process project control. The whole process of investment planning is divided into three stages: preparations, engineering implementation, and project acceptance. Material planning management mainly includes procurement plans, procurement strategies, statistical analysis, and plan assessment of material, engineering and service projects. With the emergence of more and more digital and intelligent means and the sheer scale of investments and material procurement for power grid construction, more precise and efficient investment management and material management are required. Coordination between investment management and material management is urgently needed to strengthen the precision management of power grid projects.

Most of the existing studies simply focus on enhancing the efficient management of materials or lean management of investments, and little attention is paid to the coordinated development of materials and investments. Reference [1] proposes a whole-process refined management system for the power material supply chain. A support vector machine is built with supply chain hyperplane vectors and kernel functions, and an analysis model of power material

MSEA 2023, May 26-28, Nanjing, People's Republic of China
Copyright © 2023 EAI
DOI 10.4108/eai.26-5-2023.2334215

consumption is built to obtain the volumes of user consumption and demand, which are used to establish a refined management system. References [2-4] introduce a “project management specialist” model to enhance the quality effect of power material supply chain operation and deepen the construction of a power material supply chain ecosystem. References [5-8] propose a power material lean management strategy and a whole-process control system for material planning based on reserve warehouse. Reference [9] proposes to promote precision investments of power grid enterprises through post-project evaluation. Reference [10] uses the demand heat graph and the demand vector graph to assess the social benefits of power grid infrastructure projects and use the economic evaluation method to assess their economic benefits, thereby optimizing the strategy for building a precision investment evaluation system for such projects. References [11-13] propose an investment plan management system under three-rate joint monitoring for the purpose of enhancing quality and efficiency.

This paper focuses on studying the coordinated management strategy of modern smart supply chain and precision investments in power grid. It analyzes the data structures and management systems of material planning and integrated planning, proposes to improve them by supporting business coordination through data sharing, and provides the principle and key measures of coordinated management to enhance coordination between material planning and integrated planning. The ultimate goal is to enhance the level of precision investments and promote the high-quality development of power grid.Other paragraphs are indented (BodytextIndented style).

2. Analysis on Data Coordination between Material Planning and Integrated Planning

Material planning management and integrated planning management are different management requirements in different stages of a project. They need to enable data sharing and mutual business support. This section focuses on discussing the coordinated management model for material planning and integrated planning, analyzing the current coordinated management model, and indicating the direction for improving such coordinated management by starting from an analysis on data structure.Other paragraphs are indented (BodytextIndented style).

2.1. Current Coordinated Management Model

Material planning management is at the forefront and a key part of material management. It plays an important role in balancing the development demand of enterprises and social resources. It mainly includes procurement plans, procurement strategies, statistical analysis, and plan assessment of material, engineering and service projects. Integrated planning addresses the annual operation plan of an enterprise, and the investment plan is one of its components. The annual investment arrangement of an enterprise is determined under the guidance of its strategy and plan, with full consideration to its internal and external constraints.

The coordinated management of material and integrated planning runs through the whole process of project construction. During the preparation stage, preparations such as development of a proposed plan, selection of a project, and communication of the integrated planning should be made based on the reserve warehouse of projects. During the project

implementation stage, the production unit reports the procurement demand based on the communicated integrated planning, and the material department provides materials according to the material procurement tendering, contract signing, and material shipment and arrival processes. During this project implementation stage, the project is under construction step by step as planned. Project acceptance application occurs in the project acceptance stage, when acceptance, completion, commissioning, settlement, appraisal of price, final accounting, audit, and transfer of assets take place one after another until the project is concluded.

Material planning management must address a large-scale project and needs plenty of manpower to complete complicated tasks. Through the whole process of project construction, efforts must be made to strengthen data sharing between material planning and investment planning, improve the material planning and investment planning management systems, and enhance the effect of coordinated management.

2.2. Direction for Improving Data Sharing under the Coordinated Management Model

The standard application of material planning information in the front end of integrated planning should be promoted through a shared data management platform for material planning and integrated planning. Currently, the types and standard prices of materials in integrated planning offered for reference during the feasibility study, preliminary design, and construction stages are not consistent and thorough enough. As a result, great material adjustments have to be made from the feasibility study to the final construction stage, which affects the schedule management. Therefore, based on a shared management platform for material planning and integrated planning and through the formulation and submission of an annual demand forecast plan, the lists, technical specifications, and latest procurement standards of power grid standard materials classified into two grades and three types can be applied during the preparation stage that includes the establishment, feasibility study, and preliminary design of the project and in the design source, so as to better realize source management and coordination for the application of standardization results. Planning Business Chain Process of “Four-plan Integration” is shown in figure 1.

