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USING AHP ON PATENT VALUATION

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Summary*:* *As the knowledge economics grows rapidly, the value of intangible assets is more emphasized in business nowadays. Intangible assets include intellectual capital and intellectual property. Intellectual property is often protected by patents, which are the claims for intellectual property. Since the enterprise is willing to pay the patent for the sustainable growth, we propose an objective scoring system, which is implemented by AHP, for patent valuation of enterprise.*

1. Introduction

Intellectual Property Rights (IPRs) can be highly valuable rights playing a key role in many fields of business. At first, IPR valuation has centred on Brand Valuation. Recently, the concern about IPR has broadened to include all Intangible Assets (Arthur Andersen & Co., 1992). However, there are many researches based on an accounting perspective. In this study, we provide the multi-dimension perspective to value IPR. Intellectual Property Rights include brand valuation, trademark rights, patent rights, copy rights and so on. In this paper, we focus on patent rights.

A patent can be described as an exclusive right of limited duration over a new, non-obvious invention capable of industrial application where the right- to sue others for infringement, is granted in return for publication of the invention. There is a distinction between the underlying invention which might be called the underlying intellectual asset and the intellectual property right which confers exclusive rights over that invention as defined in the claims of the relevant patent (Pitkethly, 1997).

For those managing both patent applications and granted patents it is essential to know the value of each sufficiently accurately if one is to make well-founded decisions about their management. Since only a small proportion of patents turn out to be of extraordinary value in the long run and given that IP department budgets are limited any methods which lead to a better understanding of the value of given patent applications or patents should be welcomed (Pitkethly, 1997). Patents are a major force in the world economy, and one of only a few metrics commonly employed to gauge the tides of new ideas and innovation that are driving our economy. Even with the present declining rates of R&D investment, leading nations spend over $1 billion dollars each day generating intellectual property. There are over 7 million patents in force worldwide, growing at 12 to 14% per year. Patent licensing revenues are growing at 25 to 35% per year, generating global revenues in excess of $150 billion. In the U.S., the leading patent generating nation in the world, annual patent issuances have nearly doubled from 96,727 in 1990 to 187,822 in 2001. And, during 2002, 45 to 75% of the market capitalization of the Fortune 500

companies consisted of intangible, intellectual capital assets such as brands, patents and knowledge (Moor and Craig, 2003).

The aim of valuing patents is to enable those managing them to know their value sufficiently accurately and objectively to make well-founded decisions concerning their management. Since the enterprise is willing to pay the patent for the sustainable growth, we propose an objective scoring system, which is implemented by AHP, for patent valuation of enterprise. The purpose of this paper is to obtain the important criteria and their weight. These criteria include qualitative and quantitative criteria. We use the four dimensions to value a patent. They are technology essence, cost dimension, product market and technology market. Fist, there are four criteria under the technology essence dimension: refinement, application scope, compatibility and complexity.
Secondly, cost dimension includes R&D cost, transfer cost and reference cost. Thirdly, product life cycle stage, potential market share, market size and utility/advantage are according to product market dimension. Finally, technology market includes three criteria: the number of supplier, the number of demander and commercial level. The results show the most important dimension is product market and the most important criterion is utility/advantage.

This paper is organized as follows. Section 2 includes important criteria for valuing a patent or intellectual property. The model construction and implementation are showed in Section 3. Finally, conclusions and recommendations are presented in Section 4.

2. Effect Factors of Technology Valuation

There are many researches to provide the measure criteria of technology valuation. Bidault (1989) provides the four kinds factors of technology pricing. Four kinds of factors include “the profitability of a technology”, “the cost of research and development’, “transfer cost” and others. The profitability of a technology includes four sub-factors: potential market and future market share, total production cost, invest turnover rate before licensee pay royalty, the apportioned cost ratio between licensor and licensee and payment way of licensee. The cost of research and development include two viewpoints. In licensor side, they think about the saving cost, time and risk. In licensee side, it depends on R&D cost by itself. Transfer cost is the only factor that can be estimated currently. According to Teece (1977), the definition of transfer cost means the cost of transferring and absorbing specific knowledge about enterprises, systems and industry to make technology transferred effect. Four factors influence the transfer cost. They are characteristics of technology provider, characteristics of technology, application ability of technology by licensee and economic conditions of licensee. Other effect factors are industry standards and tort cost. According to Arnold (1986), the influenced factors of technology value are divided to eight kinds. They are essence of technology, cost factors, product market factors, competitive factors, protection of intellectual property rights, resource of licensee, law and political affairs and contract factors. The above descript factors affecting technology pricing. Therefore, patent is concrete to present technology. With patents increasingly sharing the spotlight with brands in the world of intellectual capital assets and market capitalization analyses, it has become essential that patents join brands in lining up against traditional approaches to setting asset values (Moore and Craig, 2003).

