

## Analysis of International Research Topic Characteristics of Library and Information Science in China (Postprint)

**Authors:** Shi Yanqing, Sun Jianjun

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### Abstract

[Purpose/Significance] This study examines the thematic characteristics of articles published by Chinese scholars in leading international journals of Library and Information Science.

[Method/Process] The study conducts a holistic analysis of literature keywords, dividing publications into three stages based on volume fluctuations to delineate overall research hotspots. It further performs a fine-grained analysis of the stage with the highest publication output and fastest growth rate, employing keyword co-occurrence methods to investigate the temporal evolution of research themes.

[Results/Conclusion] Chinese scholars' international research themes exhibit high concentration and low diversification. Over the past decade, scientometrics and social network topics have experienced rapid development, while research interest in knowledge organization and management has remained consistently strong.

### Full Text

## Analysis of Research Theme Characteristics of Chinese Library and Information Science in International Journals

**Shi Yanqing, Sun Jianjun**

School of Information Management, Nanjing University, Nanjing 210023, China

### Abstract

[Purpose/Significance] This paper analyzes the thematic structure and characteristics of Chinese library and information science articles published in international authoritative journals. [Method/Process] We conducted a comprehensive

analysis of literature keywords, dividing the research into three stages based on changes in annual publication volume to identify overall research hotspots. We then selected the stage with the maximum number of publications and fastest growth rate for finer-grained analysis, examining the temporal evolution of research themes using keyword co-occurrence methods. [Result/Conclusion] Chinese scholars' international research themes are relatively concentrated with low diversification. Over the past decade, scientometrics and social network themes have developed rapidly, while knowledge organization and management themes have maintained enduring popularity.

**Keywords:** co-word analysis; scientometrics; research hotspot; visualization analysis

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## 1. Introduction

With the trend of information ubiquity and the development of data science, library and information science research is no longer confined to single documentary information, exhibiting trends of multi-source data, diversified content, and interdisciplinary methodological integration. Since the 1992 National Science and Technology Information Conference changed “science and technology intelligence” to “science and technology information,” more information science clusters have integrated into the library and information science field, and research paradigms have evolved from the traditional Library Information Science (LIS) independent entity toward integration with Information Management Science (IMS). In an environment of scientific globalization, the internationalization of information science has driven the international development of China's library and information discipline. Qiu Junping et al. [1] analyzed China's international publications in library and information science from 1916-2011, finding rapid growth in output with over 70% of papers concentrated in the five years from 2007-2011. Other studies have found that China's knowledge transfer targets are primarily developed countries, with research themes concentrated in four directions: library and information theory, intelligence technology application, discipline evaluation, and business competitive intelligence [2]. Overall, Chinese scholars' publication volume in international authoritative journals has increased year by year, with international cooperation becoming an important model for many scholars to publish international papers [3].

To reveal the international development and research trends in China's library and information science field in recent years, this study employs co-word analysis to examine the research characteristics of Chinese library and information science in international journals. We explore Chinese scholars' research patterns, thematic scope, and research frontiers in the context of big data, aiming to help domestic scholars clarify core issues and tackle challenges through comparison with broader international research.

Co-word analysis is one of the three major quantitative methods in informa-

tion science and is frequently used for content analysis [4]. Since 2006, research on co-word analysis has increased both domestically and internationally, covering discipline hotspots, development processes, research levels, and interdisciplinary relationships [5]. Keywords represent authors' concise summaries of article content, and a large collection of keywords from academic achievements in a discipline over time can reveal the overall content characteristics, research structure, and context [6], making keywords the most commonly used word source for co-word analysis [7]. When different keywords appear together in one article, they indicate relationships between research themes. Large-scale keyword co-occurrence forms a complex network where co-occurrence frequency represents research theme popularity. Therefore, we selected keywords as the carrier for analyzing research theme structure.

## 2. Data Sources

We used the Web of Science Core Collection as our data source, collecting all literature in the library and information science field with Chinese author participation from 1987-2016. Any document with "China" in the author address field was included, yielding 2,817 records with the search formula: SU=Information Science & Library Science AND CU=China, time span: 1987-2016, document type: Article.

