

## A TER Model of Forming Technology Standards

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**Abstract.** The technology standards' role has already surpassed technological problem itself. Instead, technology standards become key factors to determine the competition rules. This paper deploys research aiming at the forming TER model of technology standards. The purpose is to provide reference in theory and practice for raising Chinese technology standards level, furthermore to enhance China's independent innovation capability. The formation of technology standards based on technology, motivated by economy and affected by subjects of regulation. The three factors together affect the technology standards' building, developing and substituting.

**Keywords:** technological innovation, technology standards, regulation, complete advantage

### 1. Introduction

In the heated market competition, the flagship of a certain field keeps ahead by transferring its core technology and product with high added-value to standards. The standard has become an important factor in accelerating the transformation of the innovative fruits. In the whole process of innovation, the standard has become the motivation and an end for innovation. One of the principal purposes of innovation is to set down the standards of control indicators, and in turn one of the main purposes of establishing standards is to lead innovation and to raise innovative capability.

In the "The opinion about accelerating pushing standardization independent innovation of Standardization Administration of China", the standard has been defined as "the carrier of independent innovation". In the entire process of innovation, the standard has become the motivation and purpose. One of the main purposes of innovation is to formulate the standard with controllability index. And the main objectives of formulating the standard is leading the direction of innovation and improving the ability of innovation.

In the traditional industries, the problems about technology standardization are not complex. But with the rapid development of technological innovation, the obviously shorten cycle of technological innovation, and the upgrading requirements on standardization, the existed problems in the work of technology standards become more and more prominent [1]. The modern economy, as a foundation, technology standards have important influences on economic development led by technological innovation [2]. The modern technology has not been traditional simple technology. It is a complex integrated system. To develop these complex technologies, many kinds of technology resource and organization resource have to be integrated. These resources usually cross over the boundary of enterprises, industries, even countries, and involved many different actors in different fields such as technology, economy and regulation [3, 4]. Any single enterprise mustn't have these resources. So, in order to research the forming path of technology standards based on

technological innovation, we must start from the research on technology, economy and regulation, and then make sure that the three factors compose technology (T) path, economy (E) path and regulation (R) path.

## **2. The Forming Path of Technology Standards**

### **2.1. The Technological Path Based on the Foundation of Forming Technology Standards**

The formation of technology standards is affected by many factors, but basically technology is the basis of technology standards. Swann suggested that one of the important purposes of standardization is to establish a basic structure of technology which is sound, open and well-organized [5]. In essence, the formation and replacement of technology standards are the process of technological transformation. Different corporations and industries press their technological advancement along different technological trajectories. The technological trajectory refers to a set of possible technological direction and it is a model of technological innovation determined by technological paradigm [6]. An effective application of standards will usually shape the future technological trajectories [7], the formation of which is made jointly by the new technology itself and market demand. Under such an influence, some technologies gain a better development and finally become technology standards. Thus, a certain technology standard forms the technological trajectory with the passing of time. The development of technological trajectories will initiate the change of standards and the technological progress made by technological innovation is an ultimate cause for the transformation of technological trajectories. Accordingly, technological trajectories, technological innovation and technology standards are closely related to one another. The fundamental role of technologies is indispensable in forming technology standards. Technological path constitutes the basic path for the formation of technology standards.

### **2.2. The Economic Path Based on the Motivation to Forming Technology Standards**

The technology standard is a system made by collective choice. The drawing up of technology standards requires consistency with a goal of increasing the efficiency of economic activity [8]. Under the circumstances in which the technology is increasingly cyberized and systemized, the choice of technologies is made not simply by selecting the advantages and disadvantages of a technology, yet it is made after the producers and customers take full consideration of various kinds of economic factors and balance the economic performance. In most cases, the formation of technology standard is out of commercial motive.

(1) The network effect makes the economic path become a driving force for the formation of technology standards. The network effect makes economic factors become the key factor as to whether to adopt a technology or not. When users' value of a technology is added with the increase of the total amount of network users, the technology is in possession of network effect. Grindley considered that under the influence of network effect, the winner of a standard competition between technologies is not necessarily the best of all, but the one that is adopted in the most extensive scope and establishes a supply network for complementary commodities [9, 10].

(2) The Establishment of technology standards is the requirement of reducing the transaction cost. Reducing the cost is the important inner motive to propel the standardization of corporations. The competition between technologies will bring about uncertainty which will cause a great loss to social well-being. Meanwhile, variety of products often brings about difficulties for users in judging which kind of products is more suitable, thus resulting in the decrease of trade volume or even in malfunction of the market. The standards are helpful to reduce the transaction cost and alternative cost. Moreover, the technology standards play a role in strengthening the transparency of information and simplifying the negotiation procedure. They can dispel worries of manufacturers in adopting the advanced technology and at the same time they provide enough information for consumers to make choices [11].

