Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
September-October 2022 Page No. 1211 – 1222
Article History: Received: 06 April 2022, Revised: 28 April 2022, Accepted: 04 May 2022, Publication: 15 May 2022

Design of Lean Management and Control Model for Power Grid Material Bidding and Purchasing Process

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Abstract:
Design a lean management and control model for the power grid material bidding and procurement process to meet the basic procurement business functions, and improve the lean management and control level of the power grid material bidding and procurement process through functions such as procurement resource management. The data layer collects data required for management and control through automatic collection and external import collection. The collected data is transmitted to the model method layer and stored in the data center and cloud space at the same time; the model method layer includes the power grid material agreement inventory demand prediction algorithm and power grid materials Various technologies such as bidding and purchasing decision-making, minimum path calculation, scheduling model, etc., provide technical support for the analysis of management and control functions such as material procurement, material warehousing and distribution at the management and control analysis layer. The analysis results of the management and control analysis layer use reports, curves and images through the decision support layer The way is displayed to the controller. Experimental results show that the model can effectively count the bidding requirements of power materials, and use the shortest path length to transport power grid materials, saving a lot of management and control costs for power companies.
Keywords: Power grid materials; bidding and procurement process; lean; management and control model; management and control analysis layer; decision support layer.

I. INTRODUCTION

In recent years, with the wave of planning and construction of smart grid of power grid and provincial power companies, the field of material supply chain has also continuously promoted the construction of intelligence and informatization. While continuously optimizing and improving the functions of the material management system, grid power company launched the sunshine e-commerce platform and simple material monitoring platform, and basically completed the unified information platform coverage of material supply chain business. As the centralized procurement business platform of Yunnan power grid, Yunnan power grid materials Co., Ltd. is responsible for the business operation of the whole process from the aspects of procurement plan, procurement

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scheme, procurement documents, supplier management, announcement of bid winning results [1]. At present, the above business processes mainly rely on the sunshine e-commerce platform, but the sunshine e-commerce platform has only been online for more than two years. In addition to meeting the basic procurement business functions, other functions such as statistical analysis function, procurement business charge refund function, procurement business file preservation function and procurement resource management function are lacking [2], In practice, there are still a large number of manual offline operations in the procurement business, and the corresponding data account cannot be exported. A large number of manual verification is required for the refund of procurement business charges [3-5], which is difficult to meet the requirements of material and bidding management reform of network and provincial companies.

At present, the procurement business involves the whole chain of procurement service department, supplier service department and finance department. In the work, if the products delivered by the upstream department to the downstream Department rely on offline operation, it is difficult to ensure the timeliness and standardization of the work, and it is difficult to achieve effective coordination among departments. Procurement agency business is the main source of business income of the material company. Its income and cost are mainly handled and counted manually. There are problems such as inaccurate verification of income data [6], lagging in cost data processing and accounting, which seriously affect the compliance and accuracy of the procurement business operation of the material company. The bidding data, project files and other data generated by the procurement business can not be transferred on the e-commerce system, and can only be transmitted offline, resulting in a large number of people and ways to contact the data, and the confidentiality is difficult to be effectively controlled, which is likely to lead to the problem of disclosure of procurement data. In case of disclosure, the source of disclosure shall be investigated and locked The circulation path is very difficult. Therefore, it is necessary to design a lean control model for the bidding and procurement process of power grid materials, connect the work of each department through the model process, realize the information control of the whole process of procurement business, and improve the standardization and coordination of procurement business.

At present, there are many researches on the management and control of power grid materials. LV shaomeng and others designed an intelligent construction and management platform [7] to realize the effective management and control of materials, but did not consider the lean problem. Lin Dan and others evaluated the information physical system of distribution network [8], but ignored the management and control of power grid materials. The lean control model of power grid material bidding and procurement process is designed to build a lean control system of procurement process through information means, form information support and lean management for the whole process of procurement business, realize electronic online operation in the whole process of procurement business, standardize business operation behavior, improve business efficiency and reduce the burden of manual statistics, Improve the lean level of procurement business.

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II. LEAN MANAGEMENT AND CONTROL MODEL OF POWER GRID MATERIAL BIDDING AND PURCHASING PROCESS

2.1 Overall structure of the lean control model

Figure 1 shows the overall structure of the lean management and control model of the power grid material bidding and procurement process.

