Identification and Analysis of Historical Root Literature in the International Smart Library Field Based on Citation Publication Year Spectroscopy: Postprint

Authors: Gao Daobin, Li Zhijie, Wu Hong

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Abstract

[Purpose/Significance] Smart library research should not only focus on the present and explore the future, but also review the past and trace its origins. This study identifies and analyzes historical root literature in the international smart library domain, providing researchers with a reference for tracing the development trajectory of the field and discovering key milestone literature. [Method/Process] Utilizing 617 citing documents and 14,949 references in the smart library field from the Web of Science Core Collection as the data source, and based on the citation publication year spectrum function of CRExplorer software, this paper constructs a framework for identifying and analyzing historical root literature. According to the annual citation volume of references and the trend of the 5-year median deviation curve, the research stages of this field are divided into the foundation period, germination period, initial development period, and rapid development period. On this basis, 17 historical root literature items are identified. [Results/Conclusion] Literature analysis reveals that research in the smart library field exhibits the following characteristics: historical root literature demonstrates significant interdisciplinary nature; research content has transitioned from technology to theory and user experience; typical research themes show weak continuity with large temporal intervals; authors are predominantly "established scholars" with emerging scholars gaining prominence in recent years.

Full Text

Preamble

Identification and Analysis of Historical Root Literature in International Smart Library Research Based on Reference Publication Year

Spectrum

Gao Daobin[1], Li Zhijie[2], Wu Hong[2]

[1]WISE Lab, Institute of Science of Science and S&T Management, Dalian University of Technology, Dalian 116024, China
[2]School of Information Management, Shandong University of Technology, Zibo 255049, China

Abstract: [Purpose/Significance] Research on smart libraries should not only focus on the present and explore the future but also review the past and trace its origins. This study identifies and analyzes historical root literature in the international smart library field to help researchers understand the development trajectory and discover pivotal works. [Method/Process] Using 617 citing documents and 14,949 references from the Web of Science Core Collection as data sources, we constructed a framework for identifying and analyzing historical root literature based on the reference publication year spectroscopy (RPYS) function in CRExplorer software. Based on annual citation counts and trends in the 5-year average median deviation curve, the field' s development was divided into four stages: preparatory period, budding period, initial development period, and rapid development period, identifying 17 historical root documents. [Results/Conclusion] Analysis reveals that historical root literature in smart library research exhibits significant interdisciplinary characteristics, with research content shifting from technology to theory and user experience. Typical research themes show weak continuity with large temporal gaps, and authors are predominantly established scholars, though emerging researchers have recently made notable contributions.

Keywords: Smart library; Reference publication year spectrum; Historical root literature; CRExplorer
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0 Introduction

Smart libraries represent the latest focus of research in library science and an inevitable direction for future library development models. In 2003, Finnish scholar Aittola first introduced the concept of smart libraries in the paper "SmartLibrary—location-aware mobile library service" [1]. In 2009, IBM proposed the "Smarter Planet" concept, and China simultaneously introduced the "Perception China"initiative. These conceptual developments sparked a research boom in smart libraries both domestically and internationally. From an academic perspective, scholars have conducted multidimensional explorations of core concepts [2-3], main characteristics [4-5], information services [6], RFID technology [7], and model design [8]. From a policy perspective, in 2016, three Chinese ministries proposed building a technical standard system for smart libraries; in 2021, the Ministry of Culture and Tourism incorporated the national smart library system construction into the "14th Five-Year Plan for Cultural

and Tourism Development" [9]; and in 2022, the General Office of the CPC Central Committee and the State Council issued the "Opinions on Promoting the Implementation of the National Cultural Digitalization Strategy," which states in Article 6: "We must coordinate the construction of the national cultural big data system, the national smart library system, and the public cultural cloud" [10]. These policies demonstrate that China' s smart library construction has evolved from technical standard development and individual demonstration projects to national-level promotion.

