

Post-print: Bibliometric Analysis of Knowledge Organization Research in the Past Decade

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Abstract

[Purpose/Significance] This study analyzes 542 knowledge organization-related publications from 2007-2016 indexed in the Web of ScienceTM Core Collection database, aiming to comprehend the current state of international research in this field and provide references and materials for domestic research. [Method/Process] Employing bibliometric methods, visual analyses and knowledge maps were generated using CiteSpace software from perspectives including annual publication output, authorship, countries and research institutions, keywords, and co-citation relationships. [Results/Conclusion] Findings indicate that authors such as B. Hjørland, I. Dahlberg, and V. Broughton have substantial publication records; collaboration among researchers and institutions is moderate; research domains primarily concentrate on knowledge organization itself, taxonomy, ontology, and related areas; cited scholars including B. Hjørland, H. A. Olson, and I. Nonaka, along with their works, exhibit high influence; Knowledge Organization and Journal of Documentation are the principal journals publishing research in this area.

Full Text

Preamble

Bibliometric Analysis of Knowledge Organization Research in the Past Decade

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Abstract

[Purpose/Significance] This study analyzes 542 knowledge organization-related documents published between 2007-2016 in the Web of ScienceTM Core Collection to grasp the current state of international research in this field and provide references for domestic research. **[Method/Process]** Using bibliometric methods and CiteSpace software, we conducted visual analyses and generated knowledge maps examining annual publications, authors, countries and research institutions, keywords, and co-citations. **[Result/Conclusion]** The analysis reveals that B. Hjørland, I. Dahlberg, and V. Broughton are among the most prolific authors; collaboration among researchers and institutions is moderately close; research areas focus primarily on knowledge organization itself, as well as taxonomy and ontology; cited scholars such as B. Hjørland, H. A. Olson, and I. Nonaka and their works possess high influence; *Knowledge Organization* and *Journal of Documentation* are the primary journals publishing knowledge organization research.

Keywords: knowledge organization; bibliometrics; visualization analysis; CiteSpace; knowledge map

As attention in information management shifts toward knowledge management, perspectives have gradually transitioned from information organization to knowledge organization in recent years. This growing interest in knowledge organization has spread throughout the library and information science field, with developments in information technology creating significant opportunities for advancement.

Knowledge organization is defined as a processing system that provides, evaluates, and systematically articulates scientific literature to produce new, orderly knowledge units that facilitate utilization and access [1]. Its essence lies in maximizing the value of knowledge elements through processes and methods including discovery, collection, organization, processing, ordering, revelation, control, and sharing [2]. This study selects foreign-language literature on knowledge organization from 2007-2016 for bibliometric analysis, aiming to provide both a holistic understanding of this research domain and references for domestic knowledge organization development.

1. Data Sources and Analysis Methods

The data for this study were sourced from the Web of ScienceTM Core Collection, specifically including three citation databases: Science Citation Index Expanded, Social Sciences Citation Index, and Arts & Humanities Citation Index (A&HCI). Data were collected on March 20, 2017, covering a ten-year span from 2007-2016. Using the search criterion Topic = "knowledge organiz*", we retrieved 542 documents. After screening for thematic relevance, no documents were found to be inconsistent with the knowledge organization theme, so all 542

retrieved documents were retained. During download, the data format was set to "full record with cited references and abstract."

We used Excel and CiteSpace software for statistical analysis and visualization of the retrieval results. Bibliometric methods were applied to analyze the statistical data from several perspectives: temporal distribution, country and institution distribution, authorship, research hotspots and frontiers, document co-citation, and author co-citation, thereby reflecting the development status and trends of international knowledge organization research from 2007-2016.

2.1.1 Temporal Distribution Characteristics

When analyzing the development trajectory of the knowledge organization domain using bibliometric methods, annual statistical analysis of publication volumes can reveal the current state of the field and predict its research prospects and development trends based on literature growth or decay patterns. Statistical analysis of the 542 documents by year yielded the results shown in [Figure 1: see original paper].

[Figure 1: see original paper]

The figure indicates that over the past decade, the number of journal articles on knowledge organization has generally shown an upward trend, with three decline points occurring in 2009, 2011, and 2014. Other periods maintained growth momentum, though with relatively large fluctuations in the later stage. Notably, in 2014, publications dropped to 53, 15 fewer than in 2013, representing the largest decline among the three downturn years.

Further analysis of the reasons for these declines reveals a correlation with the themes discussed at International Society for Knowledge Organization (ISKO) conferences. Since 1990, ISKO has held biennial international conferences that serve as the main venue for knowledge organization research. The conference themes during the study period are listed in .

