Research Patterns of Library and Information Science in China from the Perspective of Journal Articles: A Postprint

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Abstract

[目的/意义] Since 2007, the number of journal articles published annually in China's library and information science field has exceeded 20,000. Taking data released by CNKI as an example, revealing the research topics and characteristics of these journal articles can, to a certain extent, reflect the current research style of China's library and information science field, and can also provide references for researchers in China's library and information science discipline to grasp the disciplinary development context and expand research ideas.

[方法/过程] By comprehensively applying theoretical induction and comparative research methods, this study organizes the current research patterns of the library and information science discipline from four dimensions: topic selection perspective, source materials, research methods, and writing approaches, and summarizes and extracts seven research patterns of China's library and information science discipline. Taking papers published in 18 core journals of the library and information science discipline from 2015 to 2017 as the research object, a quantitative analysis is conducted on the overall quantity distribution, publication year distribution, journal distribution, and author institution distribution of the seven research patterns.

[结果/结论] The seven research patterns of China's library and information science discipline exhibit distinct characteristics driven by the combined forces of theoretical creation subjects, journal theme orientation, practical application scenarios, and modern technological development. Specifically: exploration research on emerging concepts and technology applications has created new scenarios for library and information science practice; theoretical summary research based on documentary information resources has become the mainstream research pattern; applied analysis research oriented toward front-line operations has enriched the research system of the library and information science discipline; application research on mathematical statistics has expanded the research methods of

the library and information science discipline; research on computer software application and algorithm design, catalyzed by the development of modern information technology, has broadened the research perspectives of the library and information science discipline; the interdisciplinary integration model has provided new channels for cross-disciplinary research in the library and information science discipline.

Full Text

Preamble

Study on Research Models of Library and Information Science in China from the Perspective of Journal Papers

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Abstract: [Purpose/Significance] Since 2007, more than 20,000 journal papers have been published annually in China's library and information science (LIS) field. Taking CNKI data as an example, analyzing the topic selection and research characteristics of these journal papers can reflect the current research style of China's LIS field to a certain extent and provide references for researchers to grasp the discipline's development trajectory and expand research ideas. [Method/Process] This study comprehensively applied theoretical induction and comparative research methods to examine current research models in LIS from four dimensions: topic selection angle, source materials, research methods, and writing 思路 (thinking). Seven research models in China's LIS field were summarized and extracted. Taking papers published in 18 core LIS journals from 2015 to 2017 as the research object, quantitative analysis was conducted on the overall distribution, publication year distribution, journal distribution, and author institution distribution of these seven research models. [Result/Conclusion] The seven research models in China's LIS field exhibit different characteristics driven by theoretical creation subjects, journal theme orientation, practical application scenarios, and modern technological development. Specifically: exploratory research on emerging concepts and technologies creates new scenarios for LIS practice activities; theoretical summary research based on literature information resources has become the mainstream research model; application analysis research oriented to front-line business enriches the LIS research system; applied research on mathematical statistics expands LIS research methods; research on computer software application and algorithm design stimulated by modern IT development broadens LIS research perspectives; and interdisciplinary integration models provide new channels for cross-border research in LIS.

Keywords: library science; information science; theoretical research; journal papers; research model

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Since the German librarian Schrettinger first proposed the term "library science" in 1807, the research system of library and information science (hereinafter referred to as "LIS") has become increasingly perfected over two centuries of development. When analyzing the research objects of LIS, scholars have conducted both exploratory research on the practical activities of library and information institutions and research reviews based on existing LIS research achievements. However, comprehensive research that classifies and summarizes the vast volume of research achievements in this discipline from the perspectives of topic selection angle, source materials, research methods, and writing 思路 (thinking), thereby facilitating LIS researchers to determine writing topics and research plans according to their own research questions, target positioning, and technical conditions, remains relatively rare. Based on this, this paper attempts to systematically analyze the current mainstream research models in the LIS field from the perspective of journal papers.

2 Literature Review

Research models represent the overall research characteristics manifested by a discipline or research direction during a certain period. However, domestic scholars have not yet formed a unified understanding of the boundaries of research models. According to research, the most comprehensive and accurate description of the connotation of "research model" is: research model refers to a complete set of paradigms and requirements followed in the construction of a discipline, including academic principles, theoretical system footholds, research perspectives and discourse modes, main directions of basic theory, research methods applied, and knowledge and qualities that researchers should possess [1]. That is, research models involve seven aspects: topic selection angle, research direction, research methods, knowledge accumulation, academic principles, theoretical foundation, and expression style, forming a "collection." Among these, research direction determines the type and source of writing materials, while knowledge accumulation, academic principles, theoretical foundation, and expression style form the basis for writing 思路 (thinking). Based on this understanding, research models can be subdivided into four aspects: topic selection angle, source materials, research methods, and writing 思路 (thinking). Therefore, the domestic and international research status concerning research models needs to be considered not only from the theme of research models themselves but also from these four core elements. The authors searched CNKI, Web of Science, EBSCO, ProQuest, and ScienceDirect using "research model," "topic selection angle," "source materials," "research methods," and "writing 思路 (thinking)" as search terms from both title and keyword entry points to comprehensively investigate current research related to this topic.

2.1 Research on Research Models at Home and Abroad

Currently, research by Chinese scholars on LIS research models is not common. Representative works include: Han Yi and Li Rong [2] and Zhang Qin [3], who respectively summarized information science research models connecting information decision-making, information communication, information cognition, and information behavior, and information science theoretical system research models oriented toward "decision-communication-cognition" theory from the perspective of information science theoretical research. Zhou Lixia and Ma Haiqun [4], based on summarizing information law research achievements, proposed four information law research models: traditional law-based, information management-based, departmental branch-based, and empirical analysis-based. Wang Xin [5] used rational logic and historical analysis methods to divide strategic intelligence research models into planned, dynamic, discontinuous, and differentiated collaborative types. Similar to the domestic situation, foreign scholars have not conducted systematic research on LIS research models. Representative research results related to this topic include: A. Karlqvist [6] summarized five interdisciplinary research models, namely knowledge integration, knowledge pooling, constructing necessary research frameworks, and innovating research methods and 思路 (thinking). C. A. Cederlund [7] proposed knowledge accumulation and problem-solving research models in enterprise marketing theory and discussed the imbalance relationship between the two models and corresponding solutions.

