A Co-Word Analysis of Global Research on Knowledge Organization: 1900-2019

Omid Alipour*, Faramarz Soheili** and Ali Akbar Khasseh***

*Library, Faculty of Natural Resources of Guilan University, Iran, <alipour.omid@gmail.com>

**Department of Library and Information Science, Payame Noor University, POB 19395-4697, Tehran, Iran, <soheili@pnu.ac.ir>

*** Department of Library and Information Science, Payame Noor University, POB 19395-4697, Tehran, Iran, <khasseh@pnu.ac.ir>

Omid Alipour has a BA, MA and PhD in Library and Information Science. He obtained his PhD degree from the Payame Noor University, Iran in 2021. Currently, he is Head of Library Services of the Faculty of Natural Resources of Guilan University, Iran. His research interests center on bibliometrics, citation analysis, future studies, content analysis and academic libraries.

Faramarz Soheili is an associate professor in the department of Library and Information Science at Payame Noor University, Tehran, Iran. He prefers to do research in the fields of bibliometrics, scientometrics, citation analysis, research evaluation and related areas.

Ali Akbar Khasseh is an associate professor in the department of Library and Information Science at Payame Noor University, Tehran, Iran. His main research interests are in the fields of bibliometrics, scientometrics, citation analysis, research evaluation and related areas.

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Abstract: The study's objective is to analyze the structure of knowledge organization studies conducted worldwide. This applied research has been conducted with a scientometrics approach using the co-word analysis. The research records consisted of all articles published in the journals of *Knowledge Organization* and *Cataloging & Classification Quarterly* and keywords related to the field of knowledge organization indexed in Web of Science from 1900 to 2019, in which 17,950 records were analyzed entirely with plain text format. The total number of keywords was 25,480, which was reduced to 12,478 keywords after modifications and removal of duplicates. Then, 115 keywords with a frequency of at least 18 were included in the final analysis, and finally, the co-word network was drawn. BibExcel, UCINET, VOSviewer, and SPSS software were used to draw matrices, analyze co-word networks, and draw dendrograms. Furthermore, strategic diagrams were drawn using Excel software. The keywords "*information retrieval*," "*classification*," and "*ontology*" are among the most frequently used keywords in knowledge organization articles. Findings revealed that "*Ontology*Semantic Web*", "*Digital Library*Information Retrieval*" and "*Indexing*Information Retrieval*" are highly frequent co-word pairs, respectively. The results of hierarchical clustering indicated that the global research on knowledge organization consists of eight main thematic clusters; the largest is specified for the topic of "*classification*, *indexing*, and *information retrieval*." The smallest clusters deal with the topics of "*data processing*" and "*theoretical concepts of information and knowledge organization*" respectively. Cluster 1 (*cataloging standards* and *knowledge organization*) has the highest density, while Cluster 5 (*classification*, *indexing*, and *information retrieval*) has the highest centrality. According to the findings of this research, the keyword "*information retrieval*" has played a significant role in knowledge organization studies, both as a keyword and co-word pair. In the co-word section, there is a type of related or general topic relationship between co-word pairs. Results indicated that information retrieval is one of the main topics in knowledge organization, while the theoretical concepts of knowledge organization have been neglected. In general, the co-word structure of knowledge organization research indicates the multiplicity of global concepts and topics studied in this field globally.

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1.0 Introduction

Nowadays, knowledge organization (KO) has become more critical, diverse, and widespread, and the study of its various aspects has always been one of the significant fields in library and information sciences. Only a partial image of the perspective of KO is indicated in published articles, which has made it difficult for researchers to gain an overview of the field by reviewing personal articles. Accordingly, scientometric methods can help meet this need, one of which is co-word analysis. This type of co-occurrence analysis is one of the essential bibliometric approaches accepted as a reasonable method to map the relationship between concepts, ideas, and problems in basic and social sciences (Liu et al. 2015). Although at first some researchers believed that co-words cannot map the development of the sciences (Leydesdorff 1997), the results of the use of co-word analysis in various subject areas show that it is sufficiently capable of revealing the structure of knowledge in the areas under study (Zhang et al. 2012). In the literature related to the co-word analysis of the scientific documents, cases of the use of thematic maps have been discussed, which show the relationships between the subjects. Among them, we can mention such cases: finding hidden connections in a scientific field (Bredillet 2006); discovering communication patterns between entities (Assefa and Rorissa 2013); discovering the gradual evolution of the concepts of a field of study (Mane and Börner 2004); diffusion of an idea over a period of time (Wang and Inaba 2006); revealing trends in specific subject areas (Wang and Inaba 2006); identifying prominent, main, and important topics of a field (Kumar and Jan 2012; Khasseh et al. 2017); and discovering topics that researchers have repeatedly addressed (Ryan and Bernard 2003). Co-word analysis identifies the main keywords for a topic in terms of word frequency, finds connections between words and then offers a combination of social network analysis and clustering analysis methods to explore important points of research and the evolution of the topic (Zhu and Zhang 2020). In other words, the co-word evaluates the relationship between words in literature, in which the frequency of words with each other indicates the relationship between topics (Chen et al. 2019).

