Academic Journal of Management and Social Sciences
ISSN: 2958-4396 | Vol. 12, No. 1, 2025

Research on the Dilemma and Solution Path of Patent Transformation in National Key Laboratories

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Abstract: The current situation of patent transformation in national key laboratories shows that there are problems such as institutional and mechanism flaws, disconnection between technology research and development and industries, and confusion of platform information, which have led to a large number of patents being dormant. The root cause lies in the disconnection between equipment and production lines, the imperfection of platform functions, the lack of motivation of researchers and problems with the incentive mechanism. To solve this problem, efforts can be made in four aspects: on the supply side, establish a shared pilot center and industrial cluster mechanism; on the intermediary side, improve the intermediary transformation platform to integrate information resources; on the value side, build quality-oriented evaluation and precise assessment standards; and on the mechanism side, establish a state-owned intellectual property management mechanism. Only in this way can scientific and technological achievements cross the "valley of death" and move from the laboratory to the industrial chain, injecting innovative impetus into the high-quality development of the economy and society.

Keywords: National Key laboratories; Patent transformation; Pilot stage; Research evaluation system; State-owned intellectual property management mechanism.

1. Research Background and Significance

The Party and the state have always attached great importance to the related work of patent transformation in key national laboratories.

Universities are important sources of patent achievements in China, important participants and vital forces in the country's scientific and technological innovation, and the national key laboratories supported by them are the source of innovation[1].However, there are a large number of "dormant patents" in national key laboratories, but the conversion rate is extremely low, making it impossible to truly apply the technology from the laboratory to the industrial chain to generate economic benefits[2].

According to documents such as the Outline for Building a Strong Intellectual Property Nation (2021-2035) issued by the General Office of the Central Committee of the Communist Party of China, The General Office of the State Council, etc., several Opinions on Strengthening the Construction and Development of National Key laboratories, Special Action Plan for Patent Transformation and Application 2023-2025, promote patent transformation and application and fully tap the value of patents, Vigorously developing patent-intensive industries is a strategic task for promoting high-quality development. For this reason, "solving the problem of low patent conversion rate" has become a key focus of the reform of the science and technology system, and the leap of laboratory achievements from "laboratory bench" to "production line" is a crucial bridge for building a strong country in science and technology. In the face of the reality that scientific and technological achievements are "locked in cabinets and placed on high shelves", we need to break the ice through mechanism reform and build a bridge with digital platforms, so that technological breakthroughs in laboratories can resonate with industrial upgrading and enable the value of innovative elements to multiply in the new era.

2. The Current Situation of Patent Transformation in National Key laboratories

However, the patent transformation of key laboratories in China still faces multiple predicaments throughout the entire chain, including institutional mechanisms, technological research and development, and institutional mechanisms. First, in terms of institutional mechanisms, there are unreasonable value assessment systems and unclear management policies. On the one hand, the current value assessment mechanism shows a significant problem of unity. Academic promotion evaluations overly emphasize quantitative metrics such as research projects, technological development, publications, and patent counts, while neglecting actual transformation effect. This orientation leads researchers to tend to apply for patents that are out of step with market demand or a large number of "junk patents" to obtain bonuses and reimbursements during the patent research and development stage, which is a serious deviation between the research orientation and the actual needs. The excessive pressure of professional title evaluation reduces the enthusiasm of laboratory personnel to focus on market demand, resulting in a significant decline in patent quality and making it difficult to meet the demands of transformation.

On the other hand, the incentive mechanism for national key laboratories is not sound and the management system is in urgent need of clarification. During the patent transformation stage, researchers responsible for implementation have difficulty obtaining matching incentives and benefits, which seriously affects their enthusiasm for patent transformation; Rewards and incentives are widely used for visualization or short-term achievements[3], with cash rewards being the main form of rewards, lacking long-term incentives such as equity and career development, which is not conducive to the long-term optimization and

development of patent transformation. There are still concerns about unclear systems in terms of management mechanisms. The state-owned assets management system, in accordance with government accounting standards, has corresponding assessment requirements for the preservation and appreciation of the achievements of national key laboratories. Although the preservation of state-owned equity formed by patent transformation has been removed from the scope of state-owned assets assessment at this stage, the formed state-owned equity is still managed uniformly by the state-owned assets management information system of the state-owned assets department. This has led to laboratory-related personnel's job-related invention rewards, dividend rewards, and stock option equity rewards all falling into the trap of state-owned asset loss, creating serious risks and hidden dangers, making it difficult for researchers to carry out patent transformation and obtain corresponding rights and interests, dampened their enthusiasm for patent transformation, and seriously lacking the motivation to implement it.