2.2 Research on Topic Selection Angle at Home and Abroad

Topic selection angle includes both topic selection and angle. Topic selection is choosing the main research direction, while angle further determines specific research content. Currently, domestic and foreign scholars' research on topic selection is mainly based on qualitative or quantitative research. In qualitative research, a representative work is scholar Ye Jiyuan's [8] interpretation of the "Strategic Planning Research Report on Library, Information and Archival Management Discipline of the Philosophy and Social Science Management Department of Universities," proposing five key research fields for library, information and archival management discipline. Foreign scholar P. Hernon et al. [9] also systematically combed the topic selection characteristics of academic paper writing in the LIS field using LIS as an example. In quantitative research, Liu Maosheng et al. [10] conducted a quantitative analysis of topic selection in 13 core library science journals in China from 1997-1998, concluding that LIS topic selection involves 17 aspects including library science theory, information science and information work, philology and document work, bibliography and bibliographic work, library administration, and library and information enterprise organization and management. Zhou Jiuchang [11] analyzed keywords in library science master's theses in CNKI from 2006-2010, summarizing that Chinese library science master's thesis topic selection concentrates on five aspects. Li Yu, Liu Hong, et al. [12] used bibliometric analysis tools to obtain six major

topic selection directions for Chinese library science doctoral dissertations from 1994-2016.

2.3 Research on Source Materials at Home and Abroad

Writing materials form the basis of core arguments in scientific research, and their forms and acquisition means are directly influenced by research direction. For example, source materials in natural science fields are usually obtained through field scientific expeditions, experimental analysis, and simulation, while those in social science fields are mainly collected through social interviews, field surveys, questionnaires, and web surveys. Currently, domestic and foreign scholars have conducted relatively few analytical studies on source materials, with relatively more discussion by domestic scholars. Among them, Jiao Zhilan and Ma Hengtong [13] pointed out that methods for obtaining materials for library science paper writing mainly include investigation, observation, experiment, and literature retrieval. Lai Huirong [14] categorized writing materials into theoretical, factual, and contemplative types according to their attributes. Yang Xuequan [15] proposed that sources of topic selection materials in library and information science mainly include theoretical discussions and social practice, new phenomena, new businesses, and new problems emerging in library and information work practice, and inspirations and ideas generated after reading certain books and articles.

2.4 Research on Research Methods at Home and Abroad

Research methods refer to the research process of using scientific means to determine how to obtain, process, and analyze source materials according to the needs of specific arguments, and designing source materials into matching supporting arguments according to the needs of sub-arguments. Currently, domestic and foreign LIS scholars have produced numerous research results on research methods. Among them, Zhang Li, Tang Jianhui, and Liu Yongtao et al. [16] conducted a quantitative analysis of 10 important foreign journals and 3 important Chinese journals in the library and information field. Dong Chengdeng et al. [17] and Jin Shengyong et al. [18] summarized from the perspective of qualitative research that research methods in China's library and information field mainly include general research methods and specialized research methods. In addition, Chu Hetian [19], Sun Hongfei et al. [20], and Zhou Wenbo et al. [21] also conducted research on research methods in China's LIS field using quantitative analysis. Similar to domestic scholars, foreign LIS scholars are also keen on research methods research. Representative research results include: foreign scholar A. Ullah et al. [22] used systematic review methods to conclude that LIS commonly adopts empirical research, descriptive statistical analysis, and quantitative research methods; V. G. Rissø [23] conducted a statistical analysis of LIS research methods from 1970-2010, pointing out that LIS emphasizes descriptive research methods that can reflect disciplinary professionalism; J. D. Eldredge [24] collected and analyzed a large number of LIS documents and summarized

that commonly used research methods in LIS are case analysis, comparative analysis, and content analysis.

2.5 Research on Writing 思路 (Thinking) at Home and Abroad

Writing 思路 (thinking) is a comprehensive manifestation of the writing process and writing results. From the perspective of the writing process, writing 思路 (thinking) is the writing path, steps, or process formed according to the needs of research topic selection and in accordance with rigorous logic and organization. From the perspective of writing results, writing 思路 (thinking) is the paper framework constructed on the basis of the writing outline. Overall, writing 思路 (thinking) involves knowledge accumulation, academic principles, theoretical foundation, and expression style. Currently, domestic and foreign scholars have conducted relatively little research on writing 思路 (thinking), mostly focusing on analyzing the content structure or overall framework of papers. Among them, scholar Yang Xuequan [15] pointed out that when LIS scholars conduct paper creation, they should consider the overall layout structure of the paper comprehensively to ensure the unity of the macro structure and the harmony of content. In non-LIS fields, relevant research has also involved research paper structure design and writing guidance. For example, Xu Yun and Lou Ping [25] investigated 60 journal papers included in SCI and summarized the writing 思路 (thinking) and methods for basic modules such as titles, abstracts, and main texts. Foreign scholar A. Alluqmani et al. [26] conducted quantitative analysis on acronyms, sentence length, word length, and other indicators in scientific papers to analyze the writing styles of several disciplines.

Through reviewing current domestic and foreign research on LIS research models, it is evident that academic achievements specifically targeting LIS research models remain relatively rare. Related research mostly focuses on single angles such as topic selection, source materials, research methods, and writing 思路 (thinking), which are merely components of research models. In view of this, this paper will systematically analyze current mainstream research models in the library and information field from the perspective of journal papers, integrating dimensions of topic selection angle, source materials, research methods, and writing 思路 (thinking), and use quantitative analysis to reveal the distribution characteristics of these research models in terms of overall quantity, publication year, mainstream academic journals, and author groups, thereby reflecting the basic characteristics and macro context of current Chinese LIS research models.

