Application Research on Target Cost Management Method of Lean Supply Chain of Construction Engineering Project

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Abstract: The lean supply chain of construction engineering projects is to achieve the maximum satisfaction of the owners' needs in order to effectively achieve the goal of supply chain management. This paper explores an effective method of lean supply chain cost management for construction engineering projects with target cost management, so that each participating unit on the supply chain node can fully utilizes its core competencies to minimize internal consumption and waste, and achieve the optimal overall efficiency of the supply chain. According to the requirements of the goal planning theory of the construction project company, establish a lean supply chain cost planning system for the construction project, realize the basic model of the lean supply chain cost management of the construction project, and set the target cost from the lean project of the construction project. The technical decomposition is established by the process of cost decomposition and cost pressure transmission and sub-target cost planning.

Keywords: construction engineering, lean supply chain, target cost management

1. Introduction

The lean supply chain of construction projects is to meet the requirements of supply chain management andt the needs of the owners. The supply chain cost management should be analyzed from the height of strategy, and an effective method for cost management of lean supply chain of construction projects should make the supply chain nodes give full play to its core capabilities, and minimize internal consumption and waste, and achieve the optimal overall efficiency of the supply chain.

Formal analysis, Qiangyi LI; Software, Cheng CAI; Supervision, Jinyong CHEN; Writing – original draft, Siming YU.

Objective cost method and activity-based costing method are modern cost control theories that are generated and developed in the context of modern society. Target costing and activity-based costing are two aspects of cost, not two separate methods. A new direction of cost management development is that enterprises combine the two with their own actual situation to adapt to the new competitive environment and obtain a competitive advantage. Introduce the idea of operation management in the process of lean supply chain cost management of construction projects, and carry on refined operation cost management. At the same time, combined with target cost management, it can deepen the target cost management to the level of refined operation, and through scientific operations cost calculation, we can try to make the supply chain cost control within the target cost plan, ensure the realization of project target cost management; and to be responsible for the various tasks in the project construction process according to the requirements of operation management And the center of control, the cost control is deeply implemented on each operation, with the operation as the core and the cost-based basis to achieve the goal of continuously reducing costs.

Although both the activity-based costing method and the target costing method are cost control methods that are consistent with supply chain management, the two cost control methods have different focuses: if the activity-based costing method and the target costing method are combined, the cost-management management is combined with target cost management to be performed, the target cost management is deepened to the operational level, and make the supply chain cost control within the target cost range, which can provide an optimal cost control method. Based on the above characteristics, the integration of target cost management and activity cost management is a new breakthrough in the research on lean supply chain cost management methods for construction projects.

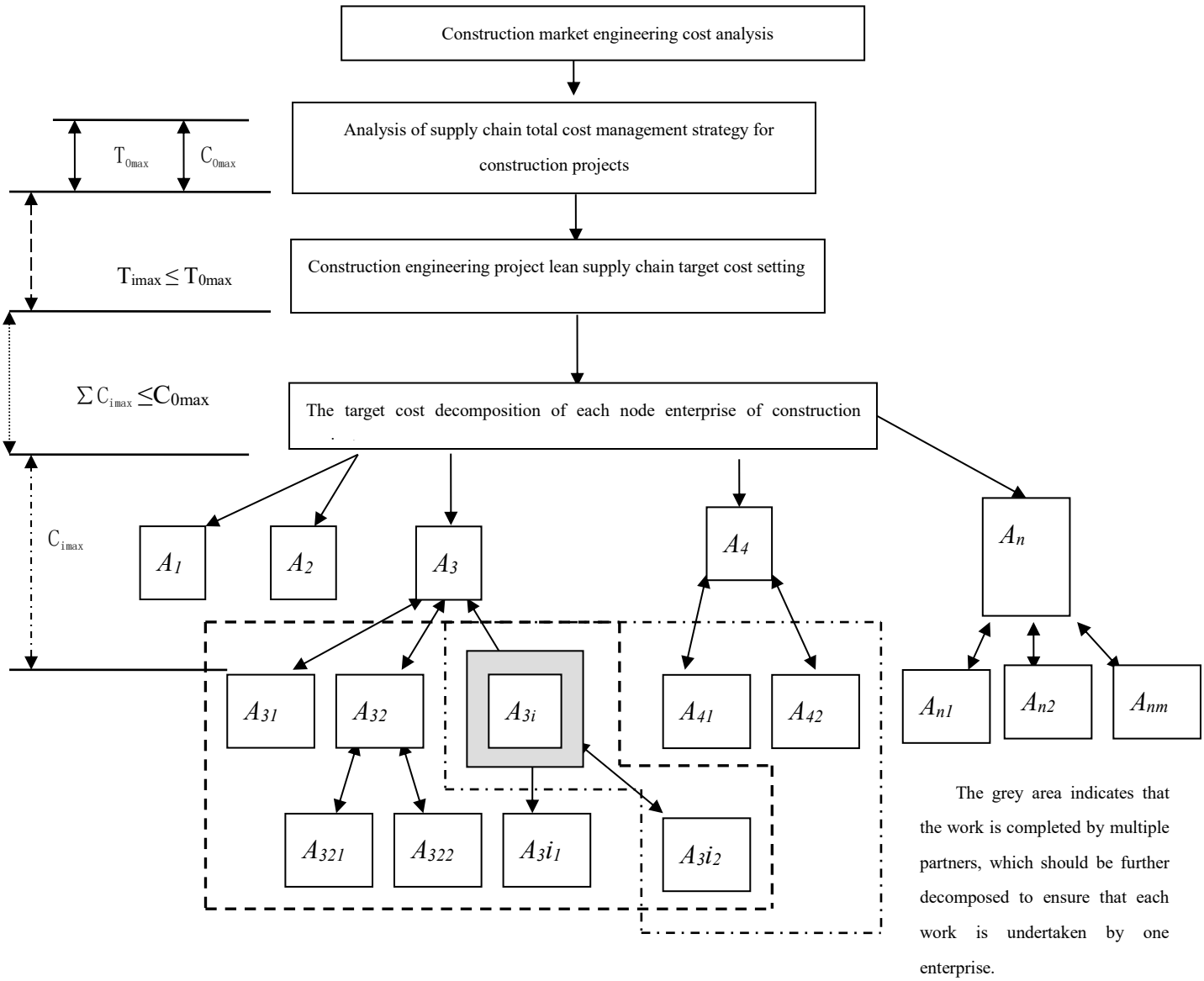
2. Framework Construction of Lean Supply Chain Target Cost Management for Construction Projects.

