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Benefit Assessment of Standardization Based on ISO Value Chain Methodology

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Abstract: On the basis of ISO value chain methodology; this paper estimates the influence of standardization on relevant value chain activities of thermal power enterprises. Taking M Thermal Power Plant as an example, this paper determines the value chain of enterprises first and then evaluate the influence of standardization on coal purchasing, power generation, safety supervision and materials management activities based on expert assessment method and BP neural network analysis method. It can be known through estimation that, from 2011 to 2014, the annual economic benefit of standardization in M Thermal Power Plant is about RMB 5. 8 million (have an influence about 2% on annual profit). At the same time, this paper evaluates the environmental benefits of standardization. After the implementation of the new environmental standards, M Thermal Power Plant reduces the discharge of SO2 for about 770 t, NOX about 4,870 t and soot and dust about 95t every year from 2011 to 2014. The standardization has a significant environmental benefits and effects.

Keywords: ISO value chain, thermal power enterprises, key value drivers, standardization benefit, assessment

1. INTRODUCTION

Since ISO value chain methodology being used in standardization profit assessment in 2012, China has participated in case studies on standardization benefit assessment in many manufacturing enterprises and has made very good achievements. Relevant case studies have been collected in the case book of ISO standardization benefit assessment and have been widely promoted in member states. The main study method adopted by ISO is to evaluate the economic benefit brought to enterprises by the implementation of standardization based on the comparison between status before and after the use of standard. However, with the constant development of the industry where the assessment object exists, this "with and without comparison method" is under restriction. For example, in some industries, due to the specialty of enterprise production and operation, it is impossible not to use standard, and therefore, it is not applicable to use "with and without comparison method" to evaluate the benefit of standardization. It is necessary to adopt specific assessment method based on the features of assessment object to measure and calculate the benefit of standardization. Taking M Thermal Power Plant as an example, this paper discusses those issues related to the standard implementation of benefit assessment of enterprises on the basis of ISO value chain methodology.

2. SPECIALTY OF STANDARDIZED BENEFIT ASSESSMENT OF THERMAL POWER ENTERPRISE

2.1 Specialty of product of thermal power enterprises

The product of thermal power enterprises and the products of other enterprises especially manufacturing enterprises are of great difference. Firstly, to see from product categories, most products of manufacturing enterprises are in diversity and difference and pay high respect to novelty and uniqueness. However, the product

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of thermal power enterprises is electric energy and, as an energy product, electric energy has the characteristic of homogeneity. No matter what the production process of thermal power enterprises is, the electric energy finally connected to the grid has to be qualified and applicable[1]. Besides, manufacturing enterprises can price independently based on the quality and performance of product, while, the on-grid price of thermal power enterprises is basically determined by the government and it is hard for enterprises to obtain the dominant right in pricing.

2.2 Specialty of standardization of thermal power enterprises

All production activities after the thermal power enterprises are putting into operation shall be done according to standard and specification[2]. The standard is very important to thermal power enterprise, just like air to human being. From this point of view, thermal power enterprises need standard in every moment. Therefore, in no circumstance, the production will be done with no standard or specification. Therefore, the standardization assessment of thermal power enterprises cannot be done with "with and without comparison method" as manufacturing enterprise.

2.3 Specialty of production of thermal power enterprises

Thermal power enterprises and manufacturing enterprises have significant difference in production. The output of manufacturing enterprises can be adjusted by enlarging and reducing capacity according to the market demand, and therefore, the enterprises themselves have major initiative. While, the generating capacity of thermal power plant are restricted by installed capacity and the credit distributed by the power grid[3]. Besides, safety production is always the priority of thermal power enterprises and it is not only the core of enterprise production and operation, but also the premise of maximization of enterprise profit. Sometimes, thermal power enterprises have to sacrifice its profit to guarantee safety production, which is significantly different from manufacturing enterprises.

