Benefit Assessment of Standardization in Industrial Upgrading Based on Value Chain Methodology

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Abstract. The standardization level is an important indicator to measure the development level of an industry. Based on value chain methodoogy, this paper innovatively puts forward a standardization benefit assessment method which is suitable for industry. A evaluation index system of standardized benefits in industrial upgrading is proposed. The smart meter industry with representative industrial development is selected as a case to reveal the mechanism of industrial benefits and industrial structure optimization generated by standards in the process of industrial upgrading. Finally, the evaluation indicators confirm that the implementation of the smart meter standard system has produced significant economic benefits, social benefits, ecological benefits and the optimization of industrial structure. This research will provide policy basis and theoretical support for the necessity of promoting the implementation of standards.

Keywords: value chain, standardization benefit, industrial upgrading, benefit assessment

1 Introduction

High-quality industrial development is the basic proposition of building a modern economic system. As one of the four national quality infrastructures, the standard is one of the important measures to promote the advanced production and modernization of the industrial chain. The standardization level is an important indicator to measure the development level of an industry. The implementation benefit of standards is an important aspect to reflect the level of industrial standardization. Therefore, it is necessary to researc the impact mechanism of standards on promoting industrial upgrading. Building a quantitative evaluation method of standardized industrial upgrading benefits is regarded as a current research priority.

At present, researches mainly focuses on the impact of standardization on the enterprise level, and few studies focus on the impact of standardization on industrial upgrading. Tassey. G pointed out that standardization plays a role in quality reliability, information, compatibility, synergy and diversity in industrial development[1]. Wang Shanshan believed that technology standardization indirectly provides a driving force for the improvement of industrial innovation ability[2]. However, all these studies are qualitative analysis, and do not provide quantitative assessment methods.

In this paper, a quantitative assessment methodology is proposed to evaluate the implementation benefits of the standard for industrial upgrading. Based on the value chain

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methodology, this paper analyzes the specialty of standardized benefit assessment in industry firstly. Then it puts forward the standardization benefit quantitative evaluation index system based on the key value drivers. Finally, the smart meter industry with representative industrial development is selected as a case. The results analyze the optimization effect of standard on industrial benefit and industrial structure in industrial upgrading, and produce remarkable economic benefit, social benefit, ecological benefit and optimization of industrial structure.

2 Value chain Methodology

Value chain methodology is the main method to assessment the implementation benefits of standards. A value chain is a series of activities related to the production of a product, a service, or an output. The output of the operation runs through each stage of the value chain in a fixed order and adds value in each stage. This concept was first put forward by Michael Porte in 1985. Based on value chain analysis, ISO has developed a methodology to evaluate and quantify the economic benefits of standards in 2010, providing unified criteria and tools for each organization to assessment the benefits of standards. [3].

The overall thinking of this method is, firstly, to analyze the value chain of an industry and the position of the enterprise in that value chain. Secondly, to identify the benefits influenced by standards. Thirdly, analyze value drivers which can reflect the impact of standards that are most relevant to enterprise value. Fourthly, determine standard benefit assessment indexes and to evaluate and integrate the results. "With and Without comparison method" is utilized to compare the status of benefit of relevant indexes in each link before and after the use of standards[4]. The steps of value chain methodology are shown as Figure 1.

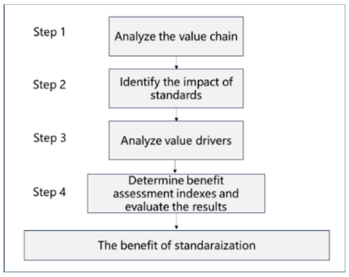

Fig. 1. The steps of value chain methodology.

3 Specialty of standardized benefit assessment of industry

3.1 Industrial value chain

When the analysis object of value chain theory changes from a specific enterprise to the whole industry, the industrial value chain is formed. The relationship between the industrial value chain and the industrial chain lies in the use of the value chain analysis method to investigate the industrial chain. Based on the industrial chain, it analyzes the value creation activities of each link in the industrial chain and the core factors that affect the value creation. The industrial value chain represents a larger value system of enterprise value integration at the

industrial level. The value chain of each enterprise is included in a larger group of value activities to realize the value creation and realization of the entire industrial chain[5].