The findings presented in scientometric studies can have a direct impact on managers' decisions (Boyack, Klavans and Borner 2005). Co-word analysis, as one of the common methods in scientometric studies, allows us to reveal the emerging thematic clusters as well as the changes of the old thematic clusters in order to predict the direction of future research (Lee and Su 2010), reveal its conceptual and semantic relationships (Leydesdorff and Welbers 2011), and draw the intellectual and cognitive structure of knowledge in the field under study. The study of knowledge structure using the co-word approach in collecting academic articles has been extensively employed to provide an insight into the topic evolution in the desired research field (Katsurai and Ono 2019). Given the importance, nature, and scope of the field of knowledge organization, it is required to study its intellectual structure and trace its scientific map. Social network analysis and science visualization also contribute to a better understanding of co-word structures. Therefore, the present study intends to investigate the co-word relationships of knowledge organization research. The results of this study play a key role in future policies in this field and give researchers a better insight into this issue. Therefore, this study aims at investigating the intellectual structure of knowledge organization studies during the period from 1900 to 2019. According to the discussed content, the research questions are as follows:

1. What is the co-word network of knowledge organization articles?
2. What are the co-word clusters of knowledge organization articles and the influential topics of each cluster?
3. How are clusters of knowledge organization presented on the strategic diagram regarding maturity and development?

2.0 Literature review

The co-word analysis has been employed in various disciplines and topics, first proposed by Callon et al. (1983) and has gradually developed and matured. Co-word analysis can reveal patterns and trends in various topics (Ding et al. 2001; Hu et al. 2013). In this section, some studies in this field are discussed.

Pattuelli (2010) analyzed the subject content of knowledge organization courses taught in ALA-accredited Library and Information Science programs (2000 course readings from 34 LIS schools in the USA and Canada). Results indicate that traditional bibliographic methods and practices remain at the core of knowledge organization courses. Findings also show that metadata has become a central component of course content and new topics from information architecture to markup languages and semantic web are becoming part of introductory-level knowledge organization education.

De la Moneda Corrochano et al. (2014) explored Spanish research on knowledge organization from 2002 to 2010.

They found a remarkable increase of male vs. female authors per publication, although the gender gap was not big.

Shen and Hu (2017) conducted a co-word analysis of information behavior in China. Their results indicated that the first article on information behavior in China was published in 1987, and the keywords "Information literacy", "Personalized services", "Network", "Information seeking" and "Digital library" had the most frequency in research on information behavior.

Khasseh et al. (2017) studied the co-word structure of iMetrics studies from 1978 to 2014. They revealed that the keywords "Impact Indicators", "Citation Analysis" and "Scientific Collaboration" had the most frequency in the research on this field. Furthermore, co-word clustering led to the establishment of eleven clusters with the titles of "Scientometric databases and indicators", "Citation analysis and theoretical foundations", "Sociology of science", "Issues related to the ranking of universities, and journals", "Information visualization and retrieval", "Mapping the intellectual structure of science", "Webometrics", "Industry–university–government relations", "Technometrics", "Network analysis" and "Scientific collaboration in universities."

Smiraglia and Cai (2017) investigated the evolution of clustering, machine learning, automatic indexing and automatic classification in knowledge organization. They found scholars involved in "clustering" and "automatic classification" who share common thematic emphases.

Olmeda Gomez et al. (2017) studied the topical trends of library and information sciences in Spain from 1985 to 2014 using the co-word method. Findings revealed that keywords "Science", "Spain", "Internet" and "Impact" had the highest frequency. Their results showed that co-word clustering led to the formation of the following 9 clusters: "Digital rights management", "Citation analysis", "Translation services", "Bibliometric analysis", "Co-authorship", "Information Retrieval", "Webometrics and Bibliometrics", "Information system" and "World wide web".

In Spanish research, Olmeda et al. (2017) conducted an authors' co-citation analysis of the articles published in the *Knowledge Organization* journal between 1993 and 2016. Their findings uncovered four clusters of authors. They concluded that visualized maps allow one to identify the groups of authors that have greater interconnection with each other and in the whole of the knowledge organization network.

Galvez (2018) studied the co-words of highly cited papers in library and information sciences from 2007 to 2017 on Web of Science. The main results demonstrated that topics on Web 2.0, evaluation of scientific activities, and alternative criteria developed in social and academic contexts such as Altmetrics, trust in virtual media, and other uses of information technologies in companies and digital e-commerce platforms have become more popular among researchers compared to other topics.

Based on texts published in the scope of the *International Society of Knowledge Organization*, Barros and de Sousa (2020) investigated the aspects and points of contact between knowledge organization and archival science. Results indicated that the field of knowledge organization makes a pivotal contribution to the development of methodologies to access information. They found a series of developments in languages, structures and classifications, that is, knowledge organization systems (KOSs). On the other hand, archival science has been developing simultaneously, but frequently seeking interlocutions with the field of knowledge organization. Barros and de Sousa (2020) concluded that the approximation of these fields is essential for the development of archival classification and description, aiming for the construction of ontologies, taxonomies and controlled vocabularies among others.

Tariq et al. (2020) studied the co-word analysis of library and information sciences concepts in Pakistan from 2001 to 2018. The results revealed that the research trend had been altered from *library* to *information science*, and the word "research" was the most popular keyword in the data network.

Deng et al. (2020) investigated the co-word connections in information-seeking behavior. Their results showed an unbalanced distribution of topics. These topics were classified into six categories: (i) information behavior in patient-centered studies; (ii) information interaction in the digital media; (iii) information literacy in the fields of health and academia; (iv) online health literacy; (v) information behavior in child-centered studies; (vi) informational behavior in medical informatics.