The construction project supply chain begins with the construction project owner's conception, site selection and feasibility study, through lean exploration, lean design, lean construction, lean procurement, lean logistics and lean services and so on various units provide products or services, ended by the final consumption of the owner. The owner is generally pre-determined the functional requirements and investment scope of the building products, and set

a target price of construction project. The competitiveness and profitability of the construction project supply chain in the market are the key factor in determining the survival and development of the project management company. Therefore, the project management company's construction of the supply chain cost control model must focus on the "construction market", find the overall target cost of the project supply chain in the construction market demand, and effectively decompose the target cost of the construction project.

2.1 The assumptions of lean supply chain target cost framework

The construction of the lean supply chain cost system model in the construction project should be based on the following assumptions:(1) The project management company is the manager of the entire lean supply chain, and the core enterprises within the chain has a dynamic and stable strategic alliance;(2) The competition strategy of the project management company's supply chain has been established;(3) The project management company has basically completed the selection of the node enterprises in the supply chain, the supply chain has been constructed, and the indicators of the node enterprises basically meet the requirements. As shown in Figure 1:



A1-survey units, A2-design unit, A3-construction unit, A4-supply unit……

An-property management unit A31-bidding A32-procurement...A3i-construction

Figure 1. Construction project lean supply chain target cost composition diagram

其中：

Ai is the construction task on the supply chain（i=1.2.3.….n）

Aij is the next sub-task of task i（i =1.2.3.….n，j =1.2.3.….n），

Aijk is the task next to the 'i'th subtask（i =1.2.3.….n，i =1.2.3.….n，k =1.2.3.….n）

T_{0max} is time objective constraint；T_{imax} is the longest working time of each task obtained by decomposition；

C_{0max} is the maximum target cost value set；C_{imax} is the maximum possible target cost value for decomposition of all subtasks.

2.2 Analysis of lean supply chain target cost planning system for construction projects

In order to ensure the smooth implementation of the target cost planning in the construction industry, according to the requirements of the construction project project company or the general contracting mode of the project and the goal planning theory, a system of target cost planning is established, as shown in Figure 2

