Design Research on Patent Services in Academic Libraries Based on User Needs Analysis: A Case Study of the Intellectual Property Information Service Center at Shandong University of Technology (Postprint)

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Abstract

[Purpose/Significance] The core value of university libraries lies primarily in maintaining high consistency between services and demands. Research on how to leverage strengths, avoid weaknesses, align with demands, and implement diversified and multi-dimensional patent services is of significant importance for university libraries to enhance service performance and demonstrate their mission commitment. [Method/Process] Based on the analysis of user needs and service design, and taking the patent service practice of the Intellectual Property Information Service Center of Shandong University of Technology as a case study, this paper explores the positioning, service content, and service models of patent services in university libraries from three dimensions: patent literacy education combining popularization and improvement, selective patent research services, and intelligence analysis and decision support services oriented toward industry-academia-research-government collaboration. [Results/Conclusion] "High-quality satisfaction of user needs" constitutes the focal point of patent service work in university libraries. For libraries to effectively conduct patent service work, reasonable positioning serves as the criterion, professional talent as the support, patent education as the priority, and effective mechanisms as the guarantee.

Full Text

Abstract

[Purpose/Significance] The core value of university libraries lies first and foremost in maintaining a high degree of consistency between services and user

needs. Research on how to leverage strengths, avoid weaknesses, align with demands, and implement diversified, multi-dimensional patent services is of great significance for university libraries to improve service performance and demonstrate mission commitment. [**Method/Process**] Based on the analysis of user needs and service design, and taking the patent service practices of the Intellectual Property Information Service Center of Shandong University of Technology as an example, this paper explores the positioning, content, and models of patent services in university libraries from three dimensions: patent literacy education that combines popularization with advancement, patent research services that selectively focus on certain areas, and intelligence analysis and decision support services oriented toward industry-academia-research-government collaboration. [**Result/Conclusion**] "High-quality satisfaction of user needs" is the focal point of patent service work in university libraries. To effectively carry out patent services, libraries must be guided by rational positioning, supported by professional talent, focused on patent education, and guaranteed by effective mechanisms.

Keywords: university library, user needs, patent service, service design
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Introduction

The core value of university libraries is first and foremost to maintain a high degree of consistency between services and needs [1]. As academic institutions serving teaching and scientific research, university libraries are receiving increasing national attention for their patent service functions. Following the *13th Five-Year Plan for National Intellectual Property Protection and Utilization* (State Council Document [2016] No. 86), which explicitly proposed establishing intellectual property service support institutions in university libraries and other information service departments with full-time or part-time personnel responsible for intellectual property information services, the *13th Five-Year Plan for National Education Development* (State Council Document [2017] No. 4) and the *Implementation Measures for the Construction of University Intellectual Property Information Service Centers* (National Intellectual Property Office Legal System Character [2017] No. 62) subsequently approved policies to "support university libraries in building intellectual property information service centers to provide services for promoting university innovation" and stipulated that "intellectual property information centers are generally established in university libraries to carry out intellectual property information services and talent cultivation." It can be said that vigorously developing patent services in university libraries is both a requirement of the national innovation-driven development strategy and an internal need for universities to cultivate talent, develop science, and serve society. In this context, how university libraries can develop diversified and multi-level patent services that meet user needs while ensuring sustainability, feasibility, and effectiveness has become a critical challenge facing the university library profession.

2 Current Status of Patent Services in University Libraries

Foreign patent intelligence service institutions are mostly located in consulting agencies and university departments [2], while university libraries tend to focus on knowledge organization and service provision based on literature resources or data [3], with patent services primarily manifested in assisting with discipline evaluation, creating subject guides, co-teaching information literacy courses, virtual reference consultation, building institutional repositories, and constructing discipline service platforms [4]. In the United States, 53% of Patent and Trademark Resource Centers (PTRC) are located in university libraries, conducting patent information consultation, patent retrieval and utilization education, patent information promotion, and establishing university patent databases, including those at the University of Washington Engineering Library, Pennsylvania State University Library, and the University of Texas at Austin Library [5]. The European Patent Office, in cooperation with member state patent offices, funds the Patents Libraries project, in which nine university libraries participate, mainly providing patent retrieval, intellectual property monitoring, user training, patent data statistical analysis, patent evaluation, and patent strategy development services [6]. The Library of the Carlos III University of Technology in Spain has established an information center on industrial property rights [7].