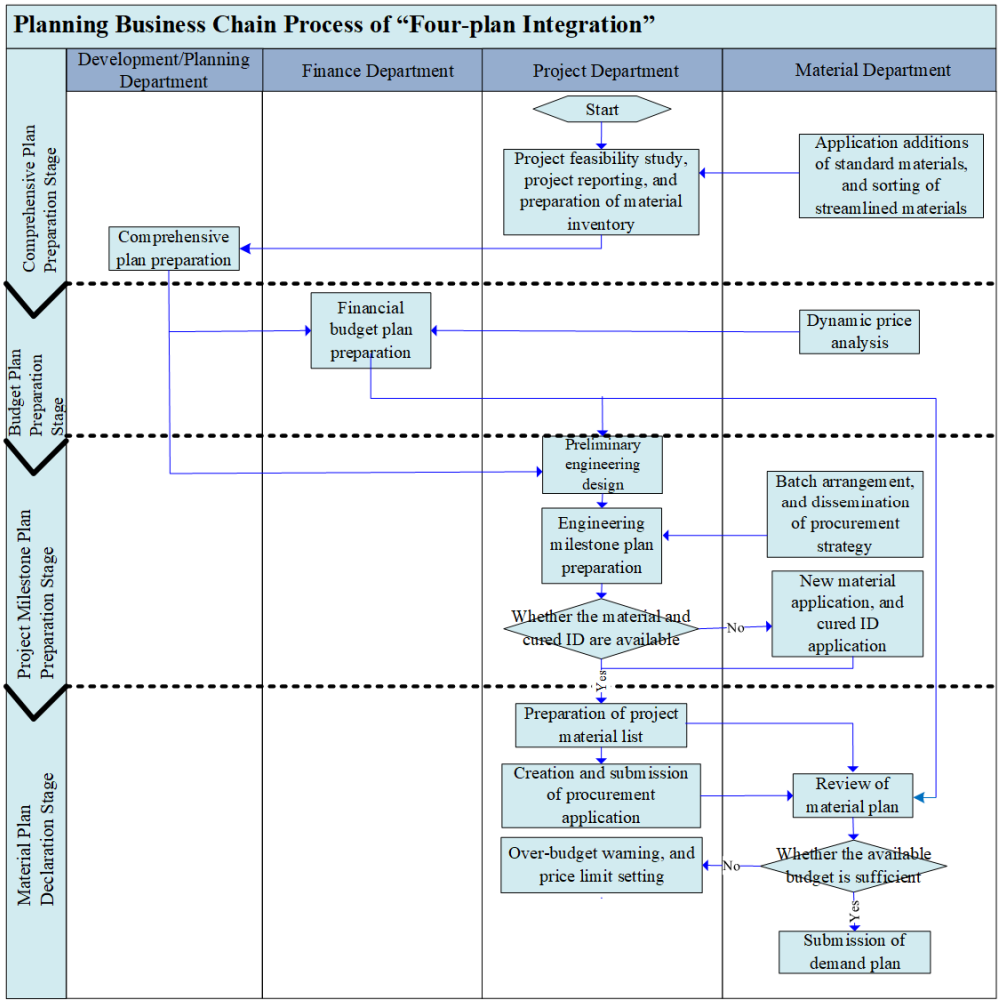

Figure 1 Planning Business Chain Process of "Four-plan Integration"

3. Design of the Coordinated Management System for Material Planning and Integrated Planning

3.1. Combination of Material Planning and Integrated Planning

Integrated planning produces an overarching annual operation and development goal after generally balancing and optimizing the core resources and development demand of an enterprise. It manages the whole process of the project from project reserve to the preparation, approval, communication and execution of the plan. The project reserve under integrated planning is made at the headquarters, provincial company, and prefectural company levels. In order to ensure quality, project reserve should be made a regular task and unexpected warehousing entry should be avoided.

