

Research on the Construction of Enterprise Patent Early Warning Mechanism and Indicator System

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Abstract: The paper outlines various types of patent risks prevalent in enterprises, details the process of patent risk early warning, investigates strategies for enterprises to address patent risks, and suggests developing comprehensive, systematic, and targeted strategic plans tailored to each enterprise's specific circumstances. Building upon this foundation, the article establishes a patent risk early warning indicator system and formulates a patent risk classification framework through decomposition analysis. Patent risks are categorized into risks in the stages of patent pre-development, patent technology R&D, patent industrialization, and patent marketing. In conclusion, the paper puts forth recommendations for refining the patent risk early warning mechanism, offering guidance for enterprises to safeguard their innovative accomplishments and intellectual property rights, ultimately bolstering their market competitiveness.

Keywords: Patent risk; Risk Early Warning; Mechanism; Indicator System.

1. Introduction

Currently, China's intellectual property rights (IPRs) are evolving into a new phase of development, transitioning from a "great nation of IPRs", where quantity predominated, to a "great power of IPRs", characterized by a more comprehensive system and heightened value. Within this context, enterprises are increasingly recognizing the importance of intellectual property risks and are inclined towards proactively identifying and addressing these risks in advance [1]. Based on the *2022 Annual Survey Report on China's Intellectual Property Rights*, it is observed that among the nearly 500 surveyed companies, a primary focus is placed on risk identification and early warning as well as risk avoidance, with 80% and 78% of companies emphasizing these two aspects respectively. Conversely, only 33% of companies prioritize litigation and rights protection. It's clear that patent litigation exerts a considerable impact, with 40% of enterprises embroiled in legal battles. The financial stakes involved in these litigations over the past five years may escalate to tens of millions of CNY. As enterprises expand, the proportion of listed companies involved in litigation has surpassed 60%, with the average cumulative litigation expenses for these firms over the past five years amounting to 11.23 million yuan [2]. It is evident that patent infringement stands out as a significant crisis encountered by enterprises in the course of their operations. Given the surge in infringement litigation, the early warning of potential patent infringement is of paramount importance [3].

The petroleum industry is renowned for its high capital and technology intensity. To deter the misappropriation or leakage of technological achievements, oil & gas companies typically safeguard their innovations by designating them as trade secrets and seeking patent protection. Nonetheless, currently, China's petroleum industry presents lower patent maintenance and industrialization rates than the average, with weaker patent protection capabilities compared to foreign counterparts [4]. This scenario not only heightens the risk of illicit technology misappropriation or leaks but also curtails the industry's ability to fully leverage its innovative potential.

This paper delves into the existing enterprise patent early warning mechanisms, covering patent risk types, the early warning process, as well as strategies for risk prevention and control. The primary aim is to institute an enterprise patent risk early warning indicator system, which is intended to furnish oil & gas enterprises with work norms for patent risk early warning activities, aiding in the establishment of comprehensive patent risk management system. By enhancing the precision and effectiveness of risk early warnings, the indicator system aspires to fortify enterprises' self-protection and risk response capabilities.

2. Enterprise Patent Early Warning Mechanism

2.1. Patent Risk Types

The patent risk types vary from different perspectives [5]. Patent risks can be categorized into the following four types based on patent acquisition, maintenance, utilization, and protection [6]: **Risks of Patent Acquisition**, including improper patent application strategy, poor quality of patent application documents, failure to conduct a comprehensive patent search for update, improper confidentiality measures in the process of patent application, risk of changes in the progress and standards of patent examination, and risk of failure to pass patent reexamination; **Risks of Patent Maintenance**, including poor management of patent documents, untimely payment of annual patent fees, and risk of invalidating the patent right; **Risks of Patent Utilization**, including risk of compliant implementation and use in the process of self-execution, risk of technology leakage and damage to interests in the process of licensing, risk of inaccurate value assessment, unreasonable terms of transfer, and loss of enterprise assets in the process of transfer, and risk brought by due diligence in the process of investment and financing; and **Risks of Patent Protection**, including inappropriate monitoring of patent infringement, insufficient means of defending rights, and improper handling of patent disputes.

