

The Cross-national Comparative Study of the Maintenance Time of Granted Patents in the Technical Field of Fixed Constructions in Different Countries

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Abstract. The maintenance information of granted patents in the technical field of fixed constructions in China, Germany, France, and Japan are empirically analyzed, which shows that there are many differences in the maintenance time of the patents granted by them. The mean value maintenance time in the technical field of fixed constructions is shorter than that of other technical fields. In the technical field of fixed constructions, the maintenance time of patents granted by France is longer than that of patents granted by China, Germany and Japan; the maintenance time of patents granted by China is the shortest; the maintenance tendencies of granted patents are greatly various in different periods. As the maintenance time extends, the number of patents falls dramatically in China, but in Germany, the number of the patents falls gradually. Large proportion of patents granted by France and Japan are distributed in long maintenance periods.

Introduction

According to the list of top 250 international contractors released by the Engineering News-Recording (ENR) in 2014, 62 contracting enterprises are from China, 5 from Germany, 5 France, and 14 Japan^[1]. In terms of market revenue overboard, China, France, Germany, and Japan respectively ranked the second with \$ 79.01 billion, the fourth with \$ 50.74 billion, the fifth with \$ 46.55 billion, and the seventh with \$ 22.24 billion^[2]. In the international contracting market, contracting enterprises of China, Germany, France, and Japan are of great technical strength and large competitive advantages. It is widely accepted that the basis of technical strength holds the key to the competitive advantage, and patent is one of the important indicators of the technical strength^[3]. That was reason why we chose patents by China, German, France, and Japan in fixed constructions technical field to research technical strength in the construction industry. Through the cross-national comparative analyses of granted patents in this technical field, we expect to discover the difference of maintenance time of patents granted by these four countries, and reveal the competitive status of the technical strength in them.

The quantity and quality of patents symbolizes the technological development potentiality and the innovation capacity of a country^[4]. Scholars have made many important discussions about the relations between the maintenance time and the technical fields. Nakanishi, Yamada believed that an expiration rate of patents in the chemical and pharmaceutical industry is lower than that of other industries^[5]. Hall and Pakes discovered that the patent quality affects the maintenance time of patents^[6]. The maintenance time of granted patent is different among different technical fields^[7]. The patents in the technical field of chemistry and electricity have a higher maintenance rate^[8]. Nevertheless, according to the information that we search, the cross-national comparative analysis about the maintenance time of granted patents in the field of fixed constructions is still insufficient.

Data collection and variable design

Data collection

In this article, the data are collected from the patents granted by China, German, France and Japan in 1994. Because the number of patents granted by China in 1994 was 3838, we selected 3838 patents equidistantly from patents granted by German, France, and Japan for comparison. Then, we recorded the information of each patent's maintenance time and its technical field, which was input in the database of maintenance time of granted patents in the technical field of fixed constructions.

The reason to use the information of the patents granted in 1994 is that in 2014, all of the patents granted in 1994 was out of the protection because of the expiration, no paying the maintenance fee or other reasons. Researching the patents granted in 1994 could lead the way for tracing the dynamic maintenance process of each patent.

Variable design

The technical field in the article is concordant with the convection of the Strasbourg Agreement Concerning the International Patent Classification, which divides the patents into eight technical field categories: A (human necessities), B (performing operations), C (chemistry and metallurgy), D (textiles and paper), E (fixed constructions), F (mechanical engineering, lighting, heating, weapons and blasting), G (physics), H (electricity). The technical field of fixed constructions in this paper falls under the fifth category: E (fixed constructions). The variable of "maintenance time" is the period from the date of authorization publication of a patent to the invalidation, termination or cancellation of the patent.

Comparative analysis of the maintenance time of granted patents in the technical field of fixed constructions in the four countries

A patent maintained for a long time is considered to be high economic and technical value^[9]. The length of the patent maintenance time indicates the size of the patent commercial value to the right holders. If the patents could not generate enough profits for the patent holders, the right holders would not pay the maintenance fee to maintain the patents in a long period. To a specific technical field, the length of the patent maintenance time is not only an important manifestation of the technical strength and status of the patent holders, but also the capacity of independent innovation in that technical field for a country.