Mokhtarpour and Khasseh (2021) analyzed the co-word structure of library and information sciences. The frequency of co-occurrence and centrality scores in the general structure of the field indicated that the word "Science" is the most important keyword; the word "Library" is in the second place. However, the results of social network analysis showed that the key role of the word "library" has decreased over time despite high frequency. Moreover, "information search and retrieval" are the most important co-word pairs. The results also suggested that the words "Internet" and "World Wide Web" have attracted the most attention of scientists in library and information sciences during the years under investigation.

Xu and Ma (2021) performed a co-word analysis for library and information sciences concepts in China from 2013 to 2018. The results suggested that topics such as "e-government", "promotion of reading" and "social media" have matured and developed. Some topics such as "bulk data", "ontology" and "cloud computing" have also been developed on a significant scale, while some other concepts

such as "knowledge sharing" and "virtual communication" are isolated and underdeveloped. Furthermore, the concepts of "mobile library", "topic services" and "user experience" are among the emerging topics with a high potential for development.

A literature review indicated that each study evaluated the co-word network in the library and information subject area using various scientometric methods. Moreover, in most previous literature, knowledge organization has been considered a part of library and information sciences. However, it seems necessary to conduct a study that looks at the issue of knowledge organization as an independent identity regarding the history and importance of this issue at national and international levels. Another point is that the reviewed literature has been topically, chronologically, or geographically limited. The present investigation is innovative in terms of topic and tools. The difference between this research and the previous literature is the comprehensiveness of the investigated records, since it has tried to include articles over a wide period of time. In addition, in the dimension of using a combined search strategy, the attempt was made to retrieve and examine the most relevant documents. Also, in the findings of this research, a strategic diagram has been drawn, which had not been used in scientometric articles in the field of knowledge organization.

3.0 Method

The present study is applied research based on a quantitative approach and scientometric indicators using co-word analysis. The statistical population of this study consists of all research papers published between 1900 and 2019 in the field of knowledge organization. In this research, a two-stage search strategy was used. In the first step, all the articles that have been indexed in the two journals *Knowledge Organization* and *Cataloging & Classification Quarterly* in the Web of Science were retrieved. These journals are among the oldest and most important journals in information and knowledge organization, and their articles have dealt directly with this subject. However, many articles in the field of knowledge organization may be published in other journals. For this reason, keyword search was used in the second step. For this purpose, first by consulting experts in the field of knowledge organization, the keywords of this field were identified (approximately 100 keywords). Then searching was done with these keywords in the Web of Science Core Collection. This search was limited to the records that are indexed in the "Information Science & Library Science" category. After extracting the records, the data of the first stage was merged with the data of the second stage and finally 17,950 articles were included in the final analysis.

For co-word analysis, all keywords of the studied documents were extracted and reviewed. Some sub-categories of the main concept were considered as a part of the main concept to a limited extent, e.g., "Library classification" was considered as belonging to "Classification".

The singular form was selected from the plural and singular forms of the keywords, e.g., "Digital library" was preferred to "Digital libraries"; and the full form was picked from their abbreviation and full forms, e.g., "Resource Description and Access" was preferred to "RDA". Also, one spelling was selected for the words with two spellings, e.g., "Information Behavior" vs. "Information Behaviour".

The total number of keywords obtained equalled 25,480, reduced to 12,478 after modification, homogenization, and elimination of duplicates. By defining a threshold value of ≥18 occurrences, 115 keywords were extracted and included in the final analysis. Therefore, a 115×115 matrix was used to plot the co-word network. It can be noted that a keyword must play a role in several common effects to be effective in the co-word network. Therefore, the keywords repeated at least ≥18 times were selected as the final research population. If the threshold value were selected lower than this value, the number of keywords would be too high, and the network would be significantly overlooked; hence, the lines were also stacked, making it difficult for the audience to understand the network. The resulting symmetric matrix was then transformed into a correlation matrix. The clusters were identified separately to plot a strategic diagram based on the clusters obtained from the hierarchical cluster analysis. Afterward, a separate co-occurrence matrix was designed for each cluster based on the keywords in each cluster. Finally, the centrality and density scores were calculated, and a strategic diagram was plotted after calling each of these matrices in UCINET.

Bib Excel, UCINET, VOSviewer, SPSS, and Excel software were used to draw the matrix, analyze the co-word networks, draw the matrix network, draw the dendrogram, and draw the strategic diagram, respectively. For the data validity and reliability, it should be mentioned that the Web of Science Core Collection has been applied to extract the data. This citation database was selected due to its internationality, credibility, history (starting from 1898), and the volume of information resources (more than 80 million records) (Birkle et al. 2020; Mokhtarpour and Khasseh 2020). The present study also has good reliability due to static data. The strategic diagram (Fig. 1) is a method that helps researchers determine and analyze the position of clusters and topical concepts of the subset of each subject area. In this diagram, the horizontal axis is often used to represent the centrality (correlation of clusters), and the vertical axis is employed to indicate the density (internal communication power of each cluster) (Ke, Yunjiang, Xiao and Weichan 2013). The horizontal axis in the strategic diagram indicates centrality and determines the power of interaction of each cluster in the studied field. The higher a cluster's centrality, the more cen-

