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Logistics cost control of railway construction projects based on material classification management and material supply plan

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Abstract. To decrease the logistics cost effectively, this paper will fulfill the goal by materials supply plan management. The first step is the classifying of materials; it will find the key materials out to improve the efficiency and effectiveness of material management. Then it's the material supply plan management of the key materials based on material requirement plan of railway construction.

Introduction

The Railway construction of our country has been in its period of rapid development and so is high railway. The investment on construction project like this is rather huge, 60-70% of which is cost of materials. The logistics cost management level of ours is not as good as that of developed countries, and it could be seen by that logistics cost percentage of our country is almost doubled of them. So there is much room for us to control the logistics cost and there will be huge gains in logistics cost control of railway construction project.

Literature review

Projects are a group of interrelated activities to achieve the strategy of the organization [1]; and construction projects are projects that take construction engineering as carrier. Logistics management is the process of planning, implementing, and controlling the efficient, effective forward and reverses flow and storage of goods, services and related information between the point of origin and the point of consumption [2]. Construction project logistics refers to the logistics processes of all materials, equipment and machinery on the construction site. Railway construction logistics cost control includes the logistics management of materials, equipments and machines.

Railway construction logistics can be divided into supply logistics and site logistics. Supply logistics refer to basically activities like resources specification, supply planning, acquisition of resources, transportation, delivery and storage control. And site logistics refer to resources' on-site planning, organizing, directing and controlling [3].

Lack of communication during construction materials supply will cause inaccurate demand forecasts, which would lead ineffective supply chain management and result in additional logistics costs. Strengthening coordination and communication become the first step to reduce logistics costs. Good communication brings precise delivery schedule. Logistics costs control can be achieved by two ways: the first, integrate the purchase process and benefit from scale economic; the second, make every parties involve in the project logistics planning process at each stages of the project [4]. In construction projects, "partnership" and "communication" are passages to successful supply chain management [5]. Centralized procurement is the best application of l purchase process integration in China. For supply information communication, MS Project can be used for planning logistics specification, logistics time and logistics resources, but it's not sensitive to demand changes and cost control. Jointly Managed Inventory (VMI) has been gradually applied in construction enterprises referred from that of commercial enterprises, but it still has a long way to make it available[6].

The material classifying method

The defects of existing methods. The traditional ABC (Activity Based Classification) method grabs a small number of valuable materials; it will increase management efficiency and reduce the difficulty of management. So it's widely used in all industries. But for railway construction projects, value is not the only factor to measure the importance of materials; the supply risks and the importance of strategic materials to the whole project must also be considered. Traditional ABC classification method doesn't consider the materials low in value but playing a key role for the entire project. In railway construction projects, ABC classification method is not fully applicable.

Railway construction project materials and equipments management approaches in china classify the materials into two kinds: materials and equipments supplied by the part A and materials and equipments procured by their own. This method classifies the materials from the point of importance, value and supply risks, and clearly separates the key materials to management them individually. To some extent, this method could improve cost management effective. But it will have the consequence of huge amount of work and inefficient management, because there may be hundreds and thousands key materials in a railway construction subproject.

The *Kraljic model* classifies the materials from the tow dimensions of the revenue impact and supply risks, but it doesn't take the logistics cost management efficiency into account. The level materials have the potential of value increase, the strategy materials and bottleneck materials need better care due to the existence of supply risks. These three kinds of materials are the focus of material management, it results that workload will increase greatly. For railway construction materials management, the Kraljic model could be a reference but not applicable, there's still much room for improvement.

New material classifying method. Combing the ABC classification method, the original materials classification method and the Kraljic model together, the nested ABC classification method classifies the materials in tow levels to grasp the key materials. In railway construction project material procurement process, to minimize the procurement cost, purchasing in bulks is selected to obtain the scale economy. But from the point of buyers, purchasing in bulks will result in the increase of inventory cost; from the point of suppliers, risks in supply markets provide bargaining chips for them. In this condition, all the three factors, i.e. the value of materials, supply risks and inventory cost, should be considered in railway construction project material procurement process to improve the effective and efficiency of material management. It needs to find a new method to classify the materials. To reach this goal, we give the nested ABC classification method, see in flowing table 1.