3 Data Sources and Research Methods

This study takes journal papers in the LIS field as the research object. The selection of journal papers, determination of the types and names of LIS research models, and the statistical analysis of the distribution of various research models in LIS journal papers were mainly based on the following considerations:

3.1 Selection of Data Sources

The CSSCI (2017-2018 edition) developed by the Chinese Social Sciences Research Evaluation Center of Nanjing University was selected as the basis for identifying 18 core journals in the LIS field. Records were retrieved from the CNKI database in December 2018, yielding 9,864 records. After eliminating 1,166 invalid records such as prefaces, news reports, library regulations and revision summaries, journal catalogs, errata, submission guidelines, meeting minutes, reading reports, indexes, library construction introductions, legislative background introductions, memorial articles, interviews, speeches, invitations, reading reflections, and photo introductions that do not possess professional paper attributes, a total of 8,698 records were retained as valid research data for this paper.

3.2 Basis for Determining Types and Names of LIS Research Models

Based on a comprehensive pre-survey of the titles, abstracts, keywords, and research methods of the final selected 8,698 LIS journal papers, and following the principle of moderate relaxation with specific designation, this study first considered the application of other disciplines' theories and methods in the LIS field from a disciplinary perspective. According to the application history and frequency of these disciplines' theories and methods in LIS, four research models were identified: research based on mathematical methods and scientometrics, algorithm design and computer software development, comprehensive application of computer software and other programs, and interdisciplinary research (excluding mathematics and computer science). Second, based on the universal consensus that theoretical research and practical empirical research are two basic mainlines of scientific research, two research models were identified: theoretical summary research based on literature information resources and application analysis research oriented to front-line business. Third, considering the sensitivity of domestic LIS scholars to emerging concepts and frontier technologies—particularly when new expressions and concepts appear in foreign LIS or computer science fields, domestic scholars can quickly combine them with LIS discipline or front-line practice to conduct analysis—the research model of emerging concept and technology application exploration in the LIS field was extracted.

3.3 Statistics on the Distribution of Seven Research Models in LIS Journal Papers

After determining the types and names of LIS research models, based on the pre-survey results of 8,698 LIS journal papers, the authors manually indexed each paper to belong to one and only one research model through comprehensive analysis of titles, abstracts, keywords, and research methods. However, due to the comprehensive and interdisciplinary nature of LIS journal paper topics, whether a paper belongs to only one research model is flexible. Therefore, during the indexing process, to highlight specificity, priority was given to labeling

with four research models: mathematical methods and scientometrics-based research, algorithm design and computer software development, comprehensive application of computer software and other programs, and interdisciplinary research (excluding mathematics and computer science). For example, if a paper involving front-line business application analysis could be identified as applying certain mathematical methods from its research methods and core arguments, it was classified into the mathematical methods and scientometrics-based research model. Or, if its research methods and core arguments involved certain computer software, algorithms, or tools, it was preferentially classified into the algorithm design and computer software development research model or the comprehensive application of computer software and other programs research model, rather than simply being classified into the front-line business application analysis research model. Similarly, if a research review explicitly stated that it used scientometric methods, tools, or software, it was classified into the mathematical methods and scientometrics-based research model rather than simply being classified into the theoretical summary research model based on literature information resources. To avoid significant indexing errors, two indexers conducted the indexing separately and then compared the results. If a paper was indexed as the same research model by both, it was considered consistent and did not require further review. If a paper was indexed as two different research models, discussion and re-indexing were required, focusing on topic selection angle and research methods to determine the appropriate research model.

4 Boundaries and Characteristics of Library and Information Science Research Models

4.1 Conceptual Definition of LIS Research Models

According to research, the term "model" first appeared in "The Book of Wei · Yuan Zigong Biography." The relevant statement is: "Therefore, the Minister of Works, Minister of the Ministry of War, and Minister of the Ministry of Justice, according to the model of the Ming Hall made by the former Minister of Works, and together with the imperial edict, the two capital models, requested to build it." Scholars gradually formed a consensus on its basic definition, that is, a model refers to a certain pattern of things. Accordingly, the research model of a discipline can be positioned from its connotation as a certain pattern of scientific research achievement creation in that discipline. Combined with the definition of research models in the previous part of this paper, specifically, the research model of LIS refers to a complete set of paradigms followed in the theoretical creation process of LIS, including academic principles and logical rules, footholds of the theoretical system, research directions and angles, written expression methods, research methods applied, and source materials used. It is a combination pattern of LIS in terms of topic selection angle, source materials, research methods, and writing 思路 (thinking) during a certain period of scientific research creation.

4.2 Conceptual Definition and Internal Characteristics of Seven LIS Research Models

4.2.1 Emerging Concept and Technology Application Exploration Research Emerging concept and technology application exploration research takes the latest concepts and information technologies appearing in foreign LIS fields and related industries as the research background. In terms of topic selection angle and writing 思路 (thinking), it tends to select new concepts or models emerging in foreign LIS fields, or some newly emerged information technology, and imagine the potential impact and shock that applying this new concept or technology might bring to LIS theoretical research (such as "On the Impact of Big Data Environment on the Development of Information Science" [27]) or practical activities (such as "New Ideas for Experience Marketing to Help Library Omnimedia Reading Promotion" [28]), and then analyze the potential topics that might be triggered in theoretical research or the practical scenarios that might be developed in LIS business fields. Such research mostly appears in the early stage of new concepts and technologies and represents LIS scholars' hypothetical, predictive research on their possible application in LIS fields—an imagination, detection, and deduction of future application scenarios. For example, relatively early scientific research achievements in LIS involving backgrounds or topics such as open access, grid, institutional repositories, cloud computing, shared space, virtual reality, augmented reality, big data, scientific data, and digital humanities can generally be classified under this research model.

