Mapping the Evolution of Social Media Analytics Research in Operations and Supply Chain Management: A Bibliometric Analysis

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This study examines the research landscape of social media analytics (SMA) in operations and supply chain management (OSCM). We identified 247 academic research articles from the Web of Science (WoS) Core Collection. Our search of the articles is based on a combination of such keywords, as "social media", "social networking", "user-generated content", "web 2.0", "Facebook", "Twitter", "big data", "analytics", "machine learning", "operations", and "supply chain". The span of the articles was between 2012 and early 2021. The research was conducted using a bibliometric analysis. We report the findings of the trends and growth of scientific research, the publication sources and source growth dynamics, highly-cited articles, most productive researchers, trending topics, and intellectual structures. Based on the findings, we offer three recommendations for future research. This study contributes to the literature by mapping the evolution of SMA in the OSCM field.

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I. INTRODUCTION

Social media or Web 2.0 offers so-called "affordance", "not what an object is, but rather what kinds of users it affords" and how it helps users. This concept is also coined "social media affordance" (Treem and Leonardi 2012). This popular technology enables increased connectivity and digital storage and traceability. The active roles of social media are popularly recognized in multiple disciplines (Kaplan and Haenlein 2010; Aral, Dellarocas, and Godes 2013). Some recent studies have considered the role of social media in the contexts of operations and supply chain management (OSCM). Social media is now recognized as a key digital tool for a variety of business activities, including sales, customer relationships, logistics, and stakeholder engagement, in both business-to-customer and business-to-business contexts (Chae, McHaney, and Sheu 2020). A recent study has identified several OSCM activities that can benefit from social media, including demand forecasting, sourcing, product development, delivery, return, and risk management (Huang, Potter, and Eyers 2020).

One of the key aspects of social media/Web 2.0 is that as social media technologies are used, new data are created and stored. This is a characteristic of digital technologies in general, which has increased the discussion about the role of big data and analytics for supply chain management (Maheshwari, Gautam, and Jaggi 2021). When compared with traditional digital technologies typically used by an organization or a network of businesses, social media technologies display some unique characteristics, including massive user groups, diverse data sources, and types, and relatively high openness of platform and data. These characteristics have created opportunities and challenges for utilizing the role of social media in OSCM. The growing interest in social media for OSCM is demonstrated by a journal issue focusing on the topic (Cheng et al. 2020). Relevant topics and approaches include an analytics approach to the value of social media in OSCM (Chan et al. 2016; Cui et al. 2018; Jeong, Yoon, and Lee 2019). This approach is also related to social media analytics (SMA) in other disciplines (Zeng et al. 2010; Fan and Gordon 2014; Batrinca and Treleaven 2015; Brooker, Barnett, and Cribbin 2016; Moe and Schweidel 2017; Lee 2018; Stieglitz et al. 2018).

The focus of SMA is on effectively harnessing social media data for a wide range of human and business activities, including disaster response, marketing, and public healthcare. Research of SMA in the OSCM field has grown for the past several years. One of the earliest relevant studies (Abrahams et al. 2015) identified the value of user-generated content for quality control. That study proposed text processing and mining techniques for product defect discovery from online customer reviews. Social media platforms are diverse (Cheng et al. 2020), including online review sites and microblogging platforms. Another study (Chae 2015) focused on harnessing data from Twitter, the most popular microblogging platform, for supply chain activities such as demand shaping, new product development, and risk management. Some recent studies adopted an empirical approach to measuring the value of social media data. Chan et al. (2016) proposed an analytic approach combining content analysis, multi-criteria decision analysis, and probability weighting function to leverage Facebook data for new product development. Another study (Cui et al. 2018) showed that demand forecasting performances can be significantly improved using machine learning algorithms (e.g., random forest) and social media data from Twitter and Facebook.

II. RESEARCH OBJECTIVES

The goal of this study is to examine the research landscape of SMA in OSCM. We aim to contribute to the literature by mapping the evolution of the research field using a bibliometric approach. The study identified 247 academic research articles addressing SMA topics for OSCM. Specifically, this study attempts to answer the following questions:

- What are the trends and growth of scientific research in SMA?
- What are the publication sources and source growth dynamics?
- What are highly cited articles and who are the most productive researchers?
- What are trending topics and popular keywords?
- What are the intellectual structures of SMA research in OSCM?

III. METHODOLOGY

We relied on the Web of Science (WoS) Core Collection database to search the articles addressing SMA and OSCM. The advanced keyword search was used while considering the following terms: ("social media" OR "social networking" OR "user-generated content" OR "web 2.0" OR "online community" OR "Facebook" OR "Twitter" OR "tweet" OR "youtube" OR "Blog" OR "Wechat" OR "Weibo" OR "Instagram" OR "Snapchat" OR "Tiktok") (Huang, Potter, and Eyers 2020) AND (analytics OR "big data" OR "data analytics" OR "data science" OR "machine learning") AND (operations OR "supply chain"). The title span of the search was 10 years between January 2012 and April 2021. The analysis relied on multiple tools. R Bibliometrix (Aria and Cuccurullo 2017a, 2017b), a popular, bibliometric R package, was the primary tool for the analysis. VOSViewer (Van Eck and Waltman 2010) and Python matplot library (Hunter 2007) were used for additional network visualization and time series analysis.

IV. RESULTS

4.1. Trends and growth of scientific research in SMA-OSCM

TABLE 1. DATA PRIMARY INFORMATION AND SUMMARY OF THE DATASET

Description	**Results**
Timespan	2012 - 2021
Sources (Journals, Books, etc.)	169
Documents	247
Average years from publication	2.52
Average citations per document	13.8
Average citations per year per doc	3.384
References	14787
DOCUMENT TYPES	
article	201
article; book chapter	1
article; data paper	1
article; early access	12
article; proceedings paper	6
editorial material	4
review	19
review; early access	3
AUTHORS	
Authors	784
Author Appearances	849
Authors of single-authored documents	30
Authors of multi-authored documents	754
AUTHORS COLLABORATION	
Single-authored documents	31
Documents per Author	0.315
Authors per Document	3.17
Co-Authors per Document	3.44
Collaboration Index	3.49

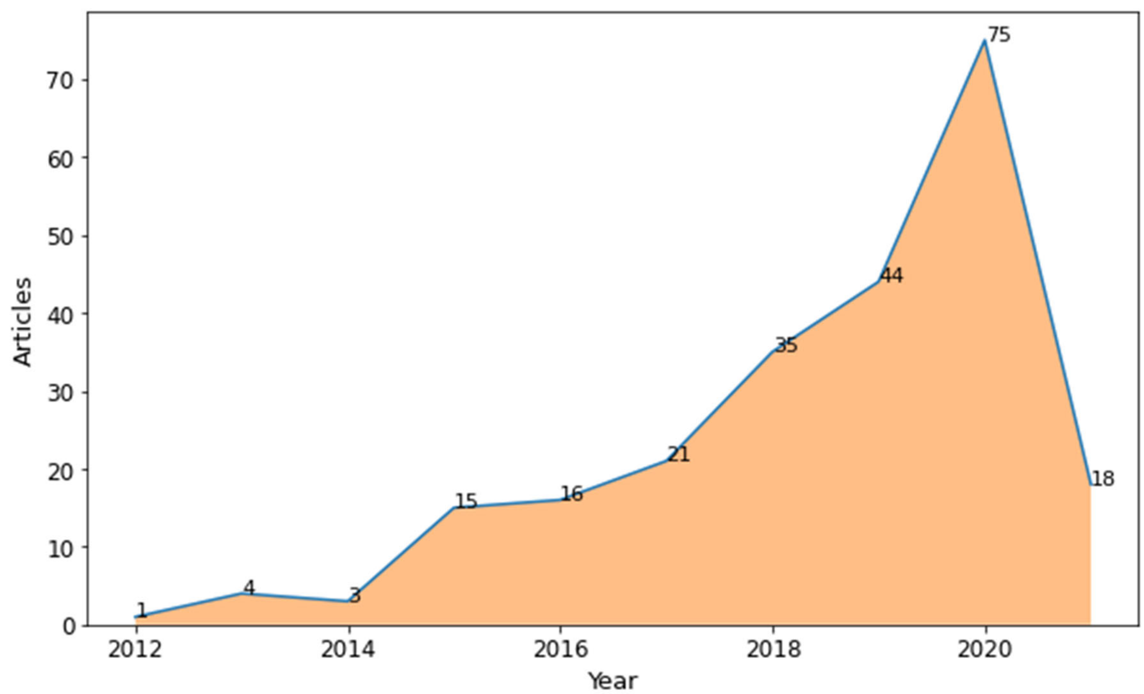

FIGURE 1. PUBLICATION GROWTH

Table 1 presents a summary of the dataset used in this study. 247 articles by 784 unique authors from 411 organizations in 49 countries are represented. On average, there are three co-authors per article and 3.3 average citations per year per article. Figure 1 shows the growth of research in this area. There has been an increase in SMA research in the contexts of OSCM during the decade. There were two noticeable periods: 2015 and 2018. Considering the 2.52 average years from publication, SMA appeared as a significant topic among some OSCM researchers starting from the early 2010s. This timing is aligned with the launches of popular social media platforms that occurred between the late 2000s and early 2010s.