From a conference perspective, the 2023 China Library Annual Conference hosted a forum themed "New Ecology and Transcendence: Co-creating the Smart Future of Libraries," which noted: "Facing opportunities and challenges brought by the trend of extensive reading, libraries must adapt strategically and transform toward 'smart hybrid libraries' " [11]. Consequently, smart libraries have become a focal point and hot topic in Chinese library research. Although the concept was formally proposed in 2003, the technological, theoretical, and practical roots preceding it remain unclear. In this context, this study traces the historical root literature of the smart library field, seeking those distant "lights" in its research history to help researchers understand the evolution of the field and deconstruct how smart libraries developed from simple concepts into today' s complex systems, thereby providing guidance for future research and construction.

1.1 Research on the Development Status of Smart Libraries in China

Research on the development status of smart libraries in China can be broadly divided into two approaches: bibliometric analysis based on journal databases and qualitative analysis of overall macro trends.

First, from a bibliometric perspective: Single-database studies include Zhang et al. [12], who used the CNKI journal database to reveal external and content characteristics of Chinese smart library literature through multidimensional bibliometric analysis; and Yuan [13], who reviewed theoretical research on smart libraries from 2010-2018 based on the China Knowledge Resource Integrated Database, summarizing existing studies on concepts, characteristics, and development trends. Multi-database studies include Li et al. [14], who used VIP, CNKI, and Wanfang databases to find that Chinese scholars had conducted in-depth discussions on fundamental issues and preliminary conceptualizations of smart library construction and service models; and Zhou et al. [15], who similarly used these three databases to discover that Chinese smart library research exhibited structural dispersion and remained in its infancy with multiple deficiencies.

Second, from a qualitative analysis perspective: Han [16] explored the technological characteristics, current status, and future trends of smart libraries from the perspective of the Internet of Things; Shi et al. [17] summarized current and

future development trends by tracing the historical evolution of library management systems and platforms; and Hu et al. [18] examined China' s smart library development from theoretical and practical perspectives, policy orientation, innovative practice, and strategic management dimensions, finding five characteristics: gradually improving policies, vertical and horizontal system coordination, diverse development models, comprehensive element upgrading, and in-depth standard exploration.

These studies offer significant insights into Chinese smart library research and construction, presenting the research status and trends from different time periods and perspectives, and generally showing an evolution from few to many, shallow to deep, and conceptualization to practice. However, limitations remain: the aforementioned research primarily focuses on domestic current status at various stages, neglecting the "external forces" and historical roots of smart library research. Only by embracing diverse influences and establishing solid historical foundations can more stable exploration proceed. Therefore, it is necessary to identify and analyze historical root literature in the international smart library field.

1.2 Research on Reference Publication Year Spectrum

The primary function of Reference Publication Year Spectrum (RPYS) is to identify important literature in a field by analyzing references, exploring their citation frequency and publication years to trace historical root literature and evolutionary processes. RPYS was first proposed by Marx in 2014 [19] and subsequently applied by foreign scholars to identify historical roots in information science [20] and global positioning systems [21]. In 2016, Thor further enriched its functionality by developing the CRExplorer software [22]. Hou [23] was the first Chinese scholar to introduce this software, systematically explaining its usage and functions for building RPYS, with empirical demonstration in citation analysis. Subsequent Chinese scholars have applied it to historical root identification in carbon emission trading [24], SARS [25], international reading therapy [26], academic entrepreneurship [27], and brain-computer interfaces [28].

In summary, RPYS is an effective method for identifying historical root literature in disciplinary fields, with good universality and operability. This method can trace the long-term evolution and origins of a field from the perspective of citation publication year distribution patterns. Therefore, this study uses this method to identify and analyze historical root literature in the international smart library field.