Web of Science provides two types of keywords: author keywords and KeyWords Plus. The latter are assigned by indexers and suffer from "indexer effect" issues that have been discussed extensively [8-11]. We selected author keywords as they effectively represent authors' perspectives. After cleaning the data by removing records without keywords, we obtained 2,289 documents for analysis.

Since author-provided keywords are uncontrolled and subjective, with different expressions for the same concept, keyword standardization was necessary to avoid misleading subsequent analysis [12]. We merged heteromorphic synonyms (different parts of speech, singular/plural forms, abbreviations, hyphenation, etc.) such as "co-authorship," "co-authors," "co-authorship analysis," and near-synonyms such as "internet" and "www." We also removed non-analytical keywords like "China" and "Hong Kong."

## 3. Overall Data Description

We conducted descriptive statistics on the 2,289 documents and visualized the temporal trend of publication volume, shown in Figure 1 [Figure 1: see original paper]. As seen in Figure 1, after removing records without keywords, publications first appeared in 1991. After 2000, annual output exceeded 10 articles with an accelerating upward trend. In 2008, the number surpassed 50 and continued growing at an even faster rate.

Based on the growth rate curve, we divided the period into three stages: Initial Stage (1991-1999), Startup Stage (2000-2007), and Development Stage (2008-2016). The total publications for these three stages were 17, 206, and 2,066

(90.26%), respectively, showing exponential growth between stages. Keyword counts were 71, 813, and 6,425 (91.27%), respectively, indicating China's expanding influence in international authoritative journals.

From a keyword perspective, we analyzed each stage separately. In the initial stage, only two keywords—"strategy" and "information system"—appeared twice, while all others appeared once. In the startup stage, keywords appearing more than five times included "internet," "e-commerce," "knowledge management," "information retrieval," "digital library," "collaboration," and "multimedia," with co-occurrence frequency exceeding one for pairs like "digital library" and "internet," and "collaboration" and "knowledge management." Compared with the previous stage, the research domain expanded with richer themes. With the development of internet technology, research on networks, multimedia, digitalization, and mobile terminals increased, along with more applied technology and algorithm studies, strengthening quantitative research.

In the development stage, both publication volume and keyword counts grew rapidly, accounting for 90.3% and 91.3% of the totals, respectively. Keywords appearing more than 50 times included "bibliometric," "social network," "citation," and "social media." Notably, compared with previous stages, bibliometrics and social network keywords increased significantly with high frequency, including "scientometric," "h-index," "network analysis," and "social network site." Bibliometrics, barely present in earlier stages, jumped to the first tier, demonstrating the importance of scientometrics and social networks in current research. This stage represents the fastest growth period and an important era for deepening science and technology policy development. In 2006, China proposed strategic transformations for international science and technology cooperation during the 11th Five-Year Plan period, elevating scientific cooperation to a national strategic level. With the deepening of the 12th Five-Year Plan and specialized policies for international science and technology cooperation, exchanges between domestic and international library and information science deepened, significantly enhancing China's international academic influence. Given that this stage's total literature and new research nodes exceed 90% of the totals, it warrants focused study to grasp Chinese scholars' academic hotspots and frontiers internationally.

#### 4. Research Theme Structure Analysis

Since 2008, Chinese library and information science scholars have published over 50 articles annually in international authoritative journals, exceeding 100 in 2009, with accelerating growth. As previous stage division shows, the development stage accounts for over 90% of total literature and keywords, necessitating further analysis of its research status and thematic structure. Using article keywords, we examined keyword co-occurrence to map research theme structure from 2008-2016.

**4.1 Determining Analysis Objects** The development stage contains 2,066 documents with 6,425 keywords. We first needed to identify high-frequency keywords for further analysis. Methods for determining high-frequency keywords include: (1) comprehensive consideration of keyword quantity and frequency based on experience [13-14], with frequency thresholds ranging from 2 to 40 [15-16]; (2) determining thresholds based on frequency change trends, such as Ma Feicheng et al. [17] using cumulative frequency above 62%, and Wang Hong [18] using keywords with frequency >22 in each stage; (3) using Donohue's high-frequency/low-frequency boundary formula [19] based on Zipf's second law.