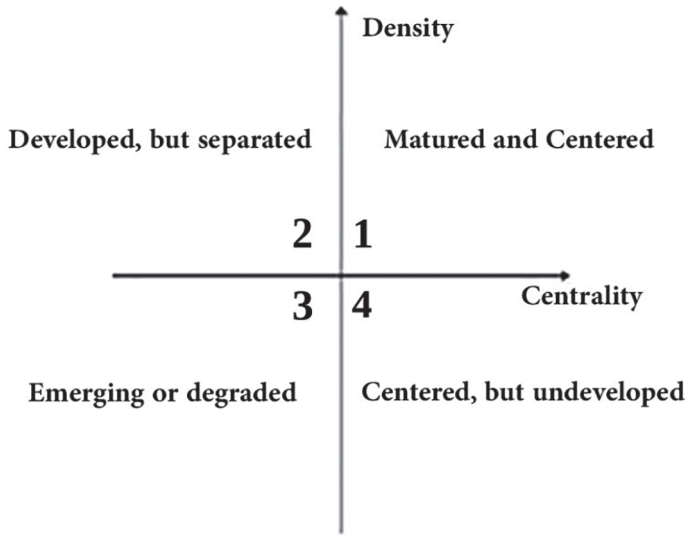

Figure 1. The sections of the strategic diagram (Melcer et al. 2015).

Rank	Keyword	Frequency
1	Information retrieval	519
2	Classification	366
3	Ontology	346
4	Digital library	334
5	Metadata	275
6	Cataloging	201
7	Semantic web	185
8	Indexing	160
9	Knowledge organization	112
10	Natural language processing	108

Table 1. Frequency distribution of keywords.

tral and essential it is. On the other hand, the vertical axis indicates the density and shows the internal relationship in a particular research field. The higher the density of a cluster, the more it will be able to maintain and develop itself (Liu et al. 2012).

4.0 Results

4.1 Frequency distribution of (most frequent) keywords in knowledge organization research

The keywords "information retrieval" with 519 frequency, "classification" with 366 frequency, and "ontology" with 346 frequency are ranked first to third, respectively, and the keywords "digital library", "metadata" and "cataloging" are at fourth to sixth places as the most frequent keywords of knowledge organization.

The co-word network of the frequent keywords in knowledge organization with density views are presented in Figure 2, according to which the keywords such as "information retrieval", "classification" and "ontology" are extensively applied in knowledge organization and the network density around them is higher than the others. It should be noted that the larger (bolder) the keyword (node) is written, the more times it is mentioned in the research and the more central role it plays in the intellectual structure governing a discipline or field.

4.2 The co-word network of knowledge organization

As shown in Table 2, the co-word pairs of "ontology" and "semantic web" with 52 frequencies, the co-word pairs of "digital library" and "information retrieval" with 21 frequencies, and the co-word pairs of "indexing" and "infor

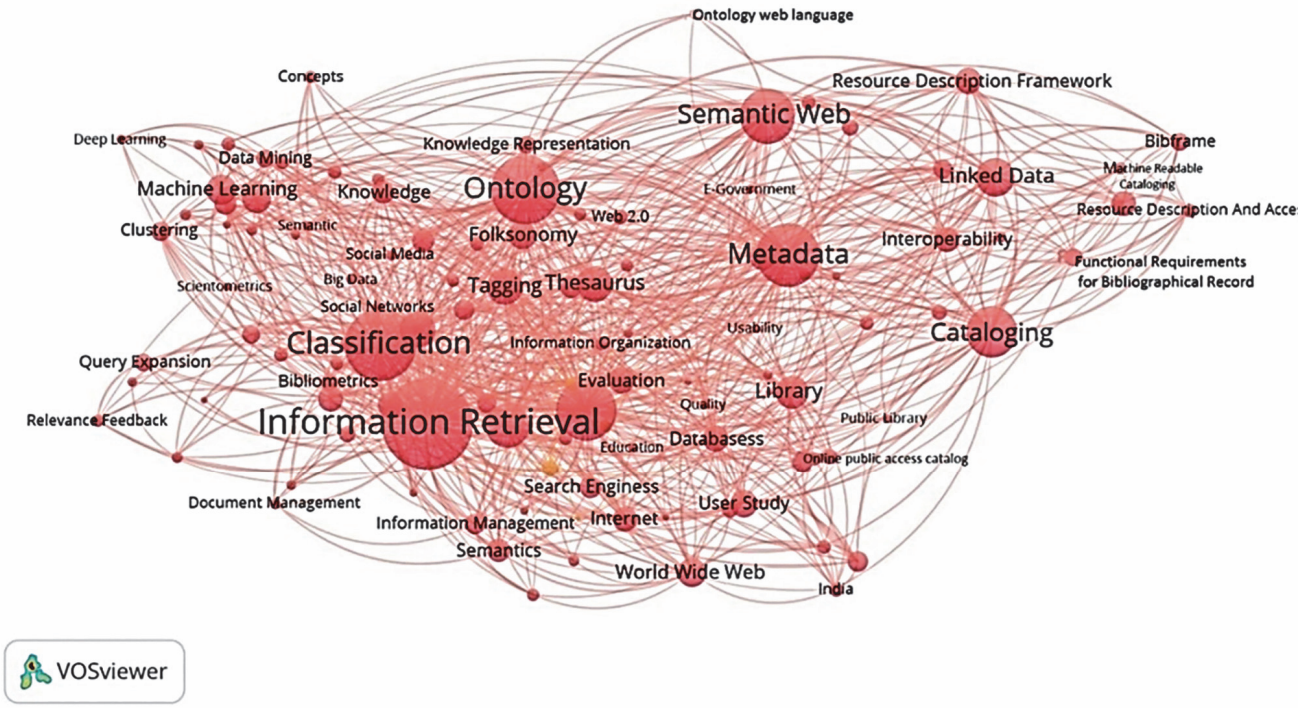

Figure 2. The co-word map of knowledge organization articles.