Since this new concept or technology is only a concept at this time and there are no complete cases matching it, this research model finds it difficult to adopt complete case analysis and other empirical research methods in its research methodology. Usually, researchers, to prove the feasibility or development prospects of these new concepts or technologies, select certain aspects of a case in the foreign LIS field as writing materials to prove a sub-argument. The entire paper usually presents very fragmented case evidence, that is, typically using Case A to prove the technical measures of the topic and Case B to illustrate the resource composition of the topic. For some new technology topics, since there are no best complete cases in foreign LIS fields, researchers sometimes select relevant cases from non-LIS fields, such as computer science or other disciplines, as supporting materials. Overall, scientific research achievements belonging to this research model are relatively weak in empirical nature. Since current LIS fields value empirical scientific research achievements more, as time goes by and the number of scientific research achievements involving this research model increases, researchers usually can no longer complete such topic creations based on pure theoretical deduction or writing imagination but need to combine typical complete cases or batches of related cases, or tools or software directly related to the new concept or technology, to conduct empirical research. That is, they need to initiate practical empirical research models.

4.2.2 Theoretical Summary Research Based on Literature Information Resources Theoretical summary is based on empirical induction, combined with theoretical deductive interpretation, to determine the necessary connections between phenomena, that is, to achieve an understanding of the regularity between phenomena. The theoretical summary research model based on literature information resources in the LIS field has a wide range of topic selection angles, involving not only historical topics such as disciplinary systems, research methods, research schools, and disciplines, fields, or figures, but also various reviews, commentaries, and theoretical and inductive scientific research achievements based on various applied texts. In the LIS field, the source materials that such scientific research achievements usually rely on are mainly primary literature information. Currently, there are three main types of primary literature information resources in the LIS field: (1) Scientific research achievements that have undergone peer review and been formally published, including monographs, journal papers, conference papers, and dissertations; (2) Publications that have not undergone peer review but have been formally published (mainly through online publication), research reports released by institutions and organizations, including various industry trends, development indexes, and situation analyses, which can usually reveal the main development trends, social and technical environments faced, and overall development status of the industry to a certain extent; (3) A category of information that does not need to undergo peer review but only states facts, requirements, positions, plans, guidelines, summaries, etc., that is, does not express an argumentative scientific research viewpoint and has been publicly published, including various news reports in the LIS field, introductions to information service content, service agreements signed with relevant providers or service agreements formulated by libraries themselves, relevant information policies, laws or ethical norms, industry standards or application norms, professional talent training programs, strategic development plans, annual summaries, job responsibility descriptions, recruitment conditions, and various annual, departmental, or post assessment standards.

From the current writing 思路 (thinking), creators of the theoretical summary model based on literature information resources are more enthusiastic about selecting the third type of primary literature information resources for scientific research creation. For example, the paper "Research on the Legal Basis of Public Library Corporate Governance Structure" [29] formed based on the comparative analysis of relevant policy and legal texts in the LIS field, and the paper "Research on Library Service Level Agreement in the 'Internet Plus' Environment" [30] formed based on the comparative analysis of service agreement texts formulated by libraries themselves. Such scientific research achievements tend to construct models, patterns, schemes, frameworks, or other general understandings from a theoretical level to timely reveal the development status, problems, or main trends of LIS front-line business practice.

Based on the number of achievements created by this selection, it currently occupies the vast majority of scientific research achievements in the LIS field

(this will be detailed later). The reasons for this, apart from the fact that most LIS researchers have humanities and social sciences backgrounds, also need to consider that scientific research achievements based on the first type of primary literature information resources, without using computer science-related methods (such as text analysis technology) or scientometric methods, are usually reviews or commentaries. Although the academic status of reviews or commentaries cannot be denied from the perspective of the completeness and maturity of disciplinary theoretical development, their academic influence is usually lower than more original theoretical creation achievements. Scientific research achievements formed based on the third type of primary literature information resources require creators to fully apply literature survey methods, content analysis, comparative analysis, synthesis, induction, and deduction in their research methods, and to conduct extensive material collection and viewpoint extraction, requiring higher theoretical induction ability. Of course, the second type of primary literature information resources usually cannot become independent source materials for scientific research creation in the LIS field (although a few LIS scholars use scientometric or computer science methods to process or analyze such information), but the viewpoints provided by the second type of primary literature information resources that can reveal the situational, industrial, periodic, or regional characteristics of the LIS field are widely used as corroborative materials for research background and research significance in scientific research achievements of other research models.

In specific writing practice, some scholars also induce theories based on observing the motion states of things. In this paper, this situation of direct observation based on the motion states of things, where the observer describes, summarizes, and induces by themselves to ultimately obtain theoretical findings, is included in "application analysis research oriented to front-line business." At the same time, to highlight specificity, in this study, if computer science-related methods or principles, or mathematical or scientometric methods or principles, are used to conduct research on the first type of primary literature information resources, it is correspondingly classified into the mathematical methods and scientometrics-based research model, algorithm design and computer software development research model, comprehensive application of computer software and other programs research model, or interdisciplinary research with other disciplines (excluding mathematics and computer science) according to the specific methods or principles applied.

4.2.3 Application Analysis Research Oriented to Front-Line Business
Application analysis research oriented to front-line business is a research style that takes front-line practical activities in the LIS field as the research object. Its source materials are not descriptions of such practical activities based on published primary literature information but are based on the creators' personal investigation as a key approach, including questionnaire surveys, expert interviews, field visits, or website surveys, with the creators describing, organizing, and analyzing the investigation results themselves, ultimately forming

scientific research achievements with high original value.