Second, there is a problem of insufficient maturity of laboratory technology and a serious absence of pilot production in the technology research and development process. Most of the national key laboratories are established by universities, and their equipment configuration is oriented towards scientific research needs and adapted to the research and development of cutting-edge technologies, rather than directly adapted to intensive, large-scale and market-oriented production, which is inherently different from the industrial production technology route. This conflict between research logic and industrial logic causes the idealized patent technology of the laboratory to be disconnected from the low cost, high efficiency and high stability requirements of industrial production, making it difficult to adapt to the complex working conditions that actual production lines need to deal with, and thus the process route cannot be directly applied to real production. This calls for the addition of a "pilot" stage of the product between the patent pilot and the production line landing procedures to bridge the gap between laboratory production and large-scale production. The pilot stage is the key link between small-scale laboratory validation and large-scale industrial production, involving practical issues such as process scale-up and stability testing. At present, research and practice related to the construction of pilot bases in China are still insufficient, and the resources invested in pilot and pilot base construction are still lacking and cannot fully support the actual needs of industrial development. There are still many cases where pilot bases have no access in practice[4]. At the same time, research institutions are constrained by their own economic and production conditions and are unable to support pilot-scale production[5]. This has led to a general lack of pilot production in national key laboratories, further exacerbating the crisis of laboratory patents being off-production.

Thirdly, in the process of industrial transformation, the patent transformation platform has the drawbacks of mixed information and lack of credibility. The existing patent conversion platforms generally have functional flaws and chaotic standards: First, most of the platforms categorize patents roughly, only in broad fields, and lack detailed labeling of many key dimensions such as industrialization suitability. The overly general classification of the platforms makes it difficult for the technology supply and demand sides to match precisely. As a result, the supply and demand sides have to go through long offline verifications to decide whether to match or not, which takes a lot of time to verify offline and leads to a high failure rate of matching. Not only does it reduce users' dependence, but it also affects the foundation of mutual trust between enterprises and national key laboratories. Secondly, most of the existing matching platforms are independently built at the provincial, municipal or university levels, lacking a unified data classification standard and sharing mechanism. The lack of uniformity in standards makes it difficult for the platforms to exchange information, and the distribution of supply and demand is unbalanced, resulting in low matching efficiency, high operating costs, and difficulty in matching, making it difficult to effectively play the role of a bridge and gradually forming a psychological stereotype in the minds of users that "the platform is useless", which has an implicit hindrance to the implementation of laboratory patents.

3. Problem Analysis

Under the guidance of the innovation-driven development strategy, national key laboratories, as key entities of scientific and technological innovation, have produced a vast number of patent achievements. However, the conversion rate of these achievements has remained low for a long time, and a large number of patents have been dormant in the laboratories, resulting in the waste of scientific research resources. An in-depth analysis of the underlying causes leads to the following four significant challenges.

The primary predicament faced by national key laboratories in patent conversion is the disconnection between laboratory equipment and production lines, and the serious absence of pilot production. Most of the research results remain at the theoretical verification stage in the laboratory, lacking the actual production environment for testing and optimization, and there is a disconnection between the experimental equipment and the production line equipment. Although most of the technologies developed by national key laboratories have significant innovation and academic value, the transition from the laboratory to the market still requires a series of pilot-scale processes such as technology maturation, process optimization, and product validation. But currently, universities generally lack well-developed pilot platforms, resulting in a large number of patent technologies not matching the actual production needs of enterprises in terms of maturity. Data shows that as many as 40 percent of universities' patent technology maturity does not match the needs of enterprises, and many promising patents are forced to "sleep" because they cannot be directly applied to enterprise production. The absence of pilot production has led to a "valley of death" for laboratory results on their way to industrialization, becoming a key bottleneck restricting the transformation of university patents[6]. Although the Special Action Plan for the Transformation and Application of Patents issued by The State Council in 2023 explicitly calls for strengthening the construction of pilot bases, in the actual implementation process, there are many problems such as insufficient investment and imperfect collaborative cooperation mechanisms, and the progress has been rather slow[7].