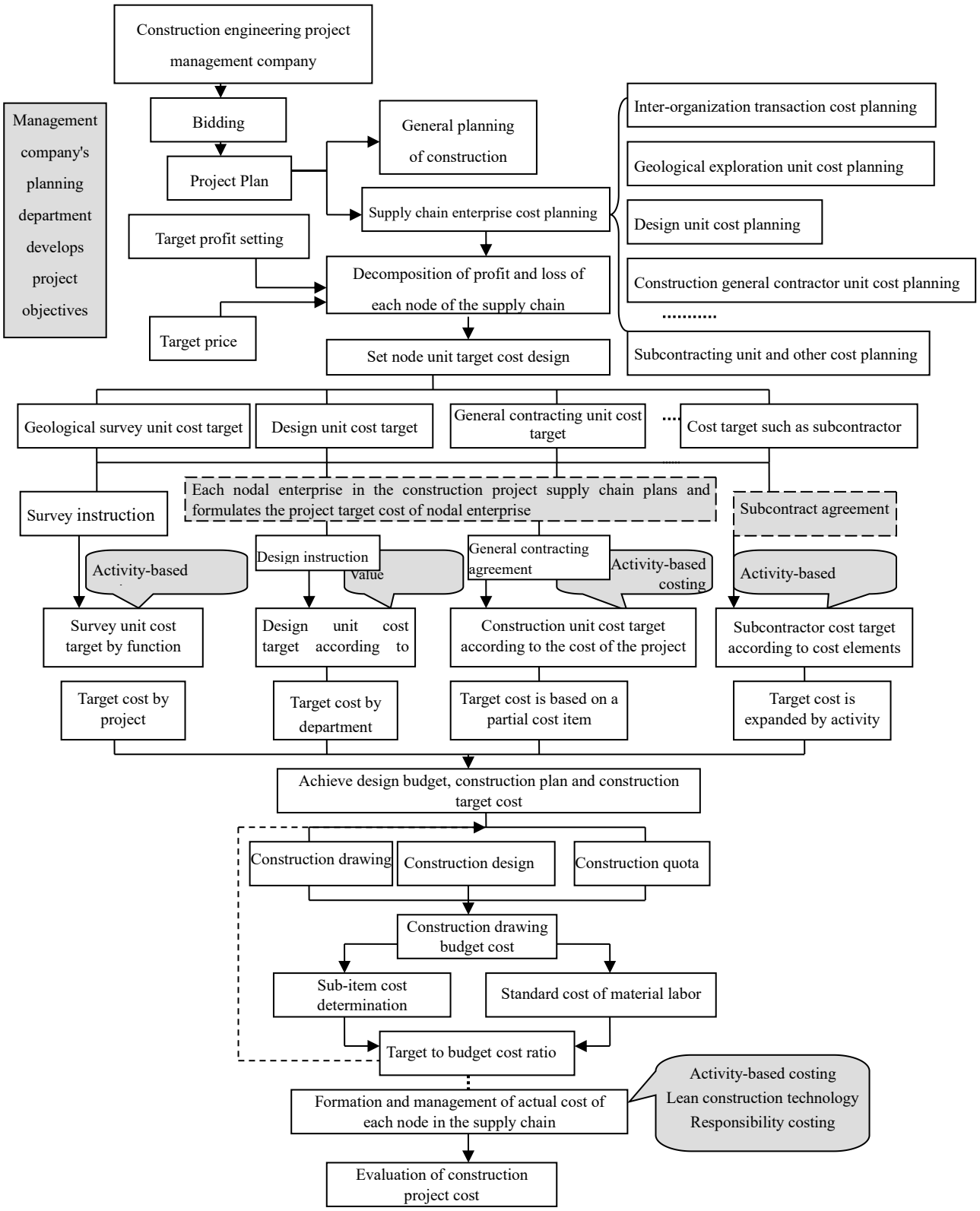


Figure 2 Construction project project lean supply chain target cost planning system

In this target cost planning system, cost planning runs throughout the entire process of building product such as planning, design and construction etc. The target cost indicators layers of decomposition to the planning, design, supply, construction and management of each department, and the cost of every employee to undertake a certain indicators. Construction engineering project lean supply chain target cost management has achieved cost control of all staff and the whole process.

The project company first determines the target price and target profit rate of the project according to the bidding situation of the construction project. The planning department determines the target cost of the construction project; at the same time, the geological exploration unit, the design unit, the construction general contractor, the subcontractor and other supply chain participants plan their own cost and target price for the bidding situation of the construction project formulate and determine the design scheme to meet the target cost through the analysis of profit and loss indicators. After the target cost and design scheme are determined, each node enterprise in the chain will successively expand the cost of the construction project according to the function and cost elements, and use the value analysis technology and activity-based cost method to analyze its cost and calculate the project budget, planned cost and construction cost. The financial and budget departments of each node in the chain compare the target cost with the estimated cost. If the budget, planning and construction costs reach the target cost, the design department cooperates with the cost management department to draw the construction drawing directly according to the preliminary design drawing and work out the construction organization and design. If the estimated cost does not reach the target cost, as shown by the dotted line, on the basis of further value analysis, the cost design department draws the construction drawing and prepares the construction organization design. The budget department prepares the construction budget according to the construction drawing and construction organization design, and the budget and cost are compared by the finance and budget departments. If the target cost is not achieved, return to the design design phase and restart the design work; if the target cost is achieved, evaluate the target cost achievement.