Rank	Co-word Pair		Frequency
1	Ontology	Semantic web	52
2	Digital library	Information retrieval	21
3	Information retrieval	Indexing	20
4	Knowledge organization	Classification	19
5	Metadata	Dublin Core	16
5	Linked data	Semantic web	16
6	Information retrieval	Search engines	15
6	Information retrieval	Query expansion	15
6	Cataloging	Metadata	15
7	Cataloging	Resource Description and Access	14
7	Digital library	Metadata	14
7	Natural language processing	Machine learning	14
7	Folksonomy	Tagging	14
7	Ontology	Knowledge management	14
8	Semantic web	Linked data	13
9	Metadata	Semantic web	12
10	Classification	Information retrieval	11
10	Linked data	Metadata	11
10	Information retrieval	User studies	11

Table 2. The frequency distribution of top co-words

mation retrieval" with 20 frequencies are in the first to the third places of most frequent co-word pairs, respectively. Two words are co-occurring if used in the same documents. The higher co-occurrence frequency of two words indicates closer connection between them (Wang and Inaba 2009; Ding et al. 2001). In other words, the greater the number of

these co-words, there are more topical similarities and connections between these two words. To some extent, the co-word can show the common research relations of the words (Ghazizadeh, Soheili and Khasseh 2018).

4.3 The co-word clusters of knowledge organization articles and topics of each cluster

Dendrograms provide useful information about clusters, authors in each cluster, and the intellectual structure of the studied topics. For this purpose, in this section, hierarchical clustering was performed according to the square matrix prepared based on 115 keywords with the most frequency, and the results are indicated in Figure 3. As shown in the dendrogram, the intellectual structure of the articles in the field of knowledge organization consists of eight main clusters, the largest of which (Cluster 5) includes 24 keywords dedicated to the topic "classification", "indexing" and "information retrieval." Afterward, Cluster 6, with 22 keywords, deals with the topic "assessment studies", and Cluster 3, with 19 keywords, discusses the topic "information literacy and expert systems". The smallest clusters are Clusters 7 and 8, each with six keywords dealing with the topics "information processing" and "theoretical concepts of information and knowledge organization", respectively.

After plotting the dendrogram, each cluster's keywords are assessed ultimately to determine each cluster's topic. The results for the clusters obtained from the hierarchical cluster analysis, along with the keywords in each cluster, are presented in the following. The keywords in each cluster reflect the relevant topics of that cluster. It should be mentioned that sometimes there are keywords in some clusters that do not seem to have a direct semantic connection with the topic of the cluster, which is not unusual in co-word analysis because these keywords have attracted little attention from researchers and have lower influence in terms of the co-word frequency and the correlation factor compared to other keywords in that cluster (Zong et al. 2013). However, the clusters were named according to the keywords in a similar subject area and a higher semantic relationship with each other. As indicated in Table 3, the co-word clusters are divided into eight clusters; now, the clusters branched from the hierarchical clustering are evaluated separately.

In this section, only the characteristics of the largest co-word cluster (Cluster 5) are discussed due to the limitation related to pages of the article (Fig. 4). There are 24 keywords such as "classification", "classification schemes", "indexing" and "online catalogs" in this cluster. Therefore, this cluster was named the topic "classification, indexing and information retrieval".

4.4 Co-word clusters of knowledge organization articles in terms of maturity (strategic diagram)

In this section, a strategic diagram was plotted using the concepts of network centrality and density. For this purpose, a frequency matrix was created for every eight clusters separately, and then a correlation matrix was established. The rank centrality and density of each cluster were then calculated, and the average of each cluster was obtained. In the next step, a strategic diagram was plotted to determine the maturity and coherence of each topic based on the data related to the centrality and density of each of the eight clusters. The total density and centrality were equal to 0.246 and 1.7555, respectively, where the y-axis is the origin and indicates density and the x-axis represents the centrality.

The origin of the diagram is placed on the values 1.945 and 0.464 according to the average centrality and density of the clusters, respectively. According to the strategic diagram of clusters resulting from co-word analysis (Fig. 5), it can be indicated that Cluster 2 (knowledge organization in digital media), Cluster 5 (classification, indexing, and information retrieval), and Cluster 8 (theoretical concepts of information, information organization and knowledge organization) are the main topics of knowledge organization and placed in Section 1 of the strategic diagram. Cluster 1 (cataloging standards and knowledge organization) is placed in Section 2 of the strategic diagram and has an insignificant influence on the subject area compared to the clusters in Section 1 of the diagram. Cluster 3 (information literacy and expert systems), Cluster 4 (information retrieval tools), Cluster 6 (assessment studies) and Cluster 7 (information processing) are in Section 3 of the diagram, which indicates the low centrality and density levels; therefore, they are in the margins of the knowledge organization network.