Before 2014, based on conference theme statistics, scholars' research primarily focused on understanding knowledge organization, theoretical exploration, and methodological investigation. Research enthusiasm continuously intensified, gradually becoming more systematic and mature, resulting in a generally steady upward trend in publication volume before 2014. Beginning in 2014, ISKO's research themes shifted toward exploring knowledge organization development in an interconnected society. When research directions change, the field's latest hotspots also shift, requiring scholars to adjust their research focus accordingly, which explains the decline in 2014 publications.

2.1.2 Country and Institution Analysis

In terms of geographical distribution of knowledge organization research, the top countries include the United States, Brazil, Spain, Canada, and ten others, as shown in [Figure 2: see original paper]. These countries account for 76.5% of

total publications, with the United States alone contributing 37.3%, indicating strong investment in knowledge organization research, particularly by the U.S., which leads in both research capacity and influence.

[Figure 2: see original paper]

Notably, China's publication output in knowledge organization also holds a relatively leading position globally. [Figure 3: see original paper] shows China's annual publication distribution. Institutions with two or more publications include the Chinese Academy of Sciences (4), Nanjing University (4), Wuhan University (3), Xi'an Jiaotong University (2), and Xidian University (2)—all strong institutions in library and information science. In terms of collaboration, all papers involved intra- or inter-institutional cooperation among Chinese scholars, with eight being co-authored with scholars from the U.S. and France. Temporally, China's annual publication volume increased significantly after 2013, likely due to growing attention to knowledge organization and substantial development in research capacity.

In the institutional knowledge map shown in [Figure 4: see original paper], node size represents publication volume, identifying active institutions in the knowledge organization field; connecting lines between nodes represent institutional collaborations, revealing relatively limited cooperation among research institutions.

Specifically, the top 10 institutions by publication volume are all universities, confirming that universities remain the core research groups in knowledge organization (see [Figure 5: see original paper]). Among them, University of Wisconsin (19), University of Washington (11), and University of Illinois (6) are American institutions. Brazil also has three universities in the top 10: Sao Paulo State University (12), Federal University of Minas Gerais (10), and Federal University of Rio De Janeiro/University of Brazil (6). Others include Denmark's Royal School of Library and Information Science (14) and Copenhagen University (11), Spain's University of Granada (10), and Canada's University of Toronto (9). This aligns with the country ranking results, as these universities have formed their own research groups, driving knowledge organization development in their respective countries.

[Figure 4: see original paper]

[Figure 5: see original paper]

2.2 Author Analysis

Price's Law states that core authors in a field produce half of its papers, with their number approximately equal to the square root of the total number of authors, expressed as $M = 0.749 \times \sqrt{n_{max}}$, where n_{max} is the maximum number of papers by any author and M is the minimum number of papers for core authors [3]. Statistical analysis of authors in the knowledge organization domain identified 1,039 total authors, yielding 32 core authors according to Price's Law.

The most prolific author, B. Hjørland, published 17 papers, establishing the core author threshold at approximately 3 papers.

Analysis of the 542 documents identified 15 authors with 4 or more papers and 40 authors with 3 or more papers (see [Figure 6: see original paper]). These 40 authors produced 174 papers, accounting for only 32.1% of total publications—falling short of Price’s Law standard where core authors should produce half of the papers. Therefore, the field has not yet formed a distinct core author group.

[Figure 6: see original paper]

According to [Figure 6: see original paper], leading authors in knowledge organization include B. Hjørland (17 papers) from the Royal School of Library and Information Science in Denmark, R. P. Smiraglia (14 papers) from the School of Information Studies at University of Wisconsin-Milwaukee, and J. T. Tennis (9 papers) from the Information School at University of Washington. This confirms that the core research groups consist primarily of university faculty with strong research capacity and profound scholarly foundations.

[Figure 7: see original paper] illustrates collaboration networks among major knowledge organization researchers, where line colors and thickness indicate collaboration years and intensity. In terms of collaboration, B. Hjørland, I. Dahlberg, and H. A. Olson maintain relatively close cooperation—all being ISKO members, with I. Dahlberg as ISKO’s founder and first president, and all currently serving as editors of *Knowledge Organization*, ISKO’s official journal. ISKO members generally collaborate more frequently.

[Figure 7: see original paper]

I. Nonaka, T. H. Davenport, and M. C. Wesley form another research collaboration circle. These three are influential scholars in knowledge management, with Nonaka and Davenport being pioneering figures in knowledge management theory. Knowledge management theoretical schools can be broadly categorized into four: technological, behavioral, economic, and strategic (with the latter two sometimes combined as integrated school).