2.1 Framework Construction for Historical Root Literature Identification and Analysis

The framework constructed in this study comprises four components: (1) Literature acquisition: retrieving and obtaining full records and references of relevant

literature in the target field through the Web of Science database. (2) Literature preprocessing: extracting the reference dataset of citing documents using CRExplorer, further screening out references with missing publication years, setting initial publication years for citing and cited documents based on research trends and annual citation patterns, and then performing deduplication based on DOI similarity. (3) Historical root literature identification and analysis: constructing RPYS based on reference data through CRExplorer. First, identify citation peaks through the 5-year average median deviation curve and export various bibliometric indicators for references under each peak, including publication year, author, title, annual citation count, and proportion of annual citations to total citations. Second, plot the chronological evolution trajectory of citation peaks and divide the research trajectory into stages based on annual citation frequency and 5-year average median deviation curve patterns. Finally, select the most frequently cited reference in each peak year as that year' s historical root literature; if multiple documents have the same annual citation count, select the one with the highest total citation count in Google Scholar as the historical root literature, and conduct thematic, content, and author analysis of identified documents in each stage. (4) Conclusions and implications: summarize characteristics of historical root literature in the research field and propose referenceable implications based on research content, author attributes, and overall evolution patterns. The implementation process is shown in Figure 1 [Figure 1: see original paper].

2.2 Literature Acquisition

This study used the Web of Science (WOS) Core Collection as the data source. Referencing the multidimensional mapping of the Chinese term "智慧图书馆" (smart library) and Zhang et al.' s research [5], as well as RFID technology [29] as a core technology in smart library construction, the following search strategy was formulated: TS=("smart library") OR ("wisdom library") OR ("smart libraries") OR ("intelligence library") OR ("smarter library") OR ("intellectual library") OR ("wisdom libraries") OR ("intelligent libraries") OR ("intelligent library") OR ("intelligence libraries") OR ("AI library") OR ("AI libraries") OR ("RFID" and "library") OR ("RFID" and "libraries"). The search retrieved 643 relevant documents. After selecting article types as journal articles, conference papers, and reviews, 617 documents were retained as the research dataset. The search was conducted on September 12, 2023.

2.3 Literature Preprocessing

The retrieved documents were imported into CRExplorer software, which automatically identified the initial publication year as 1992 and the cutoff year as 2023, recognizing 15,479 references (with the 617 WOS documents as citing documents). After removing references with missing publication years, 14,949 references remained, with the earliest reference published in 1683. These references were used to construct a two-dimensional RPYS showing "reference

publication year - annual citation count and 5-year average median deviation curve." As shown in Figure 2 [Figure 2: see original paper], before 1900, references in the smart library field were scarce with no citation peaks, providing weak reference value for identifying historical root literature. Since the first citation peak appeared in 1948 and the 5-year average median deviation curve calculation interval spans two years forward and backward from the current year, the initial reference publication year was set to 1946. Due to the large number of references with potential duplicate titles or authors, deduplication was performed using DOI numbers with a similarity threshold of 100%, meaning documents with identical DOI numbers were considered the same reference. The preprocessed references were re-imported into CRExplorer, and the resulting RPYS is shown in Figure 3 [Figure 3: see original paper].

2.4 Analysis of Historical Root Literature Across the Overall Time Span

Figure 3 shows that across the overall time span, the total annual citation counts of references in the smart library field were relatively low, peaking at over 950 citations in 2017. Before 1980, both the total annual citation counts and the 5-year average median deviation curve had small baselines and remained stable. From 1980 to 2000, both indicators showed significant upward trends, reaching a peak in 2000. From 2001 to 2010, these metrics continued to rise substantially with some fluctuations. From 2011 to 2023, the overall trend showed a "decline-rise-decline" pattern with more significant fluctuations than the previous period, reaching the overall citation peak in 2017.

Based on the 5-year average median deviation curve, citation peaks were identified across the overall time span and plotted along a timeline. The research trajectory of the smart library field was divided into four stages according to the quantity and trend of annual total citations and the 5-year average median deviation curve: preparatory period (1946-1979), budding period (1980-1990), initial development period (1991-2000), and rapid development period (2001-present), as shown in Figure 4 [Figure 4: see original paper].