5.0 Conclusions

The importance of keywords and co-word pairs is indicated by their high frequency (Hu et al. 2013). In other words, researchers have been more interested in these topics. The knowledge structure of a particular research field can be identified, and a co-word analysis can explain the existing relationships between its topics (Khasseh et al. 2017). The present study employed co-word analysis to discover topic clusters in knowledge organization. According to the findings related to high-frequency keywords, the keywords "information retrieval", "classification" and "ontology" are in the first to third places, respectively. Moreover, the keywords "digital library", "metadata" and "cataloging" are in the next ranks. The results of this section are consistent with the results of studies by Li et al. (2015), Shen and Hu (2017), Mokhtarpour and Khasseh (2021), and Deng et al. (2020). Therefore, the keywords "digital library", "catalog-

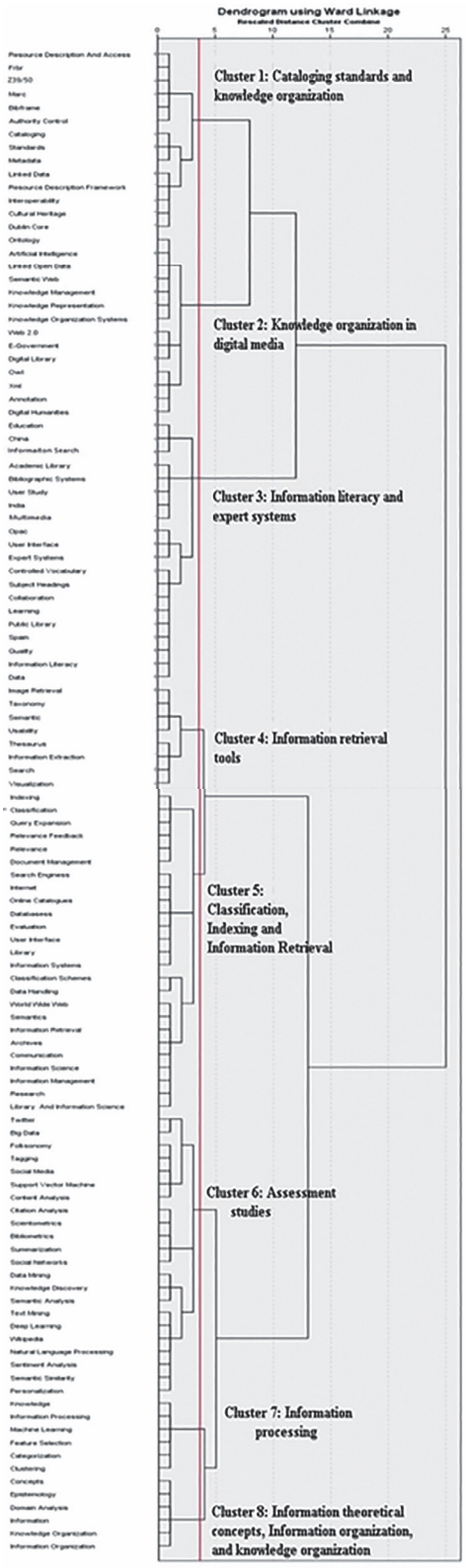

Figure 3. Dendrogram from hierarchical clustering with the co-word method.

Cluster Number	Number of Keywords	Main Subject of Cluster	Keywords in Cluster
1	14	Cataloging and knowledge organization standards	Authority Control, Bibframe, Cataloging, Cultural Heritage, Dublin Core, FRBR, Interoperability, Linked Data, Marc, Metadata, Resource Description And Access, Resource Description Framework, Standards, Z39.50
2	14	Organizing knowledge in digital media (web environment)	Annotation, Artificial Intelligence, Digital Humanities, Digital Library, E-Government, Knowledge Management, Knowledge Organization Systems, Knowledge Representation, Linked Open Data, Ontology, Ontology web language, Semantic Web, Web 2.0, XML
3	19	Information literacy and expert systems	Academic Library, information search, Bibliographic Systems, China, Collaboration, Controlled Vocabulary, Data, Education, Expert Systems, India, Information Literacy, Learning, Opac, Public Library, Quality, Spain, Subject Headings, User Interface, User Study
4	8	Information retrieval tools	Image Retrieval, Information Extraction, Search, Semantic, Taxonomy, Thesaurus, Usability, Visualization
5	24	Classification, indexing, and retrieval of information	Archives, Classification, Classification Schemes, Communication, Data Handling, Databases, Document Management, Evaluation, Indexing, Information Management, Information Retrieval, Information Science, Information Systems, Internet, Library, Library And Information Science, Online Catalogues, Query Expansion, Relevance, Relevance Feedback, Research, Search Engines, Semantics, World Wide Web
6	22	Assessment studies	Bibliometrics, Big Data, Citation Analysis, Content Analysis, Data Mining, Deep Learning, Folksonomy, Knowledge Discovery, Natural Language Processing, Personalization, Scientometrics, Semantic Analysis, Semantic Similarity, Sentiment Analysis, Social Media, Social Networks, Summarization, Support Vector Machine, Tagging, Text Mining, Twitter, Wikipedia
7	6	Information processing	Classification, Clustering, Feature Selection, Information Processing, Knowledge, Machine Learning
8	6	Theoretical concepts of information and knowledge organization	Concepts, Domain Analysis, Epistemology, Information, Information Organization, Knowledge Organization

Table 3. Co-word clusters of knowledge organization articles according to dendrograms.