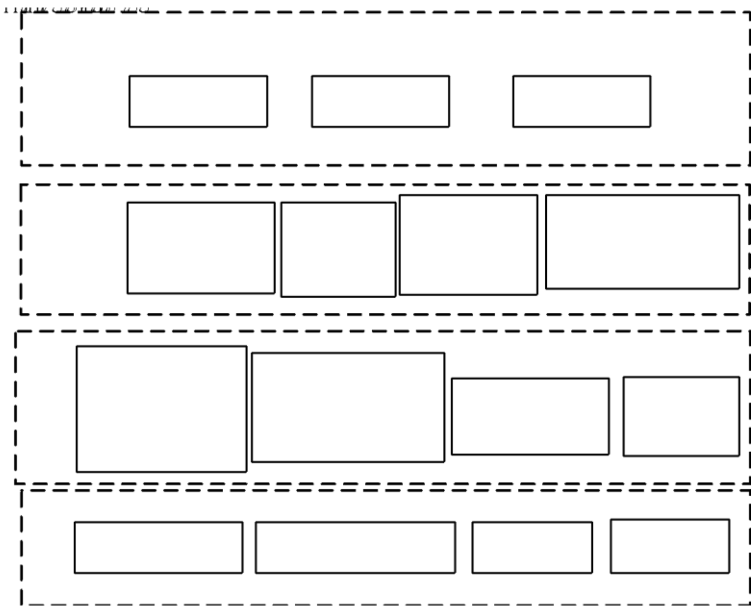

Fig. 1 The overall structure of the model.

The lean management and control model designed for the power grid material bidding and procurement process fully considers the supply and demand decision of the power grid material bidding and procurement process and the storage and distribution processing process of power grid materials. The lean management and control model includes the data layer, model method layer, decision support layer, and management and control analysis. Layer four parts. The designed model makes full use of the Internet of Things technology, and the management and control analysis layer includes a material procurement module and a material storage and distribution module. The data layer is used to collect the data required by the model through automatic collection and external import collection. The collected data is transmitted to the model method layer and stored in the data center and cloud space. The model method layer includes various technologies such as power grid material agreement inventory demand forecasting algorithm, power grid material bidding and purchasing decision, minimum path calculation, scheduling model, etc., providing technical support for material procurement, material storage and distribution at the management and control analysis layer, and the analysis results of the management and control analysis layer The decision support layer uses reports, curves, and images to display to model users.

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2.2. Material demand plan management

The structure diagram of the power grid material demand planning management module is shown in Figure 2.

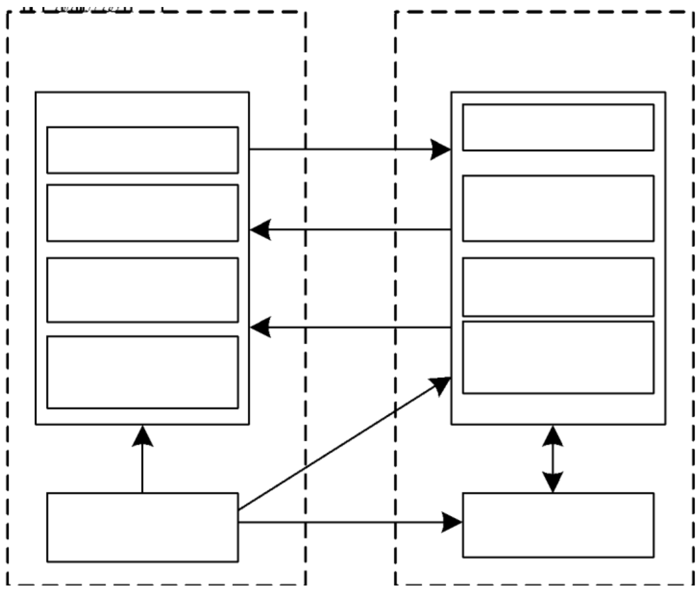

Fig. 2 Plan management structure diagram.

In the lean management and control of the power grid material bidding and procurement process, the planning management of material requirements includes the material demand planning of engineering projects, production operation and maintenance, and daily maintenance, as well as the demand planning of inventory replenishment and the procurement of office supplies. The relevant personnel for the management of the material demand plan are different demand units[9-11]. The personnel who declare the demand for power grid materials need to submit the material demand list based on the infrastructure, production, inventory and other requirements of the power grid, and establish it after the approval of the management personnel. The final material requirements plan.