Under national policy guidance and their own transformation needs, an increasing number of domestic university libraries have actively launched and expanded multi-dimensional services including patent novelty searches, patent literacy education, and patent technology analysis [8-9]. For example, Peking University Library has combined patent information services with decision support services, completing patent landscape analysis reports and discipline research hotspot predictions [10]. Tongji University Library provides patent technology analysis and early warning services for local enterprises [11]. Nanjing Tech University Library assists researchers in searching for relevant patents, analyzing technology trends, identifying valuable patents, and tracking emerging related patents through collaboration [12]. However, overall, most are still in the initial and exploratory stages [13]. A 2016 survey of 664 university libraries by Shen Jinhua found that only 100 provided patent information-related services, with libraries of "985" universities leading the practice. Specific service offerings included: patent novelty search (48 libraries), reader training (43), patent retrieval (22), patent analysis (8), patent strategy (5), patent early warning (3), and patent database construction (1). These data demonstrate that patent services in university libraries are developing slowly and struggle to meet users' diverse needs for patent information [6, 8]. Specific issues include:

(1) **Single-mode literacy education—emphasizing theory over practice.** Patent literacy education mostly remains at the classroom lecture level, with students as the primary audience. Teaching content focuses on basic patent concepts, patent literature classification, and patent information retrieval and utilization in university literature retrieval courses, rarely covering practical aspects such as patent application and examina-

tion. This emphasis on theory over practice means the content and depth fail to meet the needs of different groups for patent literacy education.

(2) **Simplistic service content—low user recognition.** As user groups' environments and research contexts change, user needs have become more diverse and complex. University libraries must vigorously explore and actively practice high-end patent services to increase user stickiness. However, current patent service content is overly simplistic, lacking in-depth mining and analysis, and far from meeting user needs, resulting in low user recognition [15].

(3) **Single service target—lack of rational positioning.** Currently, except for a few key universities, most university libraries' patent services target only internal faculty and students, rarely serving university management departments or social groups. Additionally, driven by transformation pressures, university libraries are eager to launch more types of patent services without rational positioning, leading to issues such as poor service quality and disconnected workflows, failing to maximize the benefits of libraries' patent services [9, 14].

Based on this analysis of user needs and service design, this paper takes the patent service exploration and practices of the Intellectual Property Information Service Center of Shandong University of Technology (hereinafter referred to as "the Center") as an example to discuss the positioning, content, and models of patent services in university libraries, aiming to provide references for deepening patent services and improving service quality.

3 User Needs and Service Design

As a deep-level discipline service, the patent service function of university libraries is mainly manifested in patent literacy education, patent research services, and intelligence analysis and decision support services. Its value and influence lie in the high consistency between services and needs. Therefore, we first conduct an in-depth analysis of the content and characteristics of patent service needs, and then design service models according to these needs to achieve specialization and efficiency. The specific framework is shown in Figure 1 [Figure 1: see original paper].

3.1 Patent Literacy Education

Education itself is hierarchical, and patent literacy education is no exception. The primary targets of university library patent literacy education are students, faculty, and researchers, each with different learning content and depth requirements. For undergraduate students, whose educational characteristic is learning professional knowledge through receptive methods under teacher guidance, patent literacy education mainly focuses on establishing patent awareness and mastering patent retrieval skills—these are basic needs that are relatively easy to satisfy. However, for the vast majority of engineering students who will engage

in technology R&D or science and technology management after graduation, education should also emphasize the cultivation of technological innovation and patent cognition abilities. Graduate students, whose educational characteristic combines learning with research, require patent literacy education that cultivates practical application abilities. They must not only master patent retrieval skills to draw inspiration and facilitate innovation but also learn to draft patent application documents for research outcomes. Faculty and researchers primarily need patent services for teaching and research purposes, requiring mastery of practical content including analysis of cutting-edge technologies, patentability judgment of scientific achievements, patent portfolio development, patent application essentials, examination response strategies, and patent implementation to ensure patent quality and improve conversion rates.

Patent literacy education is highly practical. In terms of content, it should not only popularize basic patent knowledge and retrieval of domestic and foreign patent literature through general education to establish correct patent cognition among faculty and students but also highlight engineering characteristics. With the cultivation of intellectual property protection awareness and innovation capability as fundamental points, and from a practical perspective, it should establish a diversified patent teaching practice model that is sequentially progressive, organically connected, clearly layered, and scientifically rational. This expands the coverage and audience of patent popularization education in universities, particularly strengthening practical patent training for engineering students and faculty. Various forms such as self-service Q&A, lectures, and case discussions should be used to reinforce patent content and embed targeted solutions to specific practical problems.