3. Implementation of Lean Supply Chain Target Cost Management for Construction Projects

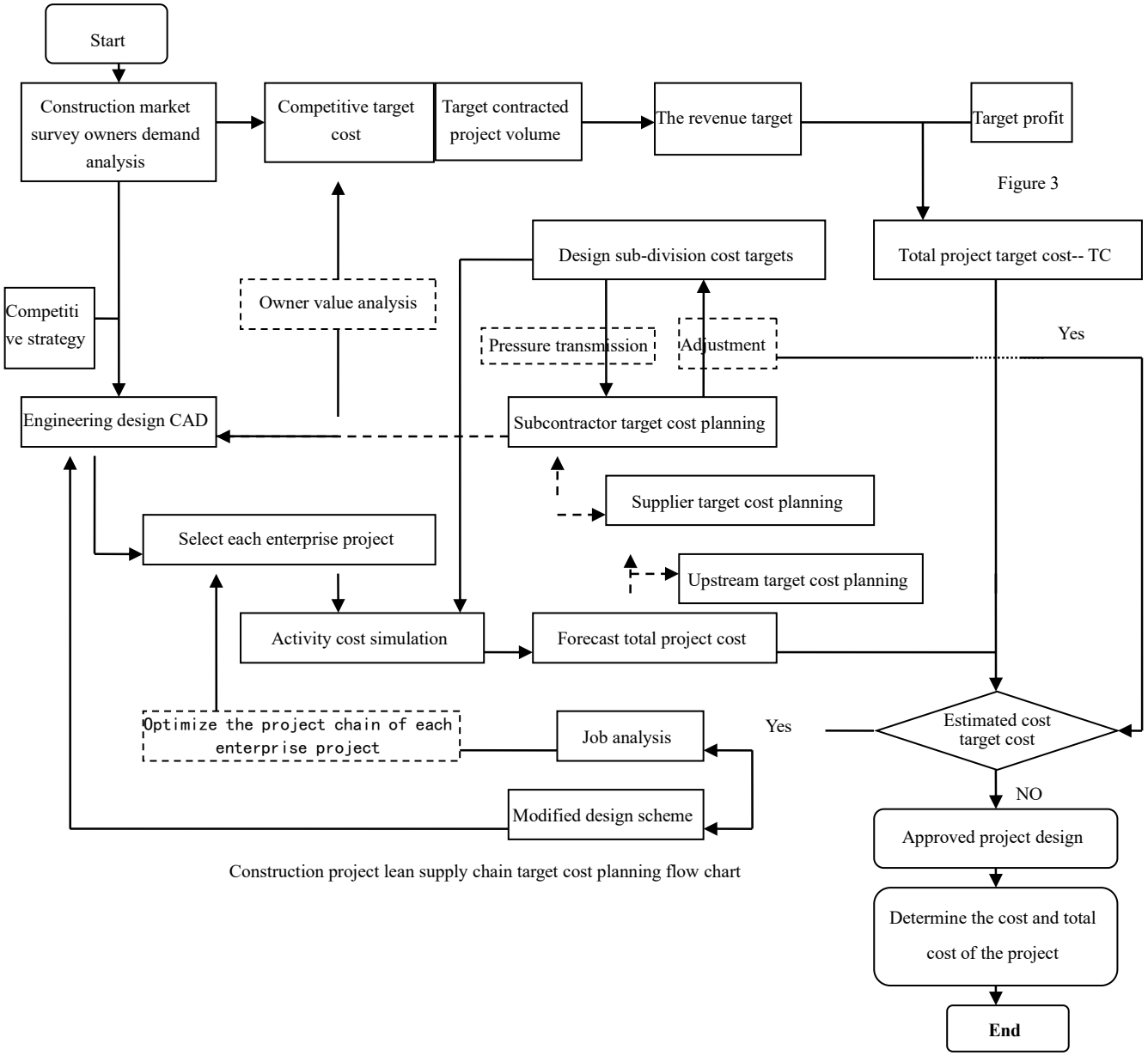
Based on the analysis of the total cost management strategy of the supply chain of the construction project, the project management company determines the supply of the construction project by analyzing the construction market demand, combining the strategic combination of the overall optimization of the lean supply chain of the construction project and the actual situation of the lean supply chain operations, determine the construction project supply chain management concepts, including the construction of the project market positioning, basic functions, characteristics, quality requirements, life cycle, market demand, etc. Market analysis is the starting point of cost control. Market analysis should deal with the overall planning and concept design of construction projects to help optimize structural cost drivers and provide a good foundation for supply chain cost management of construction projects.

3.1 Lean supply chain target cost setting

The target cost is the cost target value that must be achieved in order to realize the effective operation of the construction project supply chain and ensure the realization of the target profit. It is to determine the life cycle cost of the project to be developed, and is the expected goal of all employees in the supply chain. The construction project project lean supply chain target cost is also an important measure for effective cost comparison analysis. By comparing the actual cost of each link with the target cost, revealing the difference between actual cost and target cost, analyzing and overcoming the causes of the difference, thus realizing the construction project. Optimization of project lean supply chain cost control.

(1) Target cost planning process

The integration implementation begins with the owner's survey of the construction market and demand analysis to determine the target cost of the construction project, and ends with the breakdown of the cost and total cost of the project by each node. The planning process of lean supply chain target cost for construction projects is shown in figure 3:



Construction project lean supply chain target cost planning flow chart

After the target cost of the project is determined, the exact cost is estimated based on the current construction level and the expected price level, and there must be a deviation between the two costs. If the deviation is negative, that is, the target cost exceeds the estimated cost, indicating that the project has a cost advantage, the value engineering and continuous improvement process optimization measures can be adopted to scientifically deal with the relationship between cost rationalization and value functionalization. If the deviation is positive, the estimated cost exceeds the target cost, it is necessary to digest the deviation in design, construction, procurement, etc., such as the use of value engineering redesign project, use process transformation to optimize the construction process, strengthen consultation with suppliers to reduce procurement costs, etc. Reduce project costs without compromising the final function and quality of the construction

project to achieve the target cost. It is also necessary to continue the operational control before the project is scrapped to avoid the actual cost deviating from the target cost. Therefore, the entire project engineering project lean supply chain target cost management framework through the whole process, all-round, all personnel cost control, so that the final cost of the project meets the requirements of the owners and participants to achieve the strategic objectives of lean management of construction projects

(2) Formation of target cost

The formation process of the lean cost of the construction project lean cost is also the forecasting, analysis, determination and dynamic management process of the planned cost, as shown in Figure 4.

