

Knowledge Strategy Research Fronts and Intellectual Bases: Based on Information Visualization Methodology

S. Hussein Sajadian

Ph.D .Candidate in Information Sciences, Iranian
Research Institute for Information Science and
Technology (IranDoc) Tehran, Iran.

Corresponding Author:

Sajadian@students.irandoc.ac.ir

ORCID iD: <http://orcid.org/0000-0002-0364-1060>

Peyman Akhavan

Professor, Qom University of Technology, Qom, Iran.
and Visiting Lecturer, Iranian Research Institute for
Information Science and Technology (IranDoc),
Tehran, Iran.

akhavan@qut.ac.ir

ORCID iD: <http://orcid.org/0000-0001-6256-3288>

Asghar Mohammadi-Fateh

Visiting Lecturer, Iranian Research Institute for Information Science and Technology (IranDoc), Tehran, Iran.

amohammadi1360@yahoo.com

ORCID iD: <http://orcid.org/0000-0003-2159-1789>

Received: 10 November 2021

Accepted: 09 August 2022

Abstract

As an active and emerging research field, knowledge strategy receives extensive academic attention and acts as a compass for knowledge management strategy. The main purpose of our research is to discover and visualize emergent and transient grouping of concepts and underlying research issues and their citation and co-citation footprints in knowledge strategy scientific literature. Based on the publications from Web of Science core databases from 1965 to 2018, a total of 403 publications matched the search criteria of this study. CiteSpace is applied for visualizing and analyzing trends and patterns of knowledge strategy scientific literature. Google Fusion application is used to show data distribution of knowledge strategy. This study showed that the area distribution of knowledge strategy research is worldwide and has spread especially in the United States, Europe, and other countries. According to this study, knowledge strategy and management are the research front keywords with more citations. Zack (1999) and Alavi (2001) are knowledge strategy's most prominent intellectual bases. Identifying emerging trends and abrupt changes in knowledge strategy are among the results of this study.

Keywords: Knowledge Strategy, CiteSpace, Information Visualization, Intellectual Base, Research Front.

Introduction

The so-called knowledge-based view of the firm (Abou-Zeid, 2008; Bierly & Chakrabarti, 1999; Bolisani & Bratianu, 2018; Zack, 1999), the growing interest in knowledge management (Bolisani & Bratianu, 2018) and knowledge economy has made knowledge strategy a key topic of research and analysis. Knowledge strategy acts as a compass, and points to *what* must be done in knowledge management strategy, *where, when, why, and by who*. at the same time, knowledge management strategy focuses on *how* to do what the knowledge strategy identifies at the right place, at the right time, for the right reason, and by the right person (Asoh, 2004). Although many researchers try to detect and visualize emergent trends and abrupt changes in

scientific literature to provide readers with various kinds of information about scientific fields (e.g., Akhavan, Ebrahim, Fetрати & Pezeshkan, 2016; Chen, 2015; He, Zhang, Wang, Zeng & Zhang, 2018; Jin & Ji 2018; Moed, Markusova & Akoev, 2018; Wang, Zhu, Song, Hou & Zhang, 2018; Yang, Wang & Xue, 2016), but to the best of our knowledge, there are no results regarding the study of knowledge strategy (KS) research fronts (RF) and intellectual bases (IB) in scientific literature.

With the rapid increase in publications, a considerable amount of information or data can be processed by information visualization. Information visualization is concerned with designing, developing, and applying computer-generated interactive graphical representations of information (Chen, 2014). the art of information visualization perhaps appropriately describes the state of the field (Chen, 2006b), and the goal of information visualization is to reveal invisible patterns from abstract data (Chen, 2014).

Detecting and understanding research fronts (citing terms) and intellectual bases (cited articles) in knowledge strategy can significantly improve the ability of scientists to deal with the changes on time. Other important concepts in this study were *keywords* and *burst words*. A keyword can reflect reasonable descriptions of research hot spots, and a burst word could indicate new frontier topics. For the first time, this research discovers knowledge strategy research fronts and intellectual bases and visualizes hidden patterns. We apply different fascinating tools for visualizing and analyzing knowledge strategy scientific literature. Detecting and understanding emerging trends and abrupt changes in knowledge strategy can significantly improve the ability of practitioners to deal with the changes in this important scientific field on time. The results of this study would provide some directions for scholars to identify future research fields of knowledge strategy.

In this study, the research objectives are as follows: RO1. To figure out the yearly output of knowledge strategy publications worldwide and across Web of Science subject categories/classification; RO2. To determine keywords represented knowledge strategy research fronts, major areas, or clusters and analyze research front domain and development trends; RO3. To ascertain the intellectual bases associated with knowledge strategy research fronts, top-ranked items, and list the top references with the strongest citation bursts. We intend to answer the following key research questions (RQ) in the field of knowledge strategy: RQ1. What is the distribution of knowledge strategy publications and their co-occurrence across Web of Science subject categories; RQ2. What are the research fronts, hottest and emerging trends and abrupt changes in knowledge strategy; RQ3. Which intellectual bases, hottest intellectual bases, and the emerging trends and abrupt changes are associated with research fronts in knowledge strategy.

In the following sections, we first review the literature background, describe our methodology, report our findings, and discuss their implications for future research.

Background

As an attractive and emerging research field, knowledge strategy is receiving extensive attention from academics. Figure 1 shows the geographical distribution of knowledge strategy research around the world. As can be seen, this distribution is higher in Europe and the United States than in other parts of the world.

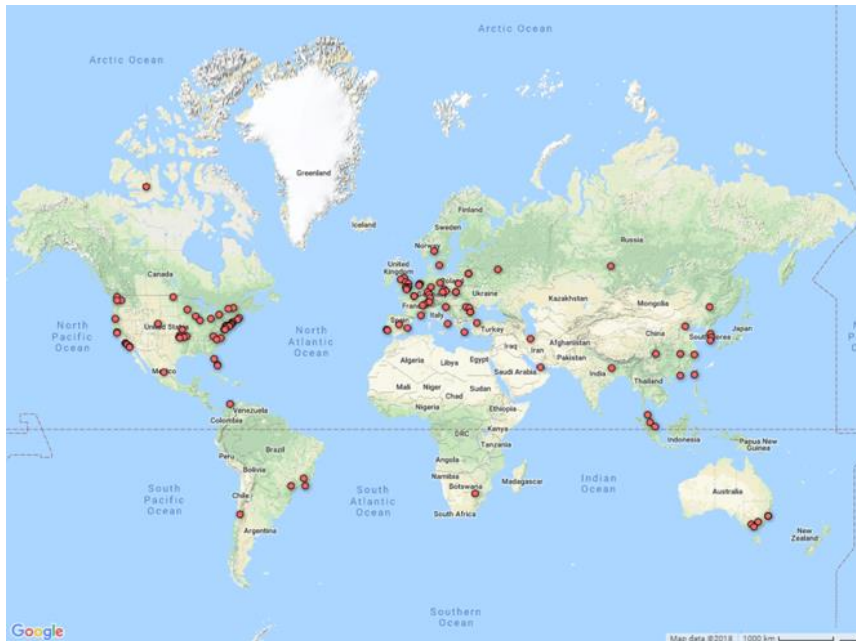


Figure 1: The area distribution of Knowledge Strategy over the world
(This map is depicted by using Google Fusion Tables)

To study any scientific subject, especially the knowledge strategy, paying attention to two concepts is very important: The research front and intellectual base. “*Research front* is an emergent and transient grouping of concepts and underlying research issues, and the *intellectual base* of a research front is its citation and co-citation footprint in the scientific literature- an evolving network of scientific publications cited by research front concepts.” (Chen, 2006a). The role of citation in scholarly communication is depicted in Figure 2 (Chen, 2006a).