2.3. Grid Material Agreement Inventory Demand Forecast Algorithm

Determine the agreement inventory procurement model based on the power grid construction requirements, classify the materials needed within a fixed period in the future, and purchase materials based on fixed service standards and technical requirements. The agreement inventory procurement mode of power grid materials can avoid the same type of bidding and procurement, realize lean management and control of power grid material bidding investment by reducing procurement costs, realize the effective integration of power grid material resources, and improve the efficiency of power grid investment and the efficiency of power grid material bidding procurement [12]. Agreement inventory procurement is the focus of lean management and control of power grid materials. The actual procurement requirements of annual materials for the lean management of the power grid material bidding procurement process need to be calculated from the remaining amount of materials in the agreement inventory and the remaining amount of physical materials, and the

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actual procurement requirements are compared with historical demand data [13] to obtain the final procurement requirements results.

The particle swarm optimization BP neural network method is used to predict the inventory demand of the power grid material agreement, and the accuracy and convergence speed of the BP neural network in predicting the inventory demand of the power grid material agreement are improved.

The process of forecasting the demand for grid material agreement inventory is as follows:

(1) Parameter initialization setting

Initialize the particle size of the particle swarm algorithm, set the maximum allowable number of iterations, the inertia weight and acceleration factor of the particle swarm algorithm, and the particle speed.

(2) Initialization of particle position

A 3-dimensional vector with a component value in the range of 0-1 is formed, and the formed N vectors are set as the initial ion population. Select a solution with higher performance from the initial population and set it as the initial solution. At this moment, the particle velocity is the initial velocity.

(3) When the fitness value of the particle swarm is better than the individual extreme value, set the position of the particle as the new position of the particle;

(4) When the global extremum of the particle swarm is better than the global extremum, the particle is set to the optimal position;

(5) Update the particle velocity and particle position in the particle swarm;

(6) Calculate the fitness values of feasible solutions for different variables, and obtain feasible solutions with optimal performance;

(7) Select the best feasible solution to replace the random particle position;

(8) When the number of iterations is the maximum number of iterations, terminate the algorithm [14], at this time the global optimal position is the required parameter, otherwise return to step (3);

(9) Establish a BP neural network-based power grid material agreement inventory demand prediction model, and set the fitness function of the prediction model as the objective function of the optimized particle swarm algorithm;

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(10) When the root mean square error of the obtained BP neural network prediction model is the lowest, the parameters obtained at this time are the optimal parameters of the BP neural network, and the particle swarm optimization BP neural network's grid material agreement inventory demand prediction model is obtained.

2.4. Procurement decision of power grid materials based on trapezoidal fuzzy number

Fuzzy number is an important algorithm used in decision-making operations. Trapezoidal fuzzy number has a complicated membership function shape. When applied to decision-making problems, it still has a high level of processing when the information is untrue and missing. Use $a=\left[a^{L},a^{ML},a^{MU},a^{U}\right]$ and $b=\left[b^{L},b^{ML},b^{MU},b^{U}\right]$ to denote trapezoidal fuzzy numbers. The addition algorithm expression of trapezoidal fuzzy numbers is as follows:

$$a+b=\left[a^{L}+b^{L},a^{ML}+b^{ML},a^{MU}+b^{MU},a^{U}+b^{U}\right] \tag{1}$$

The expression of the multiplication algorithm of trapezoidal fuzzy numbers is as follows:

$$\lambda a=\left[\lambda a^{L},\lambda a^{ML},\lambda a^{MU},\lambda a^{U}\right] \tag{2}$$

The distance algorithm expression of trapezoidal fuzzy number is as follows:

$$d\left(a+b\right)=\sqrt{\left[\left(a^{L}-b^{L}\right)^{2}+\left(a^{ML}-b^{ML}\right)^{2}+\left(a^{MU}-b^{MU}\right)^{2}+\left(a^{U}-b^{U}\right)^{2}\right]/4} \tag{3}$$