(3) The Impact of Transfer Costs upon the Establishment of technology standards. Transfer cost refers to the cost of shifting between different technology standards. Adler suggested that the standard is shifted, corporations and consumers are all confronted with transfer cost, that is, consumers' purchase decision in the second stage is locked in by their previous one [12]. For corporations, the adoption of a technology standard requires a great inflexible investment, that is, when the corporation shifts its standard, the previous investment

will be devalued quickly due to no meeting the requirement of the new technology. Similarly, for consumers, if a consumer makes an exclusive investment for his current buyer, the shift to another will cause the repeated investment. Therefore, in the process of shifting between technology standards, the technology with a lower transferring cost may become the dominant standard.

Thus, it is clear that network effect, transfer cost and transaction cost together enable the establishment of technology standards to consider more about the economic factors. So the economic path constitutes the motivation path for the formation of technology standards.

### **2.3. The Regulatory Path Based on the Subjects in Forming Technology Standards**

From the perspective of subjects in forming technology standards, the standards can be divided as three kinds. A, the standard formed by the market. B, the standard established by the government. And C, the standard made through a consultation abiding by the principle of voluntariness and unanimity. Moreover, legal regulation, especially the Intellectual Property Rights (IPR) also plays an important role in forming technology standards.

#### **(1) The Necessity for Regulation in the Standardization**

Firstly, the reason and effect for government involved in the standardization. The principal reason is to prevent malfunction of the market. In addition, a large amount of resources need to be invested in the standardization and any individual company can't lead the establishment of standards for lack of enough motivation. Moreover, the government agencies have innate rights of regulating market. When the standardization has an impact on the international trade, especially when it can be regarded as the non-tariff barriers to trade, the government needs to participate in the process of standardization. Lastly, the government can request to enter into the market equally through the regulation so as to avoid companies' limiting competitions.

Secondly, the impact of regulation from voluntary standardization organizations upon the formation of technology standards. This kind of regulation is an effective complement and substitution to the government regulation. In drawing up the standards, the convenience and the structure scope of voluntary organizations are very important to the establishment and development of standards. It will help standards spreading faster and more extensive. Meanwhile, in the context of a liberalized market, voluntary organizations exert an influence on the government regulators.

Lastly, the role of industry associations on the establishment and development of standardization. An association is the community which is set up for the sake of common characteristics such as industries and products. These associations clarify the key technological information and technological process involved in establishing standards. They can better overcome the distortion of information so as to reduce the cost for collecting and searching information, thus better considering the information and benefit of some individual corporation in the process of establishing standards. In this way, it is easier to promote all parts involved to reach unanimity.

#### **(2) The Inevitability of Combining Technology Standards with Patent**

With the rising of new hi-tech industry, it has been a trend to combine the Intellectual Property Rights (IPR) with technology standards. People's demands for technology standards include two aspects: one is the demand for patent technology and the other is the demand for technology standards themselves [13]. Technology standards can't exist without patents. In the competition of modern technology standards, a technology standard is supported by a larger amount of patents. With the increasing awareness to protect the IPR, technological achievements made by inventor and improver of hi-tech are almost covered by the IPR. Organizations for standardization have no choice but to negotiate with owners of the IPR to make the IPR as a standard. In addition, companies having formulated technology standards usually have many key technologies applied protected by patent law so that they can control technology standards after the patent technologies are adopted by technology standards. Thus they can lead the development of technology standards. Therefore, when technology standards gradually become the supreme form pursued by patent technologies, technology standards can't be separated from patent technologies. Apparently, the establishment of technology standards

is regulated by relevant regulated subjects and affected by legal regulation. Thus, regulation constitutes another main path in forming technology standards.

### 3. TER Model

Whether technology standards can be established successfully depends on their comprehensive advantages. In the process of establishing technology standards, many factors constituting technological, economic and regulatory paths work in coordination with one another and exert impact on the establishment of standards. By literatures and making empirical survey, the paper defines factors of these three paths which have a great impact on the establishment of technology standards.

Table 1 The Constituting Factors of TER Path

Factors of T Path	Factors of E Path	Factors of R Path
Technological Simplicity (T <sub>1</sub> )	Consumers' Expectations (E <sub>1</sub> )	The Ability of Regulated Subject (R <sub>1</sub> )
Technological Advancement (T <sub>2</sub> )	Install Base (E <sub>2</sub> )	The Support from Government Policy (R <sub>2</sub> )
Technological Maturity (T <sub>3</sub> )	The provision of complements (E <sub>3</sub> )	The financial aid of government (R <sub>3</sub> )
Technological Compatibility (T <sub>4</sub> )	Enabling Assets (E <sub>4</sub> )	The Protection of Patents (R <sub>4</sub> )
Technological control (T <sub>5</sub> )	Client's promise with clients (E <sub>5</sub> )	General Legal Conditions (R <sub>5</sub> )
	corporation size and market structure (E <sub>6</sub> )	Company's status in stakeholder net (R <sub>6</sub> )
	Brand name reputation and reliability (E <sub>7</sub> )	