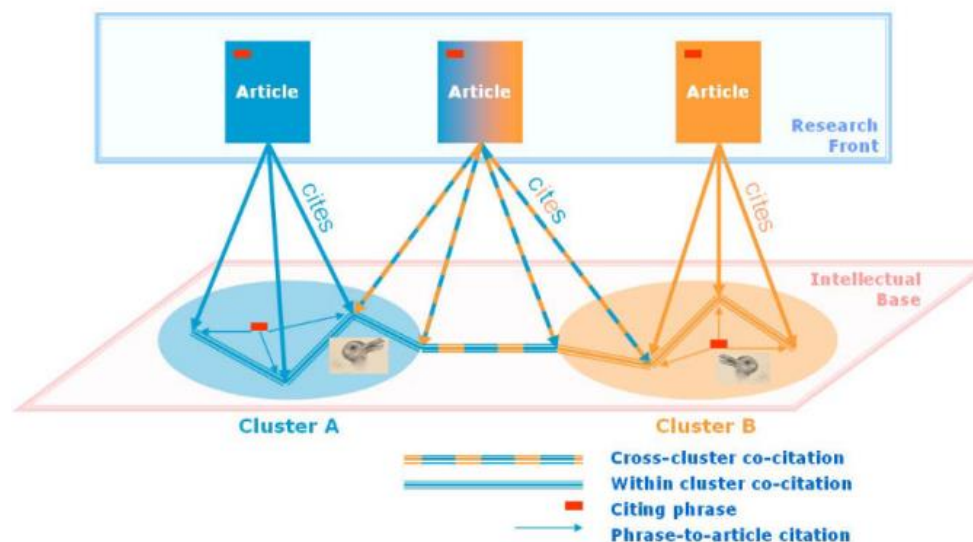


Figure 2: The role of citation in scholarly communication

The research front represents the state-of-the-art thinking of a research field (Chen, 2006a). Detecting and understanding research fronts (citing terms) and intellectual bases (cited articles) in knowledge strategy can significantly improve the ability of scientists to deal with the changes

on time.

Many researchers have studied the research fronts and intellectual bases of various research fields in their works. For instance, Takeda and Kajikawa (2009) discussed the distinction between the research front and intellectual base in the Optics research domain. In another work, Chen and Guan (2011) identified some pivot publications by CiteSpace, which work as structural holes, research fronts, and intellectual bases for the nanobiopharm-research development in the given time window. Furthermore, Schiebel (2012) produced interactive maps of research fronts and knowledge bases of research fields; This article proposes a method and some standardization for detecting and visualizing research fronts and knowledge bases with two and three-dimensional graphics inspired by geographical maps. In their study, Zhao and Strotmann (2014) tested and confirmed a previous forecast by comparing knowledge-base and research-front findings for IS 2001–2005, which expected both the information retrieval (IR) systems and webometrics specialties to shrink from 2006 to 2010. As the last example, Yang et al. (2016), with the frequency detection technology CiteSpace provided, explained the hot research topics, frontiers, and emerging trends in logistics management visually.

Other important concepts in this study are *keywords* and *burst words*. A keyword is a "significant word from a title or document used especially as an index to content" (keyword, 2018). A burst word is an emerging trend and abrupt change over a period [of time]" (Yang et al., 2018). The keyword can reflect reasonable descriptions of research hot spots, and the burst word could indicate new frontier topics (ibid).

Materials and Methods

With the rapid increase in publications, a huge amount of information or data can be processed by information visualization. Information visualization is concerned with designing, developing, and applying computer-generated interactive graphical representations of information (Chen, 2014). the art of information visualization perhaps appropriately describes the state of the field (Chen, 2006b), and the goal of information visualization is to reveal invisible patterns from abstract data (Chen, 2014).

Data Collection

Web of Science (WOS) Core Collections (SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI) are used as knowledge strategy data retrieval sources. To obtain comprehensive results, the research structure is set to TOPIC: ("knowledge strateg*"), and the timespan set to all years (1965-2018).

Data Processing

After data collection, the resultant dataset of 403 records is imported to CiteSpace 5.3. Then the scope of the overall time frame in the *time slicing* from 1993 to 2018 and the time span as two years are adjusted. Next, the term sources are selected as title, abstract, author keywords (DE), and keywords plus (ID). Then thresholds of three levels of citation, co-citation, and co-citation covariance (c, cc, ccv) are set in three-time division of proceeding, middle and rear as (2,3,15), (2,3,20), (3,3,20). The threshold of every two divisions is divided by linear interpolation. Finally, the source of the subject as titles, abstract, author keywords (DE), and Keywords plus (ID) is selected. In CiteSpace, *node types* are set as the keyword for research fronts analysis and *node types* as references for intellectual bases analysis.

Data analysis

The retrieved data from citation indexes via the WOS is used as input data for CiteSpace,

Google Fusion Tables, and SPSS to analyze data. CiteSpace, a freely available Java application developed by Chaomei Chen, a professor at Drexel University, is a popular information visualization software (e.g., Chen, 2009; Xie, 2015; Taşkın & Aydinoglu, 2015; He et al. 2018; Hou, Yang & Chen, 2018; Jin & Li, 2018; Cui & Mou, 2018; Zhang, 2019) based on scientometrics. It focuses on finding critical points in developing a field or a domain, especially intellectual turning points and pivotal points (Chen, 2006a).

CiteSpace 5.3.R4 is applied for visualizing and analyzing trends and patterns of knowledge strategy scientific literature. Google Fusion Tables is an experimental data visualization web application to gather, visualize, and share data tables (About Fusion Tables, 2018). This application shows the data distribution of knowledge strategy research on a map in Figure 1.

In CiteSpace, a current research front is identified based on burst terms extracted from titles, abstracts, descriptors, and identifiers of bibliographic records. These terms are subsequently used as labels of clusters in heterogeneous networks of terms and articles.

Burst-detection algorithms can identify emergent terms regardless of how often their host articles are cited. Therefore, a new research front can be featured in the big picture even before it attracts enough citations. CiteSpace supports a time-zone view to highlight temporal patterns between a research front and its intellectual base. A time-zone view consists of an array of vertical strips as time zones. The time zones are arranged chronologically from left to right so that a research front points back to its intellectual base.

Results

The distribution of knowledge strategy publications and the co-occurrence of them across Web of Science subject categories

In this section, we determine the yearly output of knowledge strategy publications worldwide and across Web of Science subject categories/classifications to answer the first research question.