Japanese management professor I. Nonaka represents the behavioral school, which emphasizes human agency and focuses on evaluating, changing, or improving individual skills and behaviors in both theoretical research and practical activities. Nonaka systematically distinguished between tacit and explicit knowledge, emphasizing their transformation, and introduced the concept of “ba” as a shared environment for knowledge creation [4].

The technological school emphasizes efficiency through technology, focusing on designing and building information management systems, artificial intelligence, reengineering, and groupware, viewing knowledge as an organizational resource and material object that can be identified, processed, managed, and controlled in information systems. T. H. Davenport from Boston University’s School of Management defines knowledge as a fluid combination of structural experience,

values, contextual information, and expert insight. Building on his reengineering concepts, he made pioneering contributions to knowledge management practice and systems, with his two-stage theory and knowledge management model serving as primary theoretical frameworks.

M. C. Wesley from Duke University's Fuqua School of Business represents the strategic school, which focuses on different organizations' strategic objectives. The strategic school integrates perspectives from behavioral and technological schools (such as applying information technology and emphasizing human agency) while continuously improving management and guiding specific practices.

2.3.1 Keyword Map and High-Frequency Keyword Analysis

Keywords represent authors' refinement of core research content. High-frequency keywords and noun phrases extracted from sample documents can be considered research hotspots in the field [5]. Using CiteSpace with one-year time slices, noun phrase term type, keyword node type, a threshold of 50, and default other settings, we generated a keyword map (see [Figure 8: see original paper]) containing 173 nodes and 713 links.

[Figure 8: see original paper]

Keyword analysis provides the most intuitive understanding of research priorities and hotspots. We selected 20 keywords with frequency greater than 20 (see), revealing that international knowledge organization research from 2007-2016 focused primarily on classification, information science, ontology, knowledge management, knowledge organization system, perspective, information retrieval, innovation, library, performance, and model.

The keyword "knowledge organization" appears 132 times, significantly higher than subsequent keywords, with a noticeably larger node in the map, indicating its important role in classification, information science, ontology, knowledge management, information retrieval, and library studies. Examining the citation history of this largest node (see [Figure 9: see original paper]) shows that research on knowledge organization has continued and expanded throughout the decade.

[Figure 9: see original paper]

Further analysis of shows the top 10 keywords each appear in over 30 papers with relatively large gaps between them, while the bottom 10 keywords appear around 20 times with more uniform distribution, suggesting more balanced research in the latter areas. Analysis of emerging technologies and domain-specific application keywords (see) reveals that semantic web emerged earlier with more literature, while folksonomy, web, controlled vocabulary, metadata, linked data, and tagging have received less attention. In domain applications, education appeared earlier with more literature, while health, music, Wikipedia, biotechnology, archive, books, and dynamics emerged only in the last two years with very

low frequency. Combined with high-frequency keywords, this indicates that international knowledge organization research over the past decade has concentrated on foundational theories, with insufficient integration of new technologies and practical applications, suggesting inadequate theory-practice integration.

Nodes with betweenness centrality greater than 0.1 generally play important roles in network structure and often represent key or transitional points in knowledge structure evolution. shows keywords with centrality above 0.1 (purple-ringed nodes in the map), including classification, knowledge, science, perspective, library, and network (centrality 0.13, frequency 13, not in)—all representing critical or transitional research hotspots in knowledge organization development.

2.3.2 Keyword Cluster Analysis

Clustering the keyword map using the LLR algorithm produced cluster labels (see [Figure 10: see original paper]) and a cluster report (see). Clusters indicate similarity in research subjects and content among related documents, representing research hotspots to some extent. Silhouette values (S) greater than 0.7 indicate highly effective and convincing clusters, while $S > 0.5$ indicates reasonable clusters. The keyword map ([Figure 10: see original paper]) yielded 11 clusters overall.

[Figure 10: see original paper]

The cluster list () shows that in terms of content, knowledge organization research hotspots include library, thesauri, community, categorization, environment, knowledge management, congress subject heading, domain analysis, man-made object, decision making, and organization of information. The latter three themes form overly small, dispersed clusters and are not displayed in [Figure 10: see original paper]. Temporally, knowledge organization clusters concentrate in the 2010-2014 timeframe, indicating this period as the hotspot explosion phase within the decade, while no obvious clusters formed in the last two years, suggesting more dispersed research. Analyzing extracted cluster keywords by average year reveals: 2010—community, firm, management, categorization, semantic memory; 2011—library, classification, feminist thesauri, man-made object, language production, verb retrieval; 2012—environment, impact, education, congress subject heading, interoperability, authority control; 2013—knowledge management, knowledge creation, quality management; 2014—domain analysis, archive, change. This roughly shows a transformation from foundational theory to technology integration and then to practical application. Meanwhile, fewer clusters formed in 2013-2014, with none in recent years, indicating research hotspots have begun to disperse.