To avoid subjectivity in manual selection, we applied Donohue's formula to obtain 95 high-frequency keywords for further analysis. The top 50 keywords are shown in Table 1 .

High-frequency keywords represent relatively concentrated research areas, reflecting discipline hotspots during specific periods. Keyword co-occurrence reveals inter-theme relationships and research directions. We conducted co-word analysis by counting co-occurrences of the 95 keywords across all articles, generating a 95 $\times$ 95 matrix (partial view in Table 2 ).

Keyword co-occurrence is heavily influenced by individual keyword frequency. To eliminate this effect, we used the Ochiai coefficient to transform the high-frequency keyword co-occurrence matrix into a similarity matrix. The Ochiai coefficient is calculated as:  $XY \text{ coefficient} = (\text{co-occurrence count of X and Y}) / \sqrt{(\text{frequency of X} \times \text{frequency of Y})}$ . The standardized matrix eliminates frequency differences, truly representing keyword correlations, where larger values indicate closer relationships.

As Table 2 shows, the co-word matrix is relatively sparse with many zero values. To avoid errors from zero values in subsequent analysis, we converted the Ochiai similarity matrix to a dissimilarity matrix by subtracting it from 1, shown in Table 3 . The dissimilarity matrix represents keyword differences, where larger values indicate weaker similarity and greater distance.

**4.2 Multidimensional Scaling Analysis** Multivariate statistical analysis is central to co-word analysis, with three common methods: factor analysis, cluster analysis, and multidimensional scaling. Multidimensional scaling maps multiple variables to two- or three-dimensional space through model fitting, using visualization to display data relationships and enabling intuitive observation of research hotspot clustering and thematic structure.

Generally, dissimilarity matrices are most suitable for multidimensional scaling. We used SPSS software's ALSCAL procedure, setting "data as distance data," selecting symmetric shape, and using ordinal data as the measurement level for two-dimensional analysis of the dissimilarity matrix, with results shown in Figure 2 [Figure 2: see original paper].

The model's fit statistic RSQ (coefficient of determination) is 0.96294, indicating

good model fit. The coordinate map displays the overall thematic landscape. Based on keyword distance distribution, no clear large categories emerge, suggesting Chinese scholars' international publications have concentrated themes without forming distinct factions, indicating insufficient diversification. However, based on relative distance, three broad content areas can be identified:

**Scientometrics Theme (Quadrant I):** Keywords include “bibliometric,” “citation,” “h-index,” “scientometric,” “co-word analysis,” and “impact factors.” These keywords have relatively high frequency, indicating Chinese library and information science scholars publish more data analysis-oriented articles, with scientometrics comprising a large proportion. In addition to scientometrics, scientific collaboration keywords appear frequently in this area, such as “co-author,” “collaboration network,” “international collaboration,” and “interdisciplinary.” With network technology development, scientific research has shifted from individual to collaborative work in the E-science environment to obtain more information resources, reduce research costs, and create scientific value more effectively. Research on collaboration behavior has consequently increased, spanning qualitative to quantitative approaches. Figure 2 shows Chinese scholars' articles in this area tend toward quantitative research.

**Data Analysis Theme (Quadrant II):** Keywords include network analysis, spatial analysis, and visualization terms like “social network site,” “road network,” and “spatial analysis,” plus data analysis methods such as “big data,” “data mining,” “cluster,” and “classification,” and technology-oriented terms like “machine learning,” “artificial intelligence,” and “natural language processing.” Analysis method keywords are distributed at the boundary between Quadrants I and II, indicating that scientometrics, academic relationship studies, and network analysis all use clustering, visualization, and other data analysis methods, which remain commonly used in library and information science.

**Knowledge Management Theme (Quadrant III):** Keywords like “information security,” “digital divide,” “information service,” and “information sharing” focus on information service and management. This quadrant also includes “library,” “university library,” and “academic library,” plus user-oriented terms like “user study,” “sentiment analysis,” and “virtual community.” Few technology-oriented or data analysis keywords appear in this section.

Quadrant IV contains the fewest and most sparsely distributed keywords, with “digital library” and “satisfaction” at the boundary between Quadrants III and IV, close to the knowledge management theme discussed above.

