A Bibliometric Review of Information Systems Research From 1975-2018: Setting an Agenda for IS Research

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ABSTRACT

Information systems (IS) scholars attempted to explore the intellectual structure of the IS discipline from previous literature. However, the corpus data, analytical method, and sample size are significantly different among these review studies, which lead to rather mixed results. In this bibliometric review, the authors portray and visualize the panorama of the evolutionary process of IS research with two powerful bibliometric tools, including both CiteSpace and VOSviewer. Specifically, based on a series of bibliometric algorithms (e.g., SCI-Map and referene-NLP), the authors analyze 80,147 primary articles and 1,325,376 secondary articles in the IS domain to examine its 1) intellectual output mode, 2) knowledge bases, and 3) the popular and promising topics in the future from the evolutionary and clustering perspectives. By doing so, the authors provide a comprehensive navigation for the IS studies and set up an agenda for future research.

KEYWORDS

Bibliometric Review, CiteSpace, Information Systems (IS), Landscape of Information Systems Research, VOSviewer

INTRODUCTION

As an emerging and applied inter-discipline, Information Systems (IS) has engaged great interest of scholars and practitioners since 1975 (Burton Swanson & Ramiller, 1993; Ives, Hamilton, & Davis, 1980; Taylor, Wingen, & Wingen, 2010; Zmud, 2003). Unlike traditional disciplines of business research, the scope and topics of IS research are always changing with the advancement and application of information technologies (Grover & Lyytinen, 2015; N. R. Hassan, Mingers, & Stahl, 2018). Although the diversity and adaptability of the research themes in the IS field have make this discipline practically significant, it might threaten the academic rigor (Avison & Elliot, 2006; Bakshi & Krishna, 2007; Banville, 1989; Córdoba & Paucar-Caceres, 2018; Robey, 2003; Taylor et al., 2010; Zmud, 2003), confuse the future research directions, and hinder the development of IS academic studies. Thus, the exploration of IS discipline has become an increasingly concerned issue (Jeyaraj & Zadeh, 2019b)(Jeyaraj & Zadeh, 2019a)[30] .

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Recognized this, researchers have attempted to explore the various aspect of IS disciplines by conducting systematic review, such as the intellectual core of the IS research (Larsen & Levine, 2005; Sidorova, Evangelopoulos, Valacich, & Ramakrishnan, 2008), the collaboration network of IS scholars (Gallivan & Ahuja, 2015; Xu, 2014), knowledge concepts/themes in IS journals (Jeyaraj & Zadeh, 2019a; Lee & Chen, 2012), the maturity of the IS topics (Córdoba & Paucar-Caceres, 2018; Wade, Biehl, & Kim, 2006), the diversity of IS research over time (Bernroider, Pilkington, & Córdoba, 2013; Liu, Li, Goncalves, Kostakos, & Xiao, 2016), and the impacts of journals, authors, and articles (Khan & Trier, 2018; Taylor, Dillon, & Van Wingen, 2008). However, there are two gaps of these review research. First, majority of these review articles only cover a limited number of journals during a particular period for a specific topic. For instance, Khan and Trier (2018) collected 3587 articles published in eight AIS journals between 1995 and 2014 to examine academic performance of IS researchers. Second, based on incomplete data and different techniques, such as classification (Vessey, Ramesh, & Glass, 2002), co-word analysis (Liu et al., 2016), content analysis (Córdoba & Paucar-Caceres, 2018) and social network analysis (Vidgen, Henneberg, & Naudé, 2007), to analyze different data, such as abstracts, keywords, titles, citation frequency, and authors, these reviews provided rather mixed results. In light of these considerations, it is necessary to conduct a systematic and comprehensive literature review to uncover the intellectual structure and the evolutionary process of IS field, identify its promising research topics, and put forward an agenda for future research.

To fill the research gaps, the authors quantitatively and comprehensively analyze all articles published in IS journals from Web of Science (Wos) database with bibliometric methods and visualize the results with two well-established bibliometric analysis tools, including CiteSpace and VOSviewer. This study makes four contributions to the literature. First, the sample size is comprehensive, which contains 80,147 primary articles and 1,325,376 secondary articles published from 1975 to 2018. The results can provide a comprehensive understanding of the IS disciplines compared to previous reviews that focused on a limited range of journal. Second, the authors conduct the bibliometric analysis from two perspectives, including evolutionary perspective and clustering perspective. From the evolutionary perspective, the authors can see how research focus of IS changed over time. From the clustering perspective, the authors can have an insight into the IS subfields and predict the research hotspots of each IS subfield. Third, the authors attempt to have a comprehensive understanding of the IS field through social network and intellectual network analysis, which is consist with the intellectual (thematic) dimension and social dimension of the scientific field (Khan & Trier, 2018). Finally, the authors perform a systematic review of the IS literature and describe the panorama for the evolution of IS field, which can provide scholars and practitioners not only a profound knowledge for the development and evolution of the IS domain, but also a guidance for IS future research, contributing to the thriving and prosperous of the IS discipline.

RESEARCH METHOD

Bibliometric Mapping

Bibliometric mapping is a method to examine the evolution process in a particular scientific research field in the form of a map or a network (Zhu, Song, Zhu, & Johnson, 2019). Through the intellectual collaboration network and the knowledge structure network established by the bibliometric mapping, the authors can identify the status and connection of the articles, topics and authors in a particular domain, providing a guidance for future research (Fergnani, 2019; Liao et al., 2018).

CiteSpace and VOSviewer are the most commonly used for bibliometric analysis (Gokcen & Arslan, 2019; Saberi, Barkhan, & Hamzehei, 2019; Zhu et al., 2019). CiteSpace can construct different kinds of bibliometric networks, such as co-author countries co-citation, and build the networks based on timeline to analyze the evolution of the research domain. VOSviewer can be used to conduct cluster analysis, having great advantages in recognizing the same research interests or research themes. Based

on the different advantages of these two analytical tools and a series of bibliometric algorithms (e.g., SCI-Map and referene-NLP), the authors apply CiteSpace to conduct author co-citation, reference co-citation, and burst analysis, while use VOSviewer to conduct co-authorship analysis, journal co-citation analysis and keywords clusters.

