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**Title Page**

# Quo Vadis OSCM? An Analysis of Past and Future Trends in Operations and Supply Chain Management Research

**Running Title:**
**Quo Vadis OSCM?**

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## Abstract

Over the years, Operations and Supply Chain Management (OSCM) researchers have continued to examine foundational topics, while also expanding and adding new ones. Given that the field has changed a great deal, it seems valuable to examine the evolution of OSCM's intellectual structure over its 70 years of academic communications. Using bibliometrics methods, we analyze 96,125 articles containing 1,047,468 references from 31 representative OSCM journals. Our study defines primary topic areas represented in the most co-cited documents, while tracing past and current research trends. We include analyses of recent

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bursts in research attention and comparisons of trends in academic and practitioner literatures. The results from an inclusive analysis suggest that OSCM researchers have been responsive to methodological advances and to some of the dynamics in the operating environments of businesses. However, a product/manufacturing focus seems to persist, and inconsistencies between researchers' and practitioners' interests suggest that relevance of OSCM could be further improved. Current hot topics are quite different from those of the past. Trend data suggest that studies of supply chain management and data analytics issues will continue to figure largely in shaping the future research agenda. Our analysis quantifies trends and identifies sub-topics that are growing in prominence. In addition, the findings provide a benchmark for evaluating the progress of the OSCM field, while highlighting opportunities for shaping its development and directions.

**Keywords:** OSCM, Literature Review, Trends Analysis, Burst Analysis

## Introduction

The field of *Operations and Supply Chain Management* (OSCM) has its origins in the industrial revolution, followed by the "scientific methods" of the early twentieth century (Taylor, 1911). It emerged as an academic discipline after World War II, as scholarly publications began to grow in the early 1950s. As recommended by researchers of scientific progress (e.g. Kuhn, 1962; Small, 1980), fields of management regularly evaluate their intellectual structures (Kulkarni, Apte, & Evangelopoulos, 2014). Accordingly, after almost 70 years of scholarly communication in OSCM, it seems valuable to quantitatively examine topical trends in the past and present, to identify prominent knowledge domains and contributions, and to project a likely future research agenda.

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Our definition of OSCM reflects the evolution of the field from a focus on *production* management (Buffa, 1966) to *operations* management (including more attention to services) (Chase & Aquilano, 1977) to *operations and supply chain* management (Jacobs & Chase, 2020; Swink, Melnyk, & Hartley, 2020). The organizational scope of OSCM has grown, yet the core definition of OSCM has remained remarkably consistent over time and across authors: OSCM is the management of *processes* by which goods and services are designed, procured, produced, and delivered. These processes include transformational activities (e.g. production and service), as well as the management of organizational relationships and flows of materials, information, money, and people (Buffa, 1966; Chase & Aquilano, 1977; Jacobs & Chase, 2020; Swink et al., 2020).

Foregoing researchers offer both qualitative and quantitative retrospective analyses of domains within OSCM (e.g. Meredith, 1979; Buffa, 1980; Chase, 1980; Meredith & Amoako-Gyampah, 1990; Scudder & Hill, 1998; Pilkington & Liston-Heyes, 1999; Pilkington & Fitzgerald, 2006; Pilkington & Meredith, 2009; Giannakis, 2012; Kulkarni et al., 2014; Meredith & Pilkington, 2018; Pilkington & Meredith, 2018; Wang & Sun, 2019). Our study analyzes the field in ways that differ importantly from these prior research efforts. Where prior research often focuses on the roles of specific journals and/or authors, our study focuses on trends in the underlying knowledge structures contributing to the formation, development, and progression of OSCM research. We identify articles and books that are the leading contributions to the development and advancement of the OSCM field over 70 years of research activity. Moreover, we track the progress of dominant functional topics across various slices of time (over the entire horizon, by decade, and in recent 5-year periods). By classifying and tabulating the primary topics addressed by highly co-cited documents, our

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analysis captures the *conversations* that have dominated the field in each period. In addition, this study further extends prior research in the following ways.