3.2 Specialty of standardized benefit in industrial upgrading

The value of standardization in the industry is generally reflected as the result of industrial upgrading. Industrial upgrading is the improvement of production factors, structural change, production efficiency improvement and product quality improvement that increase the added value of products. The so-called standardized benefit on industrial upgrading refers to the beneficial effects produced by the systematic activities of technical standard. Therefore, it is the application of standards or standardization methods that brings about the generated benefit. Different from the traditional value chain approach, which focuses on economic and social benefits, industrial upgrading benefits include more aspects.In this paper, it will be divided into the promotion of industrial benefits and the optimization of industrial structure.,which is shown in Figure 2.

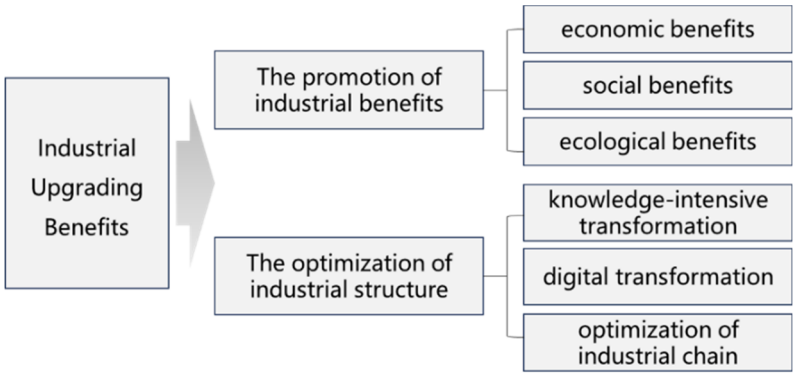

Fig. 2. The composition of industrial upgrading benefit.

Among them, the industrial benefits include economic benefits, social benefits and ecological benefits, and the industrial structure considers Knowledge-intensive transformation, digital transformation and optimization of the industrial chain.

4 Value Chain analysis of industry

4.1 The influence of standardization on industry

There are many value drivers affecting the standardized benefit. Taking economic benefit as an example, the reduction of cost, the improvement of productivition, and the improvement of product competitiveness are all important factors affecting its economic benefit. The application of technical standards is precisely through the role of these key value drivers to achieve the improvement of implementation benefit. This section mainly takes economic benefit as an example to analyze the key value drivers of economic benefit and the mechanism of technical standards on these factors.

4.1.1 Influence of standard on cost

Technical standards help reduce production costs and transaction costs. Markets need standards to effectively match the expectations of buyers and sellers, and if each market needs to buy a different version of a product, costs for both consumers and manufacturers are likely to increase[6]. In addition, many technical standards have the function of providing information and describing products, which helps to match the expectations of buyers and suppliers. Standards make it easier for all businesses to access technical knowledge, enable efficient exchange of information between organizations, reduce transaction costs, reduce the cost of purchasing semi-finished products from external suppliers, and allow manufacturers to outsource more of their activities.

4.1.2 Influence of standard on productivition

Technical standards are conducive to improving production efficiency. The development of standards is driven by the needs of the industry and helps to solve basic procedural, organizational and technical problems. It can promote the improvement of industrial productivity and efficiency by promoting the interoperability of products and processes, effectively reducing the diversity of products and services, ensuring quality and improving efficiency, and effectively disseminating technical information.

4.1.3 Influence of standard on product competitiveness

Technical standards improve product quality and market competitiveness. Quality management system standards such as ISO 9001 are among the most widely used worldwide. Quality management system standards help companies ensure quality and improve efficiency. Implementing a management system framework contributes to sustained performance improvement. The management system framework consists of programs that identify more efficient and time-saving procedures and proactively reduce errors and defects. Therefore, the use of a management system can improve efficiency and reduce costs by, for example, avoiding recalls of product batches that have already been placed on the market. Quality management system standards can help enterprises solve the economic problems caused by information asymmetry when sellers have more information about product quality than buyers.

4.2 Evaluation index system of standardized benefit in industrial upgrading

The evaluation index system of industrial upgrading benefit is sorted out from three dimensions: economic benefit, social benefits, ecological benefits and optimization of industrial structure. Under each dimension, there are a number of first-level indicators that are common to all kinds of industries, and the indicator attributes of the benefits of this dimension are characterized by qualitative descriptions, as shown in Table 1. It should be noted that for different industries, each first-level indicator will include a number of second-level indicators to fully support the corresponding first-level indicators, that is, the underlying specific quantitative or qualitative indicators. This paper will give examples of second-level indicators for segmented industries in section 5.