Patent risk types can also be classified according to five key

segments: project initiation, R&D and design, procurement, production and service, and promotion and sales [7]. **Risks of Project Initiation** include infringement risk caused by failure to conduct patent warning analysis before initiation, risk of repeated research and development caused by failure to conduct patent technology intelligence analysis, and risk of patent layout not accurately covering the core technology and innovation points of the project; **Risks of R&D and Design** include risk of technology leakage during the R&D process, risk of infringement caused by unauthorized use of patented technology or design by R&D personnel, and risk of failure to apply for patent protection for R&D results in a timely manner; **Risks of Procurement** include legal risk caused by patent infringement of products or services provided by suppliers, risk caused by unclear patent infringement liability and dispute resolution mechanisms in procurement contracts, and risk caused by insufficient investigation and evaluation of suppliers' intellectual property status during the procurement process; **Risks of Production and Service** include the increased risk of infringement caused by the use of unauthorized patented technologies or methods in the production process, risk of production lines being forced to adjust or stop due to patent infringement involving production equipment or processes, and risk of technical secrets being leaked due to insufficient confidentiality measures in the production process; and **Risks of Promotion and Sales** include risk of being sued or required to compensate for losses caused by patent infringement of the products being sold, as well as the risk of misleading consumers or infringing on the rights of others due to improper use of patent logos or slogans in sales promotion.

Resting on the two risk classification approaches, this study endeavors to incorporate patent risk early warning across the whole process of enterprise operation. It seeks to devise comprehensive strategies for various stages in terms of patent output whole process involving patent pre-development, technology development, industrialization and marketization to forestall potential infringements, redundant research endeavors, and technology leakage. Furthermore, this paper aspires to assist corporations in safeguarding their interests, diminishing patent-related risks, preserving intellectual property rights, and fostering the stable growth of businesses via precise assessments and equitable transfer terms [8].

2.2. Early Warning Process

Patent risk early warning mainly includes risk early warning monitoring, risk early warning grading, risk early warning measures and continuous improvement of risk early warning mechanisms.

With respect to patent risk early warning monitoring, the initial step involves delineating the collection scope. This encompasses gathering data on significant historical patent risk incidents domestically and internationally, pivotal patent crises within the pipeline industry globally and locally, and notable patent crises within the company's history. Subsequently, it is imperative to assign collection responsibilities clearly. The onus of gathering the first two types of risk information rests with the intellectual property management or risk management department, while each business and functional department assumes responsibility for collating department-specific patent risk data based on departmental classifications. Lastly, defining data collection and processing procedures is crucial. Standardized risk identification documents should be employed, patent risk

events within each department must be documented, the collected information needs to be summarized and categorized, and the organized data should be input into a risk database for subsequent analysis and application [9].

Concerning the patent risk early warning grading, the initial step involves setting up databases for products and peer patents. Regular searches for emerging products and technologies in the market are essential to stay abreast of the latest technological advancements [10]; Secondly, it is crucial to develop a risk early warning indicator system and a risk value calculation model to obtain the risk value. Lastly, the system should generate early warning levels and prompt corresponding precautionary measures and response strategies based on the level of the identified risks.

Patent risk early warning measures typically involve several key actions. 1. Formulate R&D strategies. This entails deciding on whether to pursue independent research and development or opt for technology acquisition based on patent risk analysis results, thereby averting resource wastage and potential patent infringements. Subsequently, a patent application strategy should be devised [11]; 2. Manage patent rights and technical secrets. Establishing a system for managing patent rights and technical secrets is paramount. This involves formulating standardized processes for patent applications and transfers; 3. Create the internal systems for innovation and reward. The innovation system includes defining application rights and patent ownership of employee-created inventions. Additionally, implementing a reward system for inventors can boost employees' innovation drive. Apart from the above points, attention should be directed towards protecting trade secrets and adhering to non-compete rules. This necessitates the establishment of regulations to prevent trade secret leaks, and setting guidelines regarding the scope, duration, and relevant compensation for non-compete restrictions.

In terms of continuous improvement of patent risk early warning mechanism, regular evaluation and feedback are required. Consistently evaluate the operational efficacy of the patent risk early warning mechanism, gather feedback from diverse departments regarding the mechanism, and iteratively enhance the mechanism [12, 13]. Monitor the executed patent risk response measures, adapt the risk response tactics based on the monitoring outcomes, and guarantee the efficiency of the early warning mechanism.

3. Construction of Patent Risk Early Warning Indicator System

On the basis of the delineated patent risk types and early warning process, along with the patent risk strategies extrapolated from the analysis, a patent risk early warning indicator system is formulated. This system is typically bifurcated into two primary components [14]: the early warning system and the pre-control system. This entails utilizing the patent early warning system to ascertain the level of warning initially and subsequently initiating the appropriate pre-control measures based on the risk level. These actions aid enterprises in promptly and effectively mitigating or averting the damages arising from patent crises [15, 16].

