A Summary of Technical Standards Implementation Benefit Evaluation Practice in Typical Countries

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Abstract. This paper has successively analyzed and compared the practice of the United Kingdom, Germany, France, Canada, Japan, ISO and other countries and organizations in the evaluation of standardization economic benefits. The collection channels and ways, and the design of evaluation model methods provide important inspiration for large enterprises to carry out technical standard implementation benefit evaluation.

Keywords: Technical Standards; Implementation Benefit Evaluation; Research Review.

1. Introduction
The evaluation of the effectiveness of the implementation of technical standards is a worldwide problem[1]. Experts and scholars at home and abroad have started research in this field since the 1960s, and have achieved a series of theoretical and practical results[2]. After applying an information security management system according to the ISO 27001 standard, its benefits on manufacturing industry in Ecuadorian is discussed [3]. Reference [4] aims to establish an evaluation index system to evaluate the comprehensive benefits of technical standard on traditional Chinese medicine hospitals. Besides, reference [5] implemented a benefits evaluation of programmable josephson voltage standard to automated potentiometer. What’s more, based on the fuzzy comprehensive evaluation method, reference [6] built an evaluation index system to evaluate the benefits of rural construction standards. This paper will systematically analyze the theoretical and practical research results in this field, and propose relevant experience enlightenment for the systematic evaluation of the implementation of the company’s technical standards.

2. Benefit Evaluation Practice of Standard Implementation in Typical Countries
2.1. UK, Department of Trade and Industry (DTI)
In 2005, the DTI adopted the standard quantitative contribution method to evaluate the contribution of standards to the growth of labor productivity. Using the data from 1948 to 2002, a model for evaluating the relationship between production labor growth and standards was established. The number of effective standards is equal to the total number of standards published in a certain period minus the number of standards terminated and abolished, showing the existence of standards and productivity positive and statistically significant relationships. The economy obtains economic output through invested capital (K), labor force (L), and total factor productivity, while progress and improvements in some areas benefit from the impact of standards and other factors, such as R&D, the introduction of foreign technologies and patents. DTI used the idea of calculating economic output in the economic field to study the effect of standardization on economic growth, and measured it using the Cobb-Douglas...
function. According to the study, the standard contributed 8.2 billion pounds out of the 29 billion pounds in UK GDP growth in 2013.

2.2. German, Standardization Institute
In 1999, the German Institute for Standardization (DIN) carried out a two-year study on "total economic benefits of standardization" in Germany, Austria, and Switzerland, using economic methods to analyze the economic development from 1960 to 1996, in which the capital and labor factors of production and technical progress indicators of business sector are applied. Based on macro data, DIN applied the transformation formula of the Cobb-Douglas production function to calculate the contribution rate of each production factor to the entire economic growth, and study the economic benefits of German standardization. The standards are related, and the contribution of the standards to the growth rate of the German economy’s annual output value is calculated. The results of the study show that standardization has contributed 0.9% of the German economy’s annual growth rate of 3.3%, accounting for about 30% of the real GDP’s average annual growth. It is estimated that the economic benefit of standardization is about 1% of GDP. Since this method only considers the impact of the number of standards, macro-trigger evaluation of the economic benefits of the standards from the national level is not applicable to the evaluation of the economic benefits of the enterprise standards.

2.3. French, Standardization Association
In 2009, the French Association for Standardization (AFNOR) used Total Factor Productivity (TFP) as a measurement indicator and conducted a study on the impact of standards on macroeconomic growth based on macroeconomic data from 1950 to 2007. The research results show that the contribution rate of standardization to the French economy is 0.81%. In addition, for every 1% increase in the number of standards, total factor productivity increases by 0.12%. Total factor productivity refers to the ratio of output to total factor input; sources of total factor productivity include technological progress, organizational innovation, specialization, and production innovation (including standardization). The output growth rate exceeding the factor input growth rate is the total factor productivity growth rate. From the perspective of economic growth, productivity, capital, labor, and other factors contribute to economic growth. From the efficiency perspective, productivity is equal to the ratio of output in the national economy to the total input of various resource elements within a certain period of time. Essentially, it reflects the ability and effort of a country (region) to rid itself of poverty, backwardness, and economic development in a certain period of time. It is a comprehensive reflection of the role of technological progress in economic development.

2.4. Japan, Industrial Standards Association
In 2007, the Japan Industrial Standards Association (JSA) conducted a study on the economic benefits of international standardization activities and the relationship between standardization and macroeconomics. Japan uses the standard effect-cost method to calculate the economic benefits of international standards. Based on the economic benefits of Japan’s participation in the preparation and revision of international standards (the economic benefits brought by Japanese standards include intellectual property rights, the reduction of technical barriers, etc.), minus the cost of preparing and revising international standards (standard development Project investment costs, such as possible meetings, manpower, travel, trials, etc.), the difference is the economic benefits that international standards can bring. The research results show that Japan will promote the transformation of a Japanese national standard (JIS) into an international standard, and reflect the country’s superior technology and product parameters into the international standard, which can generally bring 30 billion yen (equivalent to RMB 2 billion) economic benefits. When involving large-scale special products and industries, it can generate hundreds of billions of yen in economic benefits. As for the relationship between standardization and macroeconomics, Japanese research shows that the adoption of national standards can increase opportunities for trade, promote scientific research, and promote technological innovation and economic growth. Therefore, it is more important than corporate patent strategies.
2.5. International Organization for Standardization (ISO)

In 2010, the International Organization for Standardization (ISO) for the first time shifted the focus of its research to a single organization dominated by enterprises, and released a set of enterprise standardization economic benefit evaluation methods. This method is based on value chain theory for research and development. At the microeconomic level, research can also be conducted on the entire industry, with the goal of helping companies or industries clarify the value created by standards. The assessment steps include determining the industry’s value chain, clarifying the impact of standards on the company’s main business functions and related activities, determining key performance indicators and value drivers, and calculating the impact on EBITDA (Earnings Before Interest, Tax, Depreciation and Amortization). Standard economic benefits are summarized. At present, the ISO organization has adopted this method in 10 countries and 11 companies in different industrial sectors. For most cases, the overall benefits brought by the standard account for 0.5% -4% of the company's annual sales.