Let $Z=\left(z_0,z_1,z_2,z_3,z_4,z_5\right)$ denote the language decision set of power grid material bidding and procurement management and control, and transform the language decision set into a trapezoidal fuzzy number. Use $E=\left(e_1,e_2,\cdots,e_m\right)$ and $W=\left(w_1,w_2,\cdots,w_m\right)$ to denote the set of decision makers and the weight set of decision makers, $A=\left(a_1,a_2,\cdots,a_n\right)$ denotes the set of decision-making indicators, and use h_{ij} to denote the linguistic decision-making results of the power grid material bidding and purchasing decision-maker E_i on the decision-making index A_j. Fuzzy language is used to express the results of linguistic decision-making. During the decision-making process, the results of the linguistic decision-making are transformed into trapezoidal fuzzy values. The transformed trapezoidal modulus is the final power grid material bidding and purchasing decision-making result. The decision-making result is used to establish a decision matrix H.

In the process of power grid material bidding and procurement management and control, the

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decision value needs to be summarized in real time [15], and the final decision value h_j formula for obtaining the index by integrating each decision index value is as follows:

$$h_j = \sum_{i=1}^{m} w_i h_{ij} \tag{4}$$

The expression of the final decision value h_{ij} of power grid material bidding procurement is as follows:

$$h_{ij} = \sum_{j=1}^{n} w_j h_j \tag{5}$$

Calculate the distance between the trapezoidal fuzzy number h_{ij} and the corresponding fuzzy language level, process the obtained trapezoidal fuzzy number with the maximum value, calculate the fuzzy language level distance corresponding to different fuzzy languages, and set the decision result of the power grid material bidding and procurement as the decision result with the smallest distance . Through the above process, an effective comprehensive decision-making method is provided for the bidding and procurement of power grid materials.

III. EXPERIMENT ANALYSIS

In order to verify the effectiveness of the lean management and control model of the designed power grid materials bidding and procurement process, the designed model was applied to Yunnan Power Grid Materials Co., Ltd.

Taking the optical cables in power grid materials as an example, using the sample project information from 2016 to 2018 and the data on the use of optical cables as the basis of analysis, it verifies the effectiveness of the power grid material agreement inventory demand forecasting algorithm for predicting the material agreement inventory demand. Calculate the forecast results of the amount of the optical cable agreement inventory requisition of the company's different projects, and the statistical results are shown in Figure 3.

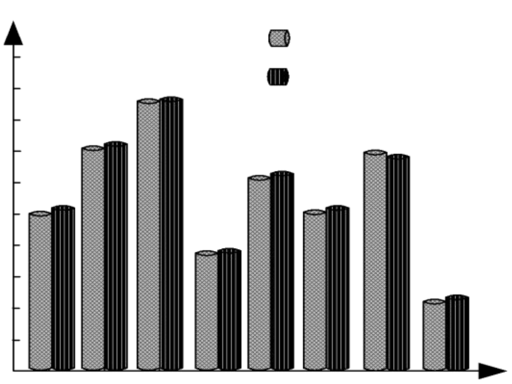

Fig. 3 Forecast results of fiber optic cable demand.

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It can be seen from the experimental results of Fig. 3 that the model in this paper can effectively predict the fiber optic cable demand of different projects, the demand forecast error is small, and the obtained fiber optic cable demand forecast result is very consistent with the actual fiber optic cable demand result curve. The model in this paper can obtain accurate fiber optic cable demand results, and provide a data basis for the practical application of the lean management and control model of the power grid material bidding and procurement process. Through the prediction of power material demand through this model, the effective correction of demand forecast error is realized, effectively avoiding over-purchasing or under-supply caused by insufficient power material purchasing demand, and realizing lean management and control of power grid material tendering and purchasing process.

The details of the power grid material projects provided by Yunnan Power Grid Materials Co., Ltd. to the Dali Power Supply Bureau of Yunnan Power Grid in 2019 are shown in Table 1.

The material requirements of the Pu'er Power Supply Bureau's 2019-2020 emergency supply material reserve framework bidding in Table 1 are shown in Figure 4.

From the experimental results in Table 1 and Figure 4, it can be seen that the use of this model can effectively count the demand for power materials bidding, and realize efficient lean control of the power grid material bidding process based on the statistical results of the power material bidding demand.