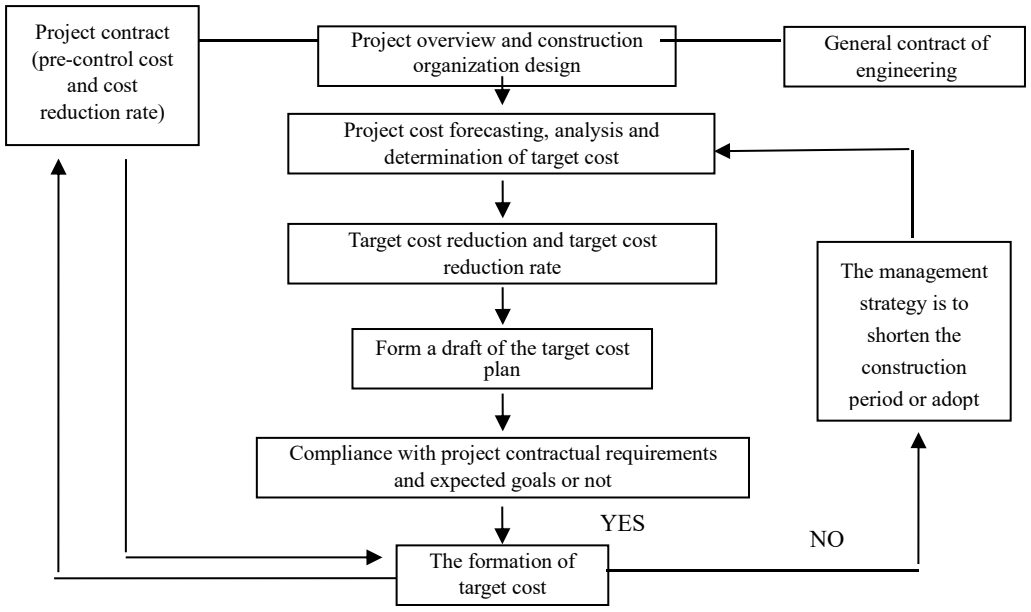


Figure 4.Formation process of target cost

(3) Calculation of target cost

Lean supply chain target cost of construction engineering projects is the product of cost forecasting and target management method. It is the starting point of target cost planning activity. The goal is to determine the allowable cost of construction project, and the target value is the maximum allowable value under the total cost of lean supply chain. The traditional target cost management theory holds that there are absolute benefits in the quality, cost and construction period of the project, that is, there are absolute contradictions between the three elements of the economic activities of construction. The improvement of project quality will definitely lead to an

increase in the project target cost. To shorten the project period, it must rely on a large amount of inventory materials to ensure that the target cost management is simply to balance the target cost and service level of the project to a certain extent. However, in the lean supply chain system of construction projects, it is compatible to improve project quality, shorten the construction period, improve service and reduce costs. Through the strategic alliance of partners, the market risk is balanced to the control of integration cost and opportunity cost in the entire supply chain, cooperative operation, so that the absolute benefits can be transformed into a relatively, controllable benefit relationship. Construction projects allow the cost to be determined by the target cost and desired target profit determined by market demand. The formula is expressed as follows:

Target cost = target price - target profit

Target cost = target price × (1- target profit margin)

The purpose of target profit margin determination is to ensure the completion of all participating companies' long-term profit plans. Project management can set the project target profit rate based on factors such as enterprise competitiveness, enterprise market share, construction project technical content, construction specification level and other factors based on its own experience. Since the construction budget quota of China is compiled according to the average level of construction enterprises, in order to facilitate the operation, the profit rate in the quota issued by the state can be directly determined as the target profit, or a small adjustment can be made on this basis.

According to the whole life cycle of the construction project, the need to pay attention to the construction market demand situation, the time T_{0max} and the quality Q requirements, the target constraints and the feasible target cost of the construction project are set.