2.5.1 Identification and Analysis of Historical Root Literature in the Preparatory Period

Following the identification process described in Section 2.1, five historical root documents were identified for the preparatory period, as shown in Table 1 . Since CRExplorer can only count citations in the publication year, Google Scholar total citation counts were used to reflect overall academic influence across the time span (retrieved on September 13, 2023; same for subsequent sections).

Table 1: Historical Root Literature in the Preparatory Period

Publication/Conference	Google Scholar Total Citations
Stockman H. Communication by Means of Reflected Power. *Proceedings of the IRE*	9,995
Meier R L. Communications Overload: Proposals from the Study of a University Library. *Administrative Science Quarterly*	142
Zadeh L A. Fuzzy sets. *Information and Control*	120,491
Fikes R E, Nilsson N J. STRIPS: A new approach to the application of theorem proving to problem solving. *Artificial Intelligence*	8,086
Shamir A. How to share a secret. *Communications of the ACM*	18,754

The first citation peak in this stage occurred in 1948, with the historical root literature being Stockman' s "Communication by Means of Reflected Power" published in *Proceedings of the IRE* [30]. This paper established the theoretical foundation for Radio Frequency Identification (RFID) technology using reflected power communication principles. Stockman was the inventor and pioneering theorist of RFID technology, which can automate library operations such as borrowing, returning, locating, and classifying materials, thereby improving service efficiency [31].

The second citation peak occurred in 1963, with Meier' s "Communications Overload: Proposals from the Study of a University Library" published in *Administrative Science Quarterly* [32]. This paper analyzed and established a communication channel capacity model applied to university libraries to address communication overload. Collecting user behavior data through sensors and communication networks is crucial for optimizing smart library services [33], and communication load affects service orientation and reduces efficiency. Meier' s model provided solutions for addressing communication overload in smart libraries.

The third citation peak occurred in 1965, with Zadeh' s "Fuzzy sets" published in *Information and Control* [34]. This paper first introduced the concept of fuzzy sets, clarified relationships between inclusion, union, and intersection, and established various properties of these concepts in fuzzy set theory. Zadeh, the "father of fuzzy sets"and a member of the U.S. National Academy of Engineering, developed a theory for handling fuzzy or uncertain information widely applied in smart library automation systems. These systems can adopt fuzzy logic control strategies based on environmental conditions and user needs to improve energy

efficiency and user comfort [35].

The fourth and fifth citation peaks occurred in 1971 and 1979, respectively. The 1971 historical root literature was Fikes and Nilsson' s "STRIPS: A new approach to the application of theorem proving to problem solving" published in *Artificial Intelligence* [36]. STRIPS represents world models as arbitrary sets of first-order predicate calculus formulas and can handle models composed of numerous formulas. Smart libraries deploy various automation systems such as automatic lighting control, air conditioning, and book retrieval systems [29]; STRIPS can be used for automation system control to achieve intelligent, adaptive environmental management [37]. The 1979 historical root literature was Shamir' s "How to share a secret" published in *Communications of the ACM* [38], which first introduced the secret sharing algorithm. Shamir, a member of the U.S. National Academy of Sciences, developed an algorithm that smart libraries can use for user authentication and access control to maintain data privacy, ensuring only authenticated users or devices can access specific resources or perform specific operations [39].

2.5.2 Identification and Analysis of Historical Root Literature in the Budding Period

Three historical root documents were identified for the budding period, as shown in Table 2 .