Comparative analysis of the mean value of maintenance time of granted patents in the technical field of fixed constructions in the four countries

The mean value of patent maintenance time can comprehensively reflect the length of the maintenance time of patents granted by different countries, so it could be a useful tool to make cross-national comparative analysis about the maintenance time. With a statistical computing for patents granted by China, America, German, and Japan in 1994, we can get the results about the mean value of maintenance time in the following table 1.

Table 1: The mean value of maintenance time of granted patents in the technical field of fixed constructions in the four countries

The percentage of patents in the technical field of fixed constructions	The mean value of maintenance time (year)		Standard deviation	
	The integral technical fields	The technical field of fixed constructions	The integral technical fields	The technical field of fixed constructions
China	2.19%	7.30	6.16	5.15
Germany	3.67%	8.87	7.95	4.81
France	3.00%	10.21	10.29	4.19
Japan	4.01%	9.52	9.25	3.06

Table 1 shows that there are great differences in the mean value of the maintenance time of the granted patents in the technical field of fixed constructions in China, German, France, and Japan. In these four countries, the mean value of maintenance time of granted patents in the technical field of fixed constructions in

France is the longest (10.29 years). Its standard deviation is 4.52, which shows relatively poor stability on the maintenance time of granted patents in this technical field. The mean values of the maintenance times of granted patents in the technical field of fixed constructions in Germany and Japan are 7.95 years and 9.25 years respectively. Their standard deviations are 4.71 and 3.28 respectively. In terms of the standard deviation, the stability in the maintenance time of patents granted by Germany is the worst, while the stability in the maintenance time of patents granted by Japan is the best. The mean value of maintenance time of granted patents by China is the least among the four countries, which is 6.16 years, and its standard deviation is 4.70, showing poor stability in the maintenance time.

Compared with the mean value of the maintenance time of the integral technical field, Table1 reveals that the mean value of the maintenance time of granted patents in the technical field of fixed constructions in China, German, and Japan is shorter than that of the integral field. When it comes to France, the situation is different. The mean value of the maintenance time of granted patents in the technical field of fixed constructions in France is longer than that of the integral technical fields.

Compared with the patent number in other technical fields, the quantity of patents in the technical field of fixed constructions is much less than that of other technical fields. The percentages of patent number in the technical field of fixed constructions in four countries are all under 5%. The comprehensive consideration of the mean value of the maintenance time and the percentage of patents together and take a further discussion, a thought-provoking conclusion could be drawn. Except for France, the higher the percentage of patents is, the longer the maintenance time is. The percentage of patents granted by Japan, German, and China descends orderly, and the mean value is 4.01%, 3.67% and 2.19% respectively. The mean values of the maintenance time of granted patents are consistent with the tendencies revealed by the percentage of patent number in the technical field of fixed constructions in four countries.

Comparative analysis of the distribution trend of different maintenance periods of granted patents in the technical field of fixed constructions in four countries.

The distribution of the patents in different maintenance periods can provide an access to observing the process of dynamic variation and reflecting the maintenance tendency of the patents. In order to compare conveniently, in this paper the maintenance time of patents are divide into seven sections: 1-3 years, 4-6 years, 7-9 years, 10-12years, 13-15 years, 16-18years and 19-20 years after patents were granted. With the statistical computing for patents granted by China, German, France, and Japan in the technical field of fixed constructions, we can get the results about the maintenance tendency in different periods in the following figure1.