Data Collection

The authors choose Web of Science core citation database as the data source, which is frequently used to search literature in previous bibliometric mapping analysis (Chaomei chen, 2014; Cheng, Huang, Yu, & Wu, 2018). It covers the world's leading academic journals, books, and conference proceedings in the sciences, social sciences, arts, humanities, and the full citation network. Considering the quality of the articles and the specific research topics, the authors collect articles published in journals of IS research in ABS journal list¹. The time span ranges from 1975 to 2018. Finally, the authors create a big bibliometric records pool of 80,147 primary articles in IS field, generating another database of 1,325,376 secondary articles (Zhu et al., 2019) automatically.

BIBLIOMETRIC ANALYSES AND RESULTS

The Annual Trend of Publications in IS

Figure 1 shows the development tendency of the IS field, which can be roughly divided into four stages. In the startup phase from 1975 to 1990, the number of articles grew slowly. In the second phase from 1991 to 2005, the number of articles in IS started to accelerate when more and more scholars began to pay attention to IS due to the popularization and development of information technology. In the third phase from 2006 to 2010, the number of articles has skyrocketed. This may due to that the academic value and commercial value of information systems have been further explored, attracting wide attention from scholars and the industry. In the last phase from 2011 to 2018, the number of articles reached a saturation point and began to plateau with the maturity of IS. Generally, the number of journal articles in IS displays an upward trend from 1975 to 2018, indicating that IS domain is a valuable discipline (Avital, 2014) and in a flourishing stage (Khan & Trier, 2018).

Co-Authorship Analysis

With the accumulation of knowledge in the specific scientific domain, there are more and more challenges in publishing papers. As a result, intellectual collaboration has become a popular and effective way to improve the quality of papers and productivity of researchers (Surwase, Sagar, Kademani, & Bhanumurthy, 2011)(Surwase, Sagar, Kademani, & Bhanumurthy, 2011)[43] . More and more co-authored papers have been published. Moreover, previous studies have demonstrated that co-authored papers play a significant role in the development of a discipline, not only through publications, but also the social network created by collaboration among scholars (Savić, Ivanovic, & Jain, 2019)(Savić, Ivanovic, & Jain, 2019)[41] . Thus, it is necessary to conduct a co-authorship analysis to understand the communication frequency and academic influence of different institutions in IS. In this study, both country co-authorship and institution co-authorship analysis are conducted by VOSviewer.

Country Co-Authorship Analysis

Country co-authorship analysis is mainly used to explore the collaboration structure of countries. Figure 2 displays the country co-authored network in IS field. In the network, each node represents one particular country while the size of the node denotes the number of publications in the country. The line between two nodes represents the cooperative relationship between the two countries. The thickness of the line represents the number of co-author publications between the two countries (Ang, Wahab Mohammad, Johnson, & Hilal, 2019). In addition, the link number represents the partner number of

Figure 1. The annual trend of articles published in is journals

the country. The aggregate link thickness of each node, also known as total link strength, represents cooperation strength of the country (van Eck & Waltman, 2019)(van Eck & Waltman, 2019)[46], which is proportional to the total number of co-authored articles published by one particular country.

There are several findings in Figure 2. Firstly, the biggest node is the United States (U.S.), indicating that the U.S. has published the most articles in the IS field, followed by England, China, Taiwan, Canada, Australia, and Spain. Secondly, the U.S. is located in the center of this network, implying that it is at the core position in collaboration with other counties in the IS domain. Thirdly, the U.S. has a relatively close cooperative relationship with China, Singapore, South Korea, Spain, and Germany, indicating that geographical distance is not the obstacle of international cooperation in IS field.

In addition, Table 1 summarized the collaboration link and strength of the top 10 countries. As shown in the results, the U.S. not only has published the most articles (24,221), but also has the most partners (46) and the highest collaboration strength (7,303). However, the country co-authored articles only account for 30% of all published articles in the U.S., indicating that majority of research in the U.S. are conducted under domestic cooperation. By contrast, the proportions of country co-authored articles in China, Australia, Canada, Netherlands and Germany are all more than 50%. Especially, the proportion of country co-authored articles in Germany is up to 72.9%, which indicates German researchers apply international cooperation as the main way for research collaboration. Therefore, the U.S. can strengthen international cooperation with other countries to improve the influence of IS research globally, while other countries can try to strength international cooperation with the U.S. to improve the productivity and quality of IS research.

Figure 2. Countries co-authorship network

Table 1. Collaboration Link and Strength of The Top 10 Productive Countries

label	Links ²	Total link strength ³	Total articles	Co-author articles Proportion ⁴
U.S.	46	7303	24221	30.15%
England	46	3104	6690	46.40%
China	45	3309	5733	57.72%
Taiwan	36	848	4488	18.89%
Canada	46	1947	2952	65.96%
Australia	44	1853	2842	65.20%
Spain	44	1096	2665	41.13%
South Korea	41	1144	2606	43.90%
Germany	45	1576	2162	72.90%
Netherlands	44	1138	1857	61.28%

Furthermore, citation number is a complementary index to verify the status of a particular country in the collaborative network. Figure 3 displays the annual citation trend of the top 5 productive countries in IS field. In general, there is an upward trend in the annual citation for every country. The citation number of the U.S. has always been in a leading position since the 1975. In fact, England and the U.S. had almost the same number of citations at around 1975. However, from 1975 to 1989, only the citation number of the U.S. obtained a slow growth. Until 1990s, the citation number of England, China, Taiwan and Canada started to increase slowly. At the same time, the citation number of the U.S. started to raise rapidly and has been leading among all countries. The citation numbers of Taiwan and China have raised rapidly between 2008 and 2010, far outpacing England and Canada, whose citation reached a plateau after 2008. Surprisingly, the citation number of Taiwan began to

fell sharply since 2010. However, the citation number of China continues to maintain strong growth trend and China has become the second influential country in IS domain.

Figure 3. The annual citation trend of the top 5 productive countries. Note: The counties with minimum citation and minimum documents more than 50 are retained in the figure.

Institute Co-Authorship Analysis

Institute co-authorship analysis reveals the network structure of cooperation between institutions. Similar to country co-authorship analysis, one node represents one institution and the size of node reflects the number of articles published by a particular institution. The link between two nodes stands for the cooperative relationship. The thickness of the link represents the number of co-author publications between the two institutions. The link number represents the partner number of the institution. The aggregate link thickness of each node represents cooperation strength of the institution, which is proportional to the total number of co-authored articles published by one particular institution. Besides, institutions with the same color share the same research direction and then form in a cluster.