As a matter of fact, despite the diversity of articles from industrial organization or legal scholars on value related issues of intellectual property rights, there is a lack of scientific papers that restructure the knowledge on the evaluation of patent rights from a corporate perspective. Reitzig (2004) provides the evaluation of patent rights from a corporate perspective. Building on earlier works by Pakes (1986) and Harhoff et al. (2003) it turns out that valuation approaches using patent indicators seem especially convenient for the assessment of patent portfolios comprising a large number of intellectual property rights (Reitzig, 2004).

The value of individual intellectual assets is rarely observable. Harhoff (2003) show in a formalized fashion that for a corporation involved in technological competition, the value of a patent is best defined as its asset value. To determine a patent’s value, it is therefore necessary to consider its effects on prices,

costs and sold quantities of patent-protected products by the owner and its simultaneous effects on the proprietor's competitors. As Reitzig (2003a) shows in a survey of the theoretical literature counterfactual effects should become assessable when quantifying the following patent's latent value determinants: state of the art (of existing technology), novelty, inventive step, breadth, difficulty of inventing around, disclosure and dependence on complementary assets.

A variety of variables have been tested as indicators of patent value in empirical surveys. Reitzig (2004) analyzes the appropriateness of the 13 best-known indicator variables for business purpose by 23 empirical studies related to patent indicators and value. Table 1 shows known patent indicators.

Table 1 Indicators of patent value

Indicators of patent value
Patent age
Market value of corporation
Backward citations
Forward citations
Family size
Scope
Ownership
Number of claims
Patenting strategy
Number of applicants
Number of trans-boarder research co-operations
Key inventors
Legal disputes (opposition in particular)

Forward citations, family size and the ownership variable show the highest degree of theoretical and empirical validation. However market value also seems to be a good indicator for a company's intellectual property assets. Pioneer work on analyzing the relation between backward citations and patent value is carried out by Narin et al. (1997). Forward citations is introduced by Trajtenberg (1990) and is validated as indicators of patent value in numerous subsequent surveys, e.g. by Albert et al. (1991), Harhoff et al. (2003), Lanjouw and Schankerman (2001) and Harhoff and Reitzig (2002). Family size- and indicator known from earlier works by Grefermann et al. (1974) -is introduced as a value indicator by Putnam (1996) and again re-validated by Lanjouw and Schankerman (2001), Harhoff and Reitzig (2002) and Guellec and van Pottelsberghe de la Potterie (2000). The correlation between market value and patents is examined by Griliches (1981), Conolly and Hirschey (1988), Megna and Klock (1993) and Hall et al. (2000). All the studies mentioned above differ with respect to the quality of the research design, the sample sizes and the kinds of patents.

Hirschey and Richardson (2001) provide three scientific-based dimensions of patent quality. The detail shows in Table 2.

Table 2 Scientific-based indicators of patent quality

Indicators	Definitions
Current Impact Index (CII)	Number of citations generated by a company's most recent 5 years of patents, divided by the expected number of citations for similar high-tech companies.
Science Linkage (SL)	Average number of "other references cited" on the front page of the patent, including academic journal articles and papers presented at scientific meetings.
Technology Cycle Time (TCT)	Median age (in years) of earlier U.S. patents referenced on the front page of a U.S. patent.

In valuing a patent – as distinct from any underlying invention is by how much the returns from all possible modes of exploitation of the patented invention are greater than those that would be obtained in the absence of the patent.

Making such a distinction is difficult even when the returns from the patented invention are well defined. However in the early life of the patent or application many other types of uncertainty are also involved. There will be uncertainties about both the technical and commercial success in competitive markets of the underlying invention as well as uncertainties about the legal challenges the application and subsequent patent may have to face during its life.