4.2. Publication sources and source growth dynamics

The dataset consists of articles from 161 journals. Figure 2 shows the most relevant journals. Five journals have published five or more articles addressing SMA in OSCM. They include Production and Operations Management (POM), Annals of Operations Research (AOR), IEEE Access, International Journal of Production Research (IJPR), and Transaction Research Part E: Logistics and Transportation Review. Figure 3 shows the cumulative counts of articles published in the most relevant journals. POM, Big Data, and the International Journal of Production Economics (IJPE) had published relevant articles as early as 2014 and 2015. Other journals like the Journal of Cleaner Production, IJPR, and IEEE Access published relevant articles as early as 2017 and 2018.

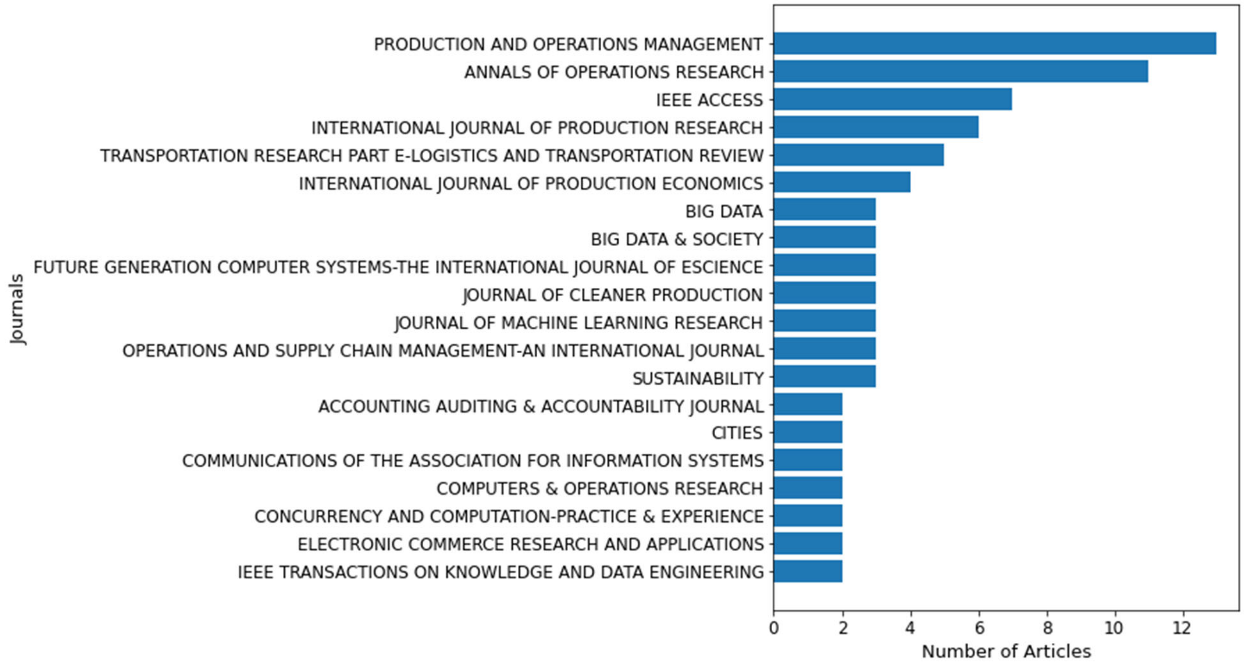

FIGURE 2. MOST RELEVANT JOURNALS

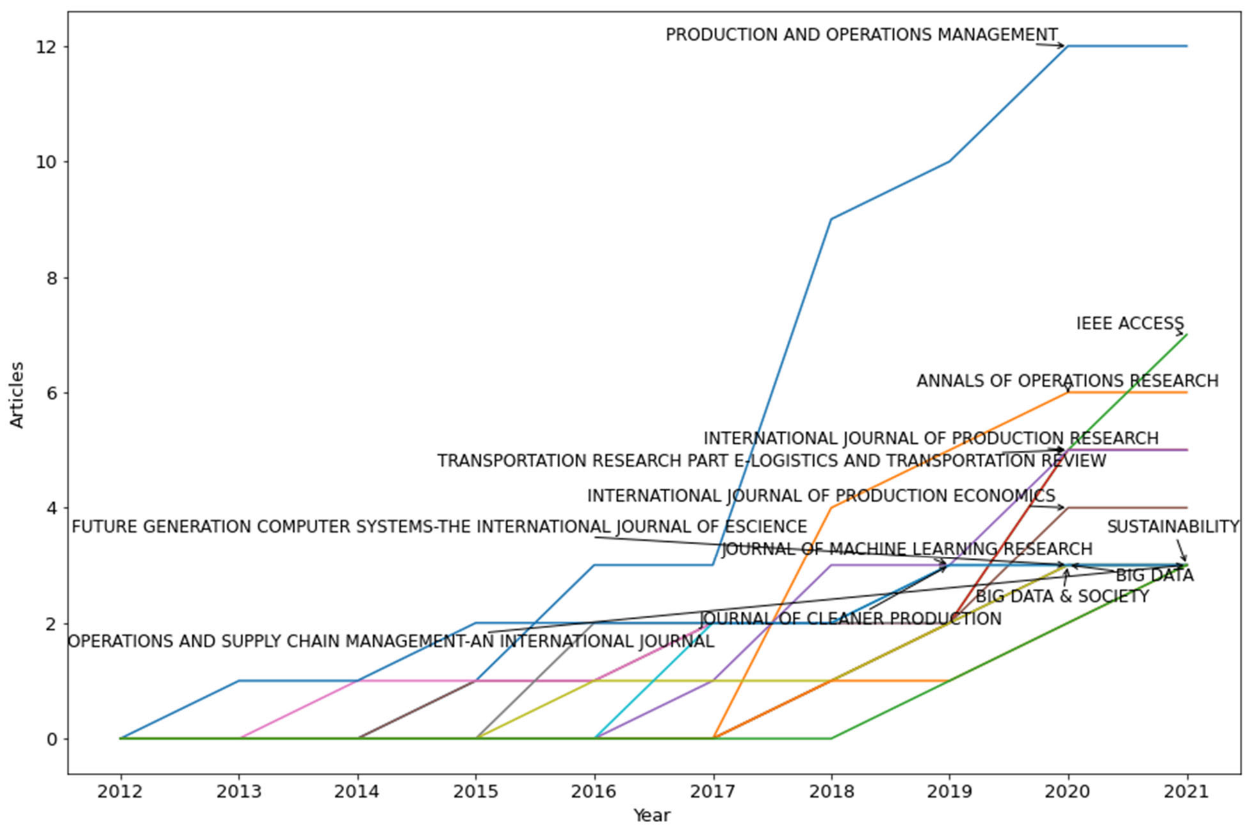

FIGURE 3. JOURNAL DYNAMICS

Two figures show the results of analyzing journal impacts. Figure 4 shows the most locally cited (LC) journals. LC refers to the citations a selected article has received from articles in our research dataset (247 articles) (Aria and Cuccurullo 2017b). The top five journals are IJPE, IJPR, POM, Decision Support Systems (DSS), and Management Science. The journals in this list are related to three disciplines: OSCM, MIS, and marketing. Figure 5 shows a list of impactful journals in terms of the H-index, which is an indicator of a selected journal's output and performance. Three journals (POM, AOR, and IJPR) ranked top in this list. For example, POM (10 H-index) has published the largest number (12) of SMA articles related to OSCM and most of the articles have been popularly cited by the articles in our research dataset.