The incomplete functions of the patent conversion platform and the lagging information sharing mechanism are also major obstacles to patent conversion in universities. The existing patent conversion platforms have obvious flaws in matching supply and demand, with the lack of trust between

the supply and demand sides and the lack of uniform standards being particularly prominent. Although the National Patent Navigation integrated service platform has initially built an information bridge for patent conversion, local platforms have problems such as redundant construction, scattered data, and serious information silos, which prevent efficient circulation of patent information[8]. In 2024, the patent conversion resource library sent 940,000 patents to 450,000 enterprises, but less than 30 percent of them actually reached cooperation intentions and successfully connected[9]. The platform lacks a unified and scientific patent value assessment standard, making it difficult for enterprises to accurately judge the technical feasibility and market potential of patents when screening them, and research institutions cannot precisely understand the actual needs of enterprises, resulting in information asymmetry between supply and demand and low matching efficiency. Qingdao University of Science and Technology has effectively promoted patent conversion by actively exploring the innovative model of "technology equity investment+transfer", with the number of patent transfers increasing by 68% year-on-year in 2023. However, this successful experience has not yet been widely promoted and applied nationwide[10].

In addition, researchers generally lack motivation in the process of patent conversion and have a vague understanding of the value of patents. The current research evaluation system focuses too much on the number of published papers and the impact factor. Patent applications are often regarded as appendage to the conclusion of research projects and the evaluation of professional titles. Researchers do not attach enough importance to the industrialization of patents and lack the initiative to promote the transformation[11]. At the same time, researchers have long been focused on academic research and lack in-depth understanding of the market value and business operation model of patents, making it difficult for them to accurately assess the potential economic value of patents. Furthermore, the use of different assessment methods can also have an impact on the property value assessment of patents, such as the assessment based on the research and development and maintenance costs of the patent, including research and development expenses, application fees, etc., and the assessment based on the relevant income, cost, and expense data of the patented product; Patent assets should be evaluated based on aspects such as the technical lifespan of the patent asset, technical maturity, and the legal lifespan of the patent, and the evaluation results vary greatly.

The insufficient connection between the incentive mechanism and the system also restricts the patent transformation in colleges anduniversities. On the one hand, there is a contradiction between empowerment reform and the management of state-owned assets. As state-owned assets, the transformation of job-related scientific and technological achievements requires strict prevention of "loss risk", which makes the approval process cumbersome, time-consuming and unclear responsibility definition. In the process of patent conversion, researchers not only have to bear high maintenance costs, but also may face the risk of legal disputes. Yan Dapeng has pointed out that researchers often get into debt or even legal trouble over issues such as patent maintenance costs. Although the Law on Promoting the Transformation of Scientific and Technological Achievements has been revised, it still needs to be further improved in specific details such as the distribution of benefits after empowerment and the disposal of state-owned assets. On the other hand, the separate management of job-related scientific and technological achievements is still in the exploratory stage. Shanghai, Zhejiang and other places have taken the lead in piloting the separation of the benefits from the transformation of scientific and technological achievements from the assessment of state-owned assets, but this model has not yet been standardized nationwide. Although Beijing University of Technology has established a "due diligence exemption" system to relieve researchers to some extent, most institutions still rely on case-by-case approval in the process of patent transformation, making it difficult to achieve large-scale and regular transformation.

Patent conversion in universities is a complex and systematic project that requires the collaboration and joint efforts of the government, universities, enterprises and society. By strengthening the construction of pilot-scale platforms and opening up channels between laboratories and production lines; Improve the functions of the patent conversion platform and establish an efficient information sharing and supply-demand matching mechanism; Optimize the incentive mechanism for scientific researchers to enhance their enthusiasm for patent conversion and their ability to recognize value; Rationalize the relationship between empowerment reform and state-owned asset management to provide institutional guarantees for patent transformation. Only in this way can we break through the current predicament of patent transformation in universities, achieve effective transformation and industrialization of scientific and technological achievements, and inject a continuous stream of innovative impetus into high-quality economic and social development.