The settings and search strategy in the WOS core collection retrieved 38 years of research in the field of knowledge strategy; in other words, the oldest research in the field of knowledge strategy is back 38 years ago. The distribution of the yearly output of knowledge strategy is shown in Figure 3. As shown in this Figure, in the past 38 years, the overall trend of knowledge strategy has been growing, and the publication years can be divided into three phases. The first phase ran from 1980 to 2001 with very slow growth in publications; the number of publications in this phase varies between 1 and 6 with a total of 36 publications per year; the average growth of publications in this period is 2.4. The second phase ran from 2002-2006 and showed a significant increase in publications; the average number of publications in this phase reaches 43. The third phase ran from 2007 to 2018, and each year's growth rate increased significantly. The total number of works is 324; the average number of publications in this phase is 27 publications per year. Compared with the past 20 years, the publication of the third phase was exploding, counting for more than 80%.

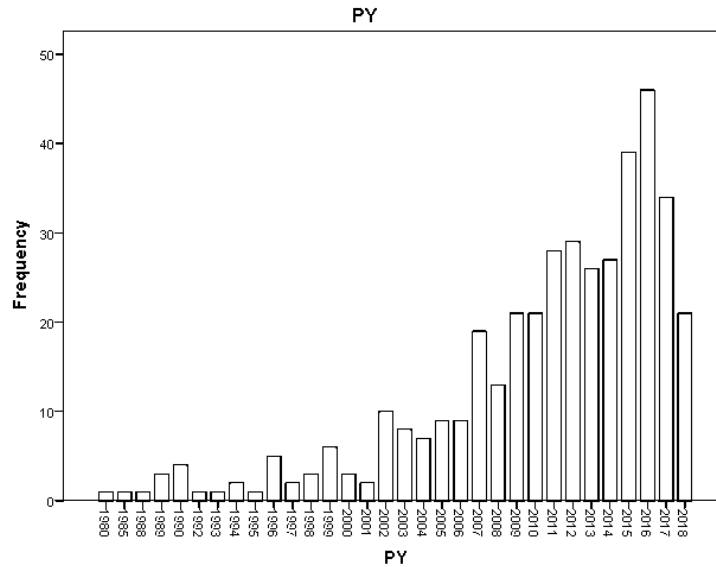


Figure 3. The distribution of the yearly output of knowledge strategy publication output

Regression’s curve estimation (Table 1) indicates a significant correlation between the knowledge strategy publication years and the number of publications per year ($R^2=0.844$). Using the prediction model, we would have an increase in the field of knowledge strategy publications in the coming years. Figure 4 depicts Regression’s curve estimation graph.

Table 1

Regression’s curve estimation summary

R	R Square	Adjusted R Square	Std. Error of the Estimate
.919	.844	.839	.517

The independent variable is Pub Year.

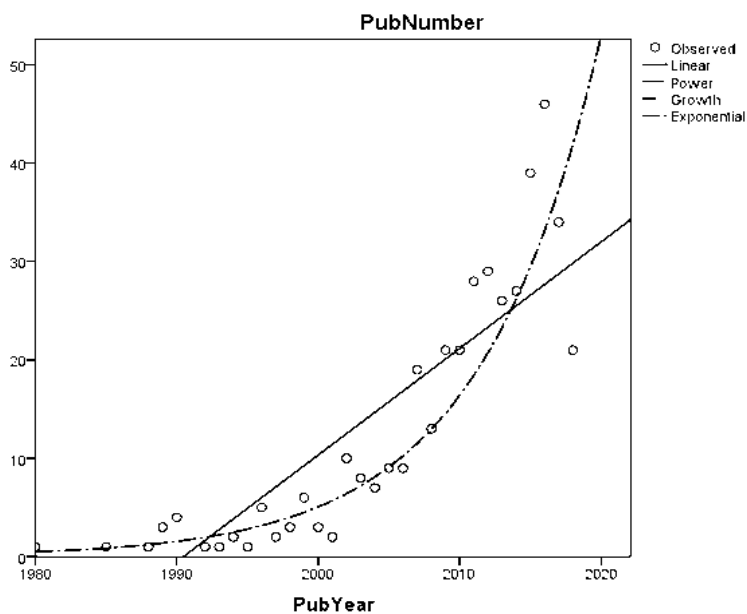


Figure 4: Regression’s curve estimation graph

The co-occurrence of knowledge strategy publications across different and previously established Web of Science subject categories/classifications is depicted in Figure 5. As shown in this Figure, *business & economics* (21.27%), *management* (16.92%), *business* (9.64%), *computer science* (7.64%), *engineering* (6.23%), *information science & library science* (5.99%), *others* (32%) have the most co-occurrence of publications and are the main research topics in the research field of knowledge strategy.

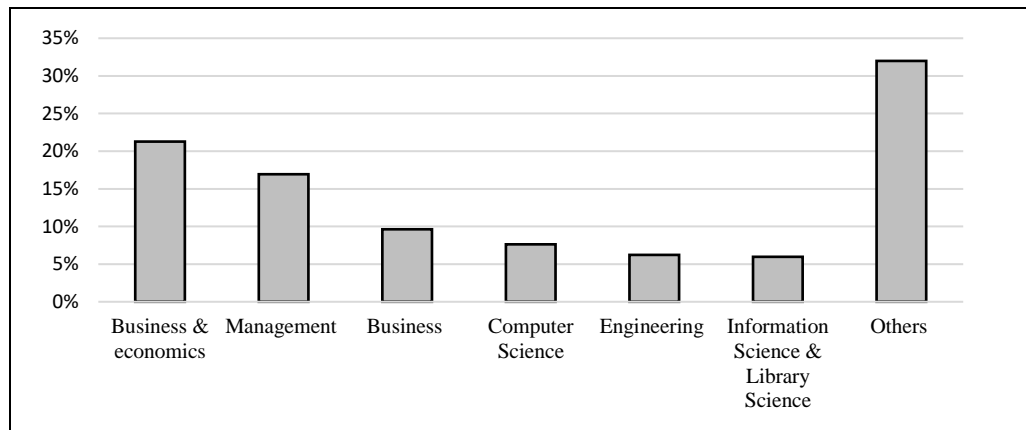


Figure 5: Co-occurrence of knowledge strategy publications across previously established WOS subject categories/classification

Research fronts, hottest research fronts, emerging trends, and abrupt changes in knowledge strategy

In this section, we determine keywords representing knowledge strategy research fronts, major areas, or clusters and analyze research front domain and development trends to answer the second research question.

The research fronts in knowledge strategy

Table 2 shows the first configuration for a 403-article co-citation network. Note that keyword is selected as node type.

Table 2

The first configuration for 403-article co-citation networks

2-year slices	criteria	space	nodes	links / all
1994-1995	2 3 0.15	18	0	0 / 0
1996-1997	2 3 0.16	37	4	4 / 4
1998-1999	2 3 0.16	48	0	0 / 0
2000-2001	2 3 0.17	19	0	0 / 0
2002-2003	2 3 0.18	69	5	8 / 8
2004-2005	2 3 0.19	76	3	2 / 2
2006-2007	2 3 0.19	169	22	44 / 118
2008-2009	2 3 0.2	208	18	36 / 78
2010-2011	2 3 0.2	277	26	52 / 140
2012-2013	2 3 0.2	337	36	72 / 256
2014-2015	2 3 0.2	355	52	104 / 282
2016-2017	2 3 0.2	505	63	126 / 445
2018-2018	3 3 0.2	215	10	20 / 33

Table 3 lists keywords that represented research fronts and their counts (frequencies) in the field of knowledge strategy between 1994 and 2018. The keywords in this table are arranged in the count and then in year order.