Russell and Parr divide all possible types of valuation of individual patents into Cost, Market and Income based methods, the latter of which includes simple DCF methods (Parr and Smith, 1994). Arthur Andersen in a report on valuing intangible assets divides valuation methods into Cost, Market Value and Economic Value methods (Arthur Andersen & Co., 1992). Razgaitis (1999) divides the evaluating methods by six classifications. They are industry standard, rating/ranking method, rules of thumb, discounted cash flow method, advanced methods (e.g. Monte Carlo method and real options) and auction method. According to Razgaitis (1999), this paper adapts AHP as evaluating methods. It belongs to rating/ranking method. There is very little research on patent valuation using AHP, so we try to use AHP to find out the importance of patent valuation factors.

3. Evaluation Structure and Results

The purpose of this section is to establish the patent valuation hierarchical structure. The AHP developed by Saaty (1980) robust and flexible multi-criteria decision analysis methodology. Formulating the decision problem in a hierarchical structure is the first and probably the most important step. Once the hierarchy has been constructed, the decision maker begins the prioritization procedure to determine the relative importance of the element in each level of the hierarchy. Then with the results of experts' interviews, we can know the licensee and licensors' prefer weights under each criterion of the evaluation system.

This research is according to literatures in section 2 and experts' interview to establish our evaluation hierarchy. We establish a patent valuation hierarchy as show in Fig. 1. Level 1 is our goal. In second level, we consider four aspects, including essence of technology, cost dimension, product market and competitive dimension. Thirdly, four criteria for essence of technology, three criteria for cost dimension, four criteria for product market and three criteria for the competitive dimension with respect to our consideration aspects are evaluated and selected outranking listed in level 3.

Four factors under essence of technology are refinement, application scope, compatibility and complexity. Refinement means that complete technology or ripe technology is more valuable than the technology of needing sustained developing or improving. More application scope of technology means more valuable. Compatibility means the degree of existing technology. Complexity means that licensee's technology level or licensor's relative technology support. Three factors under cost dimension are R&D cost, transfer cost and reference cost. R&D cost is the cost of research and development process. Transfer cost includes the cost of pre-engineering technological exchange, the engineering costs, the cost of R&D personnel and the pre-start-up training costs and the excess manufacturing costs. Reference cost includes industry standard of technology price, the price of competitive or similar technology, investment return rate and tort cost. There are four criteria about product market. They are product life cycle, potential market share, market size and utility/ advantage. The utility/ advantage means if technology can start a new market, its value is more than existing market technology. Number of technology provider, number of technology demander and commercial level are three factors under technology market dimension. Commercial level means the technology of commercial success is more valuable than the technology of un-commercial experience or uncertain market. All criteria are measured by evaluators who having different viewpoints.

