Research on the Formation and Solution of the Bullwhip Effect of Electricity Material Reserve

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Abstract—With the deepening of the power system reform together with the transformation and development of power companies, the importance of supply chain management has become increasingly prominent. As an important part of the power supply chain management of power companies, the accuracy of electricity material reserves has an impact on the entire process of the company's supply chain. This article analyzes the reasons for the bullwhip effect in the process of electricity material storage, points out the harm caused by the bullwhip effect, and proposes ways to weaken the bullwhip effect such as improving the accuracy of demand reserves, strengthening inventory management.

1. Introduction
In recent years, with the continuous deepening of the power system reform together with the transformation and development of power companies, supply chain management as a new concept and driving force for the development of power companies, and an important part of strategic planning has been highly valued. As the source of supply chain management improvement, the material reserve demand plan will have a significant impact on its accuracy and comprehensiveness on subsequent procurement, warehousing and other links. While the existence of bullwhip effect and other phenomena will lead to a certain degree of demand information authenticity. Distorted variants make the quantity of material reserves inconsistent with the actual situation, and bring about corporate inventory risks. Therefore, combing through the various links of the electricity material reserve demand stage, analyzing the causes of the bullwhip effect, and proposing solutions to weaken the bullwhip effect, is significant to improve the accuracy of material demand and the level of electricity material management.

2. The Bullwhip Effect and Formation Analysis of Electricity Material Reserve

2.1. Bullwhip effect
The bullwhip effect is a phenomenon of demand variation and amplification. When demand information in the supply chain is transmitted from the customer to the supplier, the information cannot be effectively shared, and it is distorted and amplified step by step during the transmission process, resulting in a small amount of downstream demand. The change will be magnified in the
upstream. This phenomenon acts like a swinging bullwhip on the graph, so it is called the bullwhip effect[1].

Fig.1 The bullwhip effect

2.2. Analysis on the Causes of the Bullwhip Effect in the Reserve Demand of Electricity Materials

Compared with other traditional enterprises, electricity materials have the characteristics, like large quantities, high value, and a wide range of departments. Electricity material reserves are stored at a fixed amount to meet the needs of production, operation, emergency rescue, and repair.

Electricity material reserves are organized by the professional departments of the prefectural and municipal bureaus to analyze the operation of the unit's reserves over the years, and put forward the required reserves of materials and materials. The supply chain management department summarizes the reserve quota requirements of each professional department and formulates the reserves at this level. The plan is reported to the provincial companies and professional departments of the Internet company for integration and optimization, and the supply chain department at the same level participates in the review of the list. Finally, the supply chain department will integrate the company's reserve materials list according to the list of professional reserve materials. Supply chain departments at all levels implement material reserves. According to literature and case analysis[2-5], in the process of material demand and storage, the following factors may cause the bullwhip effect risk:

(1) Demand expectation effect. In the entire process of demand reserve, there are many uncertain factors involved. When the departments make material reserve, various professional departments leave some margin for the reported reserve demand out of safety. Because of the company's professional departments at all levels have a margin when making the reserve demand, the reserve demand in head department will become very large.

(2) The lead time is too long. Due to the long period between the summary of material reserve requirements and actual purchases, the longer the lead time, the greater the deviation of the actual demand forecast in the later period. Besides the more inventory required, the purchase order is larger than the actual demand, and the bullwhip effect is also happened.

(3) Lack of information sharing. Due to the lack of real-time communication and sharing of material information with suppliers, companies cannot grasp the actual supply capabilities of upstream suppliers. In order to obtain sufficient and stable supply of materials, increase demand during storage to prevent supplier delivery problems. As a result, demand information is incorrectly amplified, which will also lead a bullwhip effect.

(4) The external environment changes. When facing the uncertainties caused by changes in natural disasters, external policies, and social environment, most of companies choose to deal with high inventories. The greater the uncertainty, the higher the corresponding inventory, which also leads to the demand is magnified.

3. The Harm of Bullwhip Effect in the Reserve Demand of Electricity Materials

The existence of the "bullwhip effect" makes the inventory of power enterprises remain high and occupy a lot of funds. At the same time, it also reduces the utilization and sales of materials, reduces the operation efficiency of the entire supply chain, and increases the difficulty and risk of material management, which may cause the following harms:
(1) Reserve demand is inconsistent with actual demand. The entire material reserve demand has been effected by subjective and objective factor. From the professional department reserve to the actual procurement process, the changing demand is significantly higher than the actual demand, which cannot objectively reflect the actual material demand of the enterprise.

(2) Increase enterprise costs. As an asset-intensive enterprise, power companies have high inventory requirements due to high reserve requirements. When the materials are actually used, the inventory cannot be quickly reduced. This makes the utilization of inventory materials low, increases the cost of corporate inventory, and occupies a large amount of fund, increases business costs.

(3) It is not conducive to the establishment of corporate trust. The existence of the bullwhip effect reduces the trust between power companies and suppliers, which is not conducive to the establishment of long-term cooperation between the upstream and downstream of the supply chain, resulting in an imbalance in the power supply chain and negatively affecting business operations.