First, we offer a broader, more inclusive view of the field, in terms of both time frame and topical scope. We analyze 96,125 articles containing 1,047,468 references from 31 representative OSCM journals. No prior study has quantitatively traced OCSM research topics from the field's academic genesis in the 1950's to today. Our study thus supplements the mostly narrative extant histories (e.g. Sprague, 2007). Further, this study takes a broader topical approach, identifying important contributions to specific types of OSCM problems and functional processes. While our analysis lists influential books and articles, our primary purpose is to trace and project topical trends rather than to identify prominent authors. Prior quantitative analyses have focused on narrow definitions of OM or SCM, with coverage only of articles in a few selected journals over limited time frames. In contrast, our study examines a wide set of referencing documents sourced in journals reflecting a more comprehensive set of OSCM subdisciplines, including production management, supply management, logistics, and even more narrowly defined OM topics. While some treat these domains as distinct fields (Pilkington & Meredith, 2018), they share common historical roots, with many scholars working across multiple domains, and with many developments in one subfield being intricately connected and applied to others. For example, it is difficult to clearly identify the intellectual boundaries that separate OM from SCM (Pilkington & Liston-Heyes, 1999). Hence, by including sub-disciplines rather than somewhat arbitrarily excluding them, our analysis provides a more holistic treatment of the complete field. We believe such a comprehensive approach is valuable for OSCM scholars who wish to gain a more grounded understanding of the field, a clearer vision of how their chosen research topics fit into the larger scheme, and a quantitatively-based sense of the prevalence of particular research

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domains. This broader perspective may also serve to mitigate myopic views that tend to prevail in some university departments, academic societies, and geographic regions.

The second contribution of this research study is to develop a new way to trace dominant topics in OSCM over time. Like foregoing bibliometric studies, we employ co-citation analysis (Small, 1980; Pilkington & Fitzgerald, 2006; Pilkington & Meredith, 2009; Giannakis, 2012; Fahimnia, Pournader, Siemsen, Bendoly, & Wang, 2019), as it is considered a less noisy metric than simple citation counts for gauging impacts of research contributions. Co-citation counts measure the number of times that two documents are both cited in another document. Many co-citations suggest shared commonalities and stronger influences on a given research topic (Small, 1973; Benckendorff & Zehrer, 2013; Leung, Sun, & Bai, 2017). For example, when two articles that address a particular type of inventory problem are frequently co-cited, this measure provides a stronger and more precise indication of the attention scholars are paying to this particular problem than simple citations metrics would provide. However, even co-citation metrics are subject to potential biases due to differences in citation norms across sub-disciplines in a field as diverse as OSCM. We offer an examination of co-citation "*shares*" and trends as a way of normalizing data for more balanced interpretations of changes in the structure of the field over time. Our study also employs bibliometric approaches including burst detection and interest index analyses that have not been previously applied to OSCM. Further, our analyses make clear separations between purely methodological contributions and problem-oriented or functionally-oriented ones, while also creating a topical framework that follow-on researchers can use to gauge future progress.

Finally, we develop insights derived from various granular, topical, and time-phased cuts of the co-citation data to identify research opportunities and directions for the field going

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forward. Over the past seven decades, researchers have identified numerous knowledge domains within OSCM; contributions include venerable theories, principles, and practices, as well those that have risen and declined in popularity. Operations research applications have successfully addressed a host of inventory, scheduling, transportation, and other resource allocation problems. Similarly, quality management, productivity management, and lean production approaches are enduring areas of study, some lasting more than three decades. Recent years witness the emergence of new research challenges and opportunities. For example, sustainability concerns, risk and resilience capabilities, and the continued advance of decision-support, processing, and communications technologies appear to be prominent in current research agenda (note, for example, recent special issues on these topics at leading OSCM journals). This article critically examines the evolution of the OSCM discipline and offers insights into research directions and opportunities going forward.

The remainder of this article is structured as follows. The next section provides a brief overview of prior bibliometrics research on OSCM. Then, we describe research methods, data collection procedure, and the software tool used for analysis. A discussion of the results follows, including a visualization of the discipline and its dominant conversations over time. The article concludes with a discussion of important findings, their implications, research opportunities, and study limitations.