Development departments at all levels are responsible for organizing project reserve and clarifying work standards and management requirements; professional departments at all levels are responsible for organizing preparation and evaluation for their respective projects. To achieve combined material standards with integrated planning, the Development Department and the Material Department at the headquarters level should coordinate to further refine the preparation standards and management requirements for reserve projects under integrated planning, to collectively prepare and deploy material inventories, and to ensure that all professional departments refer to and apply them when handling the planned reserve, thereby laying the foundation for close cooperation between material planning and integrated planning. The specific measures are shown in Table 1:

Table 1 Specific Measures for Precision Combination with Integrated Planning

Department	Business Process	Combination Measures
Development Department in the headquarters	Before preparing an integrated planning	Develop work standards and incorporate the work requirements of integrated planning that are broken down to materials into the work standards; Work with professional management departments and the Material Department to issue material inventories by project type, and guide each unit to prepare material requirements for projects under integrated planning using a template.
Development Departments of provincial companies under the grid	Preparing an annual integrated planning	Strengthen management vertically, prepare and approve the plan at all levels, and improve the lean management level; Require correct choices of materials according to the material inventories in the project feasibility study, and improve the accuracy of project investment estimation Urge professional departments to prepare material planning lists and implement professional management requirements, such as material standardization and procurement standards;
	Communicating the annual integrated planning	Strengthen the review of planned grid investments by the company for compliance and efficiency, link the grid planning investments with expected results, review the material inventories for standard application and the fund application for reasonableness, and set specific indicators to reflect evaluation results quantitatively.
Material Departments of provincial companies under the grid	Project reserve stage	Actively participate in the preparation for the project, and apply the standardization of materials, procurement standards and other professional results in the preparation of the feasibility study proposal; Connect with the technical proposal and the selection of equipment parameters for the project, ensure the implementation of technical standards from the source, ensure that the feasibility study proposal of the project is complete and the implementation of the project is in line with the practical production and operation needs, and deepen the project reserve; Dynamically adjust and improve the master data of the materials, procurement standards and other

		professional results according to the actual status of project construction and the application requirements of new equipment and technology, in order to realize closed-loop integration of material planning and the actual status of the project;
	Reserve project review stage	Fully apply the results of big data analysis on the procurement prices of materials, provide reference material estimate as support, improve the evaluation basis of the feasibility study proposal for the project, improve the accuracy of project investment estimation, and promote precision investments.

The measures mentioned above will help effectively improve the management efficiency and benefits:

(1) Follow the guidance of plans. The annual demand plan, the pre-arrangement plan, and the batch-based procurement plan should fully cover the demand for various types of materials communicated in the integrated planning. Material planning should be based on the catalog of centralized procurement, the integrated planning, the financial budget, and the project milestone plan with the approach of "making predictions based on historical data and revising the investment scale". Forecast and analysis of annual procurement demand should be made in a range of dimensions including the time of demand, the type of procurement, and procurement projects.

(2) Connect with the communicated integrated planning accurately. Based on the batch-based annual centralized procurement arrangement made by the headquarters, provincial companies under the grid should further improve timely procurement by taking measures such as moderately increasing the frequency of secondary procurement and deepening the application of standards and information technology. "Regular system" and "ad hoc system" should be combined, and procurement arrangement should be made on a monthly basis to "meet the demand and initiate tendering when a need arises". The application scope of the e-commerce procurement method should be further expanded, and auxiliary materials used in power grid construction and technical modification projects should be incorporated into the secondary e-commerce procurement sphere. The procurement demand of regular projects should be reported in compliance with the law after the projects are reviewed and approved and the budgets are issued.

(3) The "ad hoc" procurement flexibility should be fully improved, and the practice of limiting the specific procurement schedule should be abandoned. "Green channels" should be provided to meet the urgent needs of rural power grid renovation and upgrading, power supply service expansion supporting, new energy access, coal to electricity, power supply to wells, and core village projects. With comprehensive consideration to the needs and procurement scale of projects, arrangement should be made to procure materials together with the closest batch or in a separate batch in order to meet the needs of different parties in a timely and efficient manner.