Overall, Figure 2 shows that while theme module boundaries are not distinct, keywords within categories are relatively closer to each other than to keywords in other categories. Combined with the high-frequency keyword table, scientometrics and bibliometrics constitute the primary theme in Chinese scholars' international publications, with research collaboration studies comprising a significant proportion. In the context of scientific globalization and evolving E-science, research collaboration has become a trend, and applying scientometric

knowledge to study collaboration patterns provides an intuitive and convenient approach.

**4.3 Cluster Analysis** Cluster analysis is an important multivariate statistical method that groups closely related variables based on similarity. It is essentially a descriptive statistical method without statistical tests for validation, aiming to minimize within-category differences and maximize between-category differences. Hierarchical clustering is commonly used.

Following multidimensional scaling, we conducted hierarchical cluster analysis for more detailed grouping. After comparison, we selected between-groups linkage and squared Euclidean distance as the clustering method and measure, obtaining satisfactory results. For cluster naming, we adopted Zhong Jinwei's cohesion index [20], which measures each element's co-occurrence with other elements in the cluster, revealing its importance. Cluster results are shown in Table 4.

Cluster analysis yielded 10 clusters. Cluster 1 contains 10 keywords including various libraries (“library,” “digital library,” “academic library”) and user service terms (“service quality,” “system quality,” “customer satisfaction,” “user studies”). Libraries are a primary research object in library and information science. With internet technology development, library digitization has become a hotspot, reflecting not only resource aggregation capacity but also knowledge value excavation and shaping processes. Knowledge discovery based on this process redefines library user services, prompting libraries to release more service functions.

Cluster 2 focuses on network analysis, including collaboration networks, citation networks, and patent networks. In the trend of scientific globalization, collaboration has become an important mode of scientific activity. Research exploring China's international scientific cooperation patterns with different countries and regions [21-23] has remained a hotspot in library and information science.

Cluster 3 represents one of the most important research themes. The keyword “bibliometric” and its cohesion with other keywords indicate its importance. As a crucial research method in library and information science, scientometrics can be applied to various fields including meteorology and biology [24]. This cluster also includes metrics like “citation,” “h-index,” and “impact factors,” with research on co-citation networks from multidimensional perspectives [25], citation-based knowledge diffusion studies [26], and other literature studies based on bibliometric indicators receiving widespread attention.

Cluster 4 includes data processing technologies like “information retrieval,” “classification,” and “artificial intelligence.” Cluster 6 involves visualization technologies spanning image processing and computer graphics, representing important research methods. Cluster 7 is the social network [27] theme, with research on social relationships and user behavior in social networks gradually becoming a hotspot. Cluster 8 includes virtual communities, knowledge shar-

ing, and social capital themes, with strong cohesion among elements. Cluster 9 covers e-commerce, which has maintained rapid development in China. Research on how to establish user trust through network strategies [28] and how relationship-based markets adjust e-commerce models from strategic management perspectives [29] has attracted considerable attention.

**4.4 Temporal Changes in Research Themes** To further examine theme evolution, we divided the development stage into three periods (2008-2010, 2011-2013, 2014-2016) and conducted visual analysis of topic evolution. The three periods yielded 612, 677, and 1,083 documents with 1,173, 2,525, and 3,772 keywords, respectively. Due to large differences in low-frequency word counts across periods, we selected keywords with frequency  $>5$  as high-frequency terms, obtaining 48, 38, and 62 high-frequency keywords after removing meaningless terms.

We used Pajek to visualize the co-occurrence matrices. Figure 4 [Figure 4: see original paper] shows the first period's keyword co-occurrence network, where nodes represent keywords, edges represent co-occurrence relationships, edge thickness indicates weight (co-occurrence frequency), and nodes with more edges and higher weights are more important. The most important keywords were "digital library," "information service," "customer satisfaction," "electronic media," "academic library," and "computer application," indicating scholars focused on information digitization, service capabilities, and user services. Few technology keywords appeared, and data analysis terms like "scientometric" and "data mining" were peripheral, suggesting qualitative analysis dominated.