Table 2: Historical Root Literature in the Budding Period

Publication/Conference	Google Scholar Total Citations
Schmidt R. Multiple emitter location and signal parameter estimation. *IEEE Transactions on Antennas and Propagation*	17,558
Davis F D. Perceived usefulness, perceived ease of use, and user acceptance of information technology. *Management Information Systems Quarterly*	81,550
Salovey P, Mayer J D. Emotional intelligence. *Imagination, Cognition and Personality*	26,247

The first citation peak in this stage occurred in 1986, with Schmidt' s "Multiple emitter location and signal parameter estimation" published in *IEEE Transactions on Antennas and Propagation* [40]. This paper discussed processing signals received on sensor arrays to determine emitter locations and described the MUSIC algorithm. Since smart library environments contain various noise

and interference sources (e.g., crowd noise, equipment noise), sensor array signal processing can separate and suppress these noises to more accurately extract information about user behavior and environmental conditions [41].

The second citation peak occurred in 1989, with Davis' s "Perceived usefulness, perceived ease of use, and user acceptance of information technology" published in *Management Information Systems Quarterly* [42]. This paper proposed the Technology Acceptance Model (TAM) for predicting computer acceptance, primarily including perceived usefulness and perceived ease of use. Smart libraries rely on advanced information systems such as intelligent retrieval systems and automated equipment; TAM can analyze adoption levels among staff and users. By examining cognitive factors and influences in TAM, managers can better predict new technology acceptance and make adoption decisions [43].

The third citation peak occurred in 1990, with Salovey and Mayer' s "Emotional intelligence" published in *Imagination, Cognition and Personality* [44]. This paper proposed a framework for assessing and expressing emotions in oneself and others, focusing on effectively regulating emotions to improve emotional maladaptation. Salovey, a renowned psychologist and 23rd President of Yale University, contributed a theory crucial for understanding user emotions and needs in smart libraries [45]. Emotional intelligence can train smart library staff to better interact with users, provide more emotionally intelligent services, and help users manage emotional and mental health issues.

2.5.3 Identification and Analysis of Historical Root Literature in the Initial Development Period

Two historical root documents were identified for the initial development period, as shown in Table 3 .

Table 3: Historical Root Literature in the Initial Development Period

Publication/Conference	Google Scholar Total Citations
Ollivier M. RFID enhances materials handling. *Sensor Review*	12,803
Bahl P, Padmanabhan V N. RADAR: An in-building RF-based user location and tracking system. *Proceedings IEEE INFOCOM*	14,000+

The first citation peak in this stage occurred in 1995, with Ollivier' s "RFID enhances materials handling" published in *Sensor Review* [46]. This paper reviewed RFID technology development, introduced the latest multi-segment

[M/P] transponders, and noted that RFID applications improve labeling efficiency, security, and accuracy. Smart libraries use RFID technology to track and manage books and materials; the introduction of multi-segment [M/P] transponders increased tag capacity and functionality within a single unit. The miniaturization of RFID tags and advantages of passive transponder technology help smart libraries efficiently manage and track their assets.

The second citation peak occurred in 2000, with Bahl and Padmanabhan' s "RADAR: An in-building RF-based user location and tracking system" published in *Proceedings IEEE INFOCOM* [47]. This paper introduced an RF-based radar system combining empirical measurements with signal propagation modeling to enable location-aware services. Bahl, CTO of Microsoft and founder of *ACM Mobile Computing and Communications Review*, contributed a system that helps smart libraries provide location-specific information, navigation, and resource recommendations by understanding user locations, thereby improving user experience and facilitating access to needed information [48]. Smart libraries can also use RF radar systems to track resource locations and effectively mobilize internal "organs."

2.5.4 Identification and Analysis of Historical Root Literature in the Rapid Development Period

Seven historical root documents were identified for the rapid development period, as shown in Table 4 .