3. ANALYSIS ON ENTERPRISE VALUE OF THERMAL POWER ENTERPRISES

3.1 ISO value chain methodology

The value chain concept was first put forward by Michael Porter (an American scholar) in his book *Competitive Advantage* in 1985. In 2010, ISO adopted the value chain method developed by Roland Berger Strategy Consultants and carried out standardization profit assessment of a single organization worldwide. ISO believes that, exactly based on this global assessment method, the standardization benefits of different countries and different organizations can be compared with each other. The overall thinking of this method is, firstly, to determine the value chain of an industry and the position of the enterprise in that value chain and to analyze the value chain of the enterprise. Secondly, to confirm those value chain activities that has economic benefits influenced by standards. Thirdly, analyze value drivers. Fourthly, determine standard economic benefit assessment indexes and to evaluate and integrate the results. Finally, use "with and without comparison method" to compare the status of economic benefit of relevant indexes in each link before and after the use of standard.[4]

3.2 Value chain structure of thermal power enterprises

The value chain of thermal power enterprises comprises basic activities and assistant activities[5]. While, the specific links of basic activities and assistant activities of thermal power enterprises are not exactly the same to that of general manufacturing enterprises. Its basic activities mainly include coal purchasing, power generation, grid connection and power selling and settlement. Its assistant activities mainly include safety supervision, HR management, financial management, maintenance and material supply.

3.3 Analysis on basic value chain activities of thermal power enterprise

3.3.1 Coal purchasing

Coal purchasing is the premise of electric power production of thermal power enterprise. The dependence

of its economic benefit on coal cost increases continually and the coal cost accounts for more than 70% of the total generation cost[6]. Coal purchasing of M Thermal Power Plant is the responsibility of Fuel Management Department, including fuel planning (contract) management, fuel transportation and supply management, fuel purchasing and price management, fuel statistics, fuel business accounting management, fuel quality and quantity management, coal unloading coordination and coal yard management assistance and test of coal as fired, fly ash and combustibles. Sampling, sample preparation, test supervision and management of fuels (including fuel oils) entering the factory shall be the responsibility of Power Generation Department.

3.3.2 Power generation

Power generation is the central link of electric power production and also the uppermost activity of thermal power enterprise[7]. The power generation activity of M Thermal Power Plant is the responsibility of Power Generation Department. This department is the functional department responsible for the power production task and the realization of technical and economic indexes. Its main businesses include the operation management of primary and auxiliary power generation equipment and other utility systems including water source, dedusting, chemicals, fuel, desulfuration and denitration, the management of coal yard and the responsibility to maintain contact with power grid dispatching department. Besides, Power Generation Department is also responsible for the safe economic production of the enterprise to realize the designed generating capacity and various technical and economic indexes for production and operation, to break down those production indexes, to prepare annual and monthly department work plan, realize the generating capacity completely according to work plan, to guarantee the technical index quota for operation and production for coal and water consumption of power supply and to ensure the realization of production task.

3.3.3 Grid connection

Only after connecting to the grid to transmit electricity, can the thermal power enterprises gain economic benefit. Gird connection is similar to product distribution of manufacturing enterprise. The value chain of enterprises can form a closed loop only after the realization of gird connection. At the same time, the success of gird connection needs a series of strict, standard and rational operations and the result of gird connection has a direct influence on the profit of the enterprise. Power Generation Department of M Thermal Power Plant shall be responsible for gird connection. The Company can develop technical measures for the operation of electrical system, thermodynamic system, utility system and accessory equipment to learn about and know the safety and economic operation status of power generation equipment, so as to guarantee the success of gird connection.

3.3.4 Power selling and settlement

Power selling and settlement of power plant can realize capital return and guarantee the success of various production links and ensure the payment for fuel purchasing and material purchasing and payment of bank loan and interests. With reasonable financial settlement, the enterprise can reduce interest expense and improve enterprise profit rate effectively. The power selling and settlement of M Thermal Power Plant is the responsibility of General Management Department. This department can make general plan and production plan and analyze marketing and economic activities of the power plant to guarantee the normal cash flow of the power plant.

