Research on the Power Equipment Quality Inspection Industry Based on the Theory of Value Chain: A Case Study of Zhejiang Province

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Abstract. Power equipment is an important part of power grid construction, and the application of quality inspection industry standards of power equipment is the key to ensuring the safe operation of the power grid. In recent years, Zhejiang Electric Power Company has been subjected to frequent faults due to quality problems of power equipment and delayed feedback of quality inspection. Based on the theory of value chain, this article conducts a study on the power equipment inspection industry, and builds a three-dimensional combined value chain system that integrates “power equipment-quality inspection-power grid operation”. It is of great significance to reduce the security risks of power grid operation in Zhejiang Province and improve the economic and social benefits of Zhejiang Province.

1. Introduction

Electric power, as one of the widely used energy sources, plays an essential role in regional economic development and the people’s production and living. Due to the rapid development of science and technology industry in Zhejiang Provinces, the requirement of the ability and capability of power transmission is increasing. If the index for Power quality largely deviates from the normal level value, harms will be caused on power generation, transmission and consumption. Power equipment is an important components for power grid construction, and fundamental factor for power grid operation security. A survey demonstrates that the quality of power equipment causes an constant increase in the faulty rate. For example, the faulty rate caused by aging electric cables and quality problems of power equipment is high up to 39%. If the work in quality inspection industry is done in an efficient manner, including the standard execution in the process of power equipment quality inspection and the quality inspection evaluation, can greatly avoid fault risks and security events caused by the quality problem of power equipment. Given the above background, this paper concentrates on the research regarding power equipment quality industry in Zhejiang Province, introduces the theory of value chain, constructs the “power equipment-quality inspection-power grid operation” combined value chain, and
analyses this value chain. The proposed method can modify the workflow, improve the quality of power equipment, and reduce the faulty rate caused by the quality problem of power equipment in the power grid.

Quality inspection is an activity based on the demand of the entire society on the quality, healthy, security and environment of products and services. It includes air, project, product, and environment quality inspection. Quality inspection service is a technology service provided by qualified institutes, and is an important way to justify the product quality for demand and supply parties. Based on standards and codes issued by governments and industries, quality inspection institutes can measure the parameters for product material, and performance, and further provide a valid report, where the decision is made on whether the product satisfies the requirement of quality and standards by governments, industries and users. From 1900s, quality inspection industry in China appears under the administrative supervision. After joining the World Trade Organization, this supervision is gradually removed. The third-party institutes of quality inspection is well recognized. According to the recent measures of governments, the marketization in quality inspection industry is extensively promote, as well as normalization and branding of the third-party quality inspection service suppliers. With the development in the market and the improvement in the quality, the need of quality inspection is rapidly grows. Currently, the third-party quality inspection service suppliers in China mainly lie in “Zhusanjiao, Changsanjiao, and Huanbohai”, and extend to other regions of China.

Zhejiang Electric Power Company has been one of the pillars of energy suppliers in Zhejiang Province. Its main responsibility is the construction, operation, and management of the power grid in Zhejiang Province. It serves as a supporting role in maintaining the secure transmission of electric power, and plays a key role in the regional economic development and the people’s living. The improvement of power transmission ability and capability guarantees the advance of science and technology in Zhejiang. Power equipment is the basic component for the construction of a power grid, and thus their quality significantly affects the secure operation of the power grid. With the increasing need of new power equipment and the extension of operating time of old power equipment, the fault caused by the quality problem of power equipment are increasing. Statistically, the number of faults on the electric cables with different voltage levels is 581, and the faulty rate caused by aging electric cables and quality problems of power equipment is high up to 39%. According to a study, the supervision of the raw material and production technology is absent, it easily causes defects in power equipment, such as bubbles and impurities. Besides, the quality problems of power equipment are usually not found in the quality inspection of equipment producers and the third-party institutes, which will greatly deteriorate the quality of power equipment and power grid secure operation. Therefore, conducting the research on the power equipment quality inspection industry is of paramount significance for the improvement of product quality, the reduction of faulty rate, and the guarantee of power grid secure operation.

2. Value Chain Theory
The value chain theory originates from the USA. The strategist Michael E. Porter [1], [2] proposes: “every firm participates in the set of activities in the process of design, production, sale and distribution. The product activities of research, development, production and sale are combined to realize the increase in the value of the firm. All of these can be reflected by a value chain.” This means that a firm’s value is created by a series of activities, including prime and supplementary activities. The prime activities contain logistics, production, marketing and sale. The supplementary activities contains purchasing, development, human resource and firm’s infrastructure. The mentioned production and operation activities can be constructed as a complete value-created dynamic process, namely, the value chain construction of a firm. Based on this theory, Peter Nines considers the product appeal of customers as the end of the production process, while the profit is considered as the by-product of the satisfaction of the customer appeal. By doing this, the coverage of the value chain theory is expanded from the firm’s internal benefits to external ones. In addition, Jefferey F. et. al.
propose the virtual value chain theory, where every process of gathering, arrangement, selection, combination, and distribution can generate value.

For a traditional firm, its every activity aims at the maximization of the firm’s value, where the value chain theory with an emphasis on the firm’s internal value is applicable. The power grid features an open structure, which makes the traditional value chain theory unsuitable for the firm management. In the consideration of the whole value management, the firm itself is considered as the intermediate process during the value generation, as well as its up- and down-stream value activities and the rebuild of the value chain. Then the strategy of cost management is established and performed by revealing the market position and having the knowledge of the market competing. In this paper, the up- and down-stream industry regarding the power grid operation is explored. It is found that the value activities mainly include the power equipment production firms, the process of power material management, power equipment quality inspection and management. The contribution of implementing power equipment standard quality inspection on power grid reliable operation in Zhejiang is employed as the evaluation method, that is, the whole chain decomposition power equipment quality inspection industry. By the business chain, quality inspection standard and implementing benefits is correlated, which solves the problem that the tradition value chain method fails to evaluate the large-scale business system. The proposed method also considers the time lag effect of technology standard, and thus can perform the quantitative analysis for technology standard implementation benefit in the large/medium scale firms.