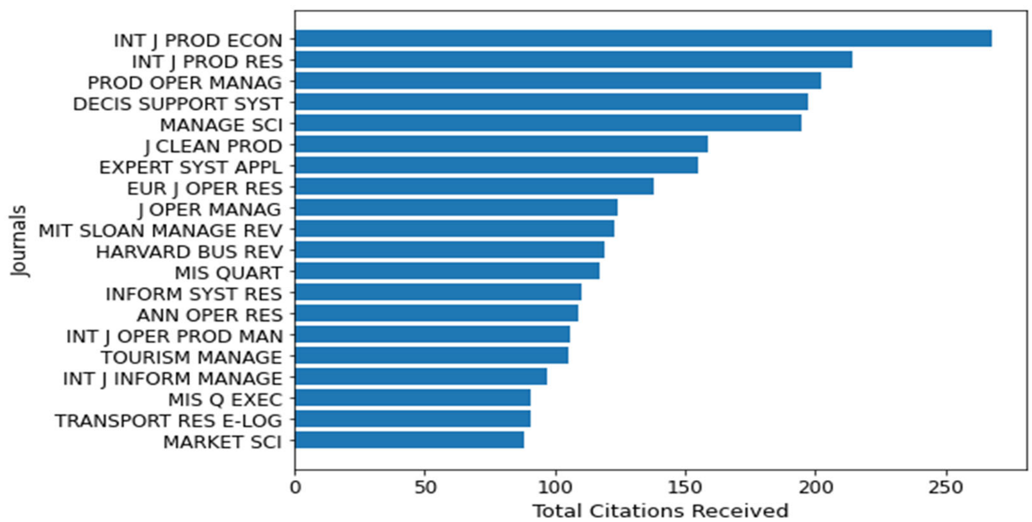

FIGURE 4. MOST LOCAL CITED JOURNALS

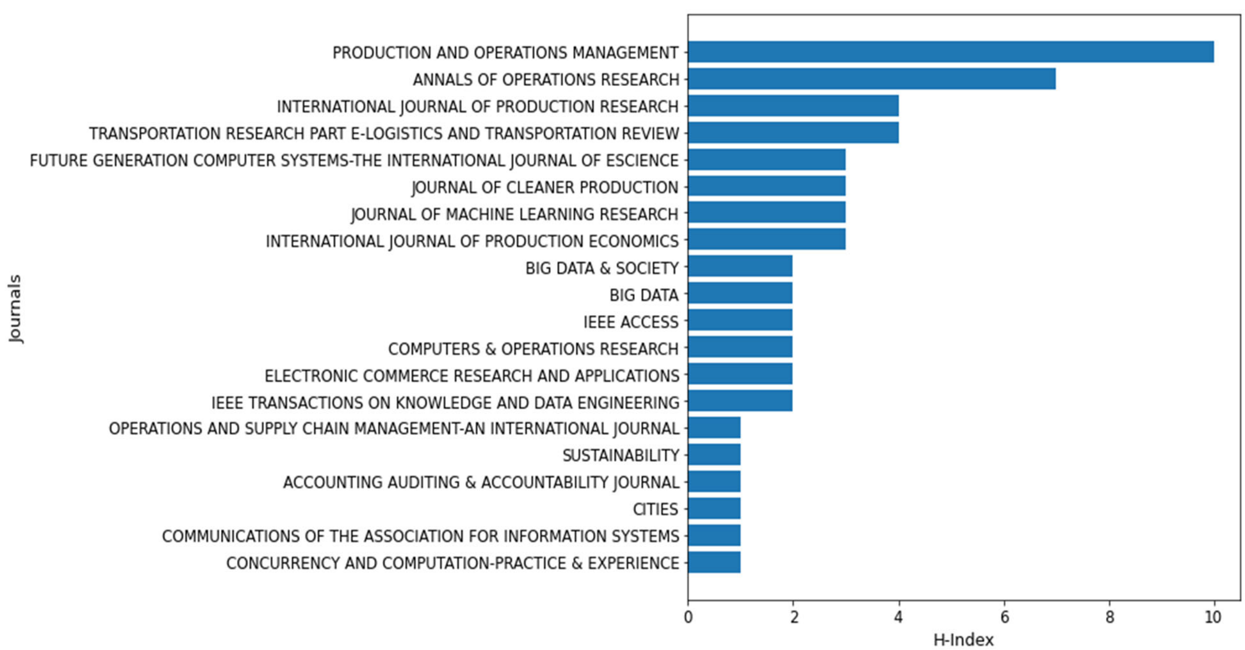

FIGURE 5. JOURNAL LOCAL IMPACT BY H INDEX

Figure 6 is a co-citation network based on cited journals in the articles. The co-citation network is built based on the degree of coupling between two journals, articles, or authors (Small 1973). It reveals three clusters of journals. One of the clusters where POM and MIS Quarterly emerge as hubs primarily includes journals in operations management (e.g., Journal of Operations Management), MIS (e.g., Information Systems Research), and marketing (e.g., Marketing Research). The articles in this cluster of journals are presumed to focus on applications of SMA in operations management and other business function areas. Another cluster is largely represented by such journals as IJPE, IJPR, European Journal of Operations Research (EJOR), and International Journal of Operations & Production Management (IJOPM). These journals focus on operations and production research with an emphasis on analytic tools. There is also a cluster of journals targeting primarily technological and computational aspects of SMA in OSCM. The journals include Decision Support Systems (DSS), Expert Systems Applications, and IEEE Transactions on Knowledge & Data Engineering.

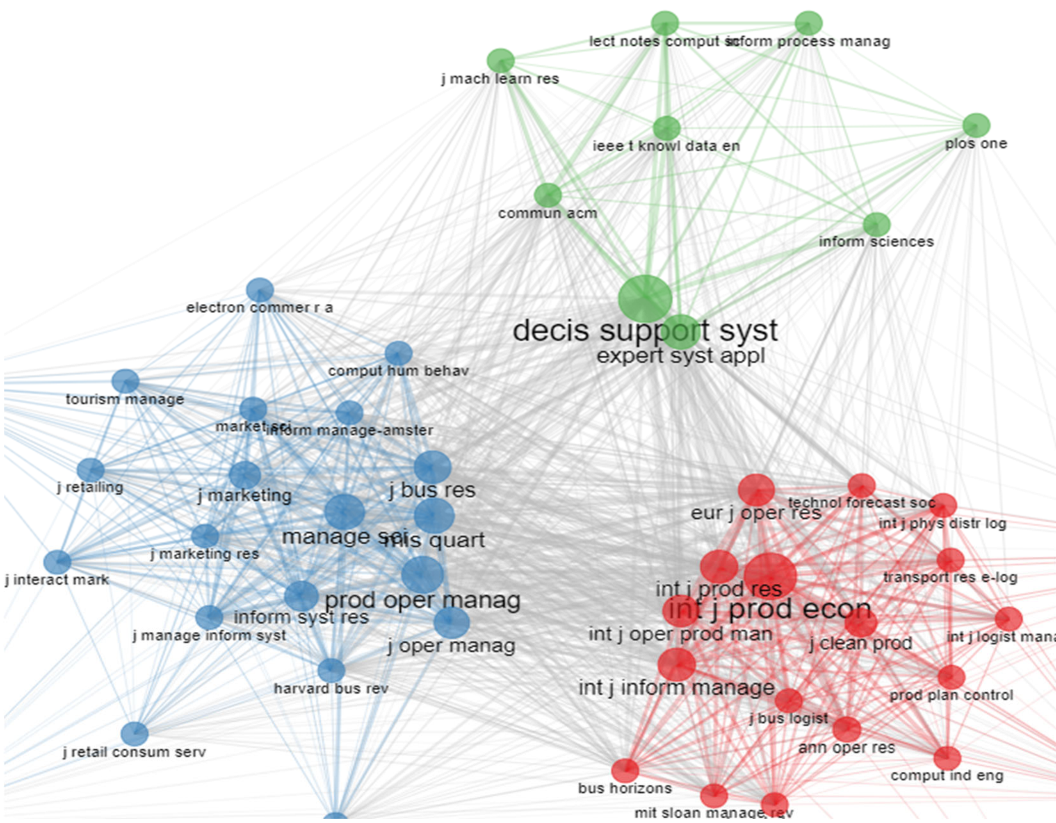

FIGURE 6. CO-CITATION NETWORK (BASED ON CITED JOURNALS)

4.3. Highly cited articles and productive researchers

Table 2 shows highly-cited articles based on Total or Global Citations (TC), which refers to the number of citations a selected article received from other articles indexed on the bibliographic database, WoS, the source of our research data. These articles include "Insights from hashtag# supplychain and Twitter Analytics: Considering Twitter and Twitter data for supply chain practice and research" (Chae 2015), "The Role of Big Data in Explaining Disaster Resilience in

Supply Chains for Sustainability" (Papadopoulos et al. 2017), and "The Impact of Big Data on World-Class Sustainable Manufacturing" (Dubey et al. 2016).