Tab1. *The nested ABC classification* method of railway construction project materials

<table>
<tr><th>Kind</th><th>Features</th><th colspan="2">Actions</th></tr>
<tr><td rowspan="5">Kind A</td><td>High in value，high in supply risks，huge amount</td><td>Kind A1</td><td>Centralized purchasing, supply in batches</td></tr>
<tr><td>High in value，high in supply risks，small amount</td><td rowspan="2">Kind A2</td><td rowspan="2">Centralized purchasing, supply in bulks</td></tr>
<tr><td>Low in value，high in supply risks，huge amount</td></tr>
<tr><td>Low in value，high in supply risks，small amount</td><td>Kind A3</td><td>Centralized purchasing, one-time supply</td></tr>
<tr><td rowspan="2">Kind B</td><td>High in value，low in supply risks，huge amount</td><td colspan="2">Centralized purchasing, supply in batches</td></tr>
<tr><td>High in value，low in supply risks，small amount</td><td colspan="2">Centralized purchasing, supply in bulks</td></tr>
<tr><td rowspan="2">Kind C</td><td>Low in value，low in supply risks，huge amount</td><td colspan="2">Purchasing by-self, supply in bulks</td></tr>
<tr><td>Low in value，low in supply risks，small amount</td><td colspan="2">Purchasing by-self, one-time supply</td></tr>
</table>

The nested ABC classification method could be shown in Two-dimensional map as figure 1.

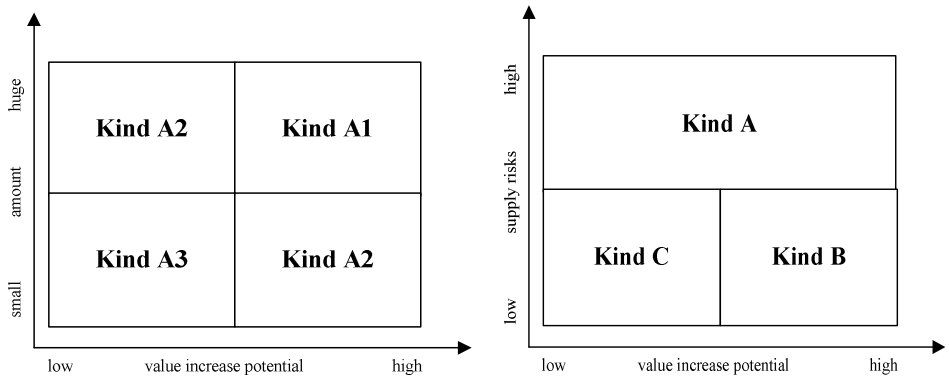

Fig 1. The nested ABC classification method

Materials of kind A are the key strategy materials in railway construction projects, and usually they take account of 80% of the value of the materials. In construction projects, cost of materials account for 70% of the project cost. As the amount of materials increase, the impact of logistics cost control to the whole project cost is more obvious, because supplying in batches will reduce the inventory under good supplier relationship. So Materials of kind A could be classified in three kinds: kind A1 that high in value and with huge amount, kind A2 that high in value or with huge amount, kind A3 that low in value and with small amount.

Materials of kind B are the materials that are low in supply risks but huge in value, and they are usually purchased centralized. Though they are not of strategic importance as materials of kind A, they are of significant importance to railway construction. They are mainly the bulk materials that have direct impact to the quality, safety and cost of the projects.

Materials of kind C are generally low in value and easy to obtain from the market, for example, Low-value consumables and turnover materials. In railway construction projects, they are Purchased by-self.

Supply logistics cost analysis

Material supply cost consists of procurement cost after discount, logistics cost related to procurement, transportation cost, capital occupation cost, storage cost and shortage cost. Since railway construction materials are usually transported by suppliers, so we didn't take transportation cost into account.

(1) Procurement cost after discount

When the purchasing quantity comes to a certain number, generally suppliers will offer discount for the buyers. For material procurement of high value, the discount will bring obvious economic effect.

(2) Logistics cost related to procurement

In the procurement process, logistics cost related to procurement are divided into variable costs and fixed costs. Variable costs refer to costs proportional to procurement frequency, for example, travelling costs and ordering costs. Fixed costs refer to costs have nothing to do with purchase frequency. In procurement process, they generally are wages, management fees of procurement department, etc.

(3) Logistics cost related to inventory

Logistics cost related to inventory consists on capital occupation cost, storage cost and risk cost. Storage cost could be divided into fixed storage cost and variable storage cost. Risk cost is mainly caused by devaluation and damage of materials. The rate of consumption, based on which the material demand plan is established, has already taken the devaluation and damage into account. So it won't calculate risk cost here.

(4) Shortage cost

Railway construction projects usually have long construction lines, a large number of workers and strict construction period. Otherwise, a huge loss could happen. In order to ensure the smooth progres of the construction projects, stock shortage is not allowed in railway construction projects.