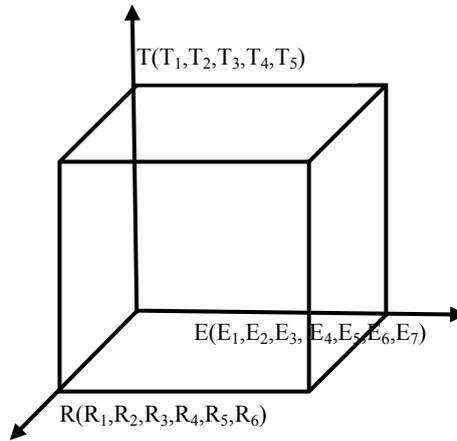


Fig.1 TER Model

Accordingly, the TER model constructed in the paper for the formation of technology standards is showed in Fig. 1. Its 3-dimension represents T-E-R paths respectively.  $T_i(i=1, \dots, 5)$ ,  $E_j(j=1, \dots, 7)$ ,  $R_k(k=1, \dots, 6)$  stands for the factors constituting T-E-R path respectively. Suppose that two competitive technologies - X and Y participate in a competition of dominant technology, both X and Y need to be aware of each other's competitiveness so as to make an appropriate strategy. According to the model, the capacity of relevant paths should be judged first. Then suppose that functions of the capacity of T-E-R paths are  $F(T)$ ,  $F(E)$ ,  $F(R)$  respectively and that comprehensive ability is  $I$ . Taking technology X as an example, the capacity of each path in technology X is presented as follow:

$$F(T)_X = \sum_{i=1}^5 a_i T_{iX} ; F(E)_X = \sum_{j=1}^7 b_j E_{jX} ; F(R)_X = \sum_{k=1}^6 c_k R_{kX} \quad (1)$$

Among the above functions,  $a_i(i=1, \dots, 5)$ ,  $b_j(j=1, \dots, 7)$ ,  $c_k(k=1, \dots, 6)$  represent weight coefficients of each factor,  $\sum a_i + \sum b_j + \sum c_k = 1$ . According to the optimization theory, the comprehensive ability of technology X is presented as:

$$I(T, E, R)_X = F(T)_X + F(E)_X + F(R)_X \quad (2)$$

(1) On the one hand, the advantage of constructing paths of the formation of technology standards is to try to maximize value of the above function. In accordance with features of industry and technology involved in technology standards, we should first define factors' weights  $a_i$ ,  $b_j$ ,  $c_k$  in each path and make a horizontal

comparison among the competing technologies to determine  $T_i$ ,  $E_j$ ,  $R_k$  in the technology X. Then we can work out values of  $F(T)$ ,  $F(E)$  and  $F(R)$  for different technologies and make a comparison among all paths' values so as to determine weight of each path. Lastly, put path's capacity value into the equation (2). Thus the comprehensive competitiveness of X is gained.

(2) On the other hand, when making horizontal comparison among  $T_i$ ,  $E_j$ ,  $R_k$ , attentions should also be paid to all factors of technology X relative to those of technology Y. Special attention should be paid to factors which are of distinct advantages or disadvantages, trying to keep the advantage and improve the disadvantage so as to make a coordinated development among all factors. If a factor of technology X is clearly superior to that of technology Y, it means that technology X may invest too many resources in this aspect. If a certain factor is clearly inferior, it may lead to failure in the competition even if the comprehensive ability is the highest. Therefore, defining the function  $D(T)$ ,  $D(E)$ ,  $D(R)$  as:

$$D(T)_{|X-Y|} = \sum_{i=1}^5 a_i |T_{iX} - T_{iY}|; \quad D(E)_{|X-Y|} = \sum_{j=1}^7 b_j |E_{jX} - E_{jY}|; \quad D(R)_{|X-Y|} = \sum_{i=1}^6 c_i |R_{iX} - R_{iY}| \quad (3)$$

To take an overall consideration of the coordinated development of all factors is to minimize the value of function D, that is to say, maximizing the path capacity on the basis of all factors' coordinated development.

## 4. Conclusions

The technology standards are made when operating strategies of corporations, activities of organizations for standardization, government intervention and market diffusion affects one another in a complicated way. They are from the technological demand of developing, manufacturing and working procedure or of the technology in use and other interactive equipments. That is to say, whether a technology standard can be established successfully depends on the competitiveness of three paths of technology, economy and regulation. The formation of technology standards is based on technology, motivated by economy and affected by regulated subject. Only with a sound technological basis, enough economic motive and support from the relevant regulated subject can a technology standard be established successfully.

## 5. Acknowledgements

This study was supported by BAHED (No. 201107111), National Natural Science Foundation of China (No. 70901023), Aviation Science Fund of China (No. 2010ZG51073).

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