## Literature Review

Many foregoing OSCM literature reviews depend primarily on qualitative and narrative analyses (Meredith, 1979; Buffa, 1980; Chase, 1980; Miller, Graham, Freeland, Hottenstein, Maister, Meredith, & Schmenner, 1981; Mabert, 1982; Voss, 1984; Hill, Scudder, & Haugen, 1988; Amoako-Gyampah & Meredith, 1989; Meredith & Amoako-Gyampah, 1990; Neely, 1993; Scudder & Hill, 1998; Pannirselvam, Ferguson, Ash, & Siferd, 1999; Gupta, Verma, &

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Victorino, 2006). Some focus on a single journal or publication type (e.g. Gupta et al., 2006), context (e.g. manufacturing, services, practice) (e.g. Mabert, 1982; Neely, 1993), or research method (Scudder & Hill, 1998). Such qualitative reviews enrich understanding, yet they are susceptible to perceptual biases and are limited by a researcher's capacity to manually analyze a field of study. In contrast, quantitative studies tend to provide more reliable and more comprehensive findings (Ramos- Rodríguez & Ruíz- Navarro, 2004; Shafique, 2013; Yalcinkaya & Singh, 2015). Moreover, a quantitative approach helps to synthesize scattered communications in scholarly communities, which then can be used to establish practical paths for future research.

Our literature search identified eight published quantitative literature review studies in which a discipline or sub-discipline of OSCM is the primary focus (Pilkington & Liston-Heyes, 1999; Pilkington & Fitzgerald, 2006; Pilkington & Meredith, 2009; Giannakis, 2012; Kulkarni et al., 2014; Meredith & Pilkington, 2018; Pilkington & Meredith, 2018; Wang & Sun, 2019). With one exception (Pilkington & Fitzgerald, 2006), the studies describe the discipline of operations management cross-sectionally, with little discussion of emerging trends. Four of the studies focus on the roles and interconnections of journals in OM and other fields (Giannakis, 2012; Meredith & Pilkington, 2018; Pilkington & Meredith, 2018; Wang & Sun, 2019). Giannakis (2012) provides a network analysis of citations across supply chain management journals. Meredith and Pilkington (2018) analyze citations in three OM journals (IJOPM, JOM, POM) to construct a research network between OM journals and journals in other fields, thereby highlighting interdisciplinary influences and knowledge exchanges. Using citations from the same three journals, Pilkington and Meredith (2018) examine the most cited journals to examine the influences of journals over the past three decades in the knowledge diffusion network. Wang and Sun (2019) provide a comparison of

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citations and author affiliations for the *International Journal of Production Research* against other leading journals. While these studies contribute to our understanding of the roles of some journals in the OM discipline, they pay less attention to the evolution of knowledge domains in OSCM, more broadly defined.

Four prior studies more directly address OM knowledge and intellectual structure (Pilkington & Liston-Heyes, 1999; Pilkington & Fitzgerald, 2006; Pilkington & Meredith, 2009; Kulkarni et al., 2014). However, these studies focus on citations listed in only one, or at most five OM journals, and over limited periods. Kulkarni et al. (2014) apply latent semantic analysis to operations management research using abstracts of 3,207 articles (DSJ, JOM, MS, MSOM and POM) to identify main research topics of operations management between 1980 and 2012. Pilkington and Liston-Heyes (1999) examine citations in IJOPM from 1994-1997 to identify five knowledge domains including: manufacturing strategy proposers, manufacturing strategy developers, Japanese manufacturing, performance measures, and best practices. A sequel work (Pilkington and Fitzgerald, 2006) extends the IJOPM analysis to 2003, adding process management and case study methods as central themes. The study identifies supply chain management, lean management, theory building from quantitative data, and sustainability as emerging subjects. Pilkington and Meredith (2009) examine co-citations from three journals (IJOPM, POM, JOM) over a 27 year period (1980-2006) with the aim of identifying structural knowledge groups. Their factor analysis identifies 12 knowledge groups that include both methodological and functional topics. Pilkington and Meredith (2009) provide a useful first-look at OM intellectual structure as represented in the three selected journals. However, it offers a somewhat narrow view of OM, arguing that it began as a discipline only in 1980 with the launch of the JOM. Other OM journals (e.g. MSOM, IJPR) are neglected, as are journals that address broader operational

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contexts (e.g. supply chains). Given this narrow focus and the fact that their study is now 10 years old, we suggest that a broader and more up to date study is needed. Indeed, Pilkington and Meredith (2009) state their hope that this type of study will be repeated each decade.