Currently, in terms of research methods, most creators of LIS scientific research achievements involving this research model will use web survey methods. However, there are two different situations in the application of web survey methods in the LIS field: (1) Collecting various literature information resources that have already appeared on the network through network channels, with the focus on "text"; (2) Collecting various activities and services carried out by relevant network content or service providers on the network, or the interfaces, system designs, or user interactions of network platforms, with the focus on "activities," "services," "systems," or "interfaces," requiring collectors to describe the survey results in text during the investigation process. According to the previous analysis, the web survey method that better meets the requirements of the application analysis research model oriented to front-line business in the LIS field should refer to the second situation.

In today's LIS field, which values empirical research more, scientific research achievements created based on front-line business application analysis usually receive higher recognition. Different from emerging concept and technology application exploration research, the topic selection angle of this research model covers various business practices that have been widely carried out in the LIS field. From the perspective of traditional physical libraries, the topic selection angle of this research model involves basic business links such as acquisition, classification, cataloging, collection, and circulation of libraries. From the perspective of digital libraries, the topic selection angle of this research model involves core elements such as digital library requirements, resources, services, technology, management, and personnel. Its writing 思路 (thinking) is usually that creators set research sample selection criteria based on a certain (or set of) business or a certain library (such as "Application Practice of WeChat in Library Information Services—Taking East China Normal University Library as an Example" [31]) or several library and information institutions (such as "Research on Publishing Services Based on Institutional Repositories in American University Libraries" [32]), and comprehensively apply case analysis, comparative analysis, web survey, field survey, questionnaire survey, and expert interview methods to analyze the information that can be collected through investigation, and induce typical practices or common behaviors of one or several library and information institutions in a certain (or set of) business practice, thereby achieving the purpose of providing targeted suggestions for the development and improvement of LIS industry practice.

From the perspective of source materials, application analysis research on traditional physical library front-line business is mainly based on field investigation, while practical application research on digital libraries is mainly realized through web surveys. Especially for some topics involving systems or platforms, most can only be conducted through web surveys, such as topics related to information construction of digital library website interfaces, real-time interactive services, and personalized customizable projects. To reflect specificity, for sci-

entific research achievements that introduce mathematical methods (including statistical methods) or use specific computer software or tools for demonstration and argumentation in the analysis process, although their source materials are front-line business practice activities in the LIS field, this study also correspondingly classifies them into mathematical methods and scientometrics-based research models, algorithm design and computer software development research models, comprehensive application of computer software and other programs research models, or interdisciplinary research with other disciplines (excluding mathematics and computer science).

4.2.4 Research Based on Mathematical Methods and Scientometrics
The prominent feature of the research model based on mathematical methods and scientometrics is that in terms of research methods, the core arguments of scientific research achievements conforming to this model mainly apply mathematical methods (including various statistical methods) or scientometric methods to process and analyze [33]. For example, "Analysis of Resource Procurement and Circulation of American Public Libraries Based on Mathematical Models" [34] and "Research on Frontier Dynamics in China's Image Retrieval Field—Bibliometric Analysis of CNKI Data Collection" [35].

Compared with the previous three research models, the topic selection angle of this research model is more distinctive, mainly involving three types: (1) Frequency analysis, regression analysis, correlation analysis, evaluation analysis, and prediction analysis related to LIS front-line business practice; (2) Taking published scientific research achievements in the LIS field as research samples to analyze the research frontiers, hotspots, trends, and progress of the entire LIS discipline or a subfield; (3) Bibliometrics, literature metrology, webometrics, informetrics, and scientometrics, including measurement indicators, measurement methods, measurement mechanisms, measurement tools, measurement result descriptions, measurement system design, measurement visualization, and knowledge mapping.

In terms of source materials, scientific research achievements using mathematical methods (including statistical methods) have materials that include both information described by creators themselves through investigation and literature related to the LIS field that has been published. Scientific research achievements using scientometric methods are mainly based on published literature related to the LIS field.

From the perspective of writing 思路 (thinking), creators using this research model prefer to start from more rigorous quantitative thinking to reveal the practical development and theoretical research characteristics of library and information science, including applying mathematical methods to construct models or conducting quantitative analysis based on scientometric methods. It should be noted that literature that purely discusses scientometric indicators and their evolution process without conducting quantitative analysis is classified into the theoretical summary research model based on literature information resources

in this study.

4.2.5 Algorithm Design and Computer Software Development Research Algorithm design and computer software development research models emphasize applying algorithms or computer software developed or designed by creators themselves to solve one or a class of problems in LIS theoretical research or practical activities. The topic selection angle focuses on achieving or enhancing personalized, automated, and intelligent services in the LIS field, covering a wide range of areas. Its research methods are mainly based on computer software experiments. In terms of source materials, it rarely uses existing LIS literature as direct analysis objects but obtains research questions from front-line practice in the LIS field. Its core materials are supported by the computer science knowledge possessed by creators and combined with information description for specific LIS application scenarios. In terms of writing 思路 (thinking), it mainly proposes a new algorithm or designs a new software, such as "Design and Implementation of Social Recommendation Algorithm Based on User-Resource-Vocabulary Tripartite Graph" [36]; or proposes improving an algorithm or enhancing existing software as the research orientation, and then designs experimental applications or prototype systems. To a certain extent, the algorithm design and prototype system development research model more pragmatically integrates computer science and library and information science knowledge, which is of revolutionary significance for promoting the automation and intelligent development of LIS theoretical research and practical application.