Table 4: Historical Root Literature in the Rapid Development Period

Publication/Conference	Google Scholar Total Citations
Yu S C. RFID implementation and benefits in libraries. *The Electronic Library*	118
Nikitin P V, et al. Phase based spatial identification of UHF RFID tags. *IEEE International Conference on RFID*	2,049
Wang J, Katabi D. Dude, where' s my card? RFID positioning that works with multipath and non-line of sight. *ACM SIGCOMM 2013 Conference*	2049+
Whitmore A, et al. The Internet of Things—A survey of topics and trends. *Information Systems Frontiers*	1,200+

Publication/Conference	Google Scholar Total Citations
Yang X, et al. Smart library: identifying books on library shelves using supervised deep learning for scene text reading. *ACM/IEEE Joint Conference on Digital Libraries*	122
Cao G, et al. How to make the library smart? The conceptualization of the smart library. *The Electronic Library*	643
Yu K, Huang G. Exploring consumers' intent to use smart libraries with technology acceptance model. *The Electronic Library*	200+

Notably, this study did not identify Finnish scholar Aittola' s 2003 paper "SmartLibrary—location-aware mobile library service" presented at the Human-Computer Interaction with Mobile Devices and Services conference. Investigation revealed that this paper is not indexed in the WOS Core Collection. However, its key content includes analysis of RFID technology embedding in smart libraries, and this stage' s results include three documents closely related to this technology. Moreover, the preparatory period identified literature by the technology' s originator, demonstrating the referential value of our identification results.

The first citation peak in this stage occurred in 2007, with Yu' s "RFID implementation and benefits in libraries" published in *The Electronic Library* [49]. This paper analyzed the feasibility of RFID systems in libraries and identified application advantages in inventory, access control, and reading statistics collection. The second and third peaks occurred in 2010 and 2013, with Nikitin' s "Phase based spatial identification of UHF RFID tags" presented at the IEEE International Conference on RFID [50], which outlined spatial identification of modulated backscatter UHF RFID tags using RF phase information and described three primary PDOA (Phase Difference of Arrival) techniques; and Wang and Katabi' s "Dude, where' s my card? RFID positioning that works with multipath and non-line of sight" presented at ACM SIGCOMM 2013 [7], which introduced a fine-grained RFID positioning system robust to multipath and non-line-of-sight scenarios. These studies, all focusing on RFID technology, provide important references for multi-scenario RFID embedding in smart libraries.

The fourth citation peak occurred in 2015, with Whitmore et al.' s "The Internet of Things—A survey of topics and trends" published in *Information Systems*

Frontiers [51]. This paper summarized IoT dissemination trends and challenges and proposed future research questions and directions. IoT technology connects various devices and sensors to the internet, enabling device communication to help smart libraries achieve automation and energy-saving goals [6]. IoT-based sensors can monitor environmental conditions (temperature, humidity, etc.) in real-time to optimize environmental control and provide more comfortable user experiences.

The fifth and sixth peaks occurred in 2017 and 2018, with Yang et al.' s "Smart library: identifying books on library shelves using supervised deep learning for scene text reading" presented at the ACM/IEEE Joint Conference on Digital Libraries [52], which proposed a library inventory construction and retrieval system based on scene text reading that significantly reduces manual labor; and Cao et al.' s "How to make the library smart? The conceptualization of the smart library" published in *The Electronic Library* [53], which clarified the smart library concept by integrating three main dimensions (technology, service, and people) and proposed strategic principles.

The seventh citation peak occurred in 2020, with Yu and Huang' s "Exploring consumers' intent to use smart libraries with technology acceptance model" published in *The Electronic Library* [54]. This paper found through questionnaire surveys that perceived ease of use positively and directly affects perceived usefulness, which in turn positively and directly affects behavioral intention. The paper provides important insights into smart library user satisfaction and behavior, enabling libraries to improve system design and service delivery to meet user needs and enhance satisfaction [43].