As the authors can see in Figure 4, the most productive research institution is City University of Hong Kong. Among the top 10 most productive research institutions, seven research institutions are from U.S., suggesting that the U.S. occupies a significant position in the field of IS. This finding is consistent with results in country co-authorship analysis. In addition, it is shown that institutions in the same cluster have close cooperative relationships with each other and are geographically close to each other, indicating that the common research interests and geographical advantage play key roles in the institution cooperation.

Table 2 reveals collaborative strength and influence of the top 10 institutions. As shown in the results, the City University of Hong Kong has the most cooperative strength, partners, and articles published in IS. The University of Maryland is the most influential research institution with the highest citation number. As to institution co-author articles proportion, the University of Arizona is as much as 93.09%. Majority of the institutions in Table 2 has more than 100. On average, 65%

Figure 4. Institutes co-authorship network. Note: Institutions with more than 100 citations are retained.

Table 2. Collaborative Strength and Influence of The Top 10 Productive Institutes

l	a	b	e	l	Links ⁵	Total link strength ⁶	Citations	Articles	Co-author articles proportion ⁷	
					City University of Hong Kong (China)	116	612	23762	708	86.44%
					The University of Maryland (U.S.)	112	359	37985	547	65.63%
					Illinois State University (U.S.)	119	334	13836	512	65.23%
					Indiana University Bloomington (U.S.)	104	252	19514	511	49.32%
					The University of Arizona (U.S.)	111	431	18781	463	93.09%
					The Pennsylvania State University (U.S.)	106	248	11780	462	53.68%
					Nanyang Technological University(Singapore)	80	167	10525	452	36.95%
					National University of Singapore (Singapore)	90	315	15246	448	70.31%
					Carnegie Mellon University (U.S.)	104	292	16988	446	65.47%
					University of Wisconsin System (U.S.)	98	266	12485	446	59.64%

articles are co-authored articles. Obviously, co-author articles proportion at the institutional level is higher than that at the country level. Thus, cooperation between institutions in different countries needs to be further strengthened.

Co-Citation Analysis

Co-citation analysis is used to study the co-citation relationship between two items, such as articles, authors or journals in a scientific field, which can effectively describe the evolutionary paths of a specific domain (Boyack & Klavans, 2010). The co-citation relationship refers to the two items simultaneously being cited by another item. In this review, the authors conduct reference co-citation, citation bursts, and author co-citation analysis by CiteSpace, and journal co-citation analysis by VOSviewer.

Reference Co-Citation Analysis

Reference co-citation analysis is used to examine the relationship among the literature and identify influential articles based on citations frequency. Figure 5 illustrates the reference co-citation network from 1975 to 2018, in the form of eleven four-year slices. Each node in figure 5 represents an article. The size of the node is proportional to the citation frequency of each article. The larger the node, the more influential the article is. The link between two nodes means that they were co-cited by one particular article. Further, rings in different colors of the nodes reveal the citation history of the article. The thickness of rings represents the citation frequency in the period.

Figure 5. Reference co-citation network Note: In each period, the top 50 articles with the most citation were retained, namely each four-year slice has a maximum of 50 nodes in the diagram.

As shown in Figure 5, the most cited article in the IS domain is ‘User Acceptance of Information Technology: Toward a Unified View’ (Venkatesh, Morris, Davis, & Davis, 2003) published in *Management Information System Quarterly* (MISQ). It put forward a unified Information Technology (IT) Acceptance Model and improved the explanation of variance in user intentions to use information technology from 17%-53% to 69.5%, making an outstanding contribution to introduction of new technology in organizations. The result implies that IT acceptance and use is the fundamental and classical research topic in IS.

Table 3 summarizes the top 12 articles with the most citations, which reveals the widely discussed topics in the IS field. There are three findings in this table. Firstly, topics related to IT Acceptance and Use were extensively discussed under different backgrounds. ‘Trust and TAM in Online Shopping: An Integrated Model’ (Gefen, Karahanna, & Straub, 2003) and ‘Consumer Acceptance and Use of Information Technology: Extending the Unified Theory of Acceptance and Use of Technology’ (Venkatesh, Thong, & Xu, 2012) are other two articles related to IT Acceptance Model, exploring the IT Acceptance Model under the background of online shopping and mobile Internet technology. Secondly, with the advance of internet technology, social media and social network sites (SNSs) have become an important research direction in the IS field. There are three influential articles related to social media and SNSs. In particular, the second highest cited article in the IS domain – ‘Users of the World, Unite! The Challenges and Opportunities of Social Media’ (Kaplan & Haenlein, 2010), classify the social media and propose 10 pieces of advice for firms that can use social media for profit. The

Table 3. Top 12 Articles with the Most citations

Articles	Authors	Published Year	Citation Frequency	Journal
User Acceptance of Information Technology: Toward a Unified View'	Venkatesh, Morris, Davis, & Davis	2003	430	MIS Quarterly
Users of the World, Unite! The Challenges and Opportunities of Social Media	Kaplan & Haenlein	2010	341	Business Horizons
Multivariate Data Analysis: A Global Perspective	Joseph F. Hair, Black, Babin, & Anderson	2010	307	Book
The Benefits of Facebook "Friends": Social Capital and College Students' Use of Online Social Network Sites	Ellison, Steinfield, & Lampe	2007	231	Journal of Computer-Mediated Communication
Social Network Sites: Definition, History, and Scholarship	M. Boyd & Ellison	2007	226	Journal of Computer-Mediated Communication
Common Method Biases in Behavioral Research: A Critical Review of the Literature and Recommended Remedies	Podsakoff, Mackenzie, Jeong-Yeon, & Podsakoff	2003	221	Journal of Applied Psychology
Trust and TAM in Online Shopping: An Integrated Model	Gefen, Karahanna, & Straub	2003	215	MIS Quarterly
Consumer Acceptance and Use of Information Technology: Extending the Unified Theory of Acceptance and Use of Technology	Venkatesh, Thong, & Xu	2012	211	MIS Quarterly
Why Should I Share? Examining Social Capital and Knowledge Contribution in Electronic Networks of Practice	Wasko & Faraj	2005	203	MIS Quarterly
'Data Mining: Practical Machine Learning Tools and Techniques'	Witten & Frank	2005	192	Book
Design Science in Information Systems Research	Hevner, March, & Park	2004	184	MIS Quarterly
Review: Knowledge Management and Knowledge Management Systems: Conceptual Foundations and Research Issues	Alavi & Leidner	2001	182	MIS Quarterly

results indicate that IT-related business issues are one concern in the IS domain. Thirdly, Knowledge Management (Alavi & Leidner, 2001; Wasko & Faraj, 2005) and Design Science Paradigm (Hevner, Sudha, March, & Park, 2004) are also popular research directions in the IS field.