4.2.6 Computer Software Application and Other Programs' Comprehensive Application Research Different from the algorithm design and computer software development research model, which highlights "originality" as its prominent feature, the key point of the computer software application and other programs' comprehensive application research model is "application," representing a "take-ism" approach. That is, creators using this research model focus their topic selection angle on in-depth analysis of the functional positioning, technical principles, operation steps, interface interaction, and user experience (such as information retrieval behavior) of a certain general computer software, or software specifically applicable to LIS business development needs, or services carried out by the LIS field based on a certain application program (such as network information retrieval), and discuss how to apply it to LIS theoretical research or actual business. For example, "Research on Abnormal Access Behavior of Electronic Resources Based on EZproxy Logs" [37]. In terms of research methods, this research model mainly uses comparative analysis, case analysis, web survey, and computer software experimental methods. Source materials are basically the same as those used in the algorithm design and computer software development research model. That is, research questions are obtained from front-line practice in the LIS field, or the process or results of computer simulation experiments are taken as research objects. Its core materials are sup-

ported by the computer science knowledge possessed by creators, combined with functional descriptions of the applied computer software or other programs, and based on information description for specific LIS application scenarios or subjects participating in experiments. In terms of writing 思路 (thinking), it mainly starts from a certain topic of LIS theoretical research or a certain problem in LIS front-line practice as the demand or scenario, analyzes how to apply a certain computer software or application, or studies user demand characteristics and behavioral features in using a certain computer software or application under specific scenarios or tasks, and provides corresponding application suggestions or experimental findings, with strong practicality.

4.2.7 Interdisciplinary Research with Other Disciplines Apart from the existing applications of mathematics, computer science, and other disciplinary methods in LIS, more broadly absorbing and applying methods or principles from other disciplines to solve theoretical research or practical problems in LIS is an attempt by relevant LIS scholars to further broaden the research horizons of this field, reflecting interdisciplinary integration, method fusion, and direction innovation. However, applying methods or principles from other disciplines to LIS usually requires creators to have high interdisciplinary theoretical foundations and cross-boundary application capabilities. On the one hand, creators need not only to fully master the methods or principles from other disciplinary fields to be applied to LIS but also to be familiar with the essential characteristics of LIS theoretical research and practical business. On the other hand, when introducing such non-LIS disciplinary methods or principles, it is also necessary to consider whether the specific scenarios of LIS theoretical research or practical activities to be solved by the applied non-LIS disciplinary methods or principles have high or even complete homogeneity with the scenarios where these non-LIS disciplinary methods or principles can be applied. Otherwise, this interdisciplinary research may suffer from "incompatibility due to different scenarios." For example, some scholars have attempted to introduce the Customer Relationship Management (CRM) model into library reader management. In fact, CRM originated and is widely applied in the commercial field. When applying CRM, business operators and customers have a direct commercial relationship, and operators take obtaining profits from customers as their core purpose and internal driving force. Compared with business operators, libraries in China are basically public welfare organizations, taking the widespread dissemination of human cultural and scientific knowledge as their sacred duty and always adhering to the principles of fairness, free service, and universal benefit. In this context, the relationship between business operators and customers and the relationship between libraries and readers are fundamentally different. Therefore, introducing CRM concepts, methods, processes, or principles into related research in the LIS field would appear scientifically inadequate.

Nevertheless, relevant scholars in China's LIS field have made beneficial attempts in this regard, such as "System Dynamics Analysis of Knowledge Capi-

tal Efficiency in Library Transformation Process" [38] and "Research on Library Knowledge Collaborative Evolution Process Based on Ecology Perspective" [39]. In terms of research methods, since this research model can potentially apply to many disciplinary fields, it does not have definite boundaries. However, creators usually follow the format of "introduced disciplinary field name" + "method" in describing research methods, such as ecological methods and system dynamics methods. In terms of source materials, creators mainly obtain research questions from front-line practice in the LIS field, with core materials supported by the creators' interdisciplinary knowledge and based on information description for specific LIS application scenarios. Its writing 思路 (thinking) is: introduce and analyze relevant principles, methods, or technologies of a certain interdisciplinary field, then analyze the theoretical needs of the LIS field or the need for practical problem solving, further analyze the feasibility or necessity of combining the two, and finally propose relevant measures for interdisciplinary application.

5 Distribution of Seven Research Models in LIS Journal Papers

Based on the previous definition and basic description of the seven LIS research models, the authors used the model names as indexing terms and, with the help of Excel software, manually indexed each of the 8,698 journal papers published in 18 core LIS journals from 2015 to 2017 to empirically study current research models in the LIS field. The analysis mainly involved the overall quantity distribution, publication year distribution, source journal distribution, and first author institution distribution of the seven research models in the LIS field.

5.1 Overall Quantity Distribution of Seven Research Models

To describe the overall quantity distribution of the seven research models in the LIS field, the authors counted the distribution of various research models among all 8,698 journal papers (see Figure 1 [Figure 1: see original paper]). Figure 1 shows that among the LIS journal papers published from 2015 to 2017, the number of papers created using the theoretical summary research model based on literature information resources accounted for the highest proportion, reaching 42%. The number of papers created using the front-line business application analysis research model ranked second, accounting for 29.82%. Papers applying mathematical methods and scientometrics research models also reached 1,788, accounting for 20.56%. It can be seen that the top three most commonly used research models in China's LIS field are the mathematical methods and scientometrics-based research model, theoretical summary research based on literature information resources, and front-line business application analysis research. Statistics show that the cumulative total proportion of journal papers created based on these three research models reaches 92.38%, while papers created based on the other four research models account for only 7.62%.

5.2 Annual Distribution of Seven Research Models

To further understand the annual distribution of these seven research models in 18 core LIS journals, the authors counted the number of journal papers involving each of the seven research models in each year from 2015 to 2017 and drew a bar chart for comparative analysis (see Figure 2 [Figure 2: see original paper]). Figure 2 shows that in the past three years, the theoretical summary research model based on literature information resources has been the most commonly used research model for LIS journal paper creation, with the number of papers involving this research model reaching 1,441 in 2015, the highest in that year. Over time, the overall number of papers using this research model has declined. During these three years, the number of journal papers created using the front-line business application analysis research model has been less than that created using the theoretical summary research model based on literature information resources each year. The top three research models in terms of annual frequency remain the theoretical summary research model based on literature information resources, the front-line business application analysis research model, and the mathematical methods and scientometrics-based research model. Overall, the quantity proportion of various research models fluctuates little each year.