Based on the value chain theory, quality inspection standard is correlated with implementing benefits by the business chain, and the “power equipment-quality inspection-power grid operation” combined value chain is constructed. The proposed method overcomes the difficulty that the traditional methods cannot evaluate the large scale business system, and efficiently reduces the power grid operation risks while improving the social and economic benefits in Zhejiang Province.

3. Value chain construction of power equipment quality inspection industry

3.1. Value chain of power material purchasing

The electric power firm is a large scale firm, which needs thousands of kinds of materials. Thus, power materials need to be managed in an unity way. Power material management is an important management subject, including material supply chain management, demand planning, and purchasing management. According to State Grid Corporation Material Management Code, material supply chain management has planning, purchasing, contracts, quality supervision, storage allocation, urgent needed materials, disposal of waste material, supplier partnership. Power material purchasing has material purchasing plan management, preparation, implementation, result validation and publication, sample quality inspection of suppliers, contract signing, quality supervision and management. Its value chain model is shown in Fig 1.

![Figure 1. Value chain model for power material purchasing](image-url)
Firstly, according to the development of State Grid Corporation purchasing method, purchasing plan management, emergency purchasing management and so on, are decided. The previous value chain activities are exploited to complete the items of purchasing activity rules and purchasing documents, as well as the document examining and approving. Power material purchasing implementation includes activities, i.e., receiving and recording bid opening documents, managing bid opening venue, and evaluating bid. After the implementation of purchasing, there is a need to acknowledge the purchasing results, release the successful candidate, validate the bid evaluated results, and approve the purchasing results. Then State Grid Corporation inspects the sample provided by suppliers through inspection institutes. According to the quality inspection results, the qualified power equipment supplier can sign the contract with the tenderer. The rest of the power equipment is inspected by the product quality supervision department. At last, when the inspection results of the products by suppliers are qualified, power material corporation does the storage allocation by the demands of power supply companies.

3.2. Value chain of power equipment production

Following the traditional enterprise production structure, the value chain of the manufacturing process power equipment enterprises has five components, as shown in Fig. 2. First, the customer order needs to be investigated and validated, including product name, size, raw materials, and quantity. The quotation, payment method and delivery time are also needed to be verified with the customers. The supply department need to contact with the material suppliers by the order requirement and ensure the information of production material preparation. The existing die and mould is used for the regular product. For the customized product, die and mould manufacturing should be produced by the given mould or outsourced to manufacturing enterprises. Take the electric cable for example, its production includes product design, product plan and processing technology and product inspection. After packaging, products are sent to warehouses or shipped to customers. Then the customer’s comments are collected and feed-backed to production department for optimizing production process and ensuring product quality.

![Figure 2. Value chain model for power equipment production](image)

3.3. Value chain of power equipment quality inspection

In the purchasing of power materials in Zhejiang, power equipment quality inspection is the most important and takes the responsibility for quality supervision and control. Power equipment quality inspection institutes also play a key role in the power equipment quality. Its inspection business value chain includes order processing, putting the samples into storage, sample inspection information registering, whose value chain is shown as in Fig. 3.
Figure 3. Value chain model for power equipment inspection

Quality inspection enterprises shows the inspection service through the website, and communicates with customers about the order information by using phone and/or chat in person. The sample receiving department receives the sample and completes the inspection information register by the management platform. The inspection information includes the basic information, such as contact address, settlement organization, inspection completing deadline etc., and sample property, production enterprise, inspection standard, etc. Then the samples are assigned to a unique number by the automatic number generation system. The sample inspection follows the rule of the nondestructive experiment before the destructive experiment. The inspection results need to be added to the system and verified to be consistent with the original records. The main inspection lab is in charge of completing the report, which then is signed and validated by the authorized person. When the inspection process is completed, the samples are returned to the sample storage room. According to the customer demand, the samples can be handled as waste materials or returned to customers. At last, the business department collects the customers’ comments, and gives feedbacks to customers. The efficient implementation of inspection can exclude the products with the bad quality and unreliable suppliers, improving the high quality of the purchased power materials and power grid operation stability.

3.4. Combined value chain of power equipment

After the analysis of the power equipment value chain activities, the combine value chain model for power equipment quality inspection industry is constructed, as shown in Fig. 4. From this figure, this combined value chain includes power equipment production enterprise, quality inspection, material purchasing, and power grid operation. Quality inspection serves as a third-party institute to affect other businesses. This process can be divided into two parts: quality inspection (1) and quality inspection (2). The former is that the power equipment produced by suppliers are inspected by the third-party institute. The latter is that the power equipment purchased by State Grid Corporation are inspected by the third-party institute, providing the theoretical ground for the rationality and correctness of purchasing. Both of these two inspection can verify the security of power equipment in power grid operation.
4. Conclusion
This paper briefly reviews the power equipment quality inspection status and the value chain development. The goal of this paper is to solve the problem of security events caused by the unqualified power equipment in Zhejiang Province. By analyzing the value chain process of power equipment, the “power equipment-quality inspection-power grid operation” combined value chain is constructed. The proposed method can realize the efficient management of power equipment quality inspection, greatly improve the power equipment quality, reduce the security risks caused by the quality problem of power equipment, and guarantee the stable and reliable transmission and supply of electric power in Zhejiang Province.

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