4. Research on the Solution to the Bullwhip Effect in the Reserve of Electricity Materials

The existence of the bullwhip effect in the reserve of electricity materials has led to an increase in inventory, an imbalance between supply and demand, and a waste of resources, which endangers the operation of the supply chain and production operations of enterprises. Therefore, it is necessary to fully integrate the reasons for the bullwhip effect in the electricity material reserve, and propose effective methods to weaken the bullwhip effect, shorten the length and vibration amplitude of the "bullwhip", and reduce the risk of demand information distortion.

4.1. Improve the accuracy of demand reserves

Improve the accuracy of demand reserve by establishing a demand reserve forecasting model. On the basis of analyzing historical consumption, with combining factors such as demand characteristics, warehouse layout, investment plan, service level, replenishment timeliness and other factors, construct a demand reserve forecasting model. By comparing the gap between forecast consumption and actual consumption to analyze the accuracy of the forecast model and look for the cause of the obvious abnormality. Improve the accuracy of the forecast by improving the forecasting method or revising the forecasting model.

4.2. Strengthen reserve management

Agreement reserves and joint reserves are effective means to strengthen reserve management. Through the implementation of these reserve management, it can strengthen the cooperation between enterprises, short the lead time, reduce the gap between demands and supply, reduce the inventory, weaken the bullwhip effect.

(1) Agreement reserve. Agreement reserve refers to a model in which a framework purchase agreement is signed with a supplier based on the forecast of material demand for a certain period in the future, and the supplier manages the user agent to exercise decision-making of inventory. Different from the previous model of replenishment supply based on reserve demand, the agreement reserve directly allocates suppliers according to the actual or predicted material demand based on the agreement, which eliminates the amplification and distortion of traditional electricity material reserve demand information in the process of transmitting to suppliers, and reduces the impact of the bullwhip effect.

(2) Joint reserve. Joint reserve is a risk-sharing reserve management model that establishes a coordination and cooperation model with suppliers. The joint reserve emphasizes the simultaneous participation of both supply and demand parties to jointly formulate a demand reserve plan and integrate it into a coordination management center. Through the coordination management center, both the supply and demand parties share the demand information, so as to partially eliminate the demand fluctuation caused by the uncertainty between supply chain nodes and the distortion of demand information, ensure the consistency of demand expectations between the supply and demand parties, and improve the stability of supply.
4.3. Establish information sharing

The direct cause of the bullwhip effect is that demand information has been distorted and amplified during demand transmission. Upstream suppliers cannot recognize and obtain real demand due to insufficient information. Therefore, it is necessary to establish an information sharing mechanism with suppliers. It is possible to eliminate the asymmetry of demand information in the process of demand information transmission. Specifically, it can be shared from the following aspects:

(1) Demand forecast information. In the traditional supply-demand relationship, the supply parties only rely on orders to communicate demand information. However, order is the product of processing market demand information, there is a large deviation between the supply based on the order and the actual demand. Suppliers can share demand forecast information and actual consumption data, and they can reasonably amend the demand forecast to communicate and confirm, thereby avoiding the amplification of demand deviation caused by repeated forecasts.

(2) Inventory information. Since inventory information is not shared, both the supply and demand sides will set up a certain safety stock in order to avoid shortages, resulting in a high overall inventory level, and corresponding demand information has been further enlarged. Shared inventory information includes inventory data and inventory strategies. By sharing information, both the supply and demand parties can clarify each other's inventory levels, which can effectively reduce the safety stock level and reduce unnecessary inventory.

4.4. Build a partnership

Through the establishment of partnerships between supply chain members, mutual benefit and win-win results can be achieved. Different from simple short-term contractual relations, the establishment of cooperative partnerships within the supply chain requires supply chain members to realize information sharing, risk sharing, overall coordination, and common pursuit of maximum benefits. In the establishment of a partnership, incentive mechanism and trust mechanism are two indispensable elements. The incentive mechanism is based on the possible conflict of interest, looking for ways to maximize common interests, using the incentive mechanism to fully mobilize the enthusiasm of partners, and eliminate opportunistic behaviors caused by information asymmetry. The trust mechanism requires mutual trust between partners, coordination of collective and individual interests, and stable cooperative relations. The establishment of trust relations is a long-term process. The establishment of partnerships generally needs to be initiated and led by core members with an important position and influence in the supply chain. Power companies can play its leading role in upstream and downstream industries and build an ecosystem of risk sharing and benefit sharing with partners.

Fig.2 The partnerships between supply chain members

5. Conclusion

Based on the results and discussions presented above, the conclusions are obtained as below:
(1) This paper analyzes the causes of the "bullwhip effect" of electricity material reserve. Due to the expected effect of demand, too long lead time, lack of information sharing, change of external environment and other factors, there is a risk of bullwhip effect in the process of power material demand reserve.

(2) The bullwhip effect risk in the process of electricity material reserve will cause reserve demand is inconsistent with actual demand, increase enterprise costs, and it is not conducive to the establishment of enterprise trust.

(3) In order to weaken the harm of bullwhip effect, this paper puts forward countermeasures such as improving the accuracy of demand reserve, strengthening inventory management, establishing information sharing, and building a partnership, so as to further promote the supply chain of power enterprises to high-efficiency and high-quality development, promote development of power enterprises.

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