Table 1. Evaluation index system of standardized benefit in industrial upgrading.

Dimension		First-level indicators
Economic benefits		Production Cost
		Transaction cost
		Production efficiency
		Utilization efficiency of resources
		Product quality
		Market competitiveness
Social benefits		Power supply security
		Power supply reliability
		Localization
		Internationalization
Ecological benefits		Save fossil energy
		GHG emissions mitigation
Optimization of industrial structure	Knowledge-intensive transformation	Technological level
	Digital transformation	Digitization level
	Optimization of industrial chain	Industrial chain coordination

5 Case study

The meter is a measurement tool used for trade settlement between the power company and the electricity custome. With the development of smart grid, the demand for smart meters continues to increase. The domestic smart meter market demand mainly comes from the bidding of the State Grid Corporation of China. Therefore, the smart meter technical standard system and the smart meter industry are selected as the specific research objects in this paper. The quantitative evaluation of the industrial upgrading value of the technical standard system is completed in this scetion.

5.1 The technical standard system of smart meters

The smart mete technical standard system are composed of 36 technical standards in five categories: general principles, master station technical specifications, electric energy information collection terminals, communication protocols and intelligent energy meters. These standards specify the system structure, basic functions and performance indicators, while clarifying the construction, operation and management requirements of the system. The energy information collection and management system built according to this set of standards can automatically collect, analyze and process the electricity consumption and related information of users. In addition, it can provide the current electricity price information and electricity consumption to users, remind and guide users to save electricity reasonably without affecting life and industrial production, so as to achieve the purpose of energy conservation and emission reduction.

5.2 Industrial chain of smart meters

The smart energy meter industrial chain is divided into upstream raw material supply link, midstream production link and downstream sales link and application link. The main participants in the upstream of the industrial chain are the supply of electronic components and the supply of structural parts. Among them, the electronic components mainly include chips, modules, transformers, relays, liquid crystals, batteries, resistance capacitors, two and three transistors, etc., and the structural parts mainly include plastic parts, metal parts and so on. The participation of the midstream production and manufacturing link of the industrial chain is mainly by the energy meter brand, responsible for the design, production and assembly of the product. The downstream of the industrial chain includes product sales and application two links, the sales body has integrators, brand owners, the application link involves all aspects of the national economy, such as basic facilities, electricity, energy, building construction, civil families and so on. The industrial value chain is shown in Figure 3.

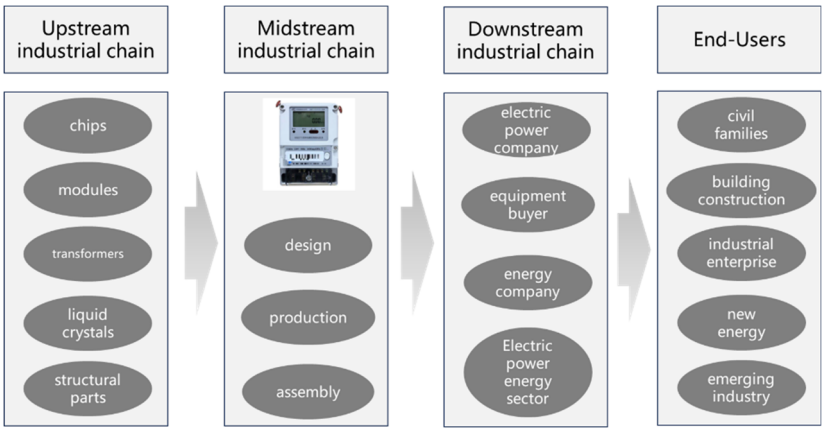

Fig. 3. The industrial value chain of smart meters.

5.3 Standardization benefit assessment of smart meters in industrial upgrading

The industrial value chain analysis method mentioned above is used to investigate and analyze the industrial changes before and after the application of this smart meter standard system. On the basis of the general evaluation index system mentioned in 4.2, the evaluation index system of smart meters is formed. It's given in Table 2.

Table 2. Standardized benefit evaluation index system of smart meters in industrial upgrading.