Citation Bursts Analysis

Citation burst analysis is used to investigate the dynamic impact of references and predict the future research directions by the growth rate of citation (C. Chen, Dubin, & Kim, 2014). Citation bursts occurs when the citation of a reference ascend at a high growth rate, implying that the study leads new research interest and becomes a topical issue at that moment. Table 4 shows the top 10 articles with the highest bursts in the whole development process of IS field, displaying the brilliant landmarks in the progress of IS science realm. Table 5 shows the top 10 articles with the most recent bursts since

2015, pointing out forward guidance for future research. The red dotted line represents the period of citation burst and the length of the red dotted line states the duration of the citation burst of the paper. The strength index refers to the growth rate of co-citation. A high strength index predicts that the research has a good prevalent trend in the future.

Interestingly, the top 10 articles with the highest burst in Table 4 are almost overlapping with the articles with the most citations in Table 3, indicating that these articles are not only highly cited articles, but also have high growth rate of citation. For instance, ‘User Acceptance of Information Technology: Toward a Unified View’ (Venkatesh et al., 2003) is the article with the most citation and burst in the IS domain. It also has the longest citation burst duration (from 2005 to 2011) as well as the highest strength index, which reveals its significant impact in the IS domain. By combining results in reference co-citation analysis and citation burst analysis, the authors found that articles in Table 3 and Table 4 have revealed the hotspots in the IS field and exerted a profound great influence in the IS field.

Table 4. Top 10 Articles with the Most Burst

References	Year	Strength	Begin	End	1975–2018
VENKATESH V., 2003, MIS QUART, V 27, P425	2003	176.8034	2005	2011	
KAPLAN AM, 2010, BUS HORIZONS, V53, P59, DOI	2010	124.6463	2013	2018	
ELLISON NB, 2007, J COMPUT-MEDIAT COMM, V12, P1143, DOI	2007	106.8562	2011	2015	
HAIR JE, 2010, MULTIVARIATE DATA AN, V9, P9	2010	104.8319	2014	2018	
BOYD DM, 2007, J COMPUT-MEDIAT COMM, V13, P210, DOI	2007	104.5071	2011	2015	
PODSAKOFF PM, 2003, J APPL PSYCHOL, V88, P879, DOI	2003	104.42	2007	2011	
VENKATESH V., 2012, MIS QUART, V36, P157	2012	100.0182	2015	2018	
GEFEN D, 2003, MIS QUART, V27, P51	2003	93.314	2005	2010	
VENKATESH V., 2000, MANAGE SCI, V46, P186, DOI	2000	84.4885	2003	2008	
ALAVI M, 2001, MIS QUART, V25, P107, DOI	2001	84.216	2003	2009	

Table 5 summarizes the top 10 articles with the most recent burst, which have been research hotspots since 2015 and are still booming, representing prospective research directions. A few findings are identified. Firstly, consistent with the above analysis, themes relate to IT Acceptance and Use receive continuous attention in the IS domain. The article with the most recent burst is the study of Venkatesh et al. (2012). Secondly, online reviews and social media are still significant research topics in the IS field, and how to use the information from e-commerce platform or social media to create more business value is the future research concerns in the IS domain. For example, the research of Mudambi and Schuff (2010) and Feng and Zhang (2010) discussed the impact of online reviews of e-commerce platform on customers or product sales. Kietzmann, Hermkens, Mccarthy, and Silvestre (2011) explored the mechanism of different social media activities on firms and put forward some response measures. Thirdly, other promising topics are related to Machine Learning, Data Mining, and Cloud Computing (Armbrust, Fox, Katz, & Konwinski, 2010; Chang & Lin, 2011; Hall et al., 2009), which are the emerging driving forces for the future development of IS. Finally, ‘Positioning and Presenting Design Science Research for Maximum Impact’ (Gregor & Hevner, 2013) attempted to clarify the advantages and contribution of design-science paradigm, improving its impact among IS researchers. Since 2015, this paper has attracted great attention. Therefore, the design science paradigm will continue to be significant research approach in future studies in IS.

Table 5. Top 10 Articles with the Most Recent Burst

References	Year	Strength	Begin	End	1975 - 2018
VENKATESH V, 2012, MIS QUART, V36, P157	2012	100.0182	2015	2018	
HAIR JF, 2011, J MARKET THEORY PRAC, V19, P139, DOI	2011	78.921	2015	2018	
HAYES AF, 2013, INTRO MEDIATION MODE, V0, P0	2013	77.4873	2015	2018	
MUDAMBIS M, 2010, MIS QUART, V34, P185	2010	62.7062	2015	2018	
ZHU F, 2010, J MARKETING, V74, P133, DOI	2010	58.902	2015	2018	
CHANG CC, 2011, ACM T INTEL SYST TEC, V2, P0, DOI	2011	56.5265	2015	2018	
HALL M, 2009, SIGKDD EXPLORATIONS, V11, P10	2009	48.3934	2015	2018	
ARMBRUST M, 2010, COMMUN ACM, V53, P50, DOI	2010	47.0407	2015	2018	
GREGOR S, 2013, MIS QUART, V37, P337, DOI	2013	45.1467	2015	2018	
KIE TZMANN JH, 2011, BUS HORIZONS, V54, P241, DOI	2011	43.7269	2015	2018	

Author Co-Citation Analysis

Author co-citation analysis is a good approach to identify the impactful authors and build the intellectual network among authors. Similar to reference co-citation analysis, the authors describe the author co-citation network in the form of eleven four-year slices, which is displayed in Figure 6. Each node represents an author and the size of the node reflects the citation number of the author. The connection between two nodes indicates the co-citation relationship of the two authors. The rings of the node record the citation process of the authors. The color of the ring reveals the co-citation year and the thickness of the ring reflects the citation number of the author in corresponding period. The purple ring in the edge of the node stands for the high betweenness centrality of the author, which manifests the author's significant impact across time. To be more specific, the node with many links of different colors will have a purple ring at the edge, which means that the author represented by the node has high betweenness centrality. In other words, the higher the betweenness centrality, the greater the author's cross-stage contribution to the development of IS field.