Table 3

The knowledge strategy's research fronts surged between 1994 and 2018

Terms	count
2017	
integrated approach	3
3rd stage	2
asset	2
capacity	2
perception	2
uncertainty	2
2016	
knowledge sharing	8
governance	5
knowledge creation	4
university	4
ambidexterity	3
children	3
dynamics	3
entrepreneurship	3
knowledge economy	3
start up	3
age	2
age at internationalization	2
architecture	2
behavior	2
docility	2
foreign market knowledge	2
international performance	2
Internet	2
knowledge acquisition	2
knowledge worker	2
learning	2
market	2
matta-Clark	2
orientation	2
product innovation	2
SME	2
splitting	2
strategic intent	2
2015	
knowledge transfer	5
empirical test	3

Terms	count
case analysis	2
cultural tourism cluster	2
culture	2
dimension	2
intelligence provider	2
knowledge trade market	2
management research	2
market orientation	2
market value	2
maturity model	2
motivation	2
multinational enterprise	2
open innovation	2
opportunity captor	2
opportunity defender	2
pharmaceutical industry	2
profit pool	2
software industry	2
strategic intelligence	2
view	2
vigilant learner	2
2014	
exploration	8
exploitation	8
organizational learning	5
student	4
knowledge management system	3
case study	2
knowledge audit	2
learning organization	2
work	2
2013	
advantage	2
modeling	2
2012	
research and development	6
organizational culture	5
organizational knowledge	5
policy	5
tacit knowledge	5
extension	4
cluster	3
empirical analysis	3
environmental innovation	3
intensive business service	3
supply chain management	3

Terms	count
sustainability	3
CIS	2
determinant	2
Italy	2
transnational corporation	2
2011	
risk	2
2010	
perspective	19
network	18
creation	17
product development	7
information	6
knowledge innovation	2
explicit knowledge	2
implicit knowledge	2
knowledge strategic alliance	2
2009	
intellectual capital	10
industry	7
competitive intelligence	4
organizational performance	2
2008	
absorptive capacity	21
organization	13
managing knowledge	5
knowledge network	2
2007	
system	16
dynamic capability	15
information technology	12
framework	6
impact	5
business strategy	4
strategic alignment	3
business	2
fit	2
human resource management strategy	2
information technology strategy	2
knowledge management strategy	2
2006	
capability	17
technology	14
2005	
model	21
2004	

Terms	count
performance	56
innovation	52
2003	
Knowledge Strategy	71
knowledge management	71
management	41
competitive advantage	12
2002	
firm	44
1996	
knowledge	36
strategy	29
competition	2
metacognition	2

As seen in Table 4 below, the top-ranked research front keyword by citation counts is *Knowledge Strategy*, with citation counts of 71. The second one is *knowledge management*, with citation counts of 71. The third is *performance*, with citation counts of 56. The 4th is *innovation*, with citation counts of 52. The 5th is *firm*, with citation counts of 44. The 6th is *management*, with citation counts of 41. The 7th is *knowledge*, with citation counts of 36. The 8th is *strategy*, with citation counts of 29. The 9th is *absorptive capacity*, with citation counts of 21. The 10th is *the model*, with citation counts of 21.

Table 4

The top-ranked research fronts in knowledge strategy by citation counts

references	citation counts
Knowledge Strategy	71
knowledge management	71
performance	56
innovation	52
firm	44
management	41
knowledge	36
strategy	29
absorptive capacity	21
model	21

As defined previously, the research front is an emergent and transient grouping of concepts and underlying research issues. As seen in the tables above, knowledge strategy and management are the research front keywords with more citations.

The hottest research fronts in knowledge strategy

To find out the hottest (largest major areas or clusters) research fronts in knowledge strategy, based on the input dataset, we focused on the big picture of the collection of

publications represented by our dataset, and the hottest research fronts in knowledge strategy can be revealed by co-occurrence keywords research map. The knowledge strategy research map has seven prominent clusters (Figure 6). The map contains 129 merged network keywords (nodes) and 444 links between 1994 and 2018. the size of the keywords represents the total number of co-occurrence frequency of keywords. The lines that connect keywords are co-occurrence links, and the number of the lines represents the co-occurrence strength.

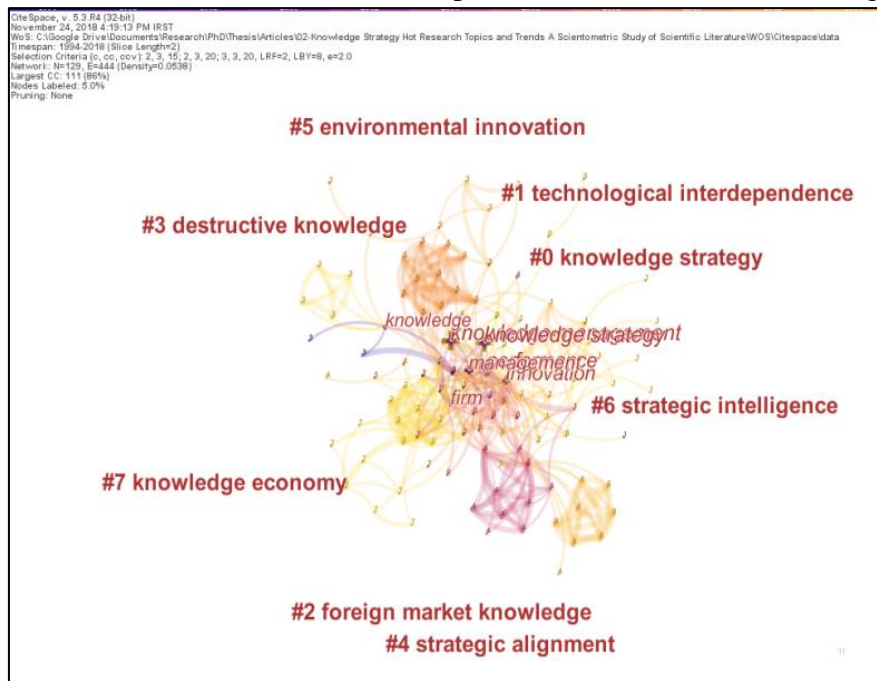


Figure 6: The hottest research fronts of Knowledge Strategy

As shown in Figure 6, the hottest research fronts (major areas or clusters) of knowledge strategy are as follows: The largest cluster (#0) is labeled as *knowledge strategy*; The second cluster (#1) is labeled as *technological interdependence*; The third cluster (#2) is labeled as *foreign market knowledge*; the next cluster (#3) is labeled as *destructive knowledge*; the other cluster (#4) is labeled as *strategic alignment*. The sixth cluster (#5) is labeled as *environmental innovation*. The seventh Cluster (#6) is labeled as *strategic intelligence*. And the smallest cluster (#7) is labeled as *knowledge economy*. The largest cluster (#0) has 18 members and a silhouette value of 0.64. The most active citer to the cluster is HARLOW, H (2013) Developing a knowledge strategy using tacit knowledge measurement: Implications for the balanced scorecard innovation and learning perspective.