Table 2 also shows the most locally cited articles. The articles highly cited by other articles in our dataset include "Insights from hashtag# supplychain and Twitter Analytics: Considering Twitter and Twitter data for supply chain practice and research" (Chae 2015), "Social Media Data Analytics to Improve Supply Chain Management in Food Industries" (Singh, Shukla, and Mishra 2018), "A Mixed-Method Approach to Extracting the Value of Social Media Data"(Chan et al. 2016), and "The Operational Value of Social Media Information" (Cui et al. 2018).

TABLE 2. MOST GLOBAL CITED ARTICLES & MOST LOCAL CITED ARTICLES

Paper	TC	Paper	LC
CHAE B, 2015, INT J PROD ECON	178	CHAE B, 2015, INT J PROD ECON	19
PAPADOPOULOS T, 2017, J CLEAN PROD	171	SINGH A, 2018, TRANSPORT RES E-LOG	12
LI JJ, 2018, TOURISM MANAGE	151	CHAN HK, 2016, PROD OPER MANAG	11
DUBEY R, 2016, INT J ADV MANUF TECH	133	CUI RM, 2018, PROD OPER MANAG	11
WU KJ, 2017, J CLEAN PROD	97	MISHRA N, 2018, ANN OPER RES	8
STIEGLITZ S, 2014, BUS INFORM SYST ENG+	93	PAPADOPOULOS T, 2017, J CLEAN PROD	7
NGUYEN T, 2018, COMPUT OPER RES	92	ABRAHAMS AS, 2015, PROD OPER MANAG	6
KING T, 2017, TRENDS FOOD SCI TECH	89	CHONG AYL, 2016, INT J OPER PROD MAN	5
ABRAHAMS AS, 2015, PROD OPER MANAG	89	CHOI TM, 2018, TRANSPORT RES E-LOG	5
LI H, 2015, ACM T GRAPHIC	88	GUHA S, 2018, PROD OPER MANAG	4
ORDENES FV, 2017, J CONSUM RES	70	BHATTACHARJYA J, 2018, INT J LOGIST MANAG	4
GHOFRANI F, 2018, TRANSPORT RES C-EMER	69	CHEN HY, 2016, PROD OPER MANAG	3
SHENG J, 2017, INT J PROD ECON	65	DUBEY R, 2016, INT J ADV MANUF TECH	3
SINGH A, 2018, TRANSPORT RES E-LOG	59	WU KJ, 2017, J CLEAN PROD	3
CHAN HK, 2016, PROD OPER MANAG	58	KUMAR S, 2018, PROD OPER MANAG	3
AKTER S, 2019, ANN OPER RES	56	AKTER S, 2019, ANN OPER RES	3
XU Z, 2016, CONCURR COMP-PRACT E	55	YAN L, 2019, PROD OPER MANAG	3
RAO YH, 2016, INFORM MANAGE-AMSTER	54	STIEGLITZ S, 2014, BUS INFORM SYST ENG+	2
WINKELHAUS S, 2020, INT J PROD RES	52	CHOI TM, 2017, RISK ANAL	2
CUI RM, 2018, PROD OPER MANAG	51	ARNABOLDI M, 2017, ACCOUNT AUDIT ACCOUN	2

The two most productive researchers are Choi TM (5 articles) and Singh A (4 articles). The other 49 researchers have published two or three articles. Figure 7 shows top-authors' production over the time period studied. An author's timeline is shown as a line in the graph and the circle size and the color intensity are proportional to the number of articles and the total citations per year respectively (Aria and Cuccurullo 2017b). For example, Chan HK's first article in SMA was published in 2016 (Chan et al. 2016) and the second co-authored paper was published in 2020 (Wang et al. 2020).

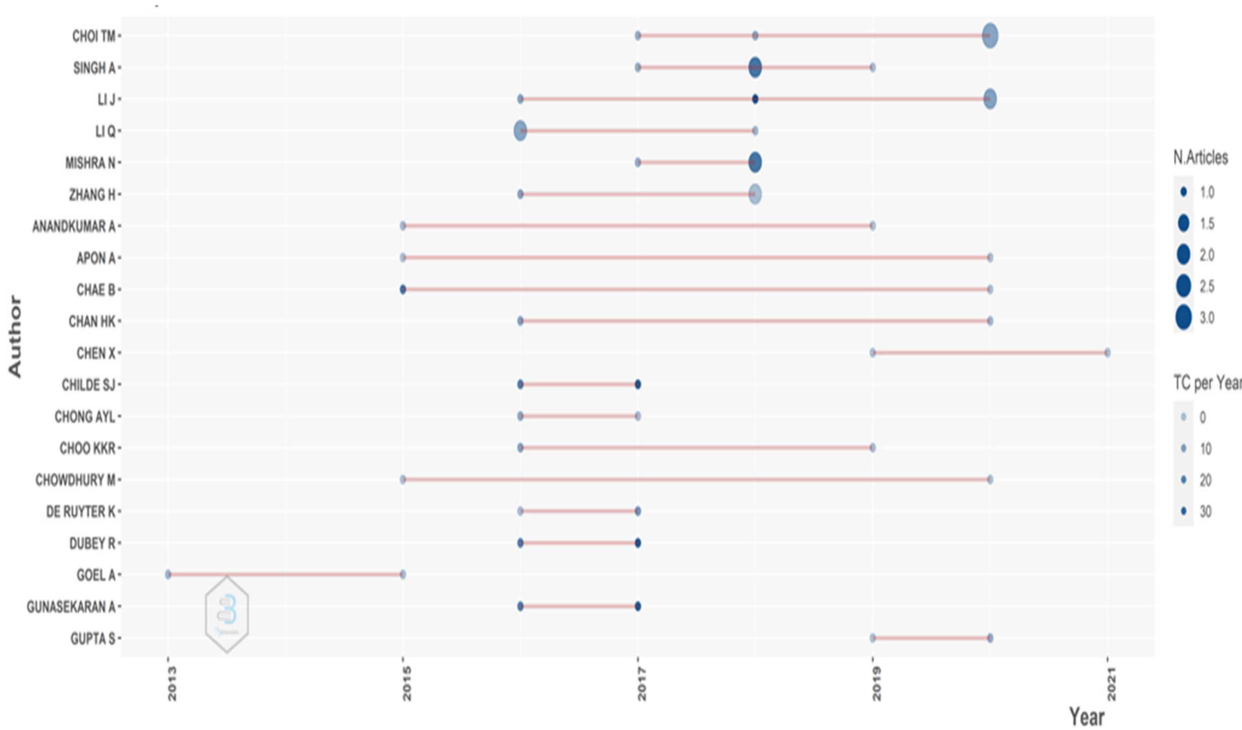

FIGURE 7. TOP-AUTHORS' PRODUCTION OVER THE TIME

4.4. Trending Topics from Authors' Keywords

Trending topics were extracted from keywords. Authors' keywords reveal the topics related to SMA in the OSCM contexts. Figure 8 shows the dynamics of top keywords based on their cumulative counts. Popular keywords used in the articles represent different methodologies, applications, platforms, and issues. Such methodologies include machine learning, text mining, sentiment analysis, classification, and deep learning. SMA appears to be discussed with business applications such as service operations, beef supply chain, Industry 4.0, and disaster management. General social networking sites such as Twitter and Facebook are popular in OSCM. Dedicated social media platforms (e.g., online review sites) are also considered in the literature (Cheng et al. 2020). Privacy appears to be among the issues discussed with SMA-OSCM.