3.2 Patent Research Services

Patent services permeate almost the entire process of scientific and technological innovation activities, with different stages requiring different services: for example, novelty searches and market prospect judgment during the project initiation stage, technical reference and learning during the innovation process, and patent application, maintenance, and transformation implementation around research outcomes during the project completion stage. These contents vary in nature, priority, and difficulty. Based on service depth, patent service needs can be divided into three categories: procedural practices where form outweighs content, universal non-procedural practices where content outweighs form, and patent practices with significant impact. Procedural practices such as patent retrieval methods, inventor changes, registration procedures, and patent annuity payments have weak technical content correlation but are repeatedly consulted in daily work. Universal non-procedural practices such as patent application document drafting and examination response have strong technical correlation, high demand, and high frequency, requiring rich patent practice experience and professional technical background support. Patent practices with significant impact, such as major project R&D and patent portfolio development, occur

less frequently but are highly integrated with patents, technology, and markets, containing high knowledge content that is crucial for project scientific validity, safety, and investment value.

To address these needs efficiently and ensure service quality, libraries should proceed from reality. First, procedural practices can be incorporated into a self-service platform to meet user needs through self-help, significantly reducing repetitive labor. Second, the essence of universal non-procedural practices is the standardized description of technical content in patent form. Even when entrusted to formal patent agencies, patent agents must thoroughly understand the technical solution before condensing and expressing the technical content in the manner required by patent law. In this context, for university libraries with patent agents, these practices can be taught to faculty and students through courses, special lectures, and acting as patent advisors. Inventors are responsible for technical content identification and organization, while patent agents control the process from a patent law perspective. For the vast majority of university libraries without patent agents, 勉强承接难以保证专利质量, the feasible approach is to quickly cultivate professional talent while temporarily entrusting patent application practices to qualified agencies. Third, for patent practices in major economic and technological activities, a diversified service team comprising subject librarians, researchers, and domain experts should be formed. Subject librarians are embedded throughout the entire process, leveraging their information collection, retrieval, processing, and macro-analysis capabilities to seamlessly integrate with researchers' professional knowledge. Researchers are responsible for professional knowledge identification, while domain experts provide interpretation. All parties complement each other's advantages and collaboratively complete tasks according to the principle of "analysis on demand, emphasizing practical results."

3.3 Intelligence Analysis and Decision Support

Industry, academia, research, and government, as important production factors and key players in the technological innovation system, have enormous needs for intelligence analysis and decision support. These include intellectual property analysis services integrated into the entire lifecycle of innovation activities, such as patent activity trend analysis, patent technology early warning, infringement risk analysis and design-around solutions, patent competitiveness evaluation, and industry/industrial development research. Decision support for research management requires using bibliometrics and statistics methods, employing big data mining technology to process, organize, and analyze patent information, transforming it into comprehensive and predictive intelligence. Government agencies need consulting suggestions for macro decision-making, such as industrial development evaluation, technology development trend prediction, and comparative analysis of scientific and technological strength.

These needs represent the highest level of current university library services, involving broad content with high technical content and knowledge density. In

response, university library patent services should follow the principles of "analysis on demand, classified analysis, and emphasizing practical results." Analysis on demand is an important foundation for patent services to play an effective role in economic and technological activities. Analysis work should closely revolve around the actual needs of these activities, conducting in-depth investigation and analysis of difficulties and confusions encountered in intellectual property, accurately refining the task objectives of information services, and formulating feasible work plans. Classified analysis means conducting analysis based on the category characteristics of various economic and technological activities. Different categories have significantly different requirements for intelligence analysis, and analytical methods and content should be adaptively adjusted to achieve "one matter, one discussion, one plan" and solve intellectual property problems in a personalized manner. Emphasizing practical results means taking the effective solution of intellectual property problems in economic and technological activities as the criterion and orientation, and providing targeted and actionable suggestions based on comprehensive and thorough evaluation of key issues.