3.2. Indicator System for Optimizing the Management

(1) Construction of the indicator system

In constructing the indicator system, this study mainly adopts the analytic hierarchy process. In terms of indicator selection, we design primary indicators in the dimensions of fundamental

guarantee, progress management, and quality monitoring. The fundamental guarantee dimension covers the development, infrastructure, equipment, scheduling, and digital technology professions, but it does not include the material profession. Thus, the indicator system is further broken down to two secondary indicators of match rate and accurate rate for the material profession. The progress management dimension includes preparation, commencement, construction, and commissioning of the project, and only the indicator of the "material claim rate" from financial data in the project construction stage is relevant to materials. Thus, the indicator system is further broken down to secondary indicators of procurement plan application rate, material procurement rate, suspected post-commencement unclaimed material rate, and suspected post-commissioning claimed material rate. The quality monitoring dimension includes the secondary indicators of material claim accuracy rate, suspected post-commencement unclaimed material rate, alarm rate against suspected unreasonable material claim for projects under construction, and alarm rate against suspected unreasonable material claim for projects put into commissioning. The three-rate joint monitoring and analysis indicator system is shown in Table 2.

Table 2 Three-rate Joint Monitoring and Analysis Indicator System

Primary Indicator	Secondary Indicator	Tertiary Indicator
Fundamental guarantee	Match rate	
	Accuracy rate	Accuracy rate of line demand plan transformation Accuracy rate of substation equipment demand plan transformation
Progress management	Procurement plan application rate	Project application rate of the procurement plan Amount application rate of the procurement plan
	Material procurement rate	
	Suspected post-commencement unclaimed material rate	
	Suspected post-commissioning claimed material rate	
Quality monitoring	Material claim accuracy rate	
	Suspected post-commencement unclaimed material rate	
	Alarm rate against suspected unreasonable material claim for projects under construction	Alarm rate of claimed line length for projects under construction Alarm rate of substation capacity for projects under construction
	Alarm rate against suspected unreasonable material claim for projects put into commissioning	Alarm rate of claimed line length for projects put into commissioning Alarm rate of substation capacity for projects put into commissioning

(2) Description of indicators

1) Match rate

Match rate refers to the proportion of projects for which the material demand reported to ERP matches the communicated integrated planning in the total number of projects for which the

material demand is reported to ERP. Match rate is used to evaluate whether the projects for which the material demand is reported are the projects communicated from the integrated planning.

2) Accuracy rate

Accuracy rate of line demand plan transformation refers to the proportion of the length of lines with procurement plan to the length of lines with demand plan; accuracy rate of substation equipment demand plan transformation refers to the proportion of substation equipment procurement plan capacity in the substation equipment demand plan capacity. Accuracy rate is used to evaluate how the material demand plan is accurately transformed into the actual procurement plan.

3) Procurement application rate

Project application rate of the procurement plan refers to the proportion of projects with reported procurement plans in the number of projects communicated in the integrated planning of the year; Amount application rate of the procurement plan refers to the proportion of the reported procurement plan amount in the total demand plan amount of the year. Procurement plan application rate is used to evaluate the procurement plan application rate of materials during the project preparation stage.

4) Material procurement rate

Material procurement rate refers to the proportion of material contracts executed in the accumulated investment plans for the projects built in ERP*0.6. Material procurement rate is used to evaluate the procurement of materials during the project construction stage.

5) Suspected post-commencement unclaimed material rate

Suspected post-commencement unclaimed material rate refers to the proportion of projects for which materials are not claimed after commencement in the total number of projects. Suspected post-commencement unclaimed material rate is used to monitor the claim of materials according to the material planning.

6) Suspected post-commissioning claimed material rate

Suspected post-commissioning claimed material rate refers to the proportion of projects for which materials are still claimed after commissioning in the total number of projects. Suspected post-commissioning claimed material rate is used to monitor the claim of materials according to the material planning.

7) Material claim accuracy rate

Material claim accuracy rate is used to calculate the ratio of actual receipt and accounting amount in the project plan to the reported amount, and it is used to evaluate the deviation of the overall material amount from the plan. Material specific claim accuracy rate refers to the proportion of certain project material actually credited into account in the reported amount specified in the project procurement plan within the statistical range. Material claim accuracy rate refers to the weighted average of the claim accuracy rates of main materials.

8) Suspected material claim non-compliance rate

Suspected material claim non-compliance rate refers to the proportion of projects for which the material claim is non-conforming in the total number of projects. Suspected material claim non-compliance rate is used to monitor the non-compliance of material claim.