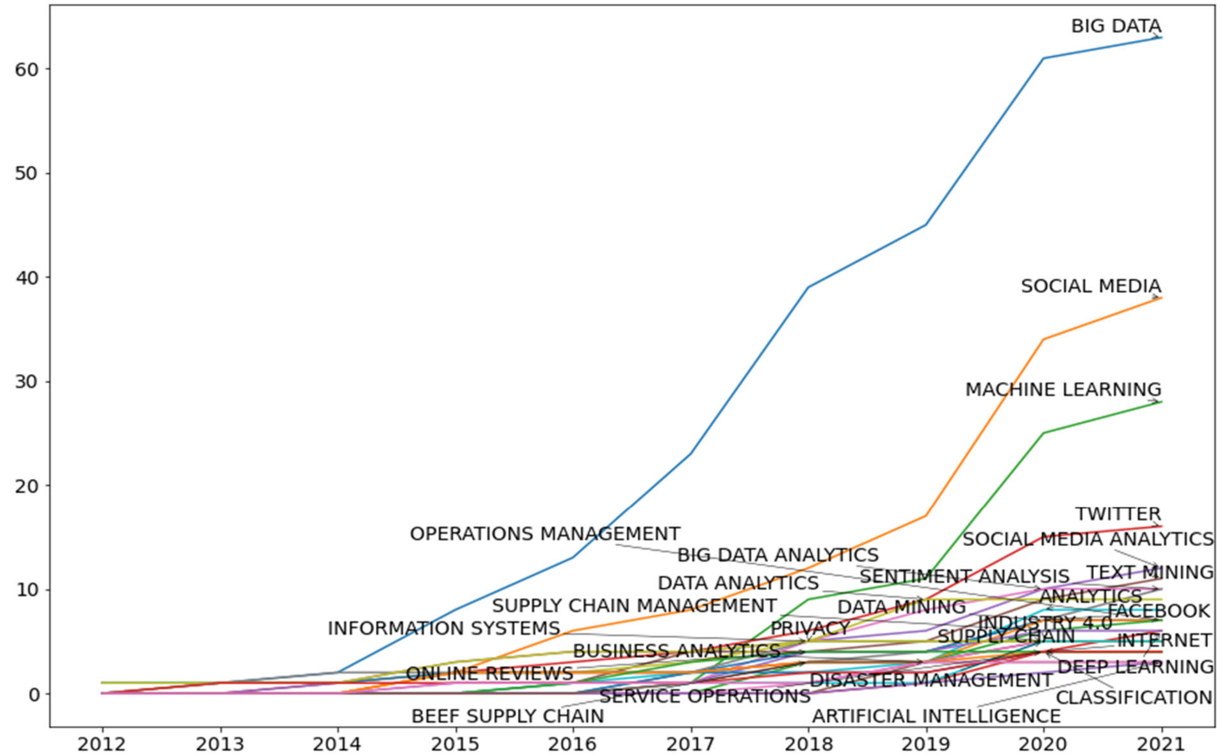

FIGURE 8. KEYWORD DYNAMICS (BASED ON CUMULATIVE COUNTS)

Figure 9 attempts to discover trending topics. Authors' keywords become dynamic as the publication of relevant articles has increased over the years and their popularity has changed. The figure shows in which year each keyword was most popular. For example, machine learning became the second most popular keyword in 2020. Other keywords like deep learning, artificial intelligence, Twitter, text mining, and sentiment analysis are similar in that they became popular in the OSCM literature in the late 2010s.

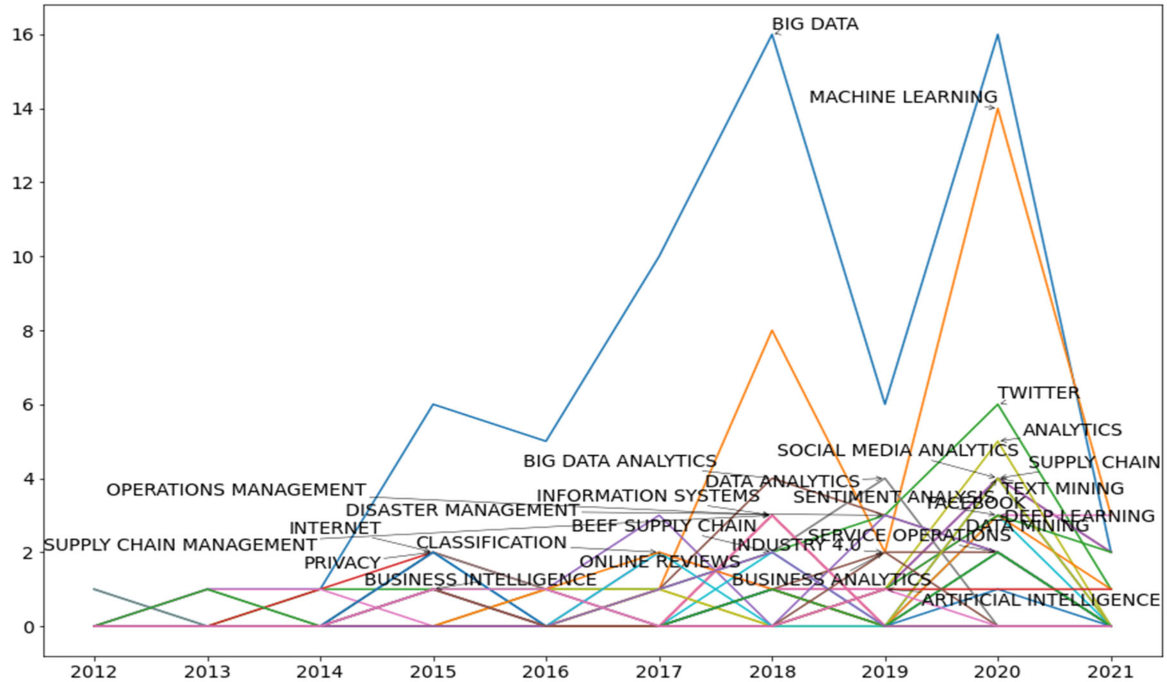

FIGURE 9. COUNTS OF TOP KEYWORDS BY YEAR

Some of those keywords are highly correlated to each other. Figure 10 represents the co-occurrence of the author's keywords and reveals many associations between them. For example, flexible manufacturing is correlated with artificial intelligence and neural networks. Disaster management is connected to deep learning, convolutional network networks, decision support, logistics, emergency services, and text mining, among others. Twitter is shown to be the most popular social media platform discussed in the OSCM literature.

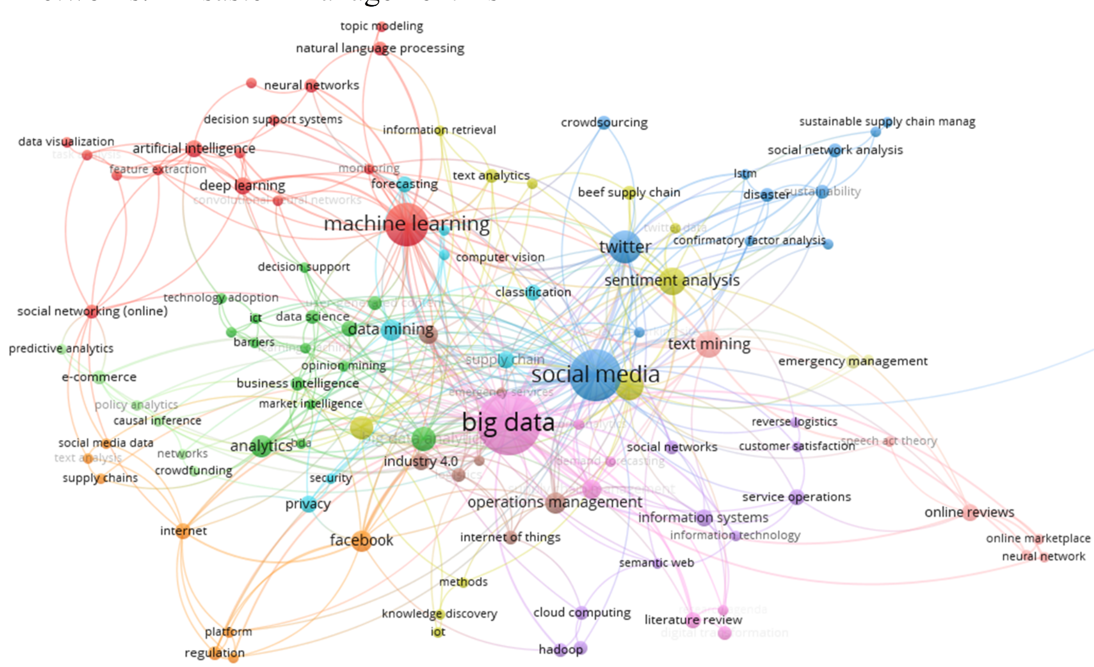

FIGURE 10. CO-OCCURRENCE OF AUTHORS' KEYWORDS

Topics are evolving over time (Griffiths and Steyvers 2004). Research of SMA in OSCM has changed and the popularity of authors' keywords is depicted in Figure 11. The line represents each topic's timeline, and the circle size is proportional to the number of documents containing the authors' keyword. Twitter and Facebook became increasingly popular in research, but online review sites' popularity appears to have declined. Sentiment analysis has been popular and new methodologies like deep learning appear in the literature in the late 2010s. Such keywords as sustainability, predictive analytics, and machine learning have become used more popularly in the articles.