3.4 Analysis on assistant value chain activities of thermal power enterprise

3.4.1 Safety supervision

Safety supervision provides basic guarantee for the value chain of thermal power plant. The policy of "put safety first and give priority to prevention" can be implemented and the safety production of enterprise can be realized only by ensuring that the enterprise can implement professional, standard and institutionalized management and strengthening safety supervision function of the enterprise. The safety management of M Thermal Power Plant shall be the responsibility of Safety Supervision Department. To guarantee the safe and

effective operation, the power plant developed relevant management measures and methods which mainly involve personnel, equipment and operation process safety, the use of dangerous articles, safety education and accident investigation and analysis.

3.4.2 Human resources management

The improvement of enterprise performance depends on good human resources management. All enterprise output, financial output and market output depend on the market price of HR management of the enterprise. HR Department of M Thermal Power Plant is responsible for the HR management and development of the whole company. To guarantee the rational allocation of human resources, HR Department of the Company developed many standards related to systems, talents, performance appraisal and salary and welfare of the Company.

3.4.3 Financial management

The result of financial management embodies the operation condition of the thermal power enterprise. Sound financial management is good for the rationalization of fuel purchasing, material purchasing and warehousing. Financial Department of M Thermal Power Plant is responsible for financial management of the Company. To guarantee the smooth implementation of financial work, the Company developed many financial management standards related to financial budget, management, accounting, asset report management and tax declaration, etc.

3.4.4 Maintenance

Equipment maintenance of thermal power enterprises mainly includes inspection and repair work. The maintenance of power generation equipment needs large resource consumption and high technology and it has a significant influence on economic benefit. Therefore, the proportion of maintenance cost in power generation cost becomes larger and larger and the link of equipment inspection becomes an essential work. It has a great potential space for maintenance cost reduction and profit improvement to inspect and maintain equipment rationally. The maintenance of M Thermal Power Plant shall be the responsibility of Equipment Department. To guarantee safe, effective and continuous operation of equipment, the Company developed many standards and regulations related to spot inspection of equipment, metal welding, relaying, equipment maintenance and technical guidance of contractors, etc.

3.4.5 Material supply

Thermal power enterprises have many different kinds of materials in large quantities, and therefore, the level of material supply management has a direct influence on the level of cost control of the whole enterprise. Material Supply Department of M Thermal Power Plant is mainly responsible for the purchasing management of materials excluding fuel. To guarantee proper material supply, the Company developed many standards related to the planning, management and warehousing of materials, equipment, accessories, office supplies and labor protection appliances, the supply, recycle and disposal of equipment and the management of material purchasing contract.

4. ANALYSIS ON ECONOMIC BENEFIT OF STANDARDIZATION OF THERMAL POWER ENTERPRISE

4.1 The influence of standardization on basic activities

Since standardization has significant influence on coal purchasing and power generation activities and standardization of other basic value chain activities has minor effect or is hard to be estimated, this part only estimates the economic benefits of the standardization of coal purchasing and power generation.

4.1.1 Coal purchasing

Key value drivers of coal purchasing mainly include coal cost and coal quality. Standardization activities have significant influences on the above mentioned key value drivers.

(1) Influence of standard on coal cost

The coal cost has many influence factors. The uppermost one in those factors is coal price which has an influence of 90% on coal cost. Except for coal price, the rest influence factors determined with Delphi Method include bargaining power, standard management, coal mixture burning, coal inventory, unit coal consumption and other relevant factors. Firstly, adopt expert assessment method to evaluate the influence of standard on coal cost. Several experts sort other factors besides coal price by order of importance to obtain the weight coefficient of various influence factors through calculation and inspect the significance of expert judgment[8]. After expert assessment, it can be known that the weight coefficient of standardization among other influence factors besides coal price is 0. 2.