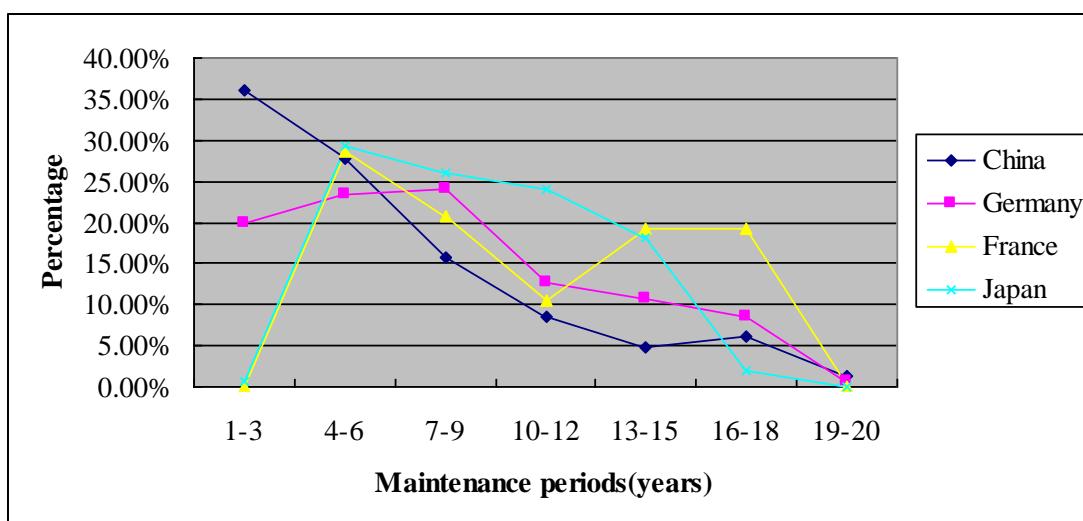


Figure1: Distribution proportion of granted patents in the technical field of fixed constructions in four countries in different maintenance periods

In general, the higher the degree of technological innovation is, the longer the maintenance time of granted patents is. If more patents are distributed in longer maintenance periods, it would reveal that the quality of the patents in this technical field is relatively better than others. Figure 1 shows that there are obvious differences in the distribution trend in different maintenance periods of granted patents in the technical field of fixed constructions in four countries. A considerable proportion of the patents granted by German, France and Japan are more likely to be distributed in longer maintenance periods, while for the patents granted by China, the proportion is much smaller.

The distribution curve of granted patents number in the technical field of fixed constructions in China resembles a “slope”. In different maintenance periods, with the maintenance time extends, the patents number which maintained effectively falls dramatically. The quantity of granted patents, whose maintenance time is no more than 3 years, accounts for 36.14% of the whole granted patents in China. And the percentage of granted patents distributed in the maintenance periods of 4-6 years, 7-9 years are 27.71% and 15.66% respectively. The maintenance times of nearly 80% of patents in the technical field of fixed constructions in China are less than 9 years. 8.43%, 4.82%, 6.02% and 1.20% of all granted patents distributes in the periods of 10-12 years, 13-15 years, 16-18 years and 19-20 years respectively. From the figure1, it is obvious that the proportion of granted patents that maintenance time is more than 10 years is pretty small in China.

The distribution curve of the number of granted patents in the technical field of fixed constructions by Germany resembles a “step plate”. In different maintenance periods, with the maintenance time extends, the number of granted patents which maintained effectively falls gradually and irregularly. When the maintenance period is 7-9 years, the percentage of granted patents which maintained effectively is the highest (24.11%). In the maintenance periods of 1-3 years and 4-6 years, the maintenance proportion of granted patents are 19.86% and 23.40% respectively. The maintenance time of 32.62% of all granted patents is more than 10 years. Specifically in the periods of 10-12 years, 13-15 years, 16-18 years and 19-20 years, the maintenance proportion of granted patents are 12.77%, 10.64%, 8.51% and 0.71% respectively.

The distribution curve of the number of granted patents in the technical field of fixed constructions by France resembles a “hump yard”. In different maintenance periods, with the maintenance time of granted patents extend, the number of granted patents which maintained effectively fluctuates dramatically. When the maintenance period is 4-6 years, the percentage of granted patents maintained effectively is the highest (28.70%). The outstanding feature of distribution trend of the patents granted by France is that the maintenance rates of granted patents are still higher (19.13%) in the periods of 13-15years and 16-18 years. The maintenance time of 48.70% of granted patents are more than 10 years.