5.3 Distribution of Seven Research Models in Core Journals

Analyzing the basic situation of the seven research models from the perspective of journal distribution can reveal the preference degree of 18 core LIS journals for various research models in the past three years (see Table 1). Table 1 shows that papers created using the emerging concept and technology application exploration research model mostly appear in *Library and Information Science*; papers created using the theoretical summary research model based on literature information resources are mainly distributed in *Library and Information Service* and *Library*; papers created using the front-line business application analysis research model are mostly found in *Library and Information Service* and *Library Science Research*; and papers formed using the mathematical methods and scientometrics research model are mainly published in *Library and Information Service* and *Information Science*. From the perspective of various core journals, most core journals publish more papers involving the theoretical summary research model based on literature information resources and the front-line business application analysis research model. Representative journals include *Library and Information Service*, *Library Tribune*, *Library Construction*, and *Library Science Research*. Some core journals publish more papers created using the mathematical methods and scientometrics research model than those created using other research models, such as *Journal of Intelligence* and *Journal of the China Society for Scientific and Technical Information*. In addition, *Data Analysis and Knowledge Discovery* has published many journal papers based on the mathematical methods and scientometrics research model, algorithm design and prototype system development research model, and comprehensive application of computer software and other programs research model. Overall, there

are significant differences in the number of papers published based on different research models in different journals, which is closely related to differences in theme characteristics, overall level, topic planning, manuscript preferences, and review rules among journals.

Table 1 Statistical Distribution of Seven Research Models in 18 Core LIS Journals in the Past Three Years (papers)

Journal Name	Emerging Concept and Technology Application Exploration	Theoretical Summary Based on Literature Information Resources	Front-Line Business Application Analysis	Mathematical Methods and Scientometrics	Algorithm Design and Computer Software Development	Computer Software Application and Other Programs' Comprehensive Application	Interdisciplinary Research
Chinese Journal of Library Science							
Journal of Academic Libraries							
Library and Information Science							
Journal of National Library of China							

Journal Name	Emerging Concept and Technology Application Exploration	Theoretical Summary Based on Literature Information Resources	Front-Line Business Application Analysis	Mathematical Methods and Scientometrics	Algorithm Design and Computer Software Development	Computer Software Application and Other Programs' Comprehensive Application	Interdisciplinary Research
Library and Information Knowledge							
Library and Information Service							
Library Journal							
Library Construction							
Library Tribune							
Information and Documentation Services							

Journal Name	Emerging Concept and Technology Application Exploration	Theoretical Summary Based on Literature Information Resources	Front-Line Business Application Analysis	Mathematical Methods and Scientometrics	Algorithm Design and Computer Software Development	Computer Software Application and Other Programs' Comprehensive Application	Interdisciplinary Research
Information Studies: Theory & Application							
Data Analysis and Knowledge Discovery							
Information Science							
Journal of Intelligence							

Journal Name	Emerging Concept and Technology Application Exploration	Theoretical Summary Based on Literature Information Resources	Front-Line Business Application Analysis	Mathematical Methods and Scientometrics	Algorithm Design and Computer Software Development	Computer Software Application and Other Programs' Comprehensive Application	Interdisciplinary Research
Journal of the China Society for Scientific and Technical Information							
Library Science Research							
Information and Documentation Work							
Library Work and Study							

Note: *Data Analysis and Knowledge Discovery* changed its name from *New Technology of Library and Information Service* in 2017. This study combined the search results under both journal names.

5.4 Distribution of Seven Research Models Among Author Groups

To explore the relationship between author groups and the seven LIS research models, the authors divided the institutions affiliated with first authors into four types: university departments, scientific research institutions (mainly including research centers, literature information centers, laboratories, and training bases), libraries, and other institutions (mainly including companies, memorial halls, archives, museums, cultural bureaus, university network information centers, and university human resources departments). Authors who published papers in 18 core LIS journals in the past three years were divided into four groups, and the quantity distribution of the seven research models among these four groups was counted (see Figure 3 [Figure 3: see original paper]).

From the perspective of total group output, in the past three years, authors who published the most papers in 18 core LIS journals came from libraries. From the distribution of different research models among author institutions, the institutions that most used the theoretical summary research model based on literature information resources and the front-line business application analysis research model are libraries, followed by university departments. In addition, authors who used the mathematical methods and scientometrics research model, algorithm design and prototype system development research model, comprehensive application of computer software and other programs research model, and interdisciplinary research model more frequently are mainly from university departments, while authors from other institutions have published relatively few journal papers based on various research models.

The reasons for this phenomenon are, to a certain extent, related to the work environment and job responsibilities of authors from different institutions. For example, libraries focus on collecting, organizing, and preserving various literature information resources to better serve readers. Therefore, compared with the other three author groups, creators from libraries pay more attention to front-line business application analysis research. Due to the positioning characteristics of teaching and scientific research in university departments, the number of journal papers created using the front-line business application analysis research model is significantly less than that created using the theoretical summary research model based on literature information resources.

6 Conclusions and Main Findings

Overall, whether from author groups in university departments or from libraries and scientific research institutions, the most involved research models are theoretical summary research based on literature information resources, front-line business application analysis research, and mathematical methods

and scientometrics-based research. It can be said that these three research models are the current mainstream research models in the LIS field. Specifically, current LIS research models have the following characteristics:

(1) **Exploratory research on emerging concepts and technologies creates new scenarios for LIS practice activities.** Although the number of papers on this research model is not large, it plays an important forward-looking role in exploring and discovering LIS research frontiers and triggering the application of new concepts and technologies in LIS front-line practice. Therefore, from the historical perspective of LIS theoretical research development, its theoretical research value and practical application significance cannot be ignored.