(5) The calculation progress of supply cost of materials

The calculation progress of supply cost of materials here concludes procurement cost after discount, logistics cost related to procurement, capital occupation cost and storage cost. Set P for price, Q for order quantity, for average amount every year, N for procurement frequency, for unit variable logistics cost related to procurement, for annual capital cost rate, for unit variable annual storage cost, for procurement cost after discount, for logistics cost related to procurement, for fixed logistics cost related to procurement, for capital occupation cost, for storage cost, for fixed annual storage cost，so

$$C_0 = P*Q. \tag{1}$$

$$C_1 = C_{10} + k_1*N. \tag{2}$$

$$C_2 = P*Q*k_2. \tag{3}$$

$$C_3 = C_{30} + k_3*Q'. \tag{4}$$

The calculation formula of supply cost of materials is

$$C = C_0 + C_1 + C_2 + C_3. \tag{5}$$

Supply logistics cost control application

Nantongpu railway line extends for 114.96Km. And its electrification project involves 12 stations, of which the catenaries project is the most important part.

The classification of materials. According to the nested ABC classification method, the first step is classifying the 970 species of materials into ABC three kinds by first level. To grasp the critical materials, the second step is selecting the key materials.

For the A kinds, materials that are worth more than 1,100,000 Yuan (1% of the value of materials in the project is about 1,100,000 Yuan) and large in quantity (more than 200) could be purchased in batches, they are of A1 kind; materials that are worth more than 400,000 Yuan (for materials value more than 400,000 Yuan account for 80% of all the materials in the project) less than 1,100,000 Yuan and large in quantity could be purchased in bulks, they are of A2 kind; materials that are worth less than 400,000 Yuan or small in quantity could be purchased one-time, they are of A3 kind.

For the B kind, select out materials that value more than 1,100,000 Yuan. It will improve the management efficiency for logistics cost control.

For materials of C kind, there is no need to select some key materials since they are all will be purchased by-self and one-time supplied.

According the classification method above, the critical materials selected are shown in table 2.

After selected by the principle above, 25 species are selected out as critical materials for the next part of supply logistics cost control. The materials selecting considered both value and importance factors. It will improve the effective and efficiency of material management.

Supply logistics cost control. Based on centralized purchasing or bulk purchases, material supply plan based on the requirements plan in this paper has almost the same price discounts implications as raw material procurement plan. So, comparing the two different supply plans here, we didn't consider the effect of discounts; the purchase price offered by the material procurement department will be the calculation basis for costs comparison.

Supply logistics cost decreased about 2.46% of the value of materials in the project through materials supply plan based on materials requirement plan. It mainly adopted the method of

purchasing in stages and supply in batches to decrease capital occupation cost and storage cost. Maybe the variable logistics cost related to procurement will increase slightly, but it has little influence on logistics cost control.

Tab2. The critical materials selected

Kind	Name	
A kind	A1 kind	Compensation pulley 1:3; Single insulated rod insulator QBN2-25/12KN; The catenaries concrete pillar H35 93/8.7+3.0; The catenaries concrete pillar H35 93/9.2+3.0; The catenaries steel pillars G250/15; Contact line CTAH-150; Contact line CTAH-85； Contact line CTAH-120
	A2 kind	The catenaries steel pillars H35 170/12+3.5; Spring compensator RTB6-S; Synthesis of silicon suspension insulator FQXSG-25/120-890H; Synthesis of silicon suspension insulator FQXSJ-25/120-840QH; Pestle head suspension insulator XWP2-70; Single insulating synthetic rod insulator FQBJ-25/12-760JH; Suspension insulator XWP2-70; type H93Z, H93N AF Line shoulder rack APL01(7.8Z)-87
	A3 kind	others
B kind	Recumbent board type Ⅲ; Copper alloy overall Droppers 16mm2; Cantilever base, single; Copper alloy wire JTM-120; Copper alloy wire JTM-70; Aluminum conductors steel-reinforced (ASCR) LBGLJ300/15； ASCR LBGLJ120/20； ASCR LBGLJ240/30； ASCR LBGLJ185/25	
C kind	others	

Conclusions

Aimed at decreasing the logistics cost, this paper researched the materials classification management and the control of material supply cost. The results show that the nested ABC classification method could be easily used, and it could achieve effective management by grapping a few critical materials from a large number of materials. The calculation result of the data from the case suggested that material supply based on demand plan could pay a significant role in logistics cost control.

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