3.1. Method for Selecting Patent Risk Early Warning Indicators

Patent risk early warning indicators can be identified by

examining the patent risk sources originating from every stage spanning technology development to patent operations. Each stage is impacted by internal and external risk factors [17]. Within every facet of the patent system operation, each factor is interconnected and engages in mutual interactions, leading to a ripple effect due to the diffusion of risks. Xu Ming et al. [15] systematically identified and structured the distinct sources and potential outcomes of patent risk behaviors across various research and development stages and scenarios. Employing questionnaire surveys and a hybrid analytic hierarchy process, they gauged the likelihood of patent risks and leveraged judicial litigation data to evaluate the detrimental impacts of such risks. Banking on this, they devised a two-dimensional risk map and categorized patent risks into three tiers based on their risk coefficients; Liu Lin et al. [16] focused on Internet enterprises as their research subjects, constructing a corporate patent risk assessment model. They established a three-tier indicator system to evaluate the magnitude of patent litigation risk encountered by enterprises by scrutinizing the enterprise's invention patent citation network; and Liu Guifeng et al. [18] developed patent maps across three levels—industries, enterprises, and competitors—to investigate the precise efficacy of patent maps within the early warning mechanism. Currently, there is a dearth of research on early warning mechanisms and indicator systems for risks throughout the entire patent output process. This paper endeavors to bridge the identified gaps.

This paper takes into account internal and external factors from the standpoint of the complete patent output process, establishes various indicators, and formulates a patent risk early warning indicator system to ensure adherence to principles of feasibility, scientific rigor, and rationality. Specifically, it includes the following aspects:

Initially, focusing on indicator sources, this system's indicators stem from enterprise details, R&D insights, market data, patent specifics, and other facets, ensuring a comprehensive coverage of all patent risk dimensions. By holistically incorporating information from these dimensions, enterprises can more precisely pinpoint potential patent risks, thereby facilitating the creation of targeted risk response strategies.

Secondly, concerning indicator establishment, the indicators within this system span the entire patent lifecycle embracing pre-development, R&D, industrialization, and market operation phases. Enterprises have the flexibility to define specific risk warning indicators based on the unique attributes and requirements of each stage. This approach empowers organizations to swiftly detect and address risks across the entirety of the patent output process, thereby guaranteeing seamless patent outcomes and successful market application.

Thirdly, looking at indicator types, this system incorporates a diverse range of indicators. It includes quantitative risk indicators like patent applications, maintenance, and infringement, while also establishing secondary indicators customized to distinct risk sources, extracting relevant indicator values from publicly available patent data. Moreover, qualitative risk indicators such as patent search data integrity, R&D trajectory, and technological positioning can be integrated. Secondary indicators can be further customized, with varying values assigned based on specific indicator conditions. Through the amalgamation of qualitative and quantitative indicators, enterprises can attain a more thorough and precise early warning system for patent risks, offering a robust foundation for devising risk response strategies.

Table 1. Patent Risk Early Warning Indicator System

Types of Risk	Dimensions	Sources of Risk
Enterprise patent risks	Risks in the stage of patent pre-development	Rise of patent search information integrity
		Risk of R&D trajectory
		Risk of technological positioning
	Risks in the stage of patent technology R&D	Risk of R&D capability constraints
		Risk of R&D capabilities loss
		Risk of R&D hardware guarantee
		Risk of R&D funding
		Risk of organizational management
	Risks in the stage of patent industrialization	Risk of patent maintenance
		Risk of patent operation
		Risk of industrialization inefficiency
		Risk of technology leakage
		Risk of technology obsolescence
	Risks in the stage of patent marketing	Risk of environmental change
		Risk of market competition
		Risk of inefficient utilization
Risk of market change		
		Risk of patent infringement

3.2. Application of Patent Risk Early Warning Indicators

Based on the incurred losses and impacts from patents, the patent risk early warning levels are segmented into levels 1-5, aligning with distinct processing priorities and early warning processing methods as outlined in Table 2. Enterprises are advised to routinely assess the operational efficacy of the patent risk early warning system, gather feedback, and dynamically adapt the early warning levels and response strategies in response to internal and external environmental shifts. According to the risk level and processing priorities, it is essential to allocate resources such

as human and financial resources appropriately to effectively manage key risks. Furthermore, enhancing employees' awareness of patent risks through training, establishing the risk management culture, and improving all employees' understanding and response to patent risks are critical steps in mitigating potential risks. Implementing tools like patent management software and databases can elevate the automation and intelligence of risk early warning systems, thereby enhancing early warning efficiency. Enterprises are encouraged to leverage the patent early warning system in accordance with their specific circumstances, promptly identify and address patent risks, shield their intellectual property rights, and fortify their market competitiveness.