Secondly, to calculate the annual average savings of M Thermal Power Plant in coal cost. Compare the unit price of the coal purchased by the enterprise with the average unit price of standard coal in Bohai Rim, and then multiply by the annual average consumption of standard coal, we will obtain the average savings of the enterprise in coal cost. By comparing with the price of standard coal in Bohai Rim, it can be known that the annual average coal cost reduction of M Thermal Power Plant was about RMB 110 million from 2011 to 2014. Except for the influence of price factor, the influence of other factors on coal cost is about RMB 20 million.

At last, it can be estimated according to the weight coefficient obtained with expert assessment method that the influence of standard on coal cost is about RMB 4 million and the annual average coal cost saving is about RMB 1 million.

(2) Standard Influence on Coal Quality

Coal quality mainly involves calorific value of coal, volatile content, etc.[9] With respect to the quality of coal, M thermal power plant inspects various important components of the coal according to the national and industry standards, spot checks and accepts the quality of coal, and pursues a claim for the situations of kilocalorie loss and sulfur excess. According to the statistics about the claim situations of kilocalorie loss and sulfur excess of the factory coal in recent years, excluding the effects of coal price and other market factors, it estimates the influence that annual standard has on the coal quality on average. For M thermal power plant, the recovered annual average losses that are recovered from the kilocalorie loss and sulfur excess by standard are over RMB 2.5 million.

4.1.2 Power Generation

Power generation is the most important activity among the company's value chain procedures, and also the most direct activity that produces economic and social benefits. The key value driving factors of the power generation involve equipment reliability, environmental protection, etc. Wherein, environmental protection not only reflects economic benefits, but also the social benefits of the company.

(1) Equipment Reliability

Equipment reliability is the basis of power generating activity, and affects the normal operation of the power generation. To analyze the equipment reliability, we shall start with the equipment failures. Take M thermal power plant for example.

Firstly, statistics of various failures and losses occurred in M thermal power plant from 2008 to 2014 are made. Based on the analysis of the failures occurred in M thermal power plant from 2008 to 2014, it is found that many failures are caused due to non-strictness of standard enforcement, or due to lack of standard. If enterprise strengthens the improvement in the aspect of standardization, 82% of losses caused by failures can be avoided, which avoids direct economic losses of RMB 15.655 million, and annual average economic losses of RMB 2.236 million.

Secondly, BP neural network algorithm is utilized to calculate the effects that standardization has on the M thermal power plant and the direct economic losses it saved. This calculation is based on the comparison

between the actual occurred failures of M thermal power plant and the failures simulated by BP neural network algorithm without implementation of standardization. Through establishment of BP neural network algorithm model with 9 input (year) and 9 output (failure number), Matlab numerical simulation software is used to design the neural network structure for calculation[10]. The analysis results show that the failure number of M thermal power plant increases in fluctuating tendency with quasi-periodicity, which indicates that with continuous running time of the power plant, the overall equipment of the power plant is increasingly aging and the failure number is in a gradual rising trend. However, if standardization management is used for the operation management of the whole power plant, and standards are revised timely at the peak value of failures (such as 2004, 2011, etc.), the number of failures can be decreased in the next few years. If standardization is not implemented or the standards are not updated timely, the failure number will rise close to the index year by year. The simulated failure number and its trend of M thermal power plant from 2004 to 2015 are respectively shown in Table 1 and Figure 1.

Table 1. The Simulated Failure Number of M Thermal Power Plant in 2004-2015

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Total
Actual Number of Failures	17	12.36	9.76	8	11	2	2	20	8	10	13	124
Simulated Number of Failures	17	18.0	18.6	19.3	20.0	20.8	21.5	22.3	23.2	24.0	24.9	255.4