3.1 Significant Interdisciplinarity in Historical Root Literature

Whether RFID technology, information transmission models, fuzzy set theory, IoT, or emotional intelligence, these are all typical technologies or theories from information science, mathematics, and even psychology—not originally within the traditional scope of library science—demonstrating significant interdisciplinarity. RFID technology has profoundly impacted smart library research, from Stockman's "Communication by Means of Reflected Power" [30] to Ollivier' s "RFID enhances materials handling" [46], showing the integration of information technology and library science. Zadeh's fuzzy set theory laid the theoretical foundation for information retrieval and automation system construction [34]. Shamir' s secret sharing algorithm provided effective methods for smart library data security [38]. Meier' s communication channel capacity model originated solutions for communication overload in smart libraries [32]. Schmidt' s sensor array signal processing technology [40] and Salovey' s emotional intelligence research [44] provide important guidance for selecting intelligent service systems and improving service content.

3.2 Research Content Shift from Technology to Theory and User Experience

Preparatory period research focused on RFID technology development, applications, and communication load management, establishing the technological foundation for smart libraries through RFID tags, communication principles, and information theory. Budding period research emphasized sensor technology, positioning, and location awareness, with sensor array technology and RFID further supporting data collection and environmental optimization, while TAM provided a framework for evaluating information technology adoption. Initial development period research concentrated on RFID system applications, including inventory management, access control, and indoor location-aware technologies (e.g., RF radar systems). Rapid development period research began focusing on smart library theory and strategy, emphasizing user acceptance and satisfaction, and integrating technology, service, and personnel. Overall, smart library research has gradually shifted from early technological exploration to theoretical framework establishment and user experience investigation.

3.3 Weak Continuity of Typical Research Themes with Large Temporal Gaps

Calculating the average time interval between historical root documents (sum of intervals between consecutive citation peaks divided by number of intervals) reveals an average gap of 4.5 years, with significant thematic differences between peaks: "RFID technology—communication channel capacity model—fuzzy set theory—STRIPS problem solver—secret sharing algorithm—sensor array signal processing—technology acceptance model (TAM)—emotional intelligence—RFID technology—RF radar system—RFID technology—UHF RFID tags—RFID positioning system—IoT—smart library strategic principles—user experience." Except for RFID-related research, other themes show substantial differences, reflecting that smart library research remains in a broad exploration stage with dispersed structure. This finding aligns with Zhou et al.' s domestic research conclusion [15], showing that smart library research exhibits dispersion both domestically and internationally. The large thematic gaps and significant differences also indicate insufficient inheritance in the field.

3.4 Predominance of Established Scholars with Emerging Researchers Recently Rising

In the early stages of the field, historical root literature authors were mostly renowned foreign scientists who established authoritative foundations. For example, the first peak' s "Communication by Means of Reflected Power" was authored by Stockman, RFID' s inventor; the third preparatory period peak' s "Fuzzy sets" was authored by Zadeh, the "father of fuzzy sets" and U.S. National Academy of Engineering member; the fifth preparatory period peak' s "How to share a secret" was authored by Shamir, a U.S. National Academy of

Sciences member; and the third budding period peak' s "Emotional intelligence" was authored by Salovey, a renowned psychologist. In middle and later stages, new forces emerged, such as Ollivier (author of "RFID enhances materials handling" in the initial development period) and Yang (author of "Smart library: identifying books on library shelves using supervised deep learning for scene text reading" in the rapid development period). Thus, established scholars and emerging researchers jointly drive smart library development, forming a diverse and dynamic research ecosystem.

4.1 Smart Library Research Requires Integrating Knowledge and Technology Across Disciplines

Smart library research and construction is an interdisciplinary task requiring integration of knowledge and technology from various fields. Information science provides the technological foundation for processing and managing information resources; communication technology offers necessary infrastructure for remote access to smart libraries; and innovations in electronic engineering provide greater interactivity and automation. Additionally, psychological research helps better understand user behavior and information retrieval habits to improve user experience and service quality. Researchers should pay attention to the latest research findings in information science, communication, electronic engineering, and psychology, applying interdisciplinary collaboration and cross-field research results to theoretical exploration, system construction, and practical operations to meet user needs, improve efficiency, and promote intelligence.