The distribution curve of the number of granted patents in the technical field of fixed constructions by Japan resembles a “trapezium”. At the two ends of the maintenance periods, the maintenance rates of granted patents are rather small. In the maintenance periods of 1-3 years, 16-18 years and 19-20 years, the maintenance rates of granted patents are 0.65%, 1.95% and 0% respectively. Apart from the two ends, the maintenance rates of granted patents fluctuate smoothly. The maintenance rates of granted patents in the maintenance periods of 4-6 years, 7-9 years, 10-12 years and 13-15years are 29.22%, 25.97%, 24.03% and 18.18% respectively.

The causal analysis of the difference of maintenance time of granted patents in the technical field of fixed constructions in four countries

The length of the maintenance time of granted patents is determined by many aspects. A series of factors contribute to the different results of the maintenance time of the patents granted by the four countries. In term of the external influencing aspects, the maintenance time of the patents is closely associated with the patent policy in a country. The difference of the specific arrangement of the patent policy leads to different characteristics of the maintenance trend. Firstly, the patent policy, especially the level of the patent maintenance fee, has a significant impact on the maintenance time^[10]. Compared with Germany, France, and Japan, the maintenance fee of China is relatively lower. Apart from the level of the maintenance fee, the payment method is also very different. In China and Japan, the patent holders need to pay the maintenance fee once a year, and the maintenance fee increases every three years. This kind of payment method may be conducive to the extension of the maintenance time. Secondly, various institutional environments of commercial operations of the patents in different countries give rise to the different situations of the maintenance time. The commercial operations of patent, such as license, assignment, and pledge, need the institutional arrangement by governments. Compared with Germany, France, and Japan, the commercial

operations of the patents in China start relatively late because of the institutional deficiencies. Thirdly, the extent of the incentives provided by the government is also an important influencing factor for the maintenance time. In four countries, especially for China, besides the central government, the local governments usually provide the patent holders with subsidies, which may influence their patent maintenance strategies.

Besides the external aspects, the internal aspects need to be taken into consideration. The quality of patent and the ability of patent management of the patent holder are two important factors that influence the maintenance time. There are many honorable construction contracting companies in these four countries, such as the CRCC (China Railway Construction Corp.) and the CSCE (China State Construction Corp.) from China, Hochtief from Germany, Vinci, Bouygues, and Eiffage from France, and Taisei and Kajima from Japan. On top of these, there is one more important aspect that needs to be considered. The companies from Germany, France, and Japan, which were established earlier, thus enjoying a long process of development, have the advantages of accumulative technical strength and the capability of management related to patent. Though companies from China have been acquiring remarkable achievements since the 1980s, the process of technical accumulation is relatively shorter, and there is still a gap in the technical strength as against these three. Compounded by the lack of patent awareness, and their incompetent of the patent management and application, Chinese companies are unable to maintain patents for a long time.

Conclusion

Through researching the mean value of the maintenance time and the maintenance tendency of granted patents in the technical field of fixed constructions in China, Germany, France, and Japan, the following conclusions can be drawn.

The mean value of the maintenance times of granted patents in the technical field of fixed constructions is shorter than that of granted patents in other technical fields. In the technical field of fixed constructions, the maintenance time of granted patents granted by France is longer than that of granted patents by other three countries. The maintenance time of patents granted by Japan and Germany are longer than that of patents granted by China. Different patent policies and commercial environments contribute to the diverse maintenance situation of granted patents in the field in four counties.

There are obvious differences in the distribution trend in different maintenance periods of the granted patents in the technical field of fixed constructions in four countries. With the maintenance time of granted patent extends, the number of the patents which maintained effectively falls dramatically in China. In Germany, the number of the patents maintained effectively falls gradually. The maintenance time of large proportion of patents granted by France and Japan are more than 13 years. The difference of the distribution curves of patents number in different counties come from the comprehensive function of multiple factors, such as different stages of economic development, policy arrangement, and others.

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