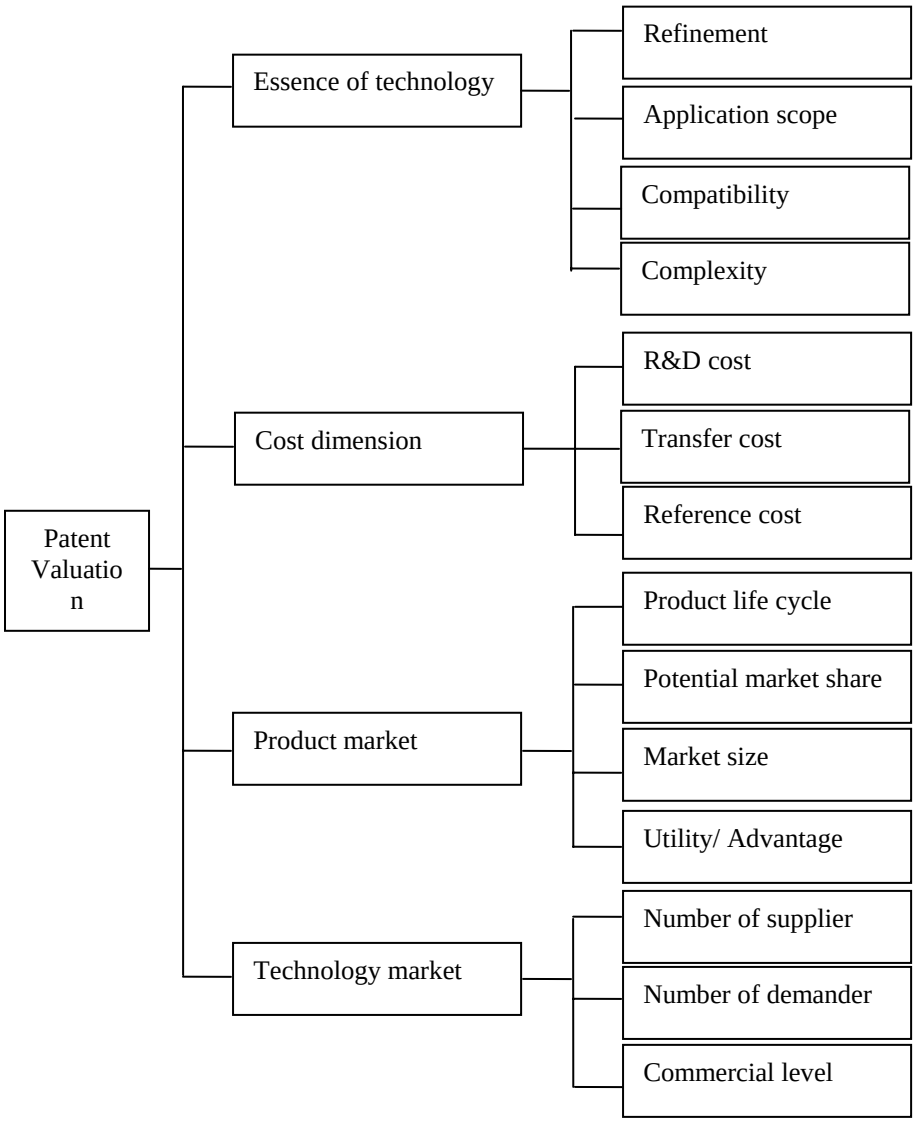

Fig. 1 Hierarchy System for Patent Valuation

We use the Expert Choice to calculate the relative weights of the elements of each level. It makes structuring and modifying the hierarchy simple and quick and it eliminates tedious calculations. The results of the weights are as Table 3.

Table 3. Weights

Aspects level	Weighting value	Criteria level	Weighting value
Essence of technology	0.155	Refinement	0.021
		Application scope	0.031
		Compatibility	0.055
		Complexity	0.048
Cost dimension	0.236	R&D cost	0.079
		Transfer cost	0.078
		Reference cost	0.079
Product market	0.454	Product life cycle	0.061
		Potential market share	0.091
		Market size	0.140
		Utility/ Advantage	0.162
Technology	0.155	Number of supplier	0.023

market		Number of demander	0.025
		Commercial level	0.107

The relative importance of the aspects level show that the product market has the highest relative importance (0.454) and followed by cost dimension (0.236). Essence of technology and technology market is the same relative importance (o.155). Under the essence of technology level, compatibility has the highest relative importance (0.055). Under the cost dimension, the three criteria almost have the same importance. Under the product market level, utility/advantage has the highest relative importance (0.162). Under the technology market, commercial level has the highest relative importance (0.107).

4. Conclusions and Recommendations

Banks, investors and insurers have come to acknowledge that patent rights have considerable influence on the value of enterprises and on the stability of patent-based business models in "knowledge economy" (Martin, 2004). Therefore, we try to establish patent valuation system. We use the AHP to find out the importance of patent valuation indictors. According to the results, the product market has the highest relative importance (0.454) and followed by cost dimension (0.236). It means that the product market is very important to make more profits. Profits are everything for an enterprise. In addition, cost is also important dimension than other two dimensions. This result is corresponding technology pricing methods. Cost, income and market are the most used methods to pricing technology. Under the essence of technology level, compatibility has the highest relative importance (0.055). It means that the degree of existing technology in the company is more important. In this situation, licensee will consider the compatibility of technology if it wants to buy a patent. Under the cost dimension, the three criteria almost have the same importance. Therefore, research and development cost, transfer cost and reference cost are almost important. No matter the licensee or licensor, they concern three kinds of cost equally. Under the product market level, utility/advantage has the highest relative importance (0.162). It means whether technology can create a new market is very important factor. Under the technology market, commercial level has the highest relative importance (0.107). Commercial success is key factor to technology market. If technology is without capability to commercialize, its value may be very low.

The limitation of this study is that numbers of licensors are fewer than licensees. It maybe makes the deviation to licensee's viewpoint. In the future, we will increase the number of licensors to answer our questionnaire. In this study, we try to use different way to evaluate a patent. We establish the patent valuation hierarchy system to give the reference basis for licensors and licensees. We hope to help licensors or licensees to evaluate a real case when they want to sell their technology or they want to buy a patent.

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