4. The Path to Breaking the Patent Transformation Dilemma of National Key Laboratories

4.1. Supply Side: Establish A Regional Shared Pilot Center and Industrial Cluster Mechanism to Address the Disconnection From "Paper Innovation" to "Industrial Demand"

1) Build a differentiated and specialized cluster mechanism

The establishment of industrial cluster mechanisms necessitates governmental authorities to construct industry-specific platforms for "demand-driven innovation, collaborative R&D, and technology commercialization," leveraging leading enterprises as supply chain orchestrators to standardize cross-sector synergies. National key laboratories are tasked with prioritizing breakthroughs in common technologies, bottleneck challenges, and frontier innovations aligned with sectoral demand maps, thereby fostering material-process-equipment integrated patent portfolios. This framework catalyzes a government-industry-academia triple helix ecosystem, bridging gaps between R&D and industrialization while establishing closed-loop innovation cycles. By harmonizing technological advancements with industrial applications, the mechanism addresses systemic disconnects between research and production, drives holistic modernization of industrial chains, and amplifies global competitiveness through strategic intellectual property (IP) assetization. The integration of policy support, market alignment, and capital engagement ensures a dynamic ecosystem where innovation seamlessly

transitions from laboratories to scalable industrial solutions, reinforcing China's position in the global innovation landscape.

2) Establish an open and sustainable ecological pilot base

To build an open and sustainable ecosystem-based pilot base, a systematic integration of government, enterprises, research institutions, and financial capital is essential. Anchored in regional industrial strengths, a full-chain service platform for "technology maturation, process validation, and market integration" must be established. Through multi-stakeholder collaboration, laboratory technology repositories, enterprise demand pools, and third-party testing resources are aggregated to form a "demand-driven pilot validation-commercial application" network. Governments lead standardization and policy empowerment, while leading enterprises customize pilot solutions by embedding supply chains and coordinating SMEs to generate scalable order pools. Research institutions optimize R&D trajectories through patent pre-incubation centers, and financial institutions mitigate risks via hybrid models like "seed funding + milestone-based equity agreements." Operationalizing the base requires a dynamic knowledge management system, where open-access platforms enable real-time process feedback to drive iterative technological upgrades. Concurrently, pilot data is leveraged to construct technology maturity assessment models, while value-added services—such as technical consulting and certification—enhance ecosystem resilience. Ultimately, the "policy-market-capital triple helix" mechanism dismantles industrialization barriers for laboratory innovations, catalyzing regional industrial cluster competitiveness through synergistic alignment of strategic priorities, market agility, and investment-driven scalability.

4.2. Intermediary end: Establish a Complete Intermediary Transformation Platform, Fully Integrate Information Resources, and Enhance the Trustworthiness of the Platform

Universities and the government should jointly build an intermediary transformation platform that is "comprehensive in service targets, complete in service functions and complete in relevant data". The platform, with "data-driven + ecological synergy" at its core, builds an intelligent service system covering the entire chain of patent transformation. In terms of functional architecture: Relying on a multi-dimensional user profiling system (integrating tags such as enterprise demands, research team conversion rates, and the location of pilot base equipment), it achieves precise matching of supply and demand through an AI semantic analysis engine; In terms of resource integration: Build an all-domain database, horizontally aggregate the national enterprise technology demand database, laboratory patent database, pilot service resource database, vertically connect the data flow of "demand analysis - pilot verification - commercial application", and provide a professional broker team for offline customized connection; In terms of service value-added: Embedding policy intelligent interpretation modules, real-time correlation with policy updates from ministries and commissions such as the Ministry of Science and Technology and the Ministry of Industry and Information Technology, and generating technology route compliance assessment reports; In terms of the ecosystem loop: Through the user behavior data feeding back to the profiling tag system, combined with the optimization matching algorithm of the pilot process data, a self-evolving mechanism of "demand mining - intelligent recommendation-service delivery - data iteration" is formed. The platform essentially reconfigors the industry-university-research collaboration network through digital technology to solve the problems of information silos and resource misallocation in traditional transformation scenarios.