Finally, researchers have applied bibliometrics and quantitative method to examine individual sub-disciplines within OSCM (e.g. behavioral operations and supply chain management, supply chain risk, supply chain finance, efficiency measurement) (e.g. Fahimnia, Tang, Davarzani, & Sarkis, 2015; Lampe & Hilgers, 2015; Xu, Chen, Jia, Brown, Gong, & Xu, 2018; Fahimnia et al., 2019). Other researchers have quantitatively analyzed the co-authorship and movement network of OSCM (e.g. Behara, Babbar, & Smart, 2014; Babbar, Behara, Koufteros, & Huo, 2017; Babbar, Behara, Koufteros, & Wong, 2018; Babbar, Koufteros, Behara, & Wong, 2019; Babbar, Koufteros, Bendoly, Behara, Metters, & Boyer, 2020), while some scholars have analyzed a specific journal (e.g. Laengle, Merigó, Miranda, Słowiński, Bomze, Borgonovo, Dyson, Oliveira, & Teunter, 2017; Wang, Lim, Zhao, Tseng, Chien, & Lev, 2020). For brevity we omit a review of these works.

Our research focuses on the developments of broader OSCM knowledge domains. OM has evolved to become OSCM in consonance with changes in globalization, economics, and technologies over the last century. Accordingly, we consider a wider set of publication outlets and epochs, and we apply more advanced analytical methods to uncover supplemental insights into OSCM knowledge structure and trends.

## Research Method

### 1.1 Bibliometrics Analysis of OSCM Research

Bibliometrics analysis is "the quantitative study of physical published units, or of bibliographic units, or of the surrogates for either" (Broadus, 1987). This method is considered a reliable meta-analytical and scientometric approach that significantly

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contributes to the understanding and appreciation of a specific field of study (Pritchard, 1969). It is applied to systematically evaluate the genesis of a domain of knowledge, to visualize its movement patterns (Guilera, Barrios, & Gómez-Benito, 2013), and to provide researchers with measures of activity, impact, and linkage (Narin, Olivastro, & Stevens, 1994; Vinkler, 2010). Bibliometrics analysis can be used to identify major topics and their fundamental structure, progression, and evolution (Vogel & Güttel, 2013).

Our research objective is to inclusively evaluate OSCM, mapping its underlying intellectual structure, knowledge development and transition, and identifying steps for further advancement. Thus, an analysis of a wide array of research publications within the OSCM discipline is required. We apply a series of co-citation analyses to provide insights into how knowledge has developed and evolved within our field of study (Small, 1973; 1978). This approach is based on the premise that, when two documents are both cited in another document(s), the documents in the pair are likely to be linked by shared commonalities (Small, 1973; Benckendorff & Zehrer, 2013; Leung et al., 2017). Accordingly, a document is considered to exert strong influence if it is co-cited more often in subsequent documents (Liu, Yin, Liu, & Dunford, 2015). If a large number of referencing documents cite a given pair of documents, it suggests a similarity or affiliation in the content of the two documents, as well as the importance of their contribution to the topic or topics addressed by the co-citing references. By identifying documents that are commonly cited together, co-citation provides a stronger indication of the structure of influence on a field than simple citation metrics provide (Small, 1980; Pilkington & Meredith, 2009; Boyack & Klavans, 2010). While citation and co-citation counts for articles are often correlated, co-citation provides a less noisy measure of the discipline-specific influence of a given document, as it controls for extraneous citations not relevant to important topics. For example, a highly cited document

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might have been cited for reasons not related to paradigm development (citations of a popular general treatise on theory, or a general textbook, for example). Co-citation measures identify linkage frequencies, thereby indicating levels of influence as well as larger network structures that describe knowledge content. Bibliometrics experts (Boyack & Klavans, 2010; Small, Boyack, & Klavans, 2014), as well as OSCM researchers (Pilkington & Fitzgerald, 2006; Pilkington & Meredith, 2009; Giannakis, 2012; Fahimnia et al., 2019) identify co-citation as a preferred bibliographic method.

By classifying and tabulating the primary topics addressed by highly co-cited documents across time, our analysis captures the *conversations* that have dominated the field in each period, where a conversation is represented by the fraction of total co-citations given to a particular topic. In addition, to uncover potentially influential topics in the future, we employ an algorithm known as "*burst detection*" that identifies references with a sudden increase in their citations. A citation burst for a reference reflects increased attention from the scholarly community for a given period. References experiencing current ongoing bursts provide signals of emerging trends in the research community. To supplement this future-oriented view, we conclude our research with the results of an "*interest index*" analysis that compares topical trends across scholarly and practitioner journals (Baskerville & Myers, 2009). In addition to suggesting future trends, this analysis provides an indication of the leading or lagging roles of scholarly research in forwarding certain topical agendas.