4 Patent Service Practices of the Center

The Center was established based on the Library and Information Science master's program at Shandong University of Technology. It currently has 15 teaching staff (12 of whom are master's supervisors in library and information science, and one holds a patent agent qualification). Shandong University of Technology is a comprehensive university focusing on engineering and science with coordinated multi-disciplinary development, with nearly 2,000 full-time faculty members and nearly 40,000 full-time students. The university undertakes numerous vertical and horizontal research projects annually, generating substantial patent service demands in patent information literacy education, scientific research, patent practice, and decision support. Faced with the contradiction between such enormous service demands and limited service team resources, the Center has carried out effective patent services based on actual conditions, establishing a service system comprising patent literacy education, patent research services, and intelligence analysis and decision support services, achieving good results. The specific situation is shown in Figure 2 [Figure 2: see original paper].

4.1 Patent Literacy Education: Combining Popularization with Advancement

(1) **Offering a compulsory course on patent information retrieval.** Since 1997, the Center has been responsible for teaching the compulsory university-wide course *Information Retrieval* (now renamed *Practical Network Information Retrieval*), with patents as one of its main components. The course covers basic knowledge including patent types, patent rights characteristics, and patent examination conditions, as well as representative patent retrieval websites, and includes hands-on retrieval practice, case discussions, and assignments. It focuses on popularizing basic patent

knowledge and cultivating patent awareness. Currently, nearly 8,000 students receive this course education each academic year, and over 100,000 students have received patent course education to date. The course has been rated as an "Excellent Resource Sharing Course" by the Ministry of Education.

(2) **Offering a general education course on *Technological Innovation and Patents*.** Different from the superficial coverage of patent knowledge in *Practical Network Information Retrieval*, the general education course *Technological Innovation and Patents* offered by the Center since 2014 integrates law and natural science with strong practical orientation, primarily targeting engineering students to enhance their practical abilities. The course content is arranged according to the process of transforming technological innovation into patents, focusing on teaching knowledge modules such as patent application, examination, reexamination, and invalidation requests. The course adopts a teaching-practice integration model: appropriately reducing abstract theoretical content while increasing practical components, such as "case teaching" based on students' innovation activities, drafting patent application documents, and judging the "three characteristics" of patents (novelty, inventiveness, and utility). This approach not only establishes students' correct patent cognition and stimulates innovation enthusiasm but also solves their confusion about patent applications. According to incomplete statistics, students obtained over 1,900 utility model patents between 2010-2018, with the number of patent applications continuing to increase.

(3) **Organizing patent promotion months, regular lectures, and appointment-based lectures.** The Center organizes intellectual property promotion months targeting faculty and students from engineering and science colleges, synchronously promoting intellectual property through bulletin boards and academic reports. It invites experts from the State Intellectual Property Office, Chinese Academy of Sciences, Shandong Provincial Development and Reform Commission, and other relevant fields to give academic reports, and invites patent agencies to interact and exchange with faculty and students. Regular lectures are held monthly at the library for all faculty and students, with flexible themes using a combination of explanation, retrieval demonstration, case discussion, and Q&A, primarily aimed at popularizing and consolidating patent knowledge and answering practical questions. Appointment-based lectures are more targeted, organized according to specific patent needs, such as a series of lectures on "Getting Close to Patents" and "How to Apply for Patents" requested by student unions, and special lectures on patent application document drafting, how to respond to corrections, and how to reply to examination opinions requested by colleges or research teams. To date, the Center has held over 120 patent lectures in various forms. Through normalized regular lectures and appointment-based lectures, the Center centrally addresses common patent issues, improving

service efficiency while incorporating these issues as cases into patent course teaching to 反哺 teaching.

(4) **Constructing a patent information service platform.** The platform includes basic service areas, training service areas, and interactive exchange areas. The basic service area provides intellectual property laws and regulations, basic intellectual property knowledge, university intellectual property, and annuity payment information to meet the information needs of various innovation entities. The training service area includes practical content such as patent application guidelines and how to reply to examination opinions, with links to the State Intellectual Property Office, Wisdom Bud, and other patent websites to guide users toward comprehensive self-service training. The interactive exchange area facilitates online or offline communication with users to answer questions at any time. The platform's establishment effectively alleviates the Center's resource constraints and the problem of extensive service demands and content.