9) Alarm rate against suspected unreasonable material claim for projects under construction

Alarm rate of claimed line length for projects under construction refers to the proportion of projects under construction in which an alarm is given in the claimed line length in the total number of projects. Alarm rate of substation capacity for projects under construction refers to the proportion of projects under construction in which an alarm is given in the claimed substation capacity in the total number of projects. Alarm rate against suspected unreasonable material claim for projects under construction is used to monitor unreasonable claim of materials.

10) Alarm rate against suspected unreasonable material claim for projects put into commissioning

Alarm rate of claimed line length for projects put into commissioning refers to the proportion of projects put into commissioning in which an alarm is given in the claimed line length in the total number of projects. Alarm rate of substation capacity for projects put into commissioning refers to the proportion of projects put into commissioning in which an alarm is given in the claimed substation capacity in the total number of projects. Alarm rate against suspected unreasonable material claim for projects put into commissioning is used to monitor unreasonable claim of materials.

4. Conclusion

This paper focuses on studying the coordinated management strategy of modern smart supply chain and precision investments in power grid in order to enhance the level of precision investments and promote the high-quality development of power grid. It analyzes the data coordinate mechanism for material planning and integrated planning and indicates the direction for improving the coordinated management from the perspective of information coordination. Based on the principles of front end management, active management, and precise management, it provides the principle and key measures of coordinated management for material planning and integrated planning to effectively support the effect of such coordinated management.

Ackowledgements: This paper is funded by Research on Collaborative Management and Control Strategy of Modern Smart Supply Chain and Grid Precision Investment.

References

[1] Jiang Fenhang, Jiang Yong, and Li Qing. Refined Management System for Whole Process of Power Material Supply Chain [J]. Techniques of Automation and Applications, 2022, 41(09): 165-168.

[2] Shi Yan, and Cui Chenlei. Paradox in the Operation Management of Power Material Supply Chain and Innovative Strategy [J]. Modern Enterprise, 2022 (04): 11-12.
[3] Sun Yu. Problems in Warehousing Management of Power Material and Measures for Improvement [J]. Modern Industrial Economy and Informationization, 2022, 12(08): 280-281.
[4] Chen Lu. Strengthen Power Material Management and Improve Economic Benefits of Enterprises [J]. China Collective Economy, 2022 (19): 34-36.
[5] Guo Deqiang. Study on the Risk Management of Material Procurement by Power Grid Enterprises [J]. Enterprise Reform and Management, 2022 (05): 22-24.
[6] Yue Heng, Shang Haiyi, and Huang Xiangjun. Research on Lean Management of Electric Power Material [J]. Logistics Technology, 2020, 39(04): 77-83.
[7] Chen Xueqin. Research on the Whole-process Control of Material Planning Based on Reserve Warehouse [J]. Shanghai Business, 2022 (06): 221-223.
[8] Si Meng, and Xu Xin. Measures for Improving the System-based Management of Material Planning [J]. China Electric Power, 2019 (02): 76-77.
[9] Yang Yaping, Zhang Zhibin, Feng Xing, and Feng Guofu. Promoting Precision Investments of Power Grid Enterprises with Post-project Evaluation [J]. China Power Enterprise Management, 2022 (07): 86-87.
[10] Yang Min, Zhao Nan, Lu Zheng, Zhao Min, Chen Dan, and Quan Luyao. Research on Accurate Investment Evaluation System and Strategy Optimization of Power Grid Infrastructure Project [J]. Machine Design and Manufacturing Engineering, 2021, 50 (10): 119-122.
[11] Chen Haihan. Study on Production Project Planning and Investment Plan Management System of Power Grid Corporation [J]. Guangdong Electric Power, 2014, 27 (05): 44-50+98.
[12] Chen Feier, Liu Panpan, Mo Ruanqing, and Qin Kuangyu. Research on Planning of Grid Investment Projects under the Three-rate Joint Monitoring and Analysis System [J]. Electric Power Equipment Management, 2020 (11): 152-154+162.
[13] Zhang Yi. Exploration on Investment Plan Management of Power Grid Infrastructure Projects Based on Quality Improvement and Efficiency Enhancement [J]. Enterprise Reform and Management, 2018 (24): 43-44.