3.2 Lean supply chain target cost decomposition and cost pressure transfer

(1) Target cost decomposition

After setting the overall target cost and time constraint of the lean supply chain, the target cost value and time constraint are decomposed to form a multi-level cost target tree composed of time-constrained sub-objective costs. Target cost decomposition refers to the specific cost of the construction project that can be allowed to be decomposed according to certain requirements into more specific and detailed sub-units such as lean exploration, lean design, lean construction, lean

procurement, lean logistics and lean service. Goal, sub-goal. Target cost decomposition mainly adopts the form of distribution to various technical objects, which is to expand financial costs according to technical elements, and mobilize geological prospectors, project designers, subcontractors, material suppliers, machinery manufacturers, bidding and supervision units, and service organizations. Such as the enthusiasm of each node in the supply chain, the activities to reduce costs spontaneously, and truly reduce the overall target cost of the set supply chain. This phase is also the central stage of the target cost planning process, called the “central implementation cycle”. From the perspective of strategic cost management, cost information is introduced into the technical information source, and the overall target cost management information source of the supply chain is fundamentally changed. The overall target cost breakdown of an effective supply chain helps to rationally allocate the supply chain's tasks and lay the foundation for the next phase of cost targets.

The cost decomposition of the supply chain of the construction project can be combined with the principle of job decomposition and particle size decomposition, which can reasonably decompose the target cost, and help to clarify the cost control responsibility of the supply chain node enterprises and evaluate the performance of each node in the supply chain.

The principle of job decomposition: the principle of job decomposition requires analyzing the operation chain according to the supply chain business process to decompose the target cost into multi-level sub-cost targets. The target tree is a good method for target cost decomposition. It mainly uses value chain analysis to determine the basic operational activities of the supply chain. Then, it analyzes the basic operations of these basic operations, and uses the value chain upstream method to decompose according to a single flow direction. The job unit is merged to obtain a job chain composed of a job process, and the target cost value is decomposed into a multi-level sub-job target cost value by top-down according to the supply chain historical operation cost data or the job cost data of the benchmark operation flow. Form a multi-layered cost target tree.

Granularity Decomposition Principle: The principle of granularity decomposition requires that job decomposition be performed hierarchically. The job decomposition at the supply chain level is not an unrestricted subdivision operation, but is decomposed to the enterprise level, that is, until a single operation is completed by a single node enterprise. As for the breakdown of the operations of a single enterprise, each enterprise is subdivided into the respective cost centers.

The combination of the above two decomposition principles can not only decompose the target cost according to a reasonable decomposition method, but also help to clarify the cost control responsibility of the supply chain node enterprise and evaluate the performance of each node enterprise in the supply chain. The total target cost of the supply chain is directly decomposed according to the operation chain to form a tree hierarchy with two relationships of and/or. The total target cost is the root of the tree, and the sub-target cost forms the leaves of the tree structure.

(2) Target cost integration, establish a homogeneous operation cost library

In order to better improve the scale efficiency of each node of the construction project and reduce the duplication of labor, after the establishment of the supply chain, the main operations must be divided into operation centers, and the small operations before and after the construction and production process should be absorbed. The degree of relevance of the work is scientifically and effectively combined, and the merger of the operations must meet certain conditions. The so-called job consolidation means that the cost of two or more jobs corresponds to the workload and add up to form a new job. In the process of consolidation, the cost of product sharing does not change, that is, the cost of the operation after the merger. The cost of the method calculation should be equal to the cost calculated by the activity-based costing method before the merger. Also, the motivations for participating in the combined operation are generally the same. The prerequisite for job consolidation is that the drivers are the same and the cost sharing is unchanged.

3.3 Lean supply chain target cost target cost plan reached

The goal cost achievement is the process of realizing the sub-cost goal of the target cost tree from the bottom up on the basis of the target cost decomposition. In order to determine the cost targets of each node of the construction project supply chain, this step is often referred to as the target cost planning of each node. The target cost planning at each sub-level conveys the target cost pressure at the project level to the project designer, geological prospector, material supplier, machinery manufacturer, subcontractor, etc., so that each node enterprise finds its own cost reduction. Measures to jointly bear the cost pressure and achieve the expected cost targets.

The target cost planning mode of the construction project is shown in Figure 4:

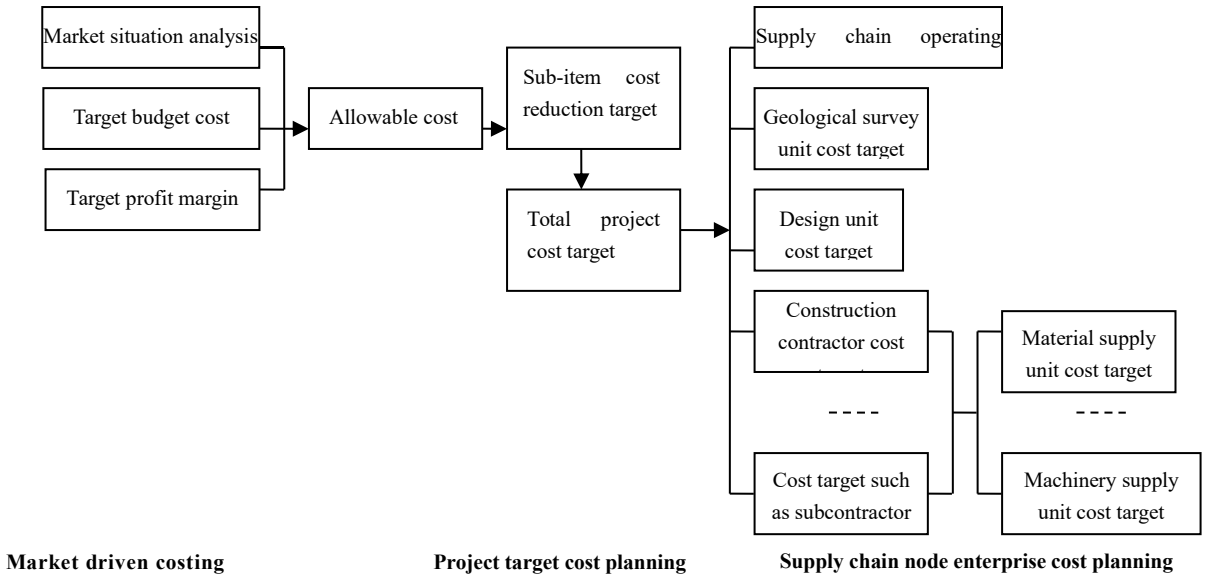


Figure 4. Process of target cost planning for construction project

As can be seen from Figure 4, in order to support this cost management system, all participants, including owners, designers, suppliers, contractors, subcontractors, and other project participants, need to work together. The final result of the target cost planning based on lean construction determines the cost target of a participating node unit, and decomposes the target according to the components of the cost project, thereby constructing the construction project management company, the project general contracting company or large-scale construction. The core enterprises are connected with the suppliers, so that the target cost planning of the construction project can be effectively integrated with the value chain, fully integrating the resource advantages of the cooperative enterprise, and it has important and far-reaching significance for the construction industry to win in the competition.

To this end, we need to do the following work [7]:

First, the owner, the main contractor and the supplier should be involved in the early stage of project implementation. This is important for the formulation of the target cost and the design of the design plan, which can reduce the cost variation and improve the cost controllability in the later stage;

Second, the owners, designers, general contractors and professional subcontractors and suppliers jointly form a cross-functional team, working together on joint cost reduction activities, and transferring cost pressures along the entire value stream to the entire value chain. All organizations;

The third is to increase the transparency of information, especially the transparency of cost information, which can enhance the trust between the participants and contribute to the achievement of cost targets;

The fourth is to establish a long-term stable, mutual trust and close partnership, as well as a risk-sharing and benefit-sharing cooperation mechanism. When problems arise, they will not cause greater losses and wastes due to mutual promotion.

Fifth, through training or other means, all project participants should pay attention to cost management, actively participate in cost management, find out factors and characteristics related to soil cost from their own work, take the initiative to strengthen cooperation and cooperation, and reduce costs by improving the quality of work.

4. Design of the allocation model of the target cost and workload of lean supply chain in construction projects.

In construction engineering project planning, survey, design, construction and maintenance and other construction activities, all need to consume a variety of resources, incurred the corresponding costs and expenses, and expect to obtain the maximum benefit. Therefore, when designing the target cost of lean supply chain, this paper mainly takes the workload or construction area of construction projects undertaken by each participating nodal enterprise in the supply chain as the base for decomposition, and confirms the target cost and expected target profit that each enterprise should bear. Such as building unit of organization design and construction of the production process, should with engineering drawings design and engineering construction drawing as the basic guide, to carry out the raw material procurement, logistics, transportation, inventory in the supply chain management, and other activities, ultimately reflected on the basis of the construction or other work area, with minimum cost into the core guiding ideology for supply chain design.

In order to minimizing the cost of construction engineering project and the profit maximization, construction engineering project management company or large construction project general contracting company needs of each child to the cost of the forehead and coalition units to deal comprehensively with the amount of work, using multi-objective linear programming technology, build a model of the distribution of the cost and effort.

Assumption:

C_{Pi}: the total target cost of the supply chain (i = 1, 2... n), there are N node enterprises in the supply chain, namely n sub-alliances; (i is the number of nodes in the supply chain; j is the subordinate participating unit of each node of the supply chain)

L_i: the total profit distribution of each node in the supply chain;

X_i: The lower cost proportion of each node in the supply chain;

C_{ij}: unit cost of the internal node enterprise of the sub-confederation, r_{ij}: cost reduction rate;

L_{ij}: unit profit of the internal node enterprise of the sub-library, $L_{ij}= C_{ij}*P_{ij}$

S: building area or workload indicator;

S_{ij}: the contracted area or other workload indicator obtained by the j-th unit in the i-th sub-dynamic alliance;

S_{ij}': the maximum workload that can be undertaken by the j-th unit in the i-th sub-dynamic alliance under existing equipment, machinery, time and technology;

Then: the steps to establish the allocation model of the target cost and workload of the construction project are as follows:

(1) Total cost of construction project target = target total budget cost - target profit

(2) Target cost of each node in the lean supply chain. According to the investment estimation table made in the feasibility study stage of the project, calculate the lower cost proportion x_j of each alliance in each link, and the target cost of each alliance node. $C_i = CL_{xi}$ (i = 1, 2... n), There are n nodes in the supply chain, that is, there are n sub-allies.