Over the years, the Center has adhered to patent teaching reform, highlighting engineering characteristics, and focusing on the working mechanism of the patent system of "technological innovation—patent confirmation—patent utilization—promoting innovation." Through compulsory courses, general education courses, patent lectures, and the patent service platform, it has established a diversified patent teaching practice model that expands the patent audience, particularly strengthening practical patent training for engineering students. In 2018, the Center's project *Patent Teaching Reform and Practice Based on Innovation Capability Cultivation* won the second prize of Shandong Provincial Teaching Achievement Award.

4.2 Patent Research Services: Selective Focus

Patent practice has interdisciplinary characteristics integrating technology, law, and management, containing numerous patent knowledge elements, standardized texts, examination procedures, and implementation rules. Given the university's annual undertaking of numerous vertical and horizontal projects with over 1,000 patent applications, mostly invention patents with high creativity, a full-package or one-to-one service model is clearly unrealistic. The Center should therefore be selective and focused in its approach. Based on patent demand content, the Center provides differentiated services:

(1) **For procedural practices where form outweighs content**, the Center fully utilizes the self-service Q&A and training functions of its service platform. Various patent practices are decomposed into seven knowledge modules according to content: basic concepts, patent retrieval and websites, patent application procedures, patent examination, patent grant and annuity payment, patent reexamination and invalidation, and patent implementation. The content is presented in Q&A format on the platform,

allowing users to log in anytime for self-service answers. This not only facilitates faculty and students but also effectively alleviates the Center's human resource shortage. In this service category, Center members act as auxiliary consultants.

(2) **For universal non-procedural practices where content outweighs form**, the Center decomposes patent service content into modules such as patent information retrieval, judgment of patent "three characteristics," patent application guidelines, patent application document drafting, patent corrections, and examination response according to the patent application process. It clarifies the core business processes of each module, with patent agents delivering professional lectures on each module. This approach not only addresses practical work needs but also compensates for shortcomings in patent education. Faculty and students can professionally handle various practices using the taught patent skills without requiring Center members to handle everything personally. Even for technically demanding patent applications, inventors organize the application materials, which are then formally and substantively reviewed by patent agents. The Center also appoints patent agents as college patent advisors to efficiently and professionally guide the handling of various issues in patent practice. Currently, the university's annual invention patent applications approach 1,000, with over 90% completed through the above collaborative form. This eliminates the trouble of inventors making multiple trips to patent agencies, improves work efficiency, and because the Center has no revenue concerns, it is more conducive to controlling improper applications from the source and ensuring patent application quality. In this service category, Center members primarily act as trainers.

(3) **For patent practices in major economic and technological activities**, the Center forms flexible service teams embedded throughout the entire process, fully leveraging their information collection, retrieval, processing, and macro-analysis capabilities to achieve seamless integration with researchers' professional knowledge. Taking the Center's service for the advanced manufacturing research institute's mechanical special processing project as an example: during the project initiation stage, the Center conducted multiple exchanges with the project team in different forms, jointly formulated service and literature retrieval plans based on thorough understanding of the team's needs, and conducted detailed searches and reviews of domestic and foreign patent literature and CNKI and SCI scientific literature to help the team quickly grasp the domestic and international research status and technical layout of key research institutions. During the R&D stage, the Center remained embedded in the team's research process, further focusing information content according to the team's research progress, specifically on patent technologies and R&D activities of key institutions in vertical processing, horizontal processing, and profile modeling. Using bibliometric and neural network analysis methods from information science, the Center identified and predicted core technologies

in these fields. During the project completion stage, the Center conducted in-depth discussions with the project team on patent applications and portfolios for over ten technologies including CNC double-station honing machines, hydraulic double-station honing machines, and CNC spinning machines, collaboratively organizing patent application materials and completing patent applications and layout. In this service category, subject librarians primarily act as intelligence analysts and patent agents.

Precisely because of the Center's professional and high-quality services, while many universities are still struggling to increase patent quantity, Shandong University of Technology's patent work has stepped onto a new stage of pursuing quality, with the number of patent implementations increasing year by year. Among them, the exclusive license fee for the chlorine-free and fluorine-free polyurethane chemical foaming patent developed by the university reached 520 million RMB. Such high returns from a single invention patent represent a major breakthrough in the history of intellectual property operation in Shandong Province and even Chinese universities.