4.3. Value side: Build a Scientific Research Evaluation System Oriented Towards Patent Transformation to Enhance the Quality of Patents for Precise Value Assessment

1) Establish a quality-oriented scientific research patent evaluation and control system

To solve the problem of "quantity over transformation" in scientific research evaluation, a "full life cycle" evaluation system oriented towards patent quality and market value should be established: at the policy level, the "four only" tendencies of "papers only, titles only" should be broken, patent conversion rate and industrialization benefits should be included in the core indicators of scientific research assessment, and differentiated weighted assessment of major application achievements should be implemented; At the technical level, establish a pre-assessment system for patent applications, use big data and artificial intelligence to develop technology maturity diagnostic tools, integrate multiple evaluation methods such as proof-of-concept and technology prediction, and build a cross-domain database of scientific and technological achievements to block low-quality patent applications; At the economic level, a cost-sharing mechanism for patent maintenance will be implemented. Through economic levers such as the dynamic link between funding allocation and patent quality and the feedback of conversion revenue to research and development, research entities will be compelled to actively screen high-value patents. The system has achieved a paradigm shift from "quantity bubble" to "quality premium" through the triple synergy of "policy guidance - tool empowerment-benefit reconstruction", clearing institutional obstacles for the marketization of patents.

2) Build precise standards for assessing the economic value of patents

To build a precise patent economic value assessment standard, a three-dimensional quantitative system of "technology - law - market" should be established. In the technology dimension, the level of patent innovation and the potential of technology radiation should be evaluated through indicators such as the breadth of IPC classification, the size of inventors, and the density of citation networks; In the legal dimension, legal stability and exclusivity value are measured by the coverage of claims and the completeness of patent text. In the market dimension, the commercial potential of the technology is quantified based on the patent life cycle, the density of family layout and the influence of the technology. This standard breaks through the traditional single-indicator evaluation paradigm and uses machine learning algorithms to extract features and optimize weights from multi-source data, ultimately generating a patent value classification index. This model provides scientific decision-making tools for research institutions to screen high-value patents and for investment

institutions to identify technology targets, helping to break the "patent bubble" dilemma.

4.4. Mechanism end: Establish a State-Owned Intellectual Property Management Mechanism

To resolve the institutional contradiction between state-owned asset supervision and the transformation of scientific and technological achievements, a three-in-one state-owned intellectual property management mechanism of "prudent empowerment-classified fault tolerance-dynamic supervision" needs to be established: In terms of institutional design, implement a separate management model for job-related scientific and technological achievements, and achieve separate operation of "technical assets" and regular state-owned assets through ledger identification and system isolation (such as independent accounting not included in the assessment of preservation and appreciation); In terms of fault tolerance, a list of due diligence exemption was established to define the compliance boundaries between scientific research decisions and market risks, and a "white list" mechanism was used to exempt non-subjective negligence from conversion losses. In terms of empowerment and innovation, pilot the "four Rights Linkage" reform (ownership, usage rights, disposal rights, and income rights), allowing pilot units to independently formulate the exit path for equity valuation and shareholding, and simultaneously implement the "Measures for the Separate List Management of Scientific and Technological Achievements in the Course of Employment" to achieve list-based management of rights and responsibilities. The policy details are used to remove the obstacles of "not daring to transfer" and "not knowing how to transfer", and to unleash the vitality of the transformation of scientific research achievements.

5. Conclusion

Against the backdrop of the deepening implementation of the national innovation-driven strategy and the full advancement of the Special Action Plan for Patent Transformation and Utilization (2023-2025), the national key laboratory system is facing a structural contradiction between "scale advantage" and "transformation efficiency". As the core carrier for undertaking major national science and technology tasks, although national key laboratories have a leading edge in the innovation chain in terms of the number of patents, they are generally constrained by institutional bottlenecks such as a low rate of industrialization of achievements and insufficient supply of high-value patents. The study reveals that the equipment gap between laboratories and production line technologies, the platform failure due to isolated supply and demand information and trust deficits, the motivation deviation due to overvaluation of scientific research and risk aversion, and the institutional obstruction due to blurred boundaries of rights, responsibilities and interests together constitute the death valley that patent transformation is difficult to cross. To address this predicament, we need to solve it from four major ports: the supply side, the intermediary side, the value segment, and the mechanism side. Help its scientific and technological achievements cross the last mile and move from the "laboratory" to the "industrial chain".

Acknowledgments

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