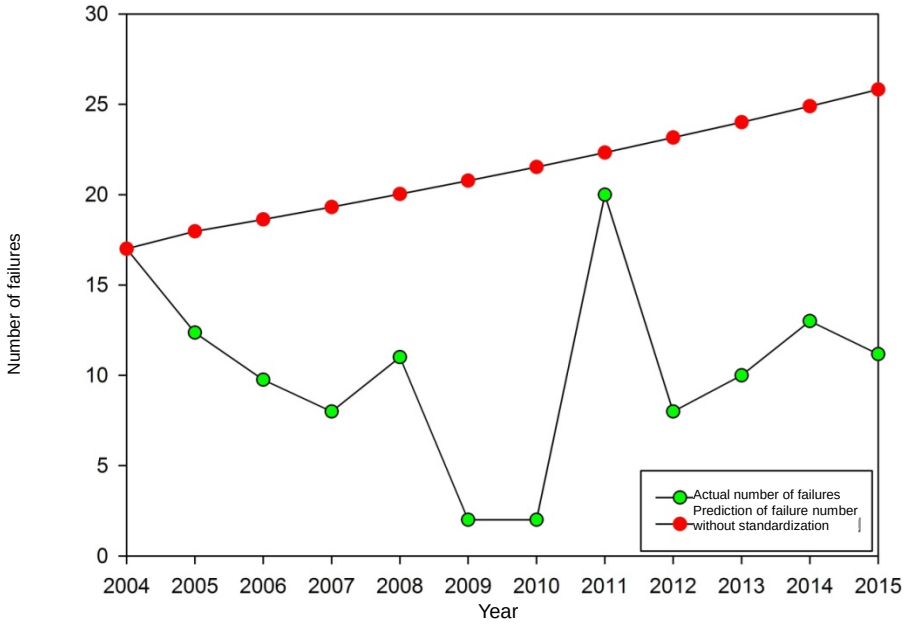

Figure 1 Diagram of the Failure Number of M Thermal Power Plant with Implementation of Standardization Compared with that without Implementation of Standardization during 2004-2015.

In Table 1, the failure number of each year during 2007-2014 is complete. While the failure number in part of months of 2004 and 2015 is missing, and the failure number in 2005 and 2006 is missing. The missing data is estimated according to the BP neural network model. There is the data of the first seven months of 2004, and the failure number of 2004 is roughly estimated by data of the first seven months. Based on the failure number of 2004 and 2007-2014, the failure number of 2005, 2006 and 2015 is estimated by the BP neural network model.

Finally, the saved losses of M thermal power plant failures during 2011-2014 are estimated. M thermal power plant has 41 failures from 2011 to 2014, the direct economic losses are approximately RMB 11 million,

and the average loss of each failure is about RMB 0.27 million. The specific data is shown in Table 2. The total number of failures caused by non-implementation of standardization during 2011-2014 is 95, and total amount of losses is RMB 25 million. Therefore, compared with that of non-implementation of standardization, the implementation of standardization saved losses of about RMB 14 million accumulatively, and saved an average of RMB 3.5 million per year.

Table 2. Statistics of Failure Number and Losses from 2011 to 2014

Year	2011	2012	2013	2014	Total
Number of Failures	20	8	10	13	41
Loss (RMB ten thousand)	96.5	485	194	323	1098.5

(2) Benefit of Environmental Protection

With the increasingly strictness of the national environmental protection policy, M thermal power plant increases investment in environmental protection this year. M thermal power plant invested RMB 0.44 billion in the equipment of desulphurization, denitration and dedusting, to avoid the annual average fine of RMB 2 million caused by violating the national environmental protection requirements.

4.2 Influence of Standardization on Auxiliary Activities

The assessment of the effect that standardization has on the auxiliary activities of value chain is similar to the basic activities, and only the influence that standardization has on the safety supervision and material management activities is analyzed.

4.2.1 The Influence of Standardization on Safety Supervision

Safety supervision activities mainly include the safety supervision of personnel and equipment in the process of production; therefore, the main value driving factors of safety supervision include personnel safety and equipment safety. The equipment safety is analyzed in the equipment reliability of power generation activity herein, so the personnel safety supervision is mainly analyzed in this section. M thermal power plant, for example, implemented the safety supervision standard, which played an important role in avoiding the life injury accidents in the process of production. No serious injury and production personal injury or death accidents occur in M thermal power plant from 2011 to 2014. Especially in 2013 and 2014, no minor injury and more serious accidents occur in the company. Company continued safety production for 4761 days by the end of 2014.