4.3 Intelligence Analysis and Decision Support: Industry-Academia-Research-Government Orientation

The Center breaks away from the traditional service model that primarily serves internal faculty and students with training statistics as the main content. Based on the needs of various entities, it provides targeted services, using bibliometrics and statistics methods to process, organize, and analyze patent information, transforming it into consulting suggestions with theoretical support and application value, such as development planning, consulting demonstration, and data statistics, thereby playing the role of "external brain" and "advisor" for university innovation, government decision-making, and enterprise development.

(1) **Providing decision support for university functional departments.** Using data mining technology, the Center has completed analysis reports on Shandong University of Technology's patent output and characteristic discipline analysis reports for vehicle engineering, biomass energy, mechanical electronics engineering, applied chemistry, and traffic information engineering and control, deeply analyzing the university's patent output, innovation capability, and patent quality from multiple dimensions. It has submitted academic reports such as "Patent Work Should Shift from Pursuing Quantity to Adjusting Structure and Improving Quality" and "Interdisciplinary Research in Universities from a Patent Perspective" to the university's Science and Technology Office and Development Planning Office, assisting the university in scientifically formulating development plans and helping correct improper incentives in the university's patent assessment policies by shifting the focus of patent rewards to market transformation, thereby controlling patent quality from the source.

(2) **Conducting patent competitive intelligence analysis for enterprises and research institutes.** Through patent consultation, training, and agency services, the Center has established good cooperative relationships with enterprises and research institutes. Leveraging its technical advantages in intelligence analysis, it conducts patent activity trend analysis, patent technology early warning, and industry/industrial development research. Commissioned by companies such as Luthai Textile Co., Ltd., the Center has conducted in-depth research on technology hotspots and competitive situations in textile printing and dyeing, pump, hydrogen energy, and building materials fields. It has represented the invalidation request and infringement litigation for the "Torch Gas Suction Compressor Series System" (Patent No. 2014102034271) and developed a "Network-based Patent Monitoring Competitive Intelligence System." Through providing various patent services, the Center has provided professional consulting references for the economic and technological activities of over twenty enterprises.

(3) **Actively engaging with local government to co-build a public intellectual property operation service platform.** Relying on its advantages in patent talent and intelligence analysis, the Center actively engages with local government to co-build the Zibo City Intellectual Property Operation Public Service Platform. The platform aims to promote intellectual property information services, enhance service levels, support scientific and technological innovation and achievement transformation, and promote integrated development between the university and the city. The platform includes online and offline components: the online platform features supply-demand display, rights protection, and online patent value evaluation modules, with full data resource sharing through comprehensive connection with the national platform; the offline component includes display areas, training areas, roadshow halls, and training classrooms. The Center mainly undertakes high-end tasks such as patent information mining, intellectual property analysis and review, decision support, and talent training.

Currently, the Center has conducted inventories of the university's existing patent quantity, quality, hotspots, and transformation situations, conducting domestic and international comparative analyses of the university's scientific and technological innovation strength and advantageous disciplines from a patent perspective to help the university know itself and its competitors. It has also reviewed the intellectual property situation of Zibo's characteristic industries such as ceramics and chemical engineering, completing dozens of vertical and horizontal projects including the State Intellectual Property Office's "Intellectual Property Strategy Construction for Small and Medium-sized Enterprises," with project funds exceeding one million RMB. As the service scope expands and service depth increases, the Center is making its voice heard from multiple dimensions, achieving good economic and social benefits.

5 Reflections

With the popularization of digitalization and networking, the halo of university libraries "having abundant resources and powerful intelligence analysis skills" is gradually disappearing. The contradiction in patent services has transformed into the conflict between users' growing demands for precision and professionalism and the lagging service capabilities of libraries. How to make patent services move toward precision and professionalism, provide professional services that meet user needs, and thereby ensure user trust, satisfaction, and loyalty, so that libraries maintain eternal vitality, the author, reviewing the Center's decades-long development of patent services, has some reflections.