Figure 5 [Figure 5: see original paper] shows the second period's network, which differed significantly. Keywords with high edge counts and weights included "bibliometric," "social network," "knowledge sharing," "scientometric," and "citation." Bibliometrics keywords occupied central positions, with "social network" connecting to five bibliometric keywords and co-occurring with measurement or data processing terms. This indicates Chinese scholars' focus shifted to scientometrics, with more data analysis keywords appearing and quantitative analysis gradually increasing. Social network-based knowledge management and sharing remained another key focus, mostly qualitative and not closely integrated with quantitative methods.

The third period (2014-2016) had the most keywords and a complex network. To simplify, we removed nodes with edge count  $\leq 3$  or weight  $<3$ , yielding the network in Figure 6 [Figure 6: see original paper]. This period shows the most complex relationships, with three main themes: scientometrics, network analysis, and information/knowledge management. "Bibliometric" is the most important node, closely related to "research trend," indicating that using bibliometrics to analyze research trends has become important. Most co-occurring terms are measurement or network analysis keywords. In network analysis, the main objects are social networks and collaboration networks, with more scientometric methods applied compared to earlier stages.

Across the three periods, we observe: (1) Data-driven research is gradually becoming mainstream. Scientometrics keywords, marginal in the first period, became central in the second and consolidated in the third, reflecting Chinese scholars' transition from qualitative to quantitative methods. However, quantitative research concentrates heavily on scientometrics, with limited application of text mining, natural language processing, machine learning, and artificial intelligence. (2) Social network research developed rapidly. The “social network” theme emerged in the early development stage and became a research focus by the middle and later periods. However, while Chinese LIS scholars have conducted numerous studies on this theme, they lack depth and systematic methodology. (3) Knowledge organization and management remain consistent themes throughout. “Knowledge management” and “knowledge sharing” have always been important nodes. Even as social networks and scientometrics surged, knowledge organization and management remained significant themes, evolving from electronic media and computer technology to social network integration and closer combination with scientometrics.

## 5. Discussion and Conclusions

This study conducted exploratory research using Web of Science Core Collection data to map Chinese scholars' research themes with detailed temporal analysis. We found that Chinese scholars' international publication themes are relatively concentrated without forming multiple independent research theme clusters, indicating low diversification. Recent research has focused primarily on social networks and scientometrics.

First, with information ubiquity and rapid social media development, pan-social trends and information explosion have created massive data containing valuable information. As an information research discipline, LIS scholars have become major groups in social network research. However, our analysis reveals that while Chinese LIS scholars have produced numerous studies on this theme, they lack depth and systematic methodology, showing scattered themes and dispersed research methods without forming a mature research style. For this important information resource, research should further integrate network structure, information dissemination, and user behavior to expand research models, strengthen theoretical support, and conduct more in-depth verification studies.

Second, scientometric and bibliometric research has always been important in LIS. Bibliographic information condenses document content, and its structured features facilitate convenient and reliable analysis, making it a favored method. Currently, scientometrics is used not only for literature analysis but also for social media tags. However, scientometrics is limited to existing bibliographic entries with limited content mining capabilities. For deeper analysis of literature and other information types, Chinese LIS scholars should break through methodological limitations within the field and explore machine learning, artificial intelligence, and text mining methods to broaden research paths through methodological integration and innovative thinking.

Finally, knowledge management remains a consistent focus and information growth point in LIS. As shown in the strategic diagram, knowledge management and sharing themes are mature and closely associated with other themes. As a discipline primarily studying information, knowledge management is a crucial area in LIS. Effectively organizing, managing, and refining information to obtain valuable knowledge is a common goal. In this domain, Chinese LIS scholars should build upon disciplinary and knowledge management theories, supported by diverse technologies, absorbing interdisciplinary methods (e.g., computer science, sociology) while focusing on new technologies and intelligent knowledge management trends to further consolidate this research theme.

This study is exploratory, and results require further verification through multiple methods. Theme trend development also needs deeper discussion. Additionally, for more comprehensive analysis of theme distribution and development, overall domestic and international discipline trends should be considered for comparative analysis to obtain more valuable and instructive conclusions, which require further analysis in future research.

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

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