The balance relationship between the cost of a node's enterprise and the total cost of the supply chain:

That is, the cost of a node enterprise = the resources consumed by the upstream enterprise to perform the operation + the profit retained by the node

(3) Sub-union internal member units (j) costs and profits. Using the actual average unit cost C_{ij}' and the planned cost reduction rate r_{ij} of each member in the previous period, the unit cost of the member can be obtained: $C_{ij}= C_{ij}'(1- r_{ij})$(i=1,2,...,$n_j$), i There are n_j units in the alliance, and the unit profit of this unit is $L_{ij}= C_{ij}*P_{ij}$. Among them, p_{ij} is the cost profit rate.

The relationship between the profit of a node's enterprise and the total cost of the supply chain:

The profit of a node enterprise = the pricing of the next node payment - the price of the node to pay the previous node - the resource cost consumed by the operation of the node

That is to say, the supply chain cost does not include the management of the expenses of each node enterprise. The total cost of the supply chain is the operating cost of each node enterprise and the retained profit between the nodes. It is actually equal to the total project cost of the project that the owner ultimately pays. Specifically, there are the following: planning cost, bidding cost, survey cost, design cost, construction and construction cost, training cost, storage cost, management information system maintenance cost, distribution cost, retained profit between nodes, etc.

(4) Workload allocation plan for members of the sub-mineral. The construction area of the project is S, S_{ij} is the construction area or other workload indicator obtained by the j-th unit in the i-th sub-dynamic alliance, and S_{ij}' is the unit under the existing equipment, machinery, time and technology. Maximum workload. The model is as follows:

The maximization model of the total profit distribution of each node in the supply chain is:

$$\max L_i = \sum_{i=1}^{n} C_{ij} \times P_i S_{ij} = \sum_{i=1}^{n} C_{ij} \times (1 - r_{ij}) P_{ij} S_{ij} \quad (i=1,2,\ldots,n \quad j=1,2,\ldots,m) \quad (4\text{-}1)$$

The target cost minimization model is:

$$\min C_{pi} = \sum_{i=1}^{n} C_{ij} \times S_{ij} = -\sum_{i=1}^{n} C_{ij}' \times (1 - r_{ij}) S_{ij} \quad (4\text{-}2)$$

$$\begin{aligned} & st: S = \sum_{i=1}^{n} S_{ij} \\ & S_{ij} \sum_{i=1}^{n} C_{ij} \le C_i \\ & \sum_{i=1}^{m} C_j = C_1, S_{ij} \le S \\ & S_{ij} \le \min(S, S_{ij}) \\ & S_{ij} \ge 0 \end{aligned} \quad (4\text{-}3)$$

It can be solved conveniently by using multi-objective linear programming.

In a word, target cost planning is a kind of technology for strategic management of future profits of engineering projects. It is a lean supply chain cost management mode that takes target

cost control as the core, realizes target cost as the purpose, and takes into account pre-event, in-process and post-event control.

5. Conclusion

Target costing is one of the main tools of supply chain cost management. Many researchers have studied the application of target cost system in manufacturing, but there is little research on lean supply chain management of construction projects. Therefore, the research based on the study of the basic model of lean supply chain cost control for construction projects is particularly important. Based on the analysis of the strategic cost management ideas embodied in the target cost planning, this paper establishes the basic model construction principles and assumptions for the lean supply chain cost control of construction projects. According to the requirements of the goal planning theory of the construction project company, establish a lean supply chain cost planning system for the construction project, realize the basic model of the lean supply chain cost management of the construction project, and set the target cost from the lean project of the construction project. The technical decomposition is established by the process of cost decomposition and cost pressure transmission and sub-target cost planning.

Firstly, the relationship between the target cost and the workload of the construction project is established. The technology of multi-objective linear programming is studied. A cost and workload allocation model is established for the cost of each sub-fund and the workload obtained by each unit within the alliance. For the construction project, the core node construction enterprise of the lean supply chain provides the method of effectively decomposing the target cost according to the workload, and finally provides the optimal supply chain design implementation algorithm.

Secondly, through the cost and benefit analysis of lean supply chain of construction engineering projects, the expenditure of lean supply chain target cost of construction engineering projects is measured, and the amount of cost incurred during and after construction projects is controlled.

In the lean planning and design phase, owners, key construction contractors, and lean suppliers participate in the development of supply chain target costs, so that all organizations in the lean supply chain maintain a sufficient rate of return. The lean supply chain target cost is determined and passed to each organization through the supply chain. After the target cost is determined, we should focus on the entire supply chain, not just the implementation of the target

cost. Because the target cost is constrained throughout the supply chain, we must use the idea of operation management to penetrate the supply chain. At the operational level, comprehensively and in-depth analysis of all aspects of the supply chain, formulating key operating points from the perspective of cost optimization, improving operations, reorganizing operational processes, optimizing the entire operation chain and value chain, and achieving target cost management based on supply chain strategy .

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