The emerging trends and abrupt changes in the research fronts of knowledge strategy

As mentioned earlier, academic research dynamic development mechanisms will be revealed effectively by analyzing research front domains and development trends according to the time distribution and changing trends of frequency co-occurrence keywords network and burst keywords.

Burst terms are used as professional and cluster logos in heterogeneous article networks. According to properties of dynamic changes of terms but not frequencies of words, we can retrieve all the burst terms from large amounts of keywords. To show the changing trends of burst keywords more clearly and comprehensively, Figure 7 lists the top 24 burst keywords

based on the starting time or *beginning* of these burst keywords. For instance, the top-ranked item by bursts is an *organization*, with bursts of 4.26; the second is *knowledge management*, with bursts of 3.78.

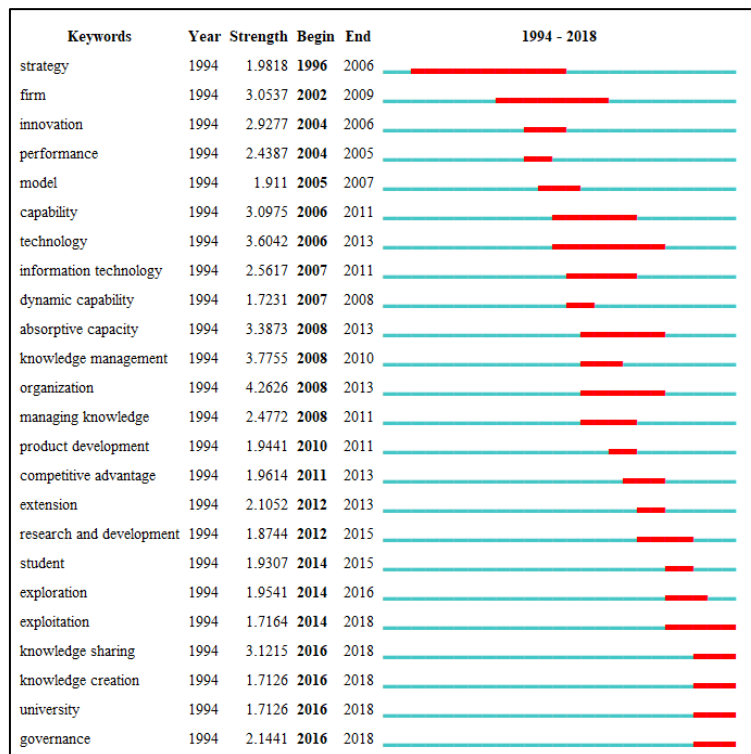


Figure 7: The top 24 knowledge strategy research fronts with the strongest citation bursts

As shown in Figure 7, beginning in 1996, a *strategy* trend emerged and was concerned for ten years (until 2006). The keyword *firm* appeared in 2002, was a trend for 7 years, and disappeared in 2009. In 2004 *innovation* and *performance* appeared. In 2005 *model* emerged. In 2006 *capability* and *technology* were concerned. In 2007 *information technology* and *dynamic capability* were concerned. In 2008 *absorptive capacity*, *knowledge management*, *organization*, and *managing knowledge* were trends. In 2010 *product development* emerged. In 2011 *competitive advantage* emerged. In 2012 *extension* and *research and development* were concerned. In 2014 *student*, *exploration*, and *exploitation* emerged. Later on, in 2016, *knowledge sharing*, *knowledge creation*, and *university* and *governance* were concerned and continued until now.

Intellectual bases, hottest intellectual bases, and the emerging trends and abrupt changes associated with research fronts in knowledge strategy

In this section, we ascertain the intellectual bases associated with knowledge strategy research fronts and top-ranked items and list the top references with the strongest citation bursts to answer the third research question.

The intellectual bases associated with research fronts

To discover the intellectual bases associated with knowledge strategy research fronts, CiteSpace was configured. Table 5 shows the first configuration for a 403-article co-citation network.

Table 5

The configuration for a 403-article co-citation networks

2-year slices	criteria	space	nodes	links / all
1994-1995	2 3 0.15	96	0	0 / 0
1996-1997	2 3 0.16	229	4	6 / 6
1998-1999	2 3 0.16	269	0	0 / 0
2000-2001	2 3 0.17	99	0	0 / 0
2002-2003	2 3 0.18	346	11	22 / 22
2004-2005	2 3 0.19	362	1	0 / 0
2006-2007	2 3 0.19	539	18	36 / 107
2008-2009	2 3 0.2	653	20	40 / 62
2010-2011	2 3 0.2	899	17	33 / 33
2012-2013	2 3 0.2	1150	30	60 / 303
2014-2015	2 3 0.2	1039	53	106 / 302
2016-2017	2 3 0.2	1182	59	118 / 702
2018-2018	3 3 0.2	543	0	0 / 0

Choose references as node type and draw the literature co-citation map based on cited frequency and centrality in CiteSpace. As Figure 8 shows, the network generated by literature co-citation analysis comprises 201 merged network nodes and 412 Links and depicts the hottest intellectual bases in knowledge strategy. On the map, each node stands for a cited publication, and the nodes' size and location represent the research's number and importance. The colors and thickness of the rings extended by nodes reflect research years and cited numbers. The thickness of the circle is in proportion to the number of cited papers in the corresponding year. Nodes with purple circles are the key nodes that connect one cluster with another.

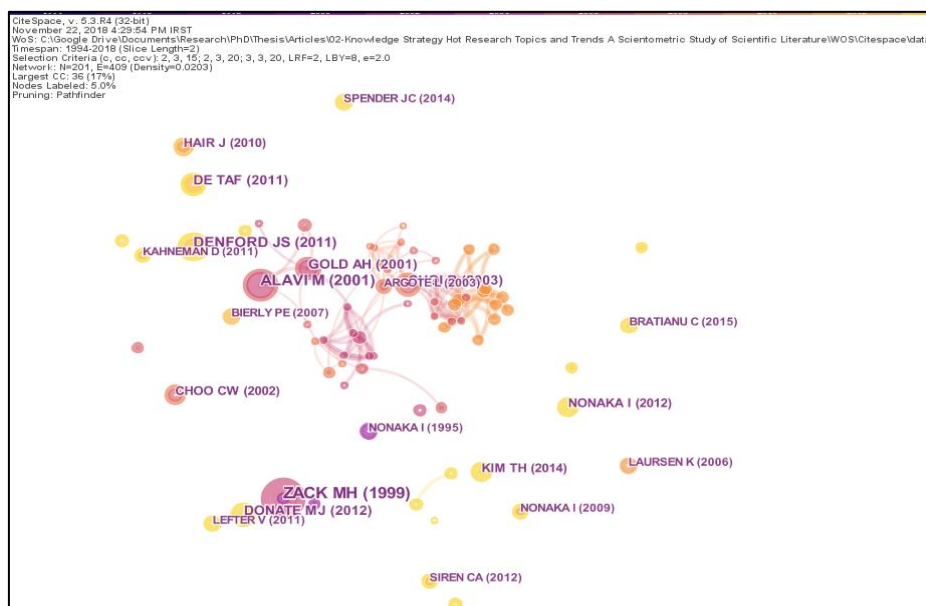


Figure 8: The intellectual bases associated with research front terms in Knowledge Strategy's research

Figure 8 shows that the most prominent intellectual bases in knowledge strategy are Zack MH (1999) and Alavi M (2001).