As shown in Figure 6, Lynne Markus has the highest betweenness centrality, indicating that his contribution spanned different stages in development process in IS field. In addition, Fred Davis, Venkatesh Viswanath, Claes Fornell, Joseph Hair, David Gefen, Wynne Chin, Wanda Orlikowski, Everett Rogers and Icek Ajzen are the other top 9 authors with the most citations in the IS field. Most of them have the betweenness centrality, indicating that their influences are significant in a long period of time. Notably, except for academic researchers in the IS domain, these top citation authors also include researchers in Marketing (Claes Fornell), Organizational Studies (Wanda Orlikowski), Communication (Everett Rogers) as well as Psychology (Icek Ajzen). This result indicates that researchers in IS discipline employ diverse research methods and theories from other disciplines as well.

Journal Co-Citation Analysis

Journal co-citation analysis do not only estimate the status and relationship of journals in the discipline, but also identify the source of knowledge of the discipline, which is of great significance to researchers and scholars (Liao et al., 2018). The authors adopt VOSviewer to plot the journal co-citation network in the form of clusters, as is shown in Figure 7. In the network, each node stands for a journal and the size of the node reflects citation number of the journal. Nodes in the same color forms a cluster, indicating that these journals in the same cluster have similar research themes. According to Figure 7, these journals in the IS domain can be divided into six clusters based on the co-citation relationship. Besides, to clarify the journal lists of the six sub-themes in the IS field, Table 6 summarized the top 5 journals with the most citation in every cluster.

As shown in Figure 7 and Table 6, the cluster with the largest number of journals is in red color, the theme of which is mainly related to Computer Science and Decision Science. In this cluster, the

Figure 6. Author co-citation network Note: In each period, the top 50 authors with the most citations were retained, namely each four-year slice has a maximum of 50 nodes in the diagram.

most cited journal is Expert Systems and Applications, which especially publishes articles related to the design, development, testing, implementation, and management of expert and intelligent systems. The second cluster is in green color and mainly deals with inter-discipline topics of Human-Computer Interaction. In this cluster, the most co-cited journal is Computers in Human Behavior, dedicating to examining the use of computers from a psychological perspective. The third cluster is in dark blue color, primarily involving topics of Information Systems and Management in business context. In this cluster, Management Information System Quarterly (MISQ) is the most cited journal, which focuses on the development of IT-based services, the management of IT resources, and the use, impact, and economics of IT with managerial, organizational, and societal implications. The yellow cluster mainly deals with themes of Management Information Systems in marketing environments. Information & Management has the most citation, covering information system development and usage for business, public administration, and international organizations. The fifth cluster is in purple color, whose major theme is Library and Information Sciences. In this cluster, Journal of the Association for Information Science and Technology is the journal with the most citation, which is a leading journal in Library and Information Sciences. The light blue cluster is the sixth cluster, primarily involving topics of Information Economics and Econometrics. The most cited journal is Management Science, drawing on a wide range of management subdisciplines, such as information systems.

In summary, Figure 7 and Table 6 show the knowledge base of the IS field and the most influential journal in each sub-base. In the IS domain, the top 5 journals with the most citation are MISQ, Communications of the ACM, Expert Systems with Applications, Information Systems Research, and Computers in Human Behavior. Except for journals in IS, journals in Social Sciences, Business, Management, Economics also have significant influence in the IS field, which reveals the diversity of the knowledge source in the IS domain.

Evolution of the Research Topics

Keywords co-occurrence analysis can be applied to explore the characteristics and relationships of topics in a specific field and identify its research hotspots from a micro perspective (Cheng et al., 2018; Fergnani, 2019). In this study, the authors examine the keywords occurrence frequency to predict their future development tendency and the keywords clusters to gain insight into the sub-themes

Figure 7. Reference co-citation network. Note: Top 1000 journals with the most citations are retained, the citation frequency of which is greater than or equal to 200.

of the IS field. As a result, the authors chose the 2018 top 65 keywords with the most occurrence frequency to analyze, which are distributed in four clusters. Table 7 shows the top 65 keywords by trend type and the annual ranking of each keyword from its first year. Specifically, the authors classify the development tendency of the keywords into 6 categories based on two criteria. The first criterion is the latest time span of keywords occurrence, with more than five years being ‘sustainable’ and less than five years being ‘emerging’. The second criterion is the trend in the keyword annual ranking, including three forms: Stable, Increase and Decrease. ‘Increase’ means an upward trend in the annual ranking over time. ‘Decrease’ shows a downward trend in the annual ranking over time. ‘Stable’ represents the annual ranking has not changed over time. In addition, Table 8 displays these keywords in the form of clusters.

According to table 7, one third of the top 65 keywords with the most occurrence frequency in 2018 appeared in 1990s and more than 75% of them are ‘sustainable’, suggesting that IS is a continuous and accumulated discipline. Moreover, 70% of the top 65 keywords are ‘increasing’, indicating that these topics continue to be widely discussed in the IS field. Among them, E-commerce, Feature Selection, Education, Decision Making, and Smartphone are in the type of ‘Sustainable & Stable’, demonstrated to be the classic research themes of IS. Social Media, Machine Learning, Cloud Computing, Facebook, and Sentiment Analysis are the top 5 keywords in the type of ‘Sustainable & Increasing’, reflecting the current and future research hotspots in the field of IS. Big Data, Deep Learning, Internet Addiction, Social Commerce, Information quality, Social Influence, Meta-Analysis, Firm Performance, Risk Management, and Opinion Mining are the keywords in the type of ‘Emerging & Increasing’, representing the most promising research themes of IS in the future.

Additionally, the popular keywords in every sub-field are shown in table 8. In the topics of Design Science Research (cluster 1), the keywords of Machine learning, Cloud computing, Sentiment analysis, and Data mining have the most occurrence in 2018, and Deep Learning, Opinion Mining and Software Testing are the most promising keywords in the future. In the theme of Social Media Research (cluster 2), Social Media, Facebook, and Twitter get the most attention, and Internet addiction is supposed to be the promising research direction in the future in IS domain. In the theme of E-commerce Research (cluster 4), there has been a growing recognition of Trust, Privacy, and Online Community. Besides, the keywords of Social Commerce, Information Quality, Social Influence, and