1. Cluster Number	2. Cluster Name	3. Density	4. Centrality
5. 1	6. Cataloging and knowledge organization standards	7. 0.813	8. 1.8205
9. 2	10. Organizing knowledge in digital media (web environment)	11. 0.516	12. 3.5256
13. 3	14. Information literacy and expert systems	15. 0.274	16. 0.6257
17. 4	18. Information retrieval tools	19. 0.393	20. 0.7619
21. 5	22. Classification, indexing, and retrieval of information	23. 0.487	24. 3.7917
25. 6	26. Assessment studies	27. 0.355	28. 0.9381
29. 7	30. Information processing	31. 0.4	32. 0.7
33. 8	34. Theoretical concepts of information and knowledge organization	35. 0.467	36. 3.4

Table 4. Density and centrality of clusters resulting from co-word analysis.

ing", "ontology", "retrieval", "indexing", and "metadata" are frequently used in these studies. In general, the keyword "information retrieval" is one of the most frequently used keywords in most related studies because of the irreplaceable role of "information retrieval" in knowledge organization, since the main purpose of information and knowledge organization systems is ultimately the optimal retrieval of information. The high frequency of the keyword "digital library" can also be interpreted as this tool plays a key role in organizing and providing information resources given the cyberspace expansion. In the co-occurrence section of words, the co-word pairs "ontology–semantic web", "digital library–information retrieval", "indexing–information retrieval", "knowledge organization–classification" and

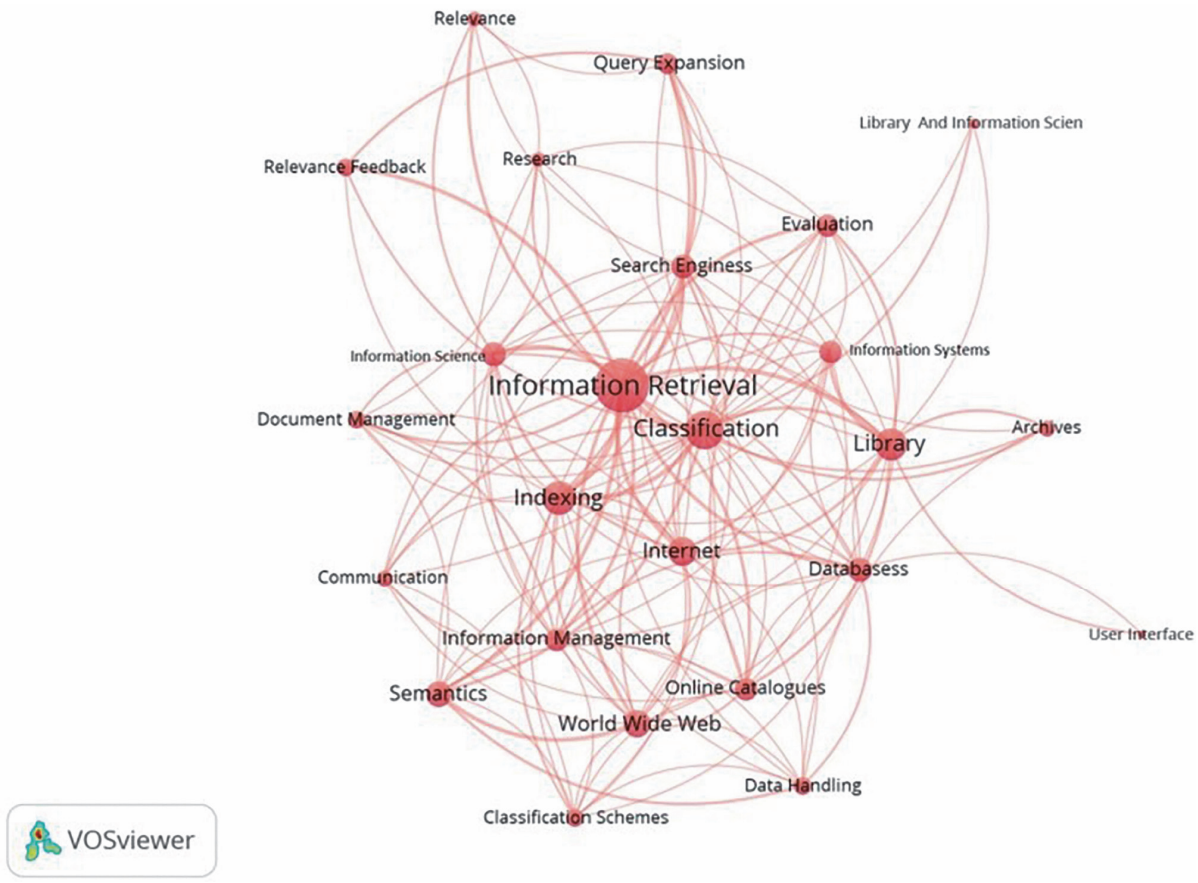

Figure 4. Co-word network of Cluster 5.