5.1 Rational Positioning Is the Criterion for Patent Services

Patent services connect with technological innovation, and a considerable proportion of their content involves natural sciences. Currently, the educational backgrounds of university library staff are mainly bachelor's, master's, and associate degrees, with professional titles mainly at intermediate, 初级, and deputy senior levels, and most lack science and engineering backgrounds [16]. The limited specialty and capability of subject librarians versus the unlimited scope of patent technology is an eternal contradiction. Combined with the complexity of patent services and the uncertainty of user needs, these factors determine that library-provided patent services cannot cover everything. Micro-level analysis of disciplinary knowledge content is a judgment and research 环节 that researchers themselves must complete. In such cases, the professional advantages of subject librarians must be combined with the professional technical advantages of the demand side, with both parties complementing each other's strengths. For example, in judging the "three characteristics" of patents or conducting patent novelty searches, university disciplines are numerous, with high technological content and cutting-edge R&D. It is extremely difficult for subject librarians to accurately provide professional information, and no matter how good the service attitude, faculty will instinctively resist. In such situations, teaching someone to fish is better than giving them a fish. Libraries cannot have excessively high expectations or overstep their bounds in positioning patent services. They must pay attention to service effectiveness and sustainability, leveraging strengths while avoiding weaknesses, and doing some things while refraining from others.

5.2 Professional Talent Is the Support for Patent Services

The fundamental issue in library development is service capability. Patents span natural technology, law, management, economics, and other disciplines. The comprehensive nature of patent content determines that patent service personnel must not only have multi-disciplinary knowledge structures, balancing technology and law, but also possess flexible thinking, strong information awareness, keen market analysis ability, and good communication skills. It is precisely because the Center has an information retrieval teaching team, experienced patent agents, and members who are mostly master's supervisors in

library and information science with multi-disciplinary science and engineering backgrounds, familiar with information science theories and data mining methods, and proficient in data analysis tools such as SPSS, Knime, and Python, that it can construct a diversified patent teaching model with patent basic knowledge teaching as universal education, technological innovation and patent teaching as advancement, normalized patent lectures as supplements, research support as guidance, and cultivating innovative applied talents as the goal. This enables the Center to professionally provide in-depth patent guidance services such as patent application document drafting, examination response, reexamination and invalidation requests, and patent rights protection, and to have sufficient strength to conduct paid cooperation with local governments and multiple enterprises, providing consulting suggestions with theoretical support and application value such as development planning, consulting demonstration, and data statistics, achieving win-win social and economic benefits. Otherwise, everything would be empty talk.

5.3 Patent Education Is the Focus of Patent Services

As academic institutions serving teaching and scientific research, university libraries have a large number of service targets with high knowledge levels and heavy workloads. Taking patent services in the research field as an example, research activities involve intellectual property issues from project initiation to completion to achievement transformation, requiring different intellectual property information service support at different stages. Subject librarians should provide necessary information services at different project stages [17]. However, due to the multi-disciplinary, multi-research-direction, and high-tech characteristics of university research, it is difficult for the limited service force of libraries to address every problem in the entire research process with targeted patent services. With limited resources and huge demands, patent education must be popularized. First, through diversified patent teaching models including compulsory courses, general education courses, normalized patent lectures, irregular special lectures, and patent service platforms, a large number of repeatedly occurring patent problems can be addressed through classrooms, lectures, and self-service solutions, minimizing the human resource gap. Second, implement tiered services, classifying service content according to problem difficulty and time/effort required for solutions, providing self-service, real-time, point-to-surface, librarian-embedded, and team-embedded services. Through differentiated services, both low-level information service needs are met and limited resources can be allocated to high-level knowledge services.

5.4 Effective Mechanism Is the Guarantee for Patent Services

As a deep-level discipline service, patent services require sufficient high-quality professionals and full work enthusiasm as basic guarantees for quality service. Currently, although many university libraries in China have established subject librarian positions, most are part-time, and most subject librarians have not

received scientific and professional patent work training, lacking practical experience. Service content mainly remains at basic levels such as patent retrieval and patent information consultation, with low compensation and few promotion opportunities. Subject librarians cannot find a sense of existence and are generally in a state of weak professional capability and insufficient work motivation. To ensure the sustainable development of professional patent services, the university level must increase support for libraries in human, financial, and material resources, incorporating libraries into the overall university development blueprint. At the library level, a subject librarian team construction mechanism should be formulated to attract more outstanding talents to join the patent service team, using various methods such as sending staff out for training, inviting experts in, exchanges, and self-study to enhance subject librarians' sense of competence in their work. In evaluation and promotion, the practical effectiveness of subject librarians' work should be highlighted, with value recognition and policy preferences given to those with outstanding performance, ensuring rewards and punishments are based on clear criteria, with mechanisms for promotion and demotion, and entry and exit. Only in this way can the vitality of subject librarians be maintained and consistency between services and needs be guaranteed.

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Note: Figure translations are in progress. See original paper for figures.