The hottest intellectual bases in knowledge strategy

As shown in Table 6 below, the top-ranked item by citation counts is Zack MH (1999) in Cluster #7, with citation counts of 10. The second one is Alavi M (2001) in Cluster #9, with citation counts of 8.

Table 6

The hottest intellectual bases in knowledge strategy research by citation counts

citation counts	references	cluster #
10	Zack MH, 1999, CALIF MANAGE REV, 41, 125	7
8	Alavi M, 2001, MIS QUART, 25, 107	9
7	Denford JS, 2011, KNOWL MAN RES PRACT, 9, 102	13
6	Choi B, 2003, INFORM MANAGE-AMSTER, 40, 403	0
6	Donate MJ, 2012, J KNOWL MANAG, 16, 22	43
6	Gold AH, 2001, J MANAGE INFORM SYST, 18, 185	9
6	De TAF, 2011, KNOWL MAN RES PRACT, 9, 327	63
5	Choo CW, 2002, STRATEGIC MANAGEMENT, 0, 0	17
5	Hair J, 2010, MULTIVARIATE DATA AN, 0, 0	23
5	Nonaka I, 2012, PRAGMATIC STRATEGY E, 0, 0	24

The emerging trends and abrupt changes in the intellectual bases of knowledge strategy

To analyze the results more to excavate the emerging trends and abrupt changes in the intellectual bases of knowledge strategy, Figure 9 lists the top 25 references with the strongest citation bursts. From this table, we find out that the most relevant literature on knowledge strategy emerged in 1999 with a high intensity of concentration. Knowledge strategy became the focus of academic research and achieved important academic results in 2012. A total of 12 documents were detected in 2012.

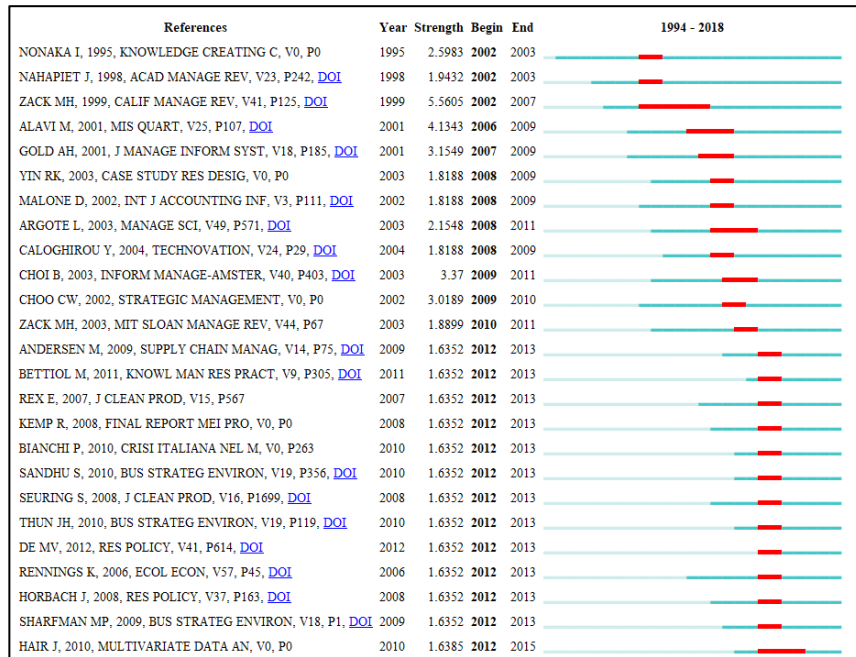


Figure 9: The top 25 Knowledge Strategy’s intellectual bases with the strongest citation bursts

As shown in Figure 9 the top-ranked item by bursts is Zack MH (1999) in Cluster #7, with bursts of 5.56. The second one is Alavi M (2001) in Cluster #9, with bursts of 4.13. The third is Choi B (2003) in Cluster #0, with bursts of 3.37. The 4th is Gold AH (2001) in Cluster #9, with bursts of 3.15. The 5th is Choo CW (2002) in Cluster #17, with bursts of 3.02. The 6th is Nonaka I (1995) in Cluster #7, with bursts of 2.60. The 7th is Donate MJ (2012) in Cluster #43, with bursts of 2.49. The 8th is Laursen K (2006) in Cluster #0, with bursts of 2.19. The 9th is Argote L (2003) in Cluster #0, with bursts of 2.15. The 10th is Nonaka I (2012) in Cluster #24, with bursts of 2.07.

Discussion

The so-called knowledge-based view of the firm and the growing interest in knowledge management and knowledge economy has made knowledge strategy a key topic of research and analysis. As an active and emerging research field, knowledge strategy receives extensive academic attention and acts as a compass for knowledge management strategy.

This study answered the three key research questions in the field of knowledge strategy: 1. What is the distribution of knowledge strategy publications and their co-occurrence across Web of Science subject categories? 2. What are the research fronts, hottest research fronts, emerging trends, and abrupt changes in knowledge strategy? 3. Which intellectual bases, hottest intellectual bases, and the emerging trends and abrupt changes are associated with research fronts in knowledge strategy?

To study knowledge strategy scientific subject, paying attention to two concepts was very important: Research front and intellectual base. Detecting and understanding research fronts (citing terms) and intellectual bases (cited articles) in knowledge strategy can significantly improve the ability of scientists to deal with the changes on time. Other important concepts in this study were *keywords* and *burst words*. A keyword can reflect reasonable descriptions of research hot spots, and a burst word could indicate new frontier topics.

The retrieved data from citation indexes via the WOS was used as input data for CiteSpace, Google Fusion Tables, and SPSS to analyze data. In CiteSpace, the knowledge strategy research front is identified based on burst terms extracted from titles, abstracts, descriptors, and identifiers of bibliographic records. These terms were subsequently used as labels of clusters in heterogeneous networks of terms and articles. Burst-detection algorithms identified emergent terms regardless of how often their host articles are cited. Therefore, new research is featured in the big picture even before it attracts enough citations. CiteSpace supported a time-zone view to highlight temporal patterns between a research front and its intellectual base.

This study showed that the area distribution of knowledge strategy research is worldwide and has spread especially in the United States, Europe, and other countries. The yearly output of knowledge strategy publications worldwide and across Web of Science subject categories/classification was figured out to answer the first research question. Regression's curve estimation indicated a significant correlation between the knowledge strategy publication years and the number of publications per year using the prediction model. We will have an increase in the field of knowledge strategy publications in the coming years. The co-occurrence of knowledge strategy publications across different and previously established Web of Science subject categories/classifications is depicted in this study. *Business & economics, management, business, computer science, engineering, Information Science & Library science* had the most co-occurrence of publications. It was the main research topic in the research field of knowledge strategy.