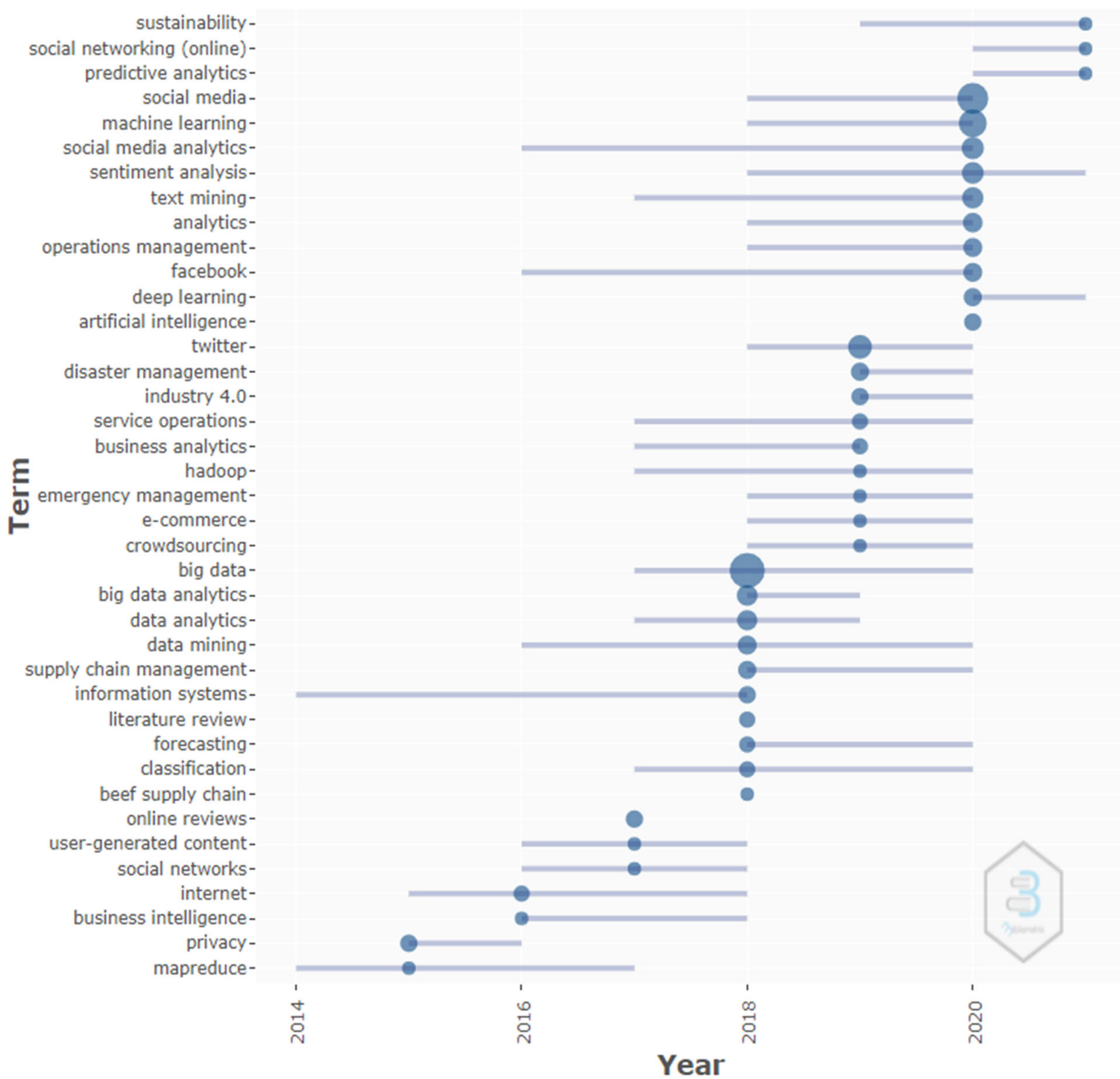

FIGURE 11. KEYWORD DYNAMICS

4.5.Intellectual structures

Discovering intellectual structures in SMA research in the OSCM contexts is based on two types of analysis: historiographic mapping (Garfield 2004) and co-citation networks of cited references (Small 1973). Historiographic mapping visualizes the most cited works year by year and the relationships between them in a chronological manner. Figure 12 visualizes 35 highly cited articles using historiographic mapping.

Three earlier studies (Stieglitz et al. 2014; Abrahams et al. 2015; Chae 2015) in the figure represent different streams of research in SCA-OSCM. Stieglitz et al.'s study presented SMA as "an emerging interdisciplinary research field". Abraham et al.'s and Chae's are similar in that both proposed frameworks for using social media data and relevant analytical methods for OSCM research. The differences lie in the types of SM data and analytical methods. The former focused on dedicated SM platforms (e.g., product review sites) as data sources and analytical methods like text classification. The latter introduced Twitter, a general social networking site, and unsupervised text analytics (e.g., sentiment analysis) and network analysis for OSCM research. There has been a significant increase in the number of highly cited articles, research topics, application areas, and analytical methods since 2016 (e.g., Chen, Zheng, and Ceran 2016; Chong et al. 2016). Such growth is evident in 2018 with two journal special issues—POM and AOR— and these articles cover diverse topics and methodologies, including demand forecasting (Cui et al. 2018), (Choi, Wallace, and Wang 2018).