First-level indicators	Sceond-level indicators	Index value
Production Cost	Single-phase meter price reduction per unit	60 ¥
	Three phase meter price reduction per unit	490 ¥
Utilization efficiency of resources	Annual electricity savings	$1.36*10^{10}$ kWh
	Device energy consumption reduction per unit	0.5W
	Annual social electricity consumption reduction	$5.17*10^{11}$ kWh
Market	Product coverage	>90%

competitiveness		
Internationalization	Annual product export volume	$4.50*10^7$ (2020)
First-level indicators	**Sceond-level indicators**	**Index value**
Save fossil energy	Annual Standard coal saving amount	$1.6*10^8$ t
GHG emissions mitigation	Annual CO_2 emission reduction	$4.5*10^8$ t
	Annual SO_2 emission reduction	$1.8*10^5$ t
	Annual NO_X emission reduction	$1.2*10^4$ t
Technological level	Derived knowledge results	40 invention patents、40 academic papers、10 software copyrigh、4 academic monographs
Digitization level	Annual labor cost reduction	$2.762*10^{10}$ ¥
Industrial chain coordination	Uniform appearance models	From 1491 to 4

5.3.1 Standardization benefit assessment of smart meters on industrial benefits

In terms of economic benefits, the use of standardized design has reduced manufacturing costs. After the technical standards of smart meters are unified, each single-phase meter is 60 yuan lower than the original price, and each three-phase meter is 490 yuan lower than the original price. Meanwhile. improving the power consumption index of the watt-hour meter requires reducing the loss of the grid. The technical standard have reduced the power consumption index of the watt-hour meter from the original 2.0W to 1.5W, and according to the calculation that 310 million watt-hour meters were installed at the end of the "Twelfth Five-Year Plan" nationwide, the annual electricity saving was 1.36 billion kWh. The power information collection and management system make the two-way information exchange between the power grid and the user, which is conducive to improving the energy utilization efficiency of the terminal equipment and reducing the electricity consumption of the whole society. It is predicted that the electricity consumption of the whole society will be reduced by 51.7 billion kWh.

In terms of social benefits, the publication and large-scale application of this set of standards had enhanced China's international influence in the field of smart grid electricity use. In 2020, the export volume of smart meters was 4.502 million. Besides. the power information acquisition system can realize the real-time monitoring of the power grid, so as to improve the safe operation ability of the power grid and the quality of power supply. It can improve the real-time monitoring ability of the user's power supply equipment to deal with the hidden dangers of the power supply equipment in time, so as to ensure safe and reliable power supply.

In terms of ecological benefits, the implementation of this set of standards has significantly improved energy efficiency. By reducing the electricity consumption of the whole society, it has saved about 0.16 million tons of standard coal, and reduced the emission of CO2, SO2 and NOx to 0.45 million tons, 180,000 tons and 12,000 tons respectively.

5.3.2 Standardization benefit assessment of smart meters on industrial structure

The popularization and application of smart meter standards has driven the smart meter industry to become knowledge-intensive. The knowledge derived from technical standards

includes 40 invention patents, 40 academic papers, 10 software copyrigh, and 4 academic monographs.

The implementation of these standards helps to promote the digitalization of the industry, effectively improve labor productivity and reduce labor costs. It is estimated that after automatic collection, most of the meter reading and charging work will be replaced by the system, which will greatly reduce the workload of meter reading and charging. It can reduce the number of personnel by 78,900 and reduce the annual labor cost by 2.762 billion yuan.

The implementation of this set of standards has accelerated the adjustment of the industrial structure of smart meters, and promoted the optimization and upgrading of the domestic power instrumentation, power equipment, chips, and components manufacturing industry. The appearance types of 1491 kinds of smart energy meters in China are unified into 4 kinds, which solves the problems of diversified technical standards and inconsistent technical indicators of smart energy meters.

6 Conclusion

Different from the traditional standardized benefit assessment methods, this paper takes industry as the research object, analyzes the specialty of standardized benefit in industrial upgrading, and puts forward the industrial value chain method. A general standardized benefit evaluation index system which can be quantified and analyzed is constructed. Finally, the smart meter industry with representative industrial development is taken as a case to illustrate the mechanism of the standard in industrial upgrading. The evaluation results prove in the form of quantitative indicators that the standard has a significant impact on economic benefit, social benefit, ecological benefit and optimization of industrial structure. The research results of this paper clarify the strategic value of standards for industrial upgrading, which provides policy basis and theoretical support for the necessity of promoting the implementation of standards.

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