2.3.3 Timezone Analysis

The timezone map reflects keyword dynamic evolution and development stages. Based on [Figure 11: see original paper], we divide the decade into three phases.

Phase 1 (2007-2010) features the largest nodes, particularly the “knowledge organization” node. Many high-frequency keywords in subsequent years co-occur with these large nodes, indicating continuous research 传承 based on theoretical foundations established during this period. Phase 2 (2011-2014) represents the main distribution phase for keyword clusters, showing rich research themes derived from earlier theoretical foundations, with smaller nodes indicating dispersing hotspots. Phase 3 (2014-2016) features even smaller nodes without obvious clusters, yet total annual publications continued rising, confirming further dispersion and refinement of research themes.

[Figure 11: see original paper]

2.4.1 Document Co-citation Analysis

With node type set to Cited Reference, threshold to default Top50, one-year time slices, and Pathfinder algorithm, CiteSpace generated a document co-citation network. Nodes consist of colored rings whose radius indicates citation frequency and warm colors indicate more recent citations. Dark red dots inside nodes signify significant citation changes in certain years. [Figure 12: see original paper] shows documents cited 15 times or more.

[Figure 12: see original paper]

The most frequently co-cited works are all by Professor B. Hjørland, whose research reflects the development trajectory of knowledge organization. His representative papers can be divided into three stages:

(1) Stage 1: Concepts, Principles, and Paradigms of Knowledge Organization

In his 2008 paper “What is knowledge organization (KO)?” Hjørland analyzed existing theories and methods before articulating his own understanding [6]. He defines knowledge organization as activities including document description, indexing, and classification conducted within libraries, databases, and archives by librarians, archivists, subject experts, and computer algorithms. As a research field, it studies the nature and quality of knowledge organization processes, knowledge organization systems, document representation, and related concepts.

Concepts are the cornerstone of knowledge organization systems, with conceptualization forming its foundation, derived from and closely related to epistemology. Different epistemologies—positivism, rationalism, historicism, and pragmatism—correspond to different conceptualizations. In his 2010 paper “Concepts, paradigms and knowledge organization,” Hjørland summarized and analyzed these conceptualizations and paradigms, concluding that pragmatism and historicism are most valuable [7]. In “Knowledge organization = information organization?” he distinguished knowledge organization from information organization (IO) and information architecture (IA) [8], noting that while they share methodological and theoretical principles, their application contexts differ:

knowledge organization belongs to the library domain, information architecture primarily applies to web information, while information organization lacks a specific application context.

(2) Stage 2: Methods and Technologies of Knowledge Organization

In 2013, Hjørland published multiple papers exploring knowledge organization methods and technologies. In “Citation analysis: a social and dynamic approach to knowledge organization,” he argued that while bibliometrics and knowledge organization have been considered separate branches of library and information science, the former can serve as a method for the latter, particularly citation analysis, which should be an important tool due to its social, historical, and dynamic characteristics [9]. “Facet analysis: the logical approach to knowledge organization” examined facet analysis as an important modern classification method widely applied in knowledge organization [10], noting its advantage of complete logical principles for system construction but disadvantage of lacking empirical evidence, relying more on a priori assumptions without model, theory, or law support. “User-based and cognitive approaches to knowledge organization: a theoretical analysis of the research literature” examined user-based systems like Book House System and cognitive science applications like WordNet, concluding that subjectivity should be distinguished from user studies, with subjective cognition representing collective community perspectives rather than individual or abstract thinking studies [11].

(3) Stage 3: Knowledge Organization in Network Environments

By 2015, research focus shifted to knowledge organization methods in network environments. With modern search engines, semantic web, and grid technologies, knowledge organization has developed toward deeper levels, with research perspectives turning to what types of retrieval systems should be built, user search capabilities, and the roles of library and information science and knowledge organization. S. Warner distinguished between computer science traditions (automatic problem conversion to ranked documents) and library-centered traditions (enhancing user choice) [12]. “Classical databases and knowledge organization: a case for Boolean retrieval and human decision-making during searches” explored whether traditional catalog databases based on Boolean retrieval models (like MEDLINE and PsycInfo) retain value [13], arguing they provide user autonomy and control over search depth and content—representing the value of information science and knowledge organization as research fields.