Table 6. The Top 5 Journals with The Most Citation in Every Cluster

	Journals	Citations in the IS field	Category & Subject Area
Cluster 1 (red)	Expert Systems with Applications (ESA)	28986	Computer Science: Artificial Intelligence, Computer Science Applications Engineering: Engineering (miscellaneous)
	Decision Support Systems (DSS)	16438	Computer Science: Information Systems Decision Sciences: Information Systems and Management Arts and Humanities: Arts and Humanities (miscellaneous) Business, Management and Accounting: Management information Systems Psychology: Developmental and Educational Psychology
	European Journal of Operational Research (EJOR)	11279	Computer Science: Computer Science (miscellaneous) Decision Sciences: Information Systems and Management Management Science and Operations Research Mathematics: Modeling and Simulation
	IEEE Transactions on Software Engineering	8843	Computer Science Software
	Journal of Systems and Software	5218	Computer Science: Hardware and Architecture, Information Systems, Software
Cluster 2 (green)	Computers in Human Behavior (CHB)	23734	Arts and Humanities: Arts and Humanities (miscellaneous) Psychology: Psychology (miscellaneous) Computer Science: Human-Computer Interaction
	Journal of Personality and Social Psychology	9008	Social Sciences: Sociology and Political Science Psychology: Social Psychology;
	Journal of Applied Psychology	6767	Psychology: Applied Psychology
	Computers & Education	6659	Social Sciences: Education, E-learning Computer Science: Computer Science (miscellaneous);
	International Journal of Human-Computer Studies	5888	Social Sciences: Education, Human Factors and Ergonomics Computer Science: Hardware and Architecture, Human-Computer Interaction Software Engineering: Engineering (miscellaneous)
Cluster 3 (dark blue)	Management Information System Quarterly (MISQ)	47830	Business, Management and Accounting: Management Information Systems Computer Science: Computer Science Applications, Information Systems Decision Sciences: Information Systems and Management
	Communications of the ACM	31001	Computer Science: Computer Science (miscellaneous)
	Information Systems Research (ISR)	24451	Business, Management and Accounting: Management Information Systems Computer Science: Computer Networks and Communications, Information Systems Decision Sciences: Information Systems and Management Social Sciences: Library and Information Sciences
	Journal of Management Information Systems (JMIS)	12703	Business, Management and Accounting: Management Information Systems Computer Science: Computer Science Applications Decision Sciences: Information Systems and Management, Management Science and Operations Research
	Organization Science	11067	Business, Management and Accounting: Management of Technology and Innovation, Organizational Behavior and Human Resource Management, Strategy and Management
Cluster 4 (yellow)	Information & Management (I &M)	10219	Business, Management and Accounting: Management Information Systems Computer Science: Information Systems Decision Sciences: Information Systems and Management
	Journal of Marketing	10127	Business, Management and Accounting: Business and International Management Marketing Economics, Econometrics and Finance: Economics and Econometrics
	Journal of Marketing Research	9986	Business, Management and Accounting: Business and International Management Marketing Economics, Econometrics and Finance: Economics and Econometrics

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Table 6. Continued

	Journals	Citations in the IS field	Category & Subject Area
	Journal of Consumer Research	6860	Business, Management and Accounting: Business and International Management Marketing Economics, Econometrics and Finance: Economics and Econometrics Arts and Humanities: Arts and Humanities (miscellaneous) Social Sciences: Anthropology
	Journal of Business Research	5449	Business, Management and Accounting Marketing
Cluster 5 (purple)	Journal of the Association for Information Science and Technology	8354	Social Sciences: Library and Information Sciences Computer Science: Computer Networks and Communications, Information Systems Decision Sciences: Information Systems and Management
	Information Processing & Management	6017	Computer Science: Computer Networks and Communications, Information Systems Social Sciences: Library and Information Sciences Decision Sciences: Information Systems and Management Engineering: Media Technology
	Scientometrics	4914	Social Sciences: Library and Information Sciences, Social Sciences (miscellaneous) Computer Science: Computer Science Applications
	Science	4843	Arts and Humanities: History and Philosophy of Science Multidisciplinary: Multidisciplinary
	Journal of Documentation	3667	Computer Science: Information Systems Social Sciences: Library and Information Sciences
Cluster 6 (light blue)	Management Science	21853	Business, Management and Accounting: Strategy and Management Decision Sciences: Management Science and Operations Research
	Marketing Science	3620	Business, Management and Accounting: Business and International Management, Marketing Economics, Econometrics and Finance: Economics and Econometrics
	American Economic Review	2869	Economics, Econometrics and Finance: Economics and Econometrics
	Journal of Finance	2019	Business, Management and Accounting: Accounting Economics, Econometrics and Finance: Economics and Econometrics, Finance
	Econometrica	1823	Economics, Econometrics and Finance: Economics and Econometrics

Notes: Category & Subject Area is obtained from Scimago Journal & Country Rank (SJR)

Table 7. Evolution of Top 65 Keywords with The Most Occurrence Frequency

Keywords	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Information Systems																		
Business Process Management																		
Information Technology																		
Business Information Systems																		
Information Systems Research																		
Information Systems Success																		
Information Systems Adoption																		
Information Systems Use																		
Information Systems Design																		
Information Systems Development																		
Information Systems Implementation																		
Information Systems Evaluation																		
Information Systems Performance																		
Information Systems Security																		
Information Systems Privacy																		
Information Systems Ethics																		
Information Systems Governance																		
Information Systems Compliance																		
Information Systems Audit																		
Information Systems Risk Management																		
Information Systems Resilience																		
Information Systems Continuity																		
Information Systems Recovery																		
Information Systems Backup																		
Information Systems Restoration																		
Information Systems Archiving																		
Information Systems Migration																		
Information Systems Integration																		
Information Systems Interoperability																		
Information Systems Portability																		
Information Systems Scalability																		
Information Systems Flexibility																		
Information Systems Adaptability																		
Information Systems Robustness																		
Information Systems Reliability																		
Information Systems Availability																		
Information Systems Maintainability																		
Information Systems Supportability																		
Information Systems Usability																		
Information Systems User Experience																		
Information Systems User Acceptance																		
Information Systems User Engagement																		
Information Systems User Satisfaction																		
Information Systems User Loyalty																		
Information Systems User Retention																		
Information Systems User Churn																		
Information Systems User Acquisition																		
Information Systems User Onboarding																		
Information Systems User Training																		
Information Systems User Support																		
Information Systems User Feedback																		
Information Systems User Research																		
Information Systems User Analytics																		
Information Systems User Segmentation																		
Information Systems User Targeting																		
Information Systems User Positioning																		
Information Systems User Messaging																		
Information Systems User Promotion																		
Information Systems User Distribution																		
Information Systems User Placement																		
Information Systems User Presentation																		
Information Systems User Packaging																		
Information Systems User Labeling																		
Information Systems User Branding																		
Information Systems User Marketing																		
Information Systems User Sales																		
Information Systems User Distribution																		
Information Systems User Promotion																		
Information Systems User Placement																		
Information Systems User Presentation																		
Information Systems User Packaging																		
Information Systems User Labeling																		
Information Systems User Branding																		
Information Systems User Marketing																		
Information Systems User Sales																		
Information Systems User Distribution																		
Information Systems User Promotion																		
Information Systems User Placement																		

Meta-analysis are emerging recently and still keeping increasing, representing the most promising research topic in this stream. Nevertheless, in cluster 3, the topic related to IS Usage and Knowledge Management Research in Organizational Environments, except for Social Capital and Innovation, other 'sustainable' keywords are in the trend of decreasing, such as Information Systems, Information Technology, Outsourcing, Knowledge Management, and Knowledge Sharing, indicating that the academics doing research in IS usage and knowledge management are shifting their focus. Big Data, Firm Performance, and Risk Management are 'emerging' and 'increasing', representing the future research direction of this cluster.