4.2 Following Technological Trajectories While Focusing on User Experience and Theoretical Frameworks

In the early stages of smart library research, technologies like RFID and IoT provided the technological foundation, but technology application is not instantaneous—it evolves and adjusts with technological development. For example, RFID technology was initially applied to book tagging and user location sensing in smart libraries, then gradually applied to access control and self-service book return as it developed toward precision and multidimensionality. Therefore, it is necessary to continuously monitor new technology trends and application scenarios to keep smart library research and construction "evergreen." However, technology is only the "skeleton" ; the "soul" of construction is user service, which requires focusing on user needs. More research should be conducted from the user perspective, investigating user satisfaction, usage intentions, and expected scenarios. The "skeleton" and "soul" require theoretical frameworks as "blood." Consequently, researchers urgently need to explore feasible theoretical frameworks that align with smart library development patterns and construction rules.

4.3 Inheriting and Innovating Classic Research with Deeper, More Focused Content

Inheriting classic research findings is crucial for ensuring knowledge continuity and serves as an important source of innovation. Researchers should deeply explore early important literature and theories to understand the field' s history and origins. By building new research on classic foundations and tracing origins to understand key issues, researchers can better integrate existing findings and promote cross-temporal knowledge inheritance and innovation. Simultaneously, more focused and in-depth research on specific themes is needed to narrow specialization scope. Currently, researchers can follow national and provincial strategic guidance, such as the "Opinions on Promoting the Implementation of the National Cultural Digitalization Strategy" [10], to focus on the national smart library system construction direction. Research should concentrate on integrated themes like "knowledge content integrated storage systems," "cloud-based smart libraries," "smart library management systems," and "smart service spaces" based on cloud computing and 5G technology, providing support for developing new service scenarios.

4.4 Following Established Scholars' Research Trails While Noticing Emerging Researchers' Insights

Distinguished scientists in information science, mathematics, and psychology laid solid foundations for smart library research and construction, with their pioneering research gradually forging the "contours" and "framework" from nothing. In the long river of research, young and insightful emerging researchers continuously "add bricks and tiles." Today, the "cottage" of smart libraries stands at the end of the road for libraries, but transforming it into a "magnificent" building of scholarly fragrance still requires exploration and construction. Researchers should follow the research trails of "masters" in the field, as their achievements and insights can truly provide "enlightening" guidance. Meanwhile, attention should be paid to emerging researchers' insights, as they possess different perspectives and innovative thinking, often exploring novel problems and bringing new ideas and cutting-edge directions to the field.

5 Conclusion

By tracing origins and studying classics, this paper identifies and analyzes historical root literature in the international smart library field using the RPYS method. The study systematically constructs a process framework for identifying and analyzing historical root literature in disciplinary fields, with core components including RPYS construction, citation peak identification, evolution trajectory plotting, and stage division. Results show that international smart library research has experienced a staged development process of "preparatory period—budding period—initial development period—rapid development period." Most historical root literature originates from cross-disciplinary fields such as

information science, mathematics, and psychology. Authors are primarily internationally renowned scientists, though a gradual "grassroots" trend has emerged in recent years, with more new-generation researchers contributing important innovative theories and methods. This suggests researchers should absorb more cross-disciplinary knowledge and technology, study classics by masters while paying attention to emerging researchers. However, the field also faces problems such as loose research structure and insufficient thematic inheritance, which limit in-depth development. These issues suggest researchers should follow national and regional policy guidance, focus on more constructive and strategic research topics, inherit classic research while injecting fresh blood, and promote innovation while preserving tradition.

This study has the following limitations: First, it did not combine multiple foreign databases, limiting the identification scope to some extent. Second, due to space constraints, only single historical root documents under each citation peak were analyzed in detail, making it difficult to fully map the research landscape. Future research will address these shortcomings to improve standardization and reference value.

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