## 1.2 Search Tactics and Data Collection

Figure 1 illustrates our data collection process. As our research aims were breadth and inclusiveness, we applied a comprehensive data searching strategy. We first downloaded the entire Operations Research and Management Science journal list (N=82) and selected journals from the Management journal list (N=51) provided by the Web of Science (WoS), a

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highly regarded source of data describing scientific activity and impact. Unlike Google Scholar, where citing sources might include not only journals but also other popular press items, proceedings, textbooks, editorials, and non-peer reviewed articles, the WoS allows a more controlled data collection procedure that limits data extraction and analysis to peer-reviewed materials.

We sent the combined WoS journal list to 10 OSCM academics,[1] asking them to rate each journal in terms of importance to the field of OSCM. We retained in our list any journal rated as important or very important[2] by any single expert. Simultaneously, we identified journals listed in 15 published OSCM literature reviews (Goh, Holsapple, Johnson, & Tanner, 1997; Soteriou, Hadjinicola, & Patsia, 1999; Barman, Hanna, & LaForge, 2001; Rungtusanatham, Choi, Hollingworth, Wu, & Forza, 2003; Zsidisin, Smith, McNally, & Kull, 2007; Charvet, Cooper, & Gardner, 2008; Craighead & Meredith, 2008; Giunipero, Hooker, Joseph-Matthews, Yoon, & Brudvig, 2008; Linderman & Chandrasekaran, 2010; Barratt, Choi, & Li, 2011; Carter & Easton, 2011; Tang & Musa, 2011; Ashby, Leat, & Hudson-Smith, 2012; Johnsen, Miemczyk, & Howard, 2017; Merigó & Yang, 2017). We combined these journals with the expert rated list, yielding a candidate list of 22 journals that were identified as important, either by the expert panel or by previously published reviews.

[1] Average years of experience for these academics was above 10, ranging from senior lecturer to full professor positions. The list included editorial board members for JOM, JSCM, POM, DSJ, EJOR, and TR-Part E. All but one key informant had published more than 10 articles in leading OSCM journals at the time of the inquiry.
[2] A five-point scale (1= not important to 5 = very important) was used to rate each journal.

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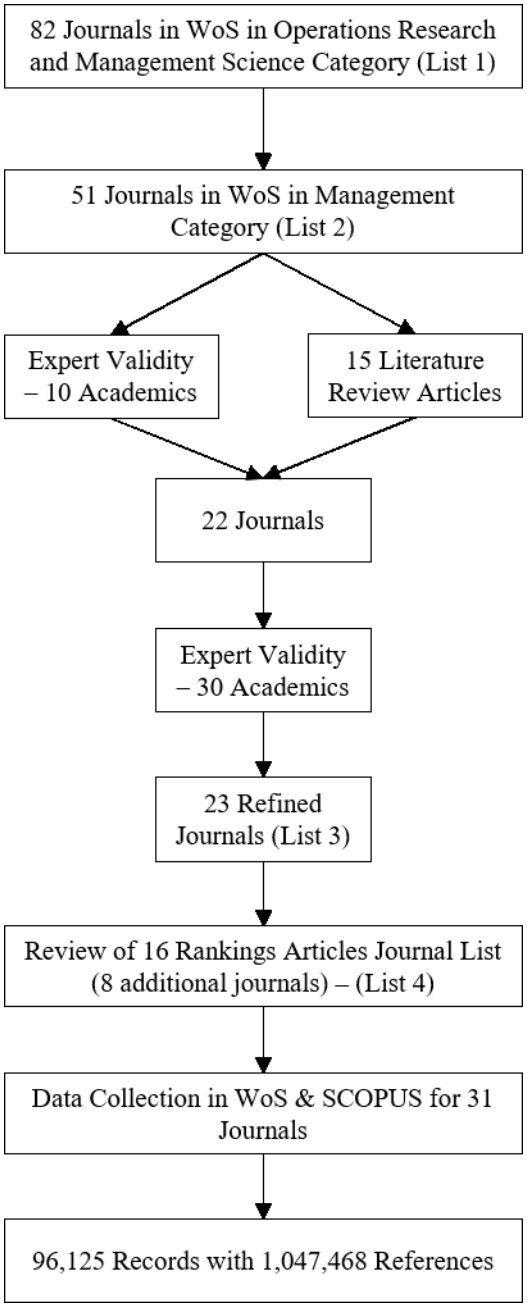