(2) **Theoretical summary research based on literature information resources is the mainstream research model in the LIS field.** From the current distribution of the number of LIS journal papers across the seven research models, the number of papers involving theoretical summary research based on literature information resources and front-line business application analysis research still dominates. This is not only closely related to the theoretical system and practical activities of the LIS discipline but also has a significant relationship with the fact that LIS theoretical creation subjects, including creators from university departments, scientific research institutions, and libraries, tend to have humanities and social sciences backgrounds.

(3) **Front-line business application analysis research enriches the theoretical research system of LIS.** Combining arguments with specific businesses of specific libraries or selecting certain libraries' practices in a certain type of business for empirical research are typical manifestations of the front-line business application analysis research model in LIS. Research based on practical application appears to have both theoretical and practical evidence, and due to reliable conclusions, it also provides strong support for expanding and enriching the theoretical research framework of LIS. From the current situation, front-line business application analysis research is a preferred research model for authors from library front-lines.

(4) **Research combined with information technology broadens the research perspective of LIS.** In an informatized, digital, networked, and data-driven society, although information technology is indispensable for the practical development of the LIS field, and currently a considerable number of papers focus on the application of information technology in LIS, from the distribution of journal papers in the past three years involving algorithm design and computer software development and computer software tool application, research results from this perspective are not the mainstream of LIS research. However, exploring LIS research topics in combination with information technology still broadens the research perspective of this discipline.

(5) **Applied research on mathematical statistics expands the research methods of LIS.** It can be seen that due to the uniqueness and rigor of mathematical methods, they have always been highly respected by theoretical researchers in various disciplinary fields. In the LIS field, some scholars even believe that only by introducing mathematical methods into LIS can LIS become an independent, complete, and pure discipline. Under the influence of this concept, LIS research pioneers created bibliometrics and further developed literature metrology, informetrics, scientometrics, and webometrics (collectively called the "Five Metrics" together with "bibliometrics") by applying relevant mathematical methods, theories, and principles to LIS research. With the increasing popularity of social media today, LIS researchers have further created Altmetrics, a concept theoretically derived from the "Five Metrics" but with its own methodological system and research direction. Although the proportion of papers on the mathematical methods and scientometrics research model is still lower than that of front-line business application analysis research, this emphasis on quantitative research and the tendency to introduce mathematical methods into LIS research further enriches the research methods and perspectives of LIS.

(6) **Disciplinary integration and cross-border research open up new channels for LIS research.** Since each discipline has its own research boundaries, methods, principles, and theories formed based on specific disciplinary research scenarios often have application scenario limitations. Applying methods, principles, and theories from other disciplinary fields to LIS research requires theoretical creators to not only have relatively profound mastery of non-LIS disciplinary methods, principles, and theories but also to have a relatively clear grasp of relevant issues and topics in the LIS field. More importantly, theoretical creators need to accurately judge the homogeneity between the scenarios where the method, principle, and theory were originally applied and the scenarios where they are applied to the LIS field. Otherwise, this interdisciplinary research may suffer from "incompatibility due to different scenarios." For most theoretical creators, this research model is more challenging. Therefore, LIS scholars who currently choose this research model to conduct theoretical creation are still in the minority.

Of course, since research model is a relatively composite abstract concept, the boundaries of the seven subdivided research models obtained accordingly are not absolutely separable but have certain connections, intersections, and integrations, which will also affect the absolute accuracy of indexing a certain journal paper under a specific research model to a certain extent—that is, indexing accuracy can only be relative. At the same time, the authors' analysis of the distribution of the seven LIS research models is mainly based on representative journal papers from the past three years, without considering other literature types such as monographs, dissertations, and conference papers, which also has certain limitations in sample comprehensiveness. Nevertheless, this study dis-

cusses the relationship between theory and practice, and most scholars agree that theory provides guidance for practice, while practice is the source and destination of theory. The two complement each other, influence each other, and promote each other's coordinated development. This understanding is also widely accepted in the LIS field. In an informatized, digital, networked, and data-driven society, front-line business activities in the LIS field are more closely combined with social development, information technology, and user needs, and are more directly and rapidly affected by them. The rapid development of LIS business practice also greatly promotes the broadening of horizons of LIS theoretical creators and further promotes the expansion of LIS research boundaries. In this context, LIS research models will also change in connotation and extension.

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Study on Research Models of Library and Information Science in China Based on Periodical Papers

Abstract: [Purpose/Significance] Since 2007, more than 20,000 journal papers have been published annually in China's library and information science field. Taking CNKI data as an example, revealing the topic selection and research characteristics of these journal papers can reflect the current research style of China's library and information science field to a certain extent, and provide references for researchers to grasp the discipline's development context and expand research ideas. [Method/Process] This paper comprehensively applied theoretical induction and comparative research methods, combed the current research models of library and information science from four perspectives of topic selection, source materials, research methods, and writing 思路 (thinking), summarized and extracted seven research models of library and information science in China, and took papers published in 18 core journals of library and information science from 2015 to 2017 as the research object, conducting empirical analysis of the distribution of these seven research models in terms of total quantity, publication year, journal, and author institution. [Result/Conclusion] The seven research models of library and information science in China have different characteristics under the comprehensive drive of theoretical creation subjects, journal theme orientation, practical application scenarios, and modern technology development, which are embodied as follows: exploratory research of emerging concepts and technologies creates new scenarios for library and information practice activities; theoretical summary research based on literature information resources has become the current mainstream research model; application analysis research oriented to front-line business enriches the research system of library and information science; applied research of mathematical statistics expands the research methods of library and information science; research on computer software application and algorithm design stimulated by modern information technology development broadens the research perspective of library and information science; and subject integration model provides new channels for cross-border research of library and information science.

Keywords: library science; information science; theoretical research; periodical paper; research model

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