This study determined keywords represented knowledge strategy research fronts, major areas, or clusters and analyzed research front domain and development trends to answer the second research question. The top 10 research front keywords by citation counts were *knowledge, knowledge management, performance, innovation, firm, management, knowledge, strategy, absorptive capacity, and model*. The hottest research fronts (major areas or clusters) of knowledge strategy were as follows: *Knowledge alignment, environmental innovation, strategic intelligence, and knowledge economy*. This study showed *strategy* trend emerged and was concerned for ten years (until 2006). The keyword *firm* appeared in 2002 and was a trend for 7 years and disappeared in 2009. In 2004 *innovation* and *performance* appeared. In 2005 *model* emerged. In 2006 *capability* and *technology* were concerned. In 2007 *information technology* and *dynamic capability* were concerned. In 2008 *absorptive capacity, knowledge management, organization, and managing knowledge* were trends. In 2010 *product development* emerged. In 2011 *competitive advantage* emerged. In 2012 *extension and research and development* were concerned. In 2014 *student, exploration, and exploitation* emerged. Later on, in 2016 *knowledge sharing, knowledge creation, university and governance* were concerned and continued until now.

As seen in the definition, knowledge strategy seeks to identify new knowledge and introduce it into the organization; therefore, particular attention should be paid to the knowledge strategy, which would provide the possibility of adapting the organization to new requirements in a turbulent environment. One of the main challenges facing today's organizations, in the changing environment, is the need to develop new knowledge based on IT, something that today's entrepreneurs and owners of organizations must have (Sousa & Rocha, 2019).

The importance of the existence of an information system (IS) is emphasized within an organization. Information systems will enable the communication of acquired knowledge. Data

protection in an implemented information system is constantly emphasized because organizational knowledge can be a competitive advantage (Kushwaha, Tripathi, Chauhan & Saxena, 2017).

According to table 3, in 2015, *knowledge transfer* had the most repetition, which shows that information technology is an important and facilitating factor in knowledge management with the advent of digital transformation. These transformation processes have the necessary tools for knowledge sharing and transfer (Urbinati, Chiaroni, Chiesa & Frattini, 2020).

In 2016, the topic of *knowledge sharing* in the field of knowledge strategy was repeated eight times. Also, according to Figure 7, this keyword has continued until the end of 2018. This shows that the issue of knowledge sharing is considered an important trend in the field of knowledge strategy. In this regard, it should be noted that many articles on knowledge management in scientific journals and publications are devoted to the importance of knowledge exchange in promoting collective learning. The authors have criticized the hoarding of knowledge and knowledge concealment as an obstacle to knowledge development (Holten, Hancock, Persson, Hansen & Hogh, 2016; Singh, Mittal, Sengupta & Pradhan, 2019).

In 2016, the keywords *exploration* and *exploitation* had the most repetition, and according to Figure 7, the starting point of these research fronts was 2014, and the endpoint in 2018. In this regard, it should be said that organizations, on the one hand, gain new knowledge through exploration, and on the other hand, through the proper use of knowledge resources within the organization, achieve ambidexterity. As important as the acquisition of new external knowledge is for the organization, the systematic utilization of knowledge resources within the organization is also important as well as knowledge management; Therefore, effective management of existing knowledge resources is a determining factor for turning ambidexterity into successful organizational performance (Ramachandran, Lengnick-Hall & Badrinarayanan, 2019).

To answer the third research question, this study ascertained the intellectual bases associated with knowledge strategy research fronts and top-ranked items and listed the top references with the strongest citation bursts. The most prominent intellectual grounds in knowledge strategy were Zack MH (1999), and Alavi M (2001) and the top-ranked item by citation counts were Zack (1999), Alavi (2001), Choi (2003), Gold (2001), Choo (2002), Nonaka I (1995), Donate (2012), Laursen K (2006), Argote (2003), Nonaka (2012).

Conclusion

Despite the widespread popularity of the knowledge-based view of the firm, knowledge management, and knowledge economy, to the best of our knowledge, no studies have been conducted and published to investigate knowledge strategy emergent and transient grouping of concepts and underlying research issues and its citation and co-citations footprints in scientific literature. For the first time, knowledge strategy research fronts and intellectual bases were discovered in this research, and hidden patterns were visualized. This study determined keywords represented knowledge strategy research fronts, major areas, or clusters and analyzed research front domain and development trends. This research also ascertained the intellectual bases associated with knowledge strategy research fronts and top-ranked items and listed the top references with the strongest citation bursts. Additionally, the yearly output of knowledge strategy publications worldwide and across Web of Science subject categories/classifications showed the growing importance of knowledge strategy among researchers in specific scientific

fields. It is necessary to mention that retrieved data from citation indexes via the Web of Sciences is used as input data for tools such as CiteSpace, Google Fusion Tables, and SPSS to analyze data. These fascinating tools can be used for research in different scientific fields. Understanding emerging trends and abrupt changes in knowledge strategy can significantly improve the ability of practitioners and researchers to deal with the changes in this important scientific field on time. The results of this study would provide some directions for scholars to identify future research fields related to knowledge strategy.

Future research

This research only studied knowledge strategy research fronts and intellectual bases. Future studies can use this work to study scientific fields related to knowledge strategy. In addition to that, other researchers can also use this work as a basis for new research in different scientific areas. As mentioned previously, data in this study were extracted from the Web of Science Core Collections; For future studies, it is suggested to use other databases such as Scopus, Google Scholar, and so on to examine the Knowledge Strategy. Meanwhile, the knowledge strategy in this paper was visualized by CiteSpace. It is suggested that other visualization tools, such as VOS viewer and SciVal, etc., should be used further to investigate the knowledge strategy research fronts and intellectual bases.

References

- Abou-Zeid, E. (2008). *Knowledge management and business strategies: Theoretical frameworks and empirical research*. <https://doi.org/10.4018/978-1-59904-486-6>
- About Fusion Tables. (2018). Retrieved from google website: <https://support.google.com/fusiontables/answer/2571232?hl=en>
- Akhavan, P., Ebrahim, N. A., Fetrati, M. A., & Pezeshkan, A. (2016). Major trends in knowledge management research: A bibliometric study. *Scientometrics*, 107(3), 1249–1264. <https://doi.org/10.1007/s11192-016-1938-x>
- Asoh, D. A. (2004). *Business and knowledge strategies: Alignment and performance impact analysis*. Doctoral Dissertation, Albany State University, New York. Retrieved from <https://www.proquest.com/openview/aacd44a5b4998c346555502d4c12997/1?pq-origsite=gscholar&cbl=18750&diss=y>
- Bierly, P. & Chakrabarti, A. (1999). Generic knowledge strategies in the US pharmaceutical industry. In *Knowledge and Strategy* (pp. 231-250). Routledge. <https://doi.org/10.1016/B978-0-7506-7088-3.50016-4>
- Bolisani, E. & Bratianu, C. (2018). *Emergent knowledge strategies: Strategic thinking in knowledge management*. Springer Cham. <https://doi.org/10.1007/978-3-319-60657-6>
- Chen, C. (2006a). CiteSpace II: Detecting and visualizing emerging trends and transient patterns in scientific literature. *Journal of the American Society for Information Science and Technology*, 57(3), 359-377. <https://doi.org/10.1002/asi.20317>
- Chen, C. (2006b). Information visualization: Beyond the horizon. In *information visualization: Beyond the horizon*. Springer London. <https://doi.org/10.1007/1-84628-579-8>
- Chen, C. (2014). Mapping scientific frontiers: The quest for knowledge visualization. In *Mapping Scientific Frontiers: The quest for knowledge visualization* (Vol. 9781447151). <https://doi.org/10.1007/978-1-4471-5128-9>