TABLE 1. This is the caption for the table. If the caption is less than one line then it is centered. Long captions are justified to the table width manually.

project name	Power transformation project of insulated bucket truck	Pu'er Power Supply Bureau invites bids for the framework of emergency supply material reserves for 2019-2020
Item Number	0006200000046255	0002200000044887
Item category	Serve	Serve
purchasing method	Open competition negotiation	Open competition negotiation
Procurement model	Special recruitment	Frame move
Total amount of bidding fee/yuan	12034	21100
Total amount of expert fee/yuan	34556446	423453
Total amount of margin/yuan	2452	235234
Total amount of agency service fee/yuan	346236	234235
Amount of winning bid / ten thousand yuan	75.64	54.433

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Assuming that the staff's daily salary is 500 yuan and the working hours are 8 hours, the statistical results are shown in Figure 5.

It can be seen from the experimental results in Figure 5 that the use of this model can save a lot of man-hours for the management of the power grid material bidding process, and can save 2 million to 3 million yuan for the management of the power grid material bidding process every year. The experimental results in Figure 4 verify that the use of this model can save a lot of management and control costs for power companies, and effectively achieve lean management of the power grid material bidding and procurement process.

The statistics use the model of this paper to lean management and control of the agreement order unmatched purchase amount deviation of the power grid material bidding process, and compare the model of this paper with the model of literature [7] and the model of literature [8]. The comparison result is shown in Figure 6.

The deviation of the unmatched purchase amount of the agreed order is an important indicator that can reflect the business flow of material demand. This indicator refers to the part of the amount of the bid for one type of material that does not match the amount of the purchase order during the agreed inventory procurement cycle. The smaller the indicator value , Which means that the lean management performance of the power grid material bidding and procurement process is better. The experimental results in Fig. 6 show that the deviation of the unmatched purchase amount of the agreed orders in the process of lean management of power grid material bidding and procurement using this model is significantly lower than that of the other two models, which verifies that the lean management performance of this model is better than the other two models.

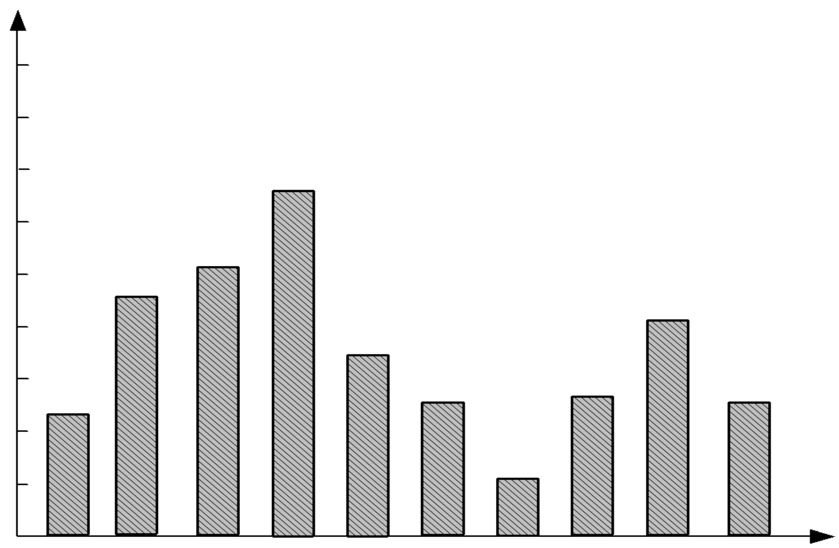

Fig. 4 Material demand statistics table.

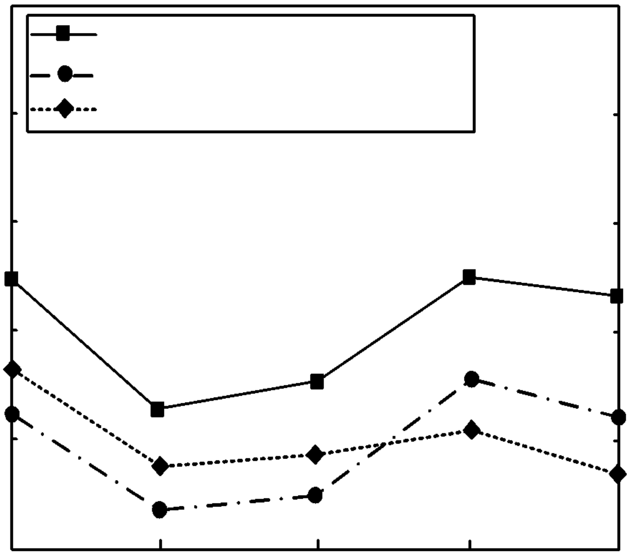

Fig. 5 Management cost of bidding and purchasing process.