Note: The keywords labeled with 'Sustainable& Increase' indicates that it has been growing continuously at least five years; the keywords with 'Sustainable & Stable' does not dramatically change in terms of ranking for at least five years; the keywords with 'Sustainable & Decrease' has been showing a continuous downward trend for at least five years; the keywords with 'Emerging & Increase' has been growing continuously less than five years; the keywords with 'Emerging & Decrease' has been suffering a continuous decline less than five years.

In summary, most keywords are in the trend of 'increasing', providing a guidance for IS research. In addition, nearly half of the 65 keywords are in the cluster of Design Science Research, indicating that IS domain is an information technology-driven discipline. Advances in the data analysis method, such as Machine learning, Cloud computing, Sentiment analysis, and Data mining, will promote the development of these sub-fields.

DISCUSSION

In order to have a comprehensive understanding of IS field and look forward future research direction, the authors conduct a bibliometric review of 80,147 primary articles and 1,325,376 references in the IS domain with two powerful bibliometric software tools – CiteSpace and VOSviewer. Firstly, the authors build the collaborative network at the country and institution level to study the intellectual output mode of IS field. Secondly, the authors carry out the co-citation and citation burst analysis to identify the most influential authors and articles in IS history as well as the most popular IS articles in recent three years. Thirdly, the authors conduct a clustering analysis of the journals in the IS field to trace the source of knowledge of IS and navigate the journals in the IS domain. Finally, the authors explore the evolutionary process of the top 65 keywords with the most occurrence frequency in 2018 in the IS field and figure out the most promising topics in each sub-themes of the IS, which provides an agenda for the future research. On these grounds, the authors discuss several aspects about the development of IS in details.

Strengthen the Cooperation Relationship at the Country and Institution Level

With the maturity of IS field, intellectual collaboration has been an effective and popular way to realize knowledge innovation and enrich research achievements as well as improve the academic influence. As the results of co-author analysis indicate, co-authored articles in the top 10 productive countries and institutions account for more than 50% of articles published. On average, every productive country has 40 partners and every productive institution has more than 100 partners. However, the cooperative relationship and cooperation strength are not balanced. For instance, among the top 5 productive countries, there is only a close cooperative relationship between the U.S. and China. Although the total cooperation strength of the U.S. is strong, the proportion of co-authored articles in the U.S. is only 30.15%. Therefore, at the country level, it is necessary to strengthen the international cooperation between productive countries, especially for countries with different research interests, which can make use of the principle of complementary advantages for knowledge fusion and innovation. Besides, at the institution level, except for cooperating with institutions of similar geographic location or research interest, it is also important to strengthen the cooperation between influential institutions to improve the academic impact in the IS field.

Table 8. The Top 65 Keywords with The Most Occurrence Frequency Based on Clusters

	Keywords	Rank	Type
Cluster 1 (Design Science Research)	Feature Selection	13	Sustainable & Stable
	Decision Making	42	Sustainable & Stable
	Machine Learning	2	Sustainable & Increase
	Cloud Computing	4	Sustainable & Increase
	Sentiment Analysis	7	Sustainable & Increase
	Data Mining	8	Sustainable & Increase
	Classification	11	Sustainable & Increase
	Genetic Algorithm	12	Sustainable & Increase
	Recommender System	15	Sustainable & Increase
	Optimization	16	Sustainable & Increase
	Text Mining	17	Sustainable & Increase
	Security	21	Sustainable & Increase
	Scheduling	27	Sustainable & Increase
	Ontology	33	Sustainable & Increase
	Requirements Engineering	37	Sustainable & Increase
	Collaborative Filtering	43	Sustainable & Increase
	Visualization	60	Sustainable & Increase
	Software Engineering	65	Sustainable & Increase
	Neural Network	22	Sustainable & Decrease
	Decision Support System	32	Sustainable & Decrease
	Simulation	39	Sustainable & Decrease
	Support Vector Machine	40	Sustainable & Decrease
	Decision Support	48	Sustainable & Decrease
	Deep Learning	19	Emerging & Increase
	Opinion Mining	52	Emerging & Increase
	Software Testing	54	Emerging & Increase
	Multi-Objective Optimization	55	Emerging & Decrease
Cluster 2 (Social Media Research)	Education	30	Sustainable & Stable
	Smartphone	49	Sustainable & Stable
	Social Media	1	Sustainable & Increase
	Facebook	5	Sustainable & Increase
	Twitter	10	Sustainable & Increase
	Motivation	23	Sustainable & Increase
	Emotion	26	Sustainable & Increase
	Personality	35	Sustainable & Increase
	Cyberbullying	36	Sustainable & Increase
	Learning	45	Sustainable & Decrease
	Virtual Reality	58	Sustainable & Decrease
	Internet Addiction	31	Emerging & Increase
	Augmented Reality	61	Emerging & Decrease

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Table 8. Continued

	Keywords	Rank	Type
Cluster 3 (IS Usage and Knowledge Management Research in Organizational Environments)	Social Capital	29	Sustainable & Increase
	Innovation	57	Sustainable & Increase
	Information System	14	Sustainable & Decrease
	Knowledge Management	20	Sustainable & Decrease
	Information Technology	24	Sustainable & Decrease
	Knowledge Sharing	53	Sustainable & Decrease
	Outsourcing	62	Sustainable & Decrease
	Big Data	3	Emerging & Increase
	Firm Performance	47	Emerging & Increase
	Risk Management	51	Emerging & Increase
	Business Intelligence	50	Emerging & Decrease
Cluster 4 (E-commerce Research)	E-commerce	6	Sustainable & Stable
	Trust	9	Sustainable & Increase
	Privacy	18	Sustainable & Increase
	Online Community	25	Sustainable & Increase
	Adoption	28	Sustainable & Increase
	Satisfaction	38	Sustainable & Increase
	Technology Acceptance	63	Sustainable & Increase
	Information Security	59	Sustainable & Decrease
	Technology Adoption	64	Sustainable & Decrease
	Social Commerce	34	Emerging & Increase
	Information Quality	41	Emerging & Increase
	Social Influence	44	Emerging & Increase
	Meta-Analysis	46	Emerging & Increase
	Customer Satisfaction	56	Emerging & Decrease