2.4.2 Author Co-citation Analysis

To identify authors playing important roles in knowledge organization evolution, lists authors cited 16 times or more.

B. Hjørland from Denmark’s Royal School of Library and Information Science ranks first with 177 citations, followed by H. A. Olson (59), I. Dahlberg (56), I. Nonaka (45), C. Beghtol (41), and J. Mai (36). Most of these scholars focus

on knowledge organization, knowledge management, and information science. Highly-cited Professor Hjørland first analyzed knowledge organization concepts, principles, and approaches before establishing methods and technologies, then shifted focus to network environments with the internet's rise. Professor H. A. Olson from University of Wisconsin-Milwaukee focuses on critical analysis of thesaurus characteristics and classification systems. Professor I. Nonaka from Hitotsubashi University specializes in knowledge management. This confirms that knowledge organization involves organizing knowledge objects through processes like arrangement, processing, revelation, and control, encompassing its theories and methods [14].

2.4.3 Journal Co-citation Analysis

To analyze theoretical sources and dissemination channels of highly-cited literature in knowledge organization, we generated a journal co-citation knowledge map (see [Figure 13: see original paper]) and listed journals cited 46 times or more (see).

[Figure 13: see original paper]

The table shows that most high-cited dissemination channels are journals, with *Knowledge Organization* and *Journal of Documentation* ranking first (184 citations) and second (156 citations) respectively. Other frequently cited journals include *Journal of the American Society of Information Science* (134), *Journal of the American Society of Information Science and Technology* (104), *Library Trends* (76), and *Information Processing & Management* (69)—all top-tier international journals, indicating authoritative sources for knowledge organization research.

3. Conclusion

This study examined knowledge organization literature from the Web of ScienceTM Core Collection (2007-2016) using bibliometric analysis to reveal publication trends, major researchers and research forces, hotspots and frontiers, and the field's knowledge base, influential scholars, and dissemination channels. Findings are as follows:

- (1) While many researchers have formed collaboration circles, collaboration frequency remains generally low. Notable high-frequency collaboration circles include those formed by B. Hjørland, I. Dahlberg, and H. A. Olson, as well as I. Nonaka, W. M. Cohen, and T. H. Davenport. H. Hjørland, H. A. Olson, I. Dahlberg, I. Nonaka, and C. Beghtol are highly cited with high centrality, and their papers constitute highly-cited literature, forming important knowledge foundations and sources for the field.
- (2) The United States, Brazil, Spain, Canada, and Denmark are major countries in knowledge organization research, with China also in a relatively leading position. Active research institutions concentrate in universities

with stronger academic environments, such as University of Wisconsin, Royal School of Library and Information Science, Sao Paulo State University, Copenhagen University, and University of Washington, though inter-institutional academic exchange and collaboration remain limited.

- (3) Over the decade, knowledge organization hotspots have continuously changed and migrated with time and technological development. Overall, research focus has gradually shifted toward technology integration and practical application, though theory-practice integration still requires strengthening. High-cited literature is primarily disseminated through top-tier international journals in library and information science, mainly including *Knowledge Organization*, *Journal of Documentation*, and *Journal of the American Society of Information Science*.

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Author Contributions

Yu Zhangkui: Primary responsibility for analyzing research hotspots and frontiers;
Shi Xiaoying, Yin Wenyan: Primary responsibility for co-citation analysis;
Wang Liqing: Responsible for topic selection, research framework, methodology, and paper revision and finalization;
Yang Kai, Guo Jingyu: Primary responsibility for spatiotemporal distribution and author analysis.

Bibliometric Analysis on the Research of Knowledge Organization in Recent Ten Years

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Abstract: [Purpose/significance] The paper analyzes the 542 literatures related to knowledge organizations in 2007-2016, which are included in the core database of Web of ScienceTM, and aims to grasp the current research situation in this field and provides references for domestic relevant research. [Method/process] Based on the method of bibliometrics, the CiteSpace software was used to analyze and draw the knowledge map from the aspects of annual issuers, authors, countries and research institutions, keywords, co-citation and so on. [Result/conclusion] The results show that authors the most publications are B. Hjørland, I. Dahlberg, V. Broughton etc; the cooperation between researchers and institutions is relatively rare; knowledge organization research areas focus on the knowledge organization itself and classification, ontology and so on; B. Hjørland, H.A. Olson, I. Nonaka and other cited scholars and their cited literatures have high influence on this theme; Knowledge Organization, Journal of Documentation is most important journals for the knowledge organization.

Keywords: knowledge organization; bibliometrics; visualization; CiteSpace; knowledge map

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

Source: ChinaXiv — Machine translation. Verify with original.