The statistics use the model of this paper to leanly control the power grid material bidding process and the change of the path length of the supplier's delivery process. The model of this paper is compared with the model of literature [7] and the model of literature [8]. The comparison result is shown in Figure 7.

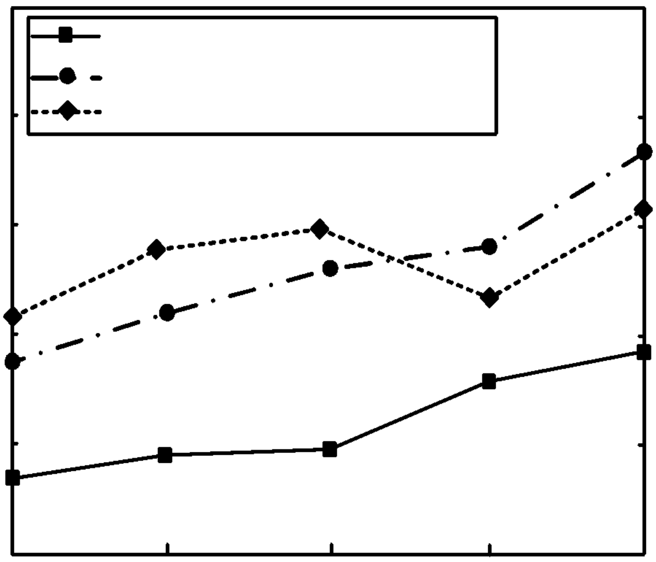

Fig. 6. Agreement order does not match the purchase amount deviation.

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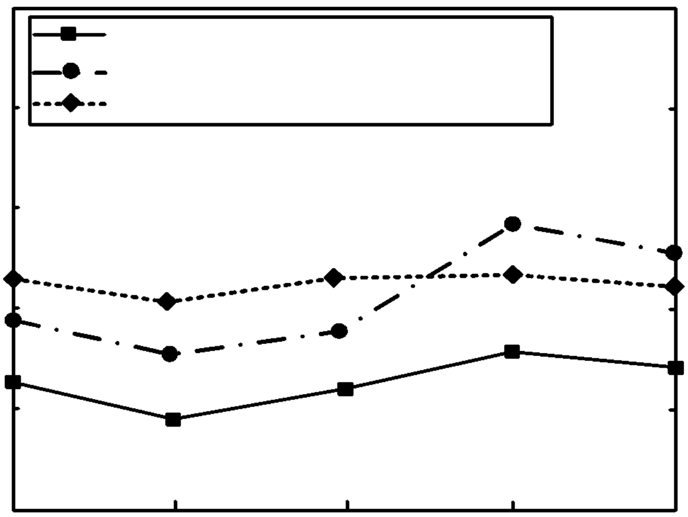

Fig. 7. The length of the electric power material transportation path.

It can be seen from the experimental results in Figure 7 that the use of this model to lean management and control of the power grid material bidding procurement process can complete the accurate delivery of power materials with the shortest path length. Use the shortest path length to transport power grid materials, save transportation costs in the process of power grid material bidding and procurement, and realize lean management and control of power grid material bidding and procurement.

IV. CONCLUSION

The construction of this project will focus on the improvement of lean management around the entire process of power grid material bidding and procurement business, to solve the current informatization support of the part of the business that is not covered by the e-commerce system in the procurement agency business of Yunnan Power Grid Material Company, and integrate the procurement project. Comprehensive statistical functions, procurement resource management, procurement charge and reconciliation management, procurement project operation management, electronic data storage and other business informationization. Incorporating lean management concepts, optimizing the existing procurement business process, strengthening the statistical analysis and management of the procurement business process, reducing the irregularities in offline operations of procurement personnel and the inefficiency of data transmission, and improving the overall operational efficiency of the procurement business. Form an information platform mechanism of "strong business in the e-commerce system and strong management of lean auxiliary systems" to strengthen the lean management of the entire process of procurement agency business.

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