Establish the Identity and Paradigm in the IS Domain

As an emerging interdisciplinary, the analysis of journal co-citation and author co-citation reveals the knowledge sources of the IS field. According to the results of journal co-citation analysis, journals in the domains of Computer Science, Decision Science, Social Psychology, Organizational Studies, Marketing, Library and Information Sciences, Econometrics as well as Strategy and Management are the main knowledge bases of IS discipline. Among journals, MISQ, Communications of the ACM, ESA, ISR, CHB, Management Science, DSS, JMIS, EJOR, Organization Science are the top 10 journals with the most citation in IS field. Additionally, results of author co-citation analysis show that the influential authors in the IS field not only come from the IS domain but also from different disciplines such as Marketing and Social Psychology. In summary, the knowledge of IS field comes from a variety of sources, which have great impact on the research topics, methods, and theories in the IS domain. In order to promote the development of the discipline, it is important to establish the discipline identity and research paradigm of the IS.

Future Research in the IS Field

In this review, the authors conduct reference co-citation and citation burst analysis to explore the most influential articles in the IS field, as well as keywords co-occurrence analysis to identify the popular

keywords in each sub-field of the IS, providing a guidance for the future research. According to the results of co-citation and citation burst analysis, the most basic and classical theme in the IS domain is 'IT use and acceptance', which has been discussed in various contexts, such as the organization, online shopping, social media. In fact, information systems is an emerging applied subject, originating from the background of organizational management (Taylor et al., 2008)(Taylor et al., 2008)[44]. Initially, information systems aims to study the traditional issues related to information technology use in the organization context, such as 'information technology acceptance in organization' and 'organization knowledge management systems'. However, with the development of information technology and the arrival of the Internet era, especially the emergence of the Internet economy, great changes have taken place in business models, which brings new research background for information systems research, such as e-commerce platforms and social medias. In recent years, with the popularity and application of information technology products, a large amount of user data is produced. Machine Learning, Data Mining, and Cloud Computing are becoming the new focus in the IS domain, further expanding the scope of the IS research. Thus, the topics in the IS field seems to be diverse and fragment. However, the intellectual core of the IS is stable and coherent, studying for novel and emerging technologies (N. R. Hassan et al., 2018), which should be a guidance for the future research.

In addition, according to the results of the keywords co-occurrence analysis, Social Media, Machine Learning, Big Data, Cloud Computing, Facebook, E-commerce, Sentiment Analysis, Data Mining, Trust and Twitter are the top 10 keywords with the most occurrence frequency in 2018, indicating that topics related to Design Science and Social Media are popular in the IS domain. Big Data, Deep Learning, Internet Addiction, Social Commerce, Information quality, Social Influence, Meta-Analysis, Firm Performance, Risk Management, and Opinion Mining are the most promising keywords in the IS domain, suggesting that themes related to these keywords are the hotspots in the IS future research.

Limitation

There are several limitations in the study. Firstly, the results should be analyzed and discussed based on this sample. Although the Web of Science core citation database is the most comprehensive database for the bibliometric review, and the sample database consists of 80,147 primary articles and 1,325,376 references, the sample size is still limited. For example, inevitably, in the exploration phase, sporadic IS articles would be published in journals of other research field, such as sociology. In addition, the authors mainly collect and analyze journal articles, which are the mainstream form of achievements. In the future research, other forms of studies such as conference articles can be included in analysis.

Secondly, this study aims to display the knowledge cooperation model in IS field, rather than exploring the impact or impact factors of the cooperative relationship. As a result, the relationship between cooperation and productivity was not examined and the relationship among co-authors or co-citation authors was not tracked. Furthermore, the factors affecting partnerships between countries or agencies also remains unclear. However, previous studies indicated that intelligence cooperation plays a significant role in the development of IS domain. Future research could explore the impact of cooperative relationship on the research development of the discipline.

Finally, although the authors describe the panorama of the IS by identifying the most influential articles, authors, journals, and keywords in the IS domain, the authors may overlook some detailed information in evolutionary process of the IS. Future research can conduct systematic review for each sub-field to clarify the focus of each sub-field (Hsiao & Yang, 2011), or conduct a comprehensive investigation of the theories in the IS domain (N. Hassan, Mathiassen, & Lowry, 2019), so as to contribute to the development of the IS theory (N. Hassan et al., 2019).

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CONCLUSION

This study is initiated to conduct a comprehensive bibliometric review to quantitatively visualizes the evolution of IS research over time. The authors analyze all the articles published in the IS journals in the ABS list between 1975 and 2018. The authors use two visualization tools, CiteSpace and VOSviewer, to detect the research center, influential authors, research frontiers, popular topics, landmark documents, subthemes, and articles with bursts within the IS literature. First, the authors reveal patterns of collaboration and research interest between countries or institutions, providing a guidance for future academic research cooperation in the IS field. Next, the authors describe the evolutionary process and the knowledge source of IS domain, uncovering the essence of IS research. Finally, the authors identify the most classical and promising topics in IS filed, setting up an agenda for IS future research. In short, the authors attempt to provide an understanding of the panorama and emerging trends in the IS literature as well as a roadmap for future research.

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ENDNOTES

- ¹ ABS journal list refers to the list of Association of Business School's Academic Journal Guide (ABS journal), aiming to distinguish the research domains and quality of academic journals in business field.
- ² The number of links equals to the partner number of the country.
- ³ Total link strength represents the number of co-authored articles of the country.
- ⁴ Co-author articles proportion is the ratio of total link strength and total articles, indicating the proportion of the articles that are finished by two or more than two countries.
- ⁵ The number of links equals to the number of partners of the institution.
- ⁶ Total link strength represents the number of co-authored articles of the institution.
- ⁷ Co-author articles proportion is the ratio of total link strength and articles, indicating the proportion of the co-authored articles of the institution.

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