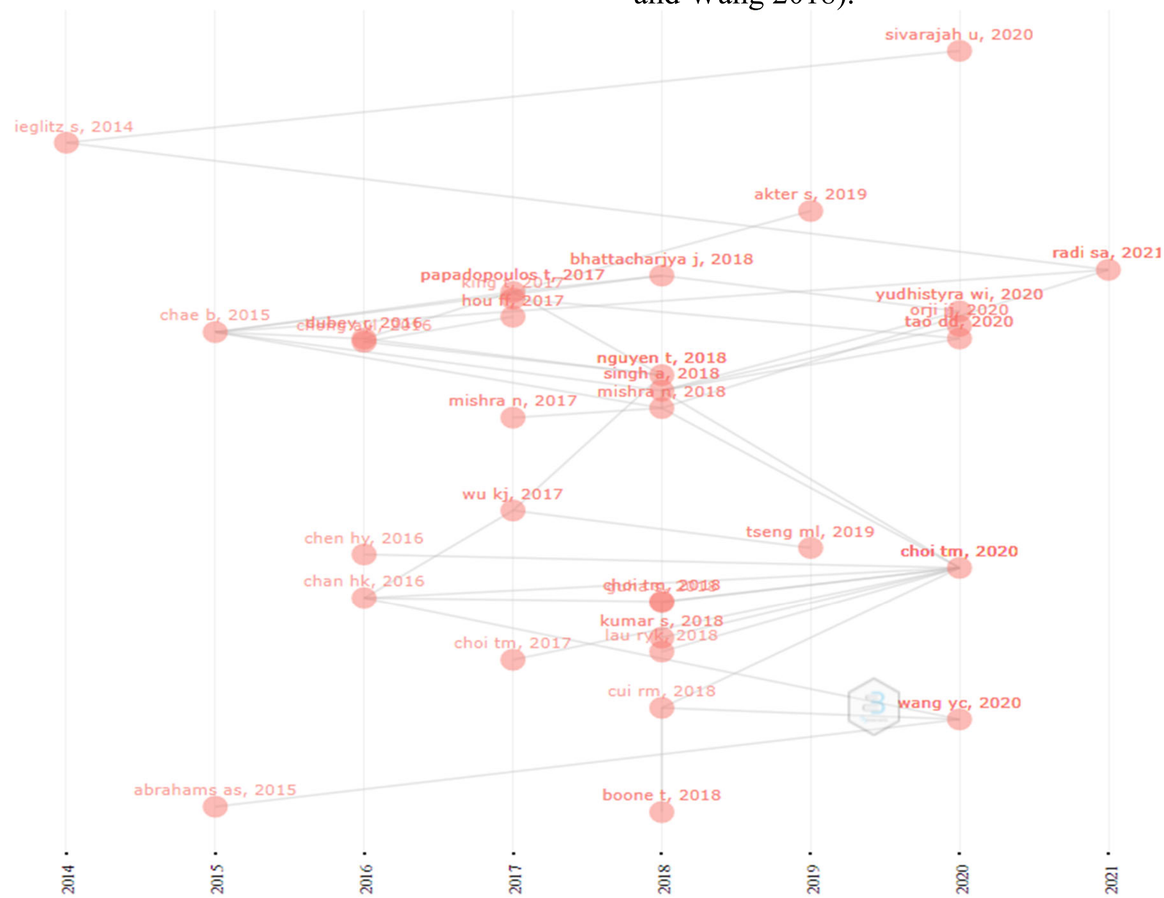

FIGURE 12. HISTORICAL DIRECT CITATION NETWORK

Figure 13 was generated to develop insights about the reference disciplines of SMA research in OSCM. Thus, the figure contains some earlier studies such as Blei et al. (2003) and Pang and Lee (2008), which have been popularly cited by later studies of SMA in OSCM. The co-citation network of cited references is built based on the degree of coupling between two cited references (Small 1973). The nodes in Figure 13 represent 87 highly cited articles (out of 14777 cited references) and the lines show their connections. Colors represent four clusters of cited references based on community detection analysis (Fortunato 2010).

The largest cluster of 31 cited references represents disciplines such as computer science (e.g., Blei, Ng, and Jordan 2003; Pang and Lee 2008), MIS (e.g., Zeng et al. 2010; Lau, Li, and Liao 2014), and marketing science (e.g., Chevalier and Mayzlin 2006; Ghose, Ipeirotis, and Li 2012). For example, Blei et al.'s and Pang and Lee's articles indicate the popularity of such big data analytics methods as topic modeling and sentiment analysis in SMA-OSCM research.

While the first cluster of cited references represents "methodological" studies, the second-largest cluster consists of 26 cited references, several of which are research notes or review articles presenting thought-provoking insights and/or opinions about data-driven or big data research. These studies include Tranfield et al. (2003), Boyd and Crawford (2012), NcAfee et al. (2012), Hazen et al. (2014) and Gandomi and Haider (2015). For example, Hazen et al. discussed data quality for conducting data science and big data analytics in supply chain and offered suggestions for research and applications.

The cited references in the third-largest cluster largely correspond to many of the articles appearing in Figure 13. These references include studies of SM (e.g., Kaplan and Haenlein 2010; O'Leary 2011; Ramanathan, Subramanian, and Parrott 2017) or SMA (e.g., Chae 2015; Cui et al. 2018). The fourth, small cluster consists of seven cited references, most of them focusing on predictive analytics, optimization, and business value of SM data (e.g., Breiman 1996; Huang and Van Mieghem 2014; Abrahams et al. 2015). Breiman's early article on bagging predictors will be influential in future studies of machine learning, particularly, ensemble methods. This fourth cluster is located in the midst of the other three, appropriate for a quantitative cluster that can be applied to discipline-focused, data-driven, or social network clusters in turn.

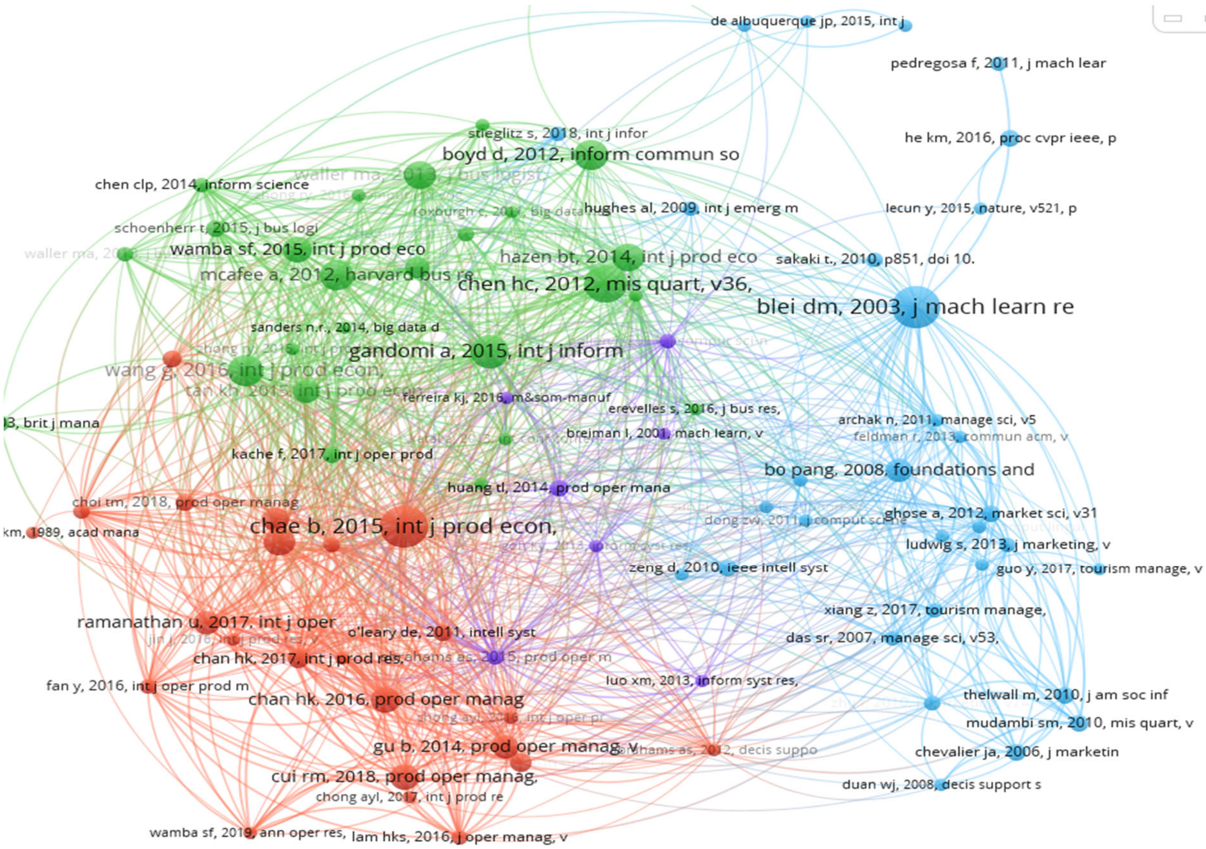

FIGURE 13. CO-CITATION NETWORK OF CITED REFERENCES

V. DISCUSSION AND CONCLUSION

The current study applied a bibliometric analysis to the articles on SMA-OSCM and revealed the trends and growth of the research area, the publication sources and source growth dynamics, highly cited studies and researchers, and popular topics and intellectual structures.

Trend analysis results (Figure 1) showed that research of SMA in OSCM has grown over the past decade. The growth of published articles in 2015 is noticeable. Compared to the year 2014, there was a 500 percent increase in the publication counts. Also, the research area experienced significant growth from 21 articles in 2017 to 75 articles in 2020. These upward trends are not separable from the increasing attention to big data analytics and social media, represented by the appearance of survey articles on the subjects (Batrinca and Treleaven 2015; Ngai, Tao, and Moon 2015; Chan et al. 2017; Lee 2018; Stieglitz et al. 2018; Wamba et al. 2018; Kuo and Kusiak 2019; Huang, Potter, and Eyers 2020). This is also evidence that SMA is part of the latest research cluster, which has become the most dominant since the year 2014 in the data-driven or data-based OSCM publications (Nguyen et al. 2021).