- Chen, C. (2015). *CiteSpace : Visualizing trends and patterns in scientific literature outline - What can we learn from scientific?* Retrieved from <http://cluster.ischool.drexel.edu/~cchen/citespace/tutorial/2015/Boston.MRS.11.29.2015.pdf>
- Chen, K. & Guan, J. (2011). A bibliometric investigation of research performance in emerging nanobiopharmaceuticals. *Journal of Informetrics*, 5(2), 233-247. <https://doi.org/10.1016/j.joi.2010.10.007>
- Chen, L. (2009). Information visualization analysis of the hot research topics and the research fronts of Information Resources Management(IRM). *2009 International Conference on Information Management, Innovation Management, and Industrial Engineering, ICIII 2009, 4*, (pp.544-547). <https://doi.org/10.1109/ICIII.2009.590>
- Cui, Y., Liu, Y. & Mou, J. (2018). Bibliometric analysis of organizational culture using CiteSpace. *South African Journal of Economic and Management Sciences*, 21(1), 1-12. <https://doi.org/10.4102/sajems.v21i1.2030>
- He, K., Zhang, J., Wang, X., Zeng, Y. & Zhang, L. (2018). A scientometric review of emerging trends and new developments in agricultural ecological compensation. *Environmental Science and Pollution Research*, 25(17), 16522-16532. <https://doi.org/10.1007/s11356-018-2160-6>
- Holten, A. L., Hancock, G. R., Persson, R., Hansen, Å. M. & Høgh, A. (2016). Knowledge hoarding: antecedent or consequent of negative acts? The mediating role of trust and justice. *Journal of Knowledge Management*, 20(2), 215-229. <https://doi.org/10.1108/JKM-06-2015-0222>
- Hou, J., Yang, X. & Chen, C. (2018). Emerging trends and new developments in information science: a document co-citation analysis (2009–2016). *Scientometrics*, 115(2), 869-892. <https://doi.org/10.1007/s11192-018-2695-9>
- Jin, Y. & Ji, S. (2018). Mapping hotspots and emerging trends of business model innovation under networking in the Internet of Things. *Eurasip Journal on Wireless Communications and Networking*, 96. <https://doi.org/10.1186/s13638-018-1115-4>
- Jin, Y. & Li, X. (2018). Visualizing the hotspots and emerging trends of multimedia big data through scientometrics. *Rapid Prototyping Journal*, 24(5), 801-812. <https://doi.org/10.1108/RPJ-05-2017-0100>
- Kushwaha, P., Tripathi, R., Chauhan, S. & Saxena, R. (2017, May). Exploring the role of knowledge sharing in the digital era: A conceptual study. *National seminar on the digital transformation of business in India: Opportunities and challenges*. Retrieved from https://www.researchgate.net/publication/317010998_Exploring_the_Role_of_Knowledge_Sharing_in_Digital_Era_A_Conceptual_Study
- Moed, H. F., Markusova, V. & Akoev, M. (2018). Trends in Russian research output indexed in Scopus and Web of Science. *Scientometrics*, 116(2), 1153–1180. <https://doi.org/10.1007/s11192-018-2769-8>
- Ramachandran, I., Lengnick-Hall, C. A. & Badrinarayanan, V. (2019). Enabling and leveraging ambidexterity: influence of strategic orientations and knowledge stock. *Journal of Knowledge Management*, 23(6), 1136-1156. <https://doi.org/10.1108/JKM-11-2018-0688>
- Schiebel, E. (2012). Visualization of research fronts and knowledge bases by three-dimensional areal densities of bibliographically coupled publications and co-citations. *Scientometrics*, 91(2), 557-566. <https://doi.org/10.1007/s11192-012-0626-8>

- Singh, S. K., Mittal, S., Sengupta, A. & Pradhan, R. K. (2019). A dual-pathway model of knowledge exchange: Linking human and psychosocial capital with prosocial knowledge effectiveness. *Journal of Knowledge Management*, 23(5), 889-914. <https://doi.org/10.1108/JKM-08-2018-0504>
- Sousa, M. J. & Rocha, Á. (2019). Strategic knowledge management in the digital age: JBR Special Issue Editorial. *Journal of Business Research*, 94, 223–226. <https://doi.org/10.1016/j.jbusres.2018.10.016>
- Takeda, Y. & Kajikawa, Y. (2009). Optics: A bibliometric approach to detect emerging research domains and intellectual bases. *Scientometrics*, 78(3), 543-558. <https://doi.org/10.1007/s11192-007-2012-5>
- Taşkın, Z., & Aydinoglu, A. U. (2015). Collaborative interdisciplinary astrobiology research: A bibliometric study of the NASA astrobiology institute. *Scientometrics*, 103(3), 1003-1022. <https://doi.org/10.1007/s11192-015-1576-8>
- Urbinati, A., Chiaroni, D., Chiesa, V. & Frattini, F. (2020). The role of digital technologies in open innovation processes: An exploratory multiple case study analysis. *R and D Management*, 50(1), 136-160. <https://doi.org/10.1111/radm.12313>
- Wang, P., Zhu, F. W., Song, H. Y., Hou, J. H. & Zhang, J. L. (2018). Visualizing the academic discipline of knowledge management. *Sustainability (Switzerland)*, 10(3),682. <https://doi.org/10.3390/su10030682>
- Xie, P. (2015). Study of international anticancer research trends via co-word and document co-citation visualization analysis. *Scientometrics*, 105(1), 611-622. <https://doi.org/10.1007/s11192-015-1689-0>
- Yang, S., Sui, J., Liu, T., Wu, W., Xu, S., Yin, L., ... Liang, G. (2018). Trends on PM2.5 research, 1997–2016: A bibliometric study. *Environmental Science and Pollution Research*, 25(13), 12284-12298. <https://doi.org/10.1007/s11356-018-1723-x>
- Yang, Z., Wang, L. & Xue, C. (2016). Research of hotspots and emerging trends in Chinese logistics research (2003-2013): A visualization analysis in CiteSpace. *Proceedings of the 6Th International Conference on Electronic, Mechanical, Information and Management Society (Emim)*, 40(Emim), 1394–1398.
- Zack, M. H. (ed.) (1999). *knowledge and strategy*. London: Routledge. <https://doi.org/10.4324/9780080509778>
- Zhang, Z. (2019). Visualization analysis of the development trajectory of knowledge sharing in virtual communities based on CiteSpace. *Multimedia Tools and Applications*, 78, 29643-29657 <https://doi.org/10.1007/s11042-018-6061-y>
- Zhao, D. & Strotmann, A. (2014). The knowledge base and research front of information science 2006-2010: An author cocitation and bibliographic coupling analysis. *Journal of the Association for Information Science and Technology*, 65(5), 995-006. <https://doi.org/10.1002/asi.23027>