4.2.2 Influence of Standardization on Material Management

The key value driving factor of material management is material cost. The materials of thermal power plant include spare parts, equipment assets, small infrastructure projects, general supplies, etc. Wherein, the change of spare parts cost is most related to the standardization, so the influence of standardization on spare parts cost is mainly analyzed in this section. For the cost savings of spare parts, the inventory savings of the spare parts of the company is calculated at first, and then it is multiplied by the weight coefficient of the standardization to estimate the cost savings of spare parts. Take M thermal power plant for example. The inventory of the spare parts of this enterprise is decreased by an annual average of RMB 1.66 million, multiplying by the weight coefficient of standardization of 0.206, so the annual average amount that standardization contributes to the inventory decrease of the spare parts is RMB 0.34 million.

Through the summary of the economic benefit of standardization of M thermal power plant, it can be found that the annual cost savings that standardization contributes to coal purchasing process is RMB 3.05 million, to the power generation process is RMB 5.50 million, annual savings of the spare parts inventory that

standardization contributes to material management is RMB 0.34 million, and the total cost savings is more than RMB 5.8 million. If it is calculated based on the annual average profit of RMB 0.3 billion of M thermal power plant during 2011-2014, the contribution rate that standardization affects the annual profit of the enterprise is about 2%.

5. ANALYSIS ON STANDARDIZED SOCIAL BENEFIT OF THERMAL POWER ENTERPRISE

5.1 Composition of Social Benefit

The standardized social benefit of thermal power enterprise is mainly reflected in two aspects of environmental protection and energy saving. In the field of environmental protection, as for the thermal power plant, coal will generates pollutants such as sulfur dioxide, nitrogen dioxide, smoke dust, etc. Among the various pollution sources, the concentration of the sulfur dioxide from the smoke discharged by thermal power generation is not high, but the total amount of emission is large. The main indicators that measure the environmental protection effects of the company include emissions of the air pollutants such as sulfur dioxide, nitrogen dioxide, smoke dust, etc. In the field of energy saving, thermal power plants are the major consumers of energy, and a lot of coal, water and fuel and other resources are consumed for power generation every year, so the main indicators that measure the energy saving effects of the company are the coal consumption, water consumption and oil consumption of power supply.

5.2 Influence of Standardization on Social Benefits

In the aspect of environmental protection, it is mainly to compare the annual reduction of air pollutant emissions of the enterprise for power generation when new environmental protection standard is implemented instead of old standard. M thermal power plant, for example, carried out the local environmental protection standard before 2014, and executed national environmental protection standard since 2014. The national environmental protection standard is much stricter than local one in the indicators of nitrogen oxide and smoke dust emissions. After the new standard is carried out in 2014, compared with the old standard executed in 2011, the emission concentrations of sulfur dioxide, nitrogen oxide and smoke dust are respectively decreased by 43.49%, 81.95% and 24.76%. It decreased by 46.6%, 81.98% and 19.75% respectively compared with 2012, and by 37.2%, 69.14% and 22.36% respectively compared with 2013. During the period of 2011 to 2014, based on the yearly generated energy of 2014, the enterprise realized the annual average emission reduction of sulfur dioxide of 771.31 tons, nitrogen oxides of 4871.65 tons, and smoke dust of 94.56 tons.

6. CONCLUSION

The application of the ISO value chain methodology in the benefit assessment of the thermal power enterprise standardization is introduced in this article. Different from the benefit assessment method of the manufacturing enterprise standardization, the with and without comparison method is not used for the benefit assessment of the M thermal power plant standardization in this article, but it starts with cost analysis, and uses expert evaluation method to assess the influence of the standardization on coal cost and spare parts cost. The BP neural net work algorithm is utilized to assess the influence of the standardization on the loss decrease of power generation failures. It measured that the contribution rate of standardization to the profit of the M thermal power plant is 2%, and the standardization produced significant environmental benefit effects.

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