The analysis of publication sources (Figure 2, 3, 4, & 5) showed the dynamics of SMA research in relation to academic journals. Given over 160 journals in the dataset, the SMA article publications were skewed toward a few representative OSCM journals, including POM, IJPR, IJPE, and AOR. The year 2018 was a milestone when several SMA articles were published in two journals: POM and AOR. POM published a special issue (Volume 27, Issue 10) on big data in supply chain management (Sanders and Ganeshan 2018). Six articles from the special issue appear to be addressing topics related to SMA, which belongs under the umbrella of big data. Among them are "The Operational Value of Social Media Information" (Cui et al. 2018) and "Big Data Analytics in Operations Management" (Choi, Wallace, and Wang 2018). Likewise, AOR published a special issue in big data analytics (Wamba et al. 2018).

A co-citation network of relevant journals showed that the research of SMA in OSCM is multidisciplinary and three broad academic disciplines or clusters emerged from the network. One cluster is largely comprised of journals focusing on production planning, logistics, and transportation, including IJPE, IJPR, AOR, EJPR, and J of Clean Production. This indicates that many published articles investigated the role of social media and analytics for a variety of operational and manufacturing practices. Another cluster consists primarily of top-tier journals in their respective business functional areas, such as operations management, MIS, marketing, and general business. This finding indicates that the SMA-OSCM research is closely tied into other business disciplines such as MIS (e.g., MISQ, ISR), marketing (e.g., J of Marketing), and management science (e.g., Kumar, Mookerjee, and Shubham 2018). The third cluster includes journals (e.g., Communications of ACM) in information and computer science and Decision Support Systems is the most cited in this group. This indicates that disciplines like computer science are considered important reference fields for SMA research in OSCM as new computational techniques and methods (e.g., machine learning) are continually emerging.

The findings (Table 2) regarding highly cited articles showed what types of articles were popularly cited. First, the most cited article (Chae 2015), which is about Twitter Analytics for OSCM, indicates that data from Twitter, among many potential SM platforms, is popularly used and discussed in OSCM research (e.g., Papadopoulos et al. 2017; Bhattacharjya et al. 2018; Cui et al. 2018). Second, many highly cited papers were survey papers reviewing the field (Sheng, Amankwah-Amoah, and Wang 2017; Stieglitz et al. 2018). Most of them focused on the role of SMA and/or big data analytics for a specific area of OSCM, including logistics (Winkelhaus and Grosse 2020), disaster management (Akter and Wamba 2019), food industries (Singh, Shukla, and Mishra 2018), and railway transportation systems (Ghofrani et al. 2018). The third trend is the articles addressing sustainability and relevant topics in connection with SMA and big data were popularly cited (Dubey et al. 2016; Papadopoulos et al. 2017; Wu et al. 2017). Fourth among the highly cited articles are those demonstrating the value of social media data for operational practices, including product defect discovery (Abrahams et al. 2015) and demand forecasting (Cui et al. 2018). The last group includes methodological articles introducing innovative methods (Chan et al. 2016) or computational approaches such as sentiment analysis and topic modeling (Rao et al. 2016; Villarroel Ordenes et al. 2017) for extracting the value of social media data.

The results of the most relevant authors showed 51 authors are having published two or more articles. This suggests that SMA is considered a research stream for these active researchers. Many relevant authors published their first paper as early as 2015 and 2016 and additional papers as late as 2020 and 2021. For half of the top authors (Figure 7), the gap between their first and second papers is just a year. For some, the gap appears to be four or five years.

The results of a search of authors' keywords (Figure 8, 9, 10, and 11) showed the dynamic nature of SMA topics in OSCM. First, the topics have become increasingly diverse over the years as more articles have been published. Initially, popular topics were SCM, OM, Internet, MapReduce, business intelligence, internet, classification, user-generated content, and online reviews. Legacy technologies and traditional methodologies (e.g., MapReduce, business intelligence) were popular until 2017. Since 2018, the topics have become increasingly diverse. This diversity is shown both in technologies and applications. Such technologies include sentiment analysis, machine learning, Twitter, Industry 4.0, deep learning, and artificial intelligence. New application areas include sustainability, service operations, emergency management, and e-commerce.

The results of a search of a direct citation network (Figure 12) and the co-citation network of cited references (Figure 13) showed the intellectual structures of SMA-OSCM research. First, those earlier articles were either (1) seeking to advance SMA as an emerging methodological approach or (2) proposing novel SMA frameworks in operational contexts. Stieglitz's article (2014) belongs to the first category as it introduced SMA as "an emerging interdisciplinary research field". Several papers are in the second category, including Twitter Analytics (Chae 2015), a text analytics framework for product defect discovery (Abrahams et al. 2015), a mixed-method approach to social media data (Chan et al. 2016), and a neural network approach (Chong et al. 2016). Second, as the value of social media data is the underlying theme in the intellectual structure, the field has paid far greater attention to two types of data: user-generated content (Abrahams et al. 2015; Chen, Zheng, and Ceran 2016; Chong et al. 2016) and Twitter data (Chae 2015; Bhattacharjya et al. 2018; Mishra and Singh 2018). Third, special issues in 2018 by two journals (POM and AOR) made a significant contribution to the formation of the intellectual structures as shown by the fact that, among 35 articles in the historical direct citation network (Figure 13), eight articles were from the two special issues. Fourth, SMA-OSCM as an emerging field converges from the intersection of three broad research inquiries or reference fields, including computer science, business & management, and OSCM. The first is considered the reference field for big data technologies and computational methodologies, with the second providing perspectives on big data and relevant phenomenon (e.g., digital transformation, Industry 4.0), and the third as the reference field for SMA applications.

There are three areas of recommendation for future studies of SMA in OSCM. First, the field can benefit from increasing diversity in data sources. While the variety of social media platforms and the value of social media data are two key themes in the literature, this study showed that customer review sites and Twitter have been most popular in SMA-OSCM. Variety (e.g., data type, data source) is considered one of the key characteristics of social media and big data. Future studies should explore the value of firm-generated content as well as data from various SM platforms, including Instagram (McCrow-Young 2021), Reddit (Proferes et al. 2021), and Youtube (Thelwall 2018). In addition, multiple data sources can be considered for a single study. Cui et al's study (2018) is in line with this recommendation as the authors explore the use of Facebook data with traditional business data for more accurate demand forecasting.

Second, methodological diversity is another area future studies should consider as there is continuing advancement, such as deep learning, in computational and statistical sciences. This study showed that topic modeling (Blei, Ng, and Jordan 2003) and sentiment analysis (Pang and Lee 2008) have been popular computational methods in the SMA-OSCM literature. There are a myriad of computational methods and algorithms (Antons et al. 2021). For example, there are different approaches, such as probabilistic and network-based, to topic modeling. In probabilistic topic modeling alone, there are numerous algorithms from supervised and unsupervised machine learning. Also, some topics modeling methods and algorithms are specifically designed for business and social science research (Roberts et al. 2014). Broader adoption of deep learning and other emerging computational techniques are expected for future studies.

Lastly, social media platforms are not stand-alone technologies. Rather, they are part of broader societal and business changes being driven by digital technologies. Likewise, SMA is part of the analytic paradigm, also known as big data, which is a major technological phenomenon and interacts with other technological breakthroughs such as Industry 4.0, smart manufacturing, and blockchain. Thus, it is important to study the interfaces between these emerging technologies and develop analytical solutions utilizing both social media data and machine-generated data for OSCM. A recent article (Choi, Guo, and Luo 2020) explores the interface between social media and blockchain and offers insights for future research in this direction.

VI. LIMITATIONS

This study is not without limitations. A bibliometric analysis depends on the data source and the metrics used in the study. Our study relied on a single bibliographic data source. While the Web of Science (WoS) is considered a popular, reliable, and comprehensive data source for bibliometric studies (Yang et al. 2021), it is noted that there are a growing number of alternatives, including Scopus, Google Scholar, Crossref, Microsoft Academic, and Dimensions (Guerrero-Bote et al. 2021), and these data sources have strengths and weaknesses. For example, a recent study reported that Microsoft Academic is more comprehensive than WoS and other data sources (Visser, van Eck, and Waltman 2021).

The goal of a bibliometric analysis is to *quantify* the impact of articles, authors, and journals using a variety of metrics. It is also noted that these quantified metrics have limits, and relying solely on them could lead to pitfalls (Belter 2015). For example, there are different reasons authors cite other papers, thus the number of times an article is cited alone may not fully capture the "impact" of the article (Belter 2015).

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