3. Typical Country Practice Analysis

From 2000 to 2015, Germany, Canada, the United Kingdom, France, ISO organizations and other countries and organizations have carried out research and practical work on standard benefit evaluation. Research results of some typical organizations are shown in Table 1.

Table 1. Comparison of standard implementation benefit evaluation in typical countries

| Country and organization | Franch AFNOR | German DIN | UK DTI | Japan JSA | ISO |
|--------------------------|--------------|------------|--------|-----------|-----|
| Year                     | 2009         | 2000       | 2005/2015 | 2007    | 2010 |
| Method                   | Production function method /GDP | Production function method /GDP | Production function method /GDP /Labor productivity | Cost comparison benefit method | Value chain analysis |
| Evaluate object          | Country and industry | Country and industry | Country and industry | Country and industry | Enterprise and business |
| Contribution rate of standards to GDP growth % | 0.8 | 0.9 | 0.3 | —— | —— |

Through the research and practice results of the above countries, we can find that, the application of technical standards has a positive effect on productivity improvement, but it needs to have an impact on productivity or benefits together with other factors of total factor productivity. Although studies in different countries are not directly comparable, especially because of differences in research cycles, the comparison of data can still reflect the potential impact of standards on productivity. Productivity improvement depends on factors other than standards that can affect technological progress, such as technological progress and education improvements. At the same time, the relationship between standards and productivity or benefits is a "black box." The production function method can evaluate the contribution of the number of standards and the growth of labor. However, it is more applicable at the national level. The evaluation method proposed by ISO is more suitable for the evaluation of enterprise standard economic benefits. The British evaluation model does not attempt to establish a mechanism for promoting productivity growth in quantitative analysis, mainly because it is difficult to obtain data to test these factors at the national or industry level. Only research conducted at the enterprise level, regardless of the use of enterprise-wide survey data or case analysis, can apply the acquired data to observe the mechanism and effect of standards.

4. Review of Standard Implementation Benefit Evaluation Practice

It can be seen from the theoretical and practical progress of the systematic evaluation of the implementation benefits of technical standards at home and abroad, although domestic and foreign countries have achieved certain results in the contribution of standards to the national economy, the
research on the evaluation indicators of the implementation benefits, and the evaluation methods of the implementation effects of the standards need to be further improved. Some limitations and deficiencies of previous research mainly reflected in the following four aspects:
First, most of the research on implementation benefits focuses on economic benefits, but there are few evaluation studies on social benefits, environmental benefits and other comprehensive benefits. Most of the existing research focuses on standard economic function analysis, such as how to encourage technological innovation and technological progress through the standard to promote economic growth, or reduce product costs by promoting economies of scale. However, for some companies, such as power companies, in addition to focusing on economic benefits, the implementation benefits of technical standards also need to pay attention to the social benefits, such as energy conservation and emission reduction, and sustainable development.

The second is that the existing theoretical research methods mostly use individual standards to implement the benefit evaluation as the research object, and the research on a package of standards to implement the benefit evaluation is still in the blank stage. The research of the existing literature has the limitation of the scope. For instance, a large company or industry has a complicated business division, many process procedures, and a technical standard system, so the existing research results are difficult to provide adequate theoretical guidance.

Thirdly, the implementation of the technical standard implementation benefit evaluation index system needs to be enriched and improved, and it is urgent to establish a comprehensive evaluation index system suitable for the characteristics of large and medium-sized enterprises and industries. Although China has established some standard implementation evaluations index system, the content of the indicators is relatively simple, the quantification of indicators is difficult, and there is subjectivity in the evaluation of qualitative indicators. Only reasonable selection of evaluation indicators can be used to quantify and determine the indicators through scientific methods.

Fourthly, in terms of implementing benefit evaluation methods, it is difficult to find an evaluation method that is universally applicable to various types of enterprises, and needs to be evaluated in accordance with the practical business of the enterprise. The methods widely used in performance evaluation mainly include principal component analysis, analytic hierarchy process, gray correlation method, data envelopment analysis, etc., each with its own characteristics and scope of application. Due to the different nature, scale and research purpose of the enterprise, the evaluation method applied in different enterprises need to be selected properly. Besides, if a method is selected, it will inevitably lead to objective feedback that will affect the implementation, and it cannot guarantee effective supervision of the implementation performance of the standard system.

5. Summary
Through the analysis of domestic and foreign evaluation methods, we found that for the standard benefit evaluation, we must solve three problems. First, a sound dimension of benefit evaluation can be set based on the domestic and international common practices and national standards classification, combined with the characteristics of enterprise business production and operation. Secondly, in terms of channels for obtaining business process data of enterprises, a combination of statistical data and survey analysis can be used to obtain business process data. Thirdly, in terms of the evaluation model of the systematic implementation of technical standards, the integration of comprehensive value chain method and fuzzy comprehensive evaluation can be considered as method tools based on the entire business value chain.

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