Table 2. Levels, Processing Priorities and Processing Methods of Patent Risk Early Warning

Patent Risk Early Warning Level	Loss Assessment	Processing Priorities	Early Warning Processing Methods
1	No loss caused	Low	Record specific information for regular review by patent managers.
2	Possible impact on patent value	Relatively low	The specific individual in charge will be responsible for managing the risk and monitoring its developments closely.
3	Partial impact on patent value	High	The head of the patent management department and the head of the patent project collaboratively execute the patent early warning response plan and present the patent risk report to the company's management.
4	Significant losses are caused to the patent value, which may lead to the failure of the whole patent project.	Very high	The patent management department works closely with company management to address and monitor patent risks effectively.
5	Serious losses are caused to the patent value, resulting in the failure of the whole project.	Highest	Under the leadership of the company's technology management and decision-making echelon, the patent management department is tasked with executing the integration of resources to mitigate patent risks promptly and minimize losses stemming from such risks.

3.3. Follow-up Research Plan of this System

This system still exhibits some shortcomings and limitations. Firstly, while it has pinpointed the origins of patent risks, it lacks adapted indicators and evaluation methodologies that enterprises can readily employ for each risk type when developing a specific risk warning indicator system and model. In practice, companies may need to fine-tune indicators according to their unique circumstances to align more effectively with their specific risk landscape and business requirements; Secondly, this system has not undergone comprehensive practical validation. Despite the theoretical analysis and discussion of various indicators, there is a dearth of empirical experience in implementing this system in real-world settings and collecting feedback data.

The social organization standard "Patent Risk Early Warning Work Norms" has been developed based on the research findings of this indicator system [19]. The upcoming focus will involve refining the indicator system to ensure that each indicator is more operational and targeted, as well as optimizing and enhancing the system through validation in practical cases to better cater to the genuine requirements of enterprise patent risk management. Additionally, building upon this indicator system, specific patent risk indicators tailored to the petroleum industry will be incorporated, including aspects such as the application prospects of patent technology in the petroleum industry and the market exclusivity of patented technologies with the aim of enhancing the pertinence and effectiveness of patent

management.

4. Suggestions on Optimization of Patent Risk Early Warning Mechanism

Drawing from the enterprise patent early warning mechanism and patent risk early warning indicator system discussed above, the subsequent recommendations are proposed for enterprises to enhance their patent early warning practices:

1. Strengthen risk identification and early warning capabilities. Set up a patent risk early warning management information system to gather and structure patent data relevant to the group's operations, encompassing competitors' patent strategies and industry technology development trends, enabling real-time monitoring of potential patent risks. Conduct routine patent risk evaluations: employ specialized patent analysis tools and methods to assess the group's patent risks both quantitatively and qualitatively regularly, guaranteeing timely detection and evaluation of new risks.

2. Improve internal control and process management. Refine the patent management process, review and update the current patent management procedures to uphold the transparency and efficiency, reinforce internal controls over patent application, maintenance, and utilization, and institute a cross-departmental collaboration mechanism: encourage information exchange and cooperative efforts among R&D, legal affairs, marketing, procurement, and other departments

to construct an integrated patent risk prevention and control network.

3. Enhance patent training and cultural development. Consistently provide patent knowledge training and host patent-focused courses to improve the patent awareness and risk prevention skills of all staff members; Motivate employees to engage proactively in identifying and averting patent risks through internal publicity and incentive mechanisms, thereby boosting their awareness of risk warning and management.

4. Create adaptable response strategies. Formulate the patent risk contingency plan. Prepare emergency plans based on varying levels of patent risks, comprising strategies like patent circumvention, patent portfolio adjustment and legal responses. Employ a dynamic management approach to continually adjust the patent risk management strategy in line with market fluctuations and enterprise growth requirements, maintaining strategy's effectiveness and flexibility.

5. Encourage external collaboration and information exchange. Partner with professional organizations by forging alliances with external entities like patent agencies and law firms to collaboratively conduct patent risk early warning and response initiatives. Engage in industry information sharing by actively attending sector-specific conferences and forums, exchanging experience on patent risk management with industry peers, and collectively elevating the standard of patent risk prevention within the sector.

5. Conclusion

This paper conducts a thorough analysis of enterprise patent early warning mechanism and establishes the risk early warning indicator system, offering a comprehensive risk management framework for enterprises. By categorizing patent risk types in detail and outlining the early warning process comprehensively, this paper furnishes a practical operation guideline for enterprises to effectively manage patent risks. The patent risk response strategies and early warning indicator system presented in this paper offer valuable guidance for enterprises seeking to sustain innovation and navigate potential patent conflicts amidst intense market competition. Furthermore, with the absence of an industry-specific patent risk early warning system, the next phase will involve devising a more intricate risk early warning indicator system and mechanism to address the litigation risks frequently encountered by Chinese petroleum firms during the extended process of innovation catch-up meant for furnishing theoretical insights for petroleum companies to identify and mitigate patent risks.

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