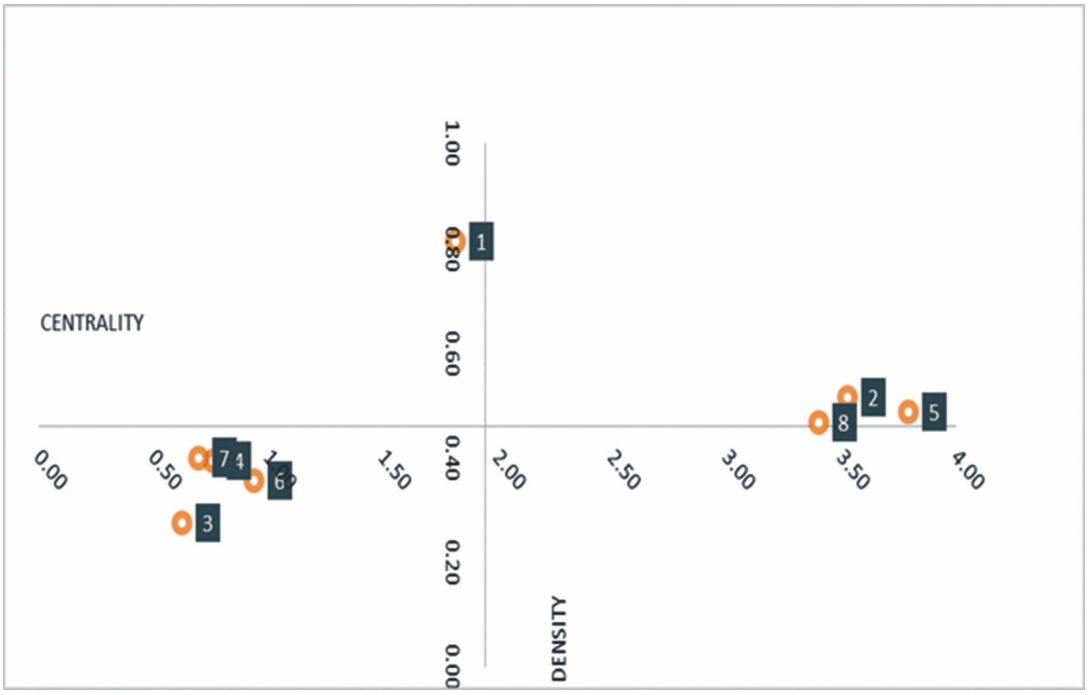

Figure 5. Strategic diagram of clusters resulting from the co-word analysis.

"metadata–Dublin Core" are also among the most frequent co-word pairs. The first point is that "information retrieval" has played a significant role in knowledge organization studies, both as a keyword and a co-word pair. As mentioned earlier, the co-word indicates the relationship between two keywords. A kind of related or general/specific topic relationship is observed between co-word pairs in this section, e.g., "ontology" and "semantic web" are in the same direction and concept. Furthermore, the co-occurrence pairs of the keywords "digital library–information retrieval-indexing–information retrieval" can be explained by the fact that the keyword information retrieval often comes with one of its tools such as digital library and indexing. The reason is the linkage, importance, and connection between the theoretical concepts of information organization and its practical tools. Morgan and Bawden (2006) conducted a study in which the respondents identified "indexing" as the most important aspect of information organization, revealing this topic's importance worldwide. The results of clustering the keywords of knowledge organization lead to the identification of eight clusters with the following titles: (i) cataloging standards and knowledge organization, (ii) knowledge organization in digital media (web environment), (iii) information literacy and expert systems, (iv) information retrieval tools, (v) classification, indexing and information retrieval, (vi) assessment studies, (vii) information processing, (viii) theoretical concepts of information, information organization, and knowledge organization. Some of the cluster titles such as information organization, information seeking, Information retrieval, and information seeking and retrieval are relatively consistent with the clustering of studies conducted by Shen and Hu (2017), Khasseh et al. (2017), Olmeda-Gómez (2017), Mokhtarpour and Khasseh (2021), which indicated the prominent role of these concepts in the field of knowledge organization. The clusters' topics also show a balance in the concepts of knowledge organization. The published articles have also addressed almost all concepts of knowledge organization, from theoretical concepts to its tools and also carried out quantitative studies. However, the number of clusters that have addressed knowledge organization tools is more than other clusters. The clusters of "classification, indexing and information retrieval", "assessment studies", and "information literacy and expert systems" are among the largest clusters, and "information processing" and "theoretical concepts of knowledge organization" are the smallest clusters. This issue indicates the significance of large cluster topics and the less importance of small cluster topics. "Information retrieval" is one of the main topics in knowledge organization, and "assessment studies" are in a good position in most studies. On the other hand, "theoretical concepts of knowledge organization" have been neglected. According to the perspectives of knowledge organization experts, the small number of theoretical studies in this field and the necessity of conducting such investigations have been emphasized, confirming this section's results. According to the data, Cluster 1 (cataloging standards and knowledge organization) has the highest density; i.e., most of the connections are between the keywords of this cluster, and the topics of these clusters tend to be significantly mature. Cluster 5 (classification, indexing, and information retrieval) also has the highest centrality, i.e., this cluster has the highest centrality in terms of influence and connection between other keywords. According to the strategic diagram, Cluster 2 (knowledge organization in digital media), Cluster 5 (classification, indexing, and information retrieval), and Cluster 8 (theoretical concepts of information, information organization, and knowledge organization) are placed in Section 1 of the diagram, are generally coherent and in the center of the studied area. Although Cluster 1 (cataloging standards and organizing knowledge), placed in Section 2 of the strategic diagram, is sufficiently coherent, it has moved toward being more specialized and has separated itself from the main topics of the studied area. It seems that this topic has much potential for growth, development, and being independent. Cluster 3 (information literacy and expert systems), Cluster 4 (information retrieval tools), Cluster 6 (assessment studies), and Cluster 7 (information processing) are placed in Section 3 of the diagram, indicating the their underdeveloped and immature status; hence, they are better to be considered by researchers, and the policy-making and research must be directed toward them.

There is no topic in Section 4 of the strategic diagram, i.e., among the clusters of knowledge organization, there is no cluster that has not been extensively emphasized or has not been reached maturity. In general, the co-word structure of studies in the field of knowledge organization indicates the multiplicity of concepts and topics investigated globally in this area. Addressing this investigation highlights the need for more attention in the country's policy-making in the scientific and technical areas of this academic field and the requirement for the identification of new research processes while clarifying the current state of knowledge.

Future Studies

1. One suggestion is that the structure and concepts of scientific products in this field be considered in other citation databases such as Scopus and Google Scholar to make a more comprehensive assessment of the status of knowledge organization research.
2. Visualization of knowledge organization information can also be studied by taking into account other related topics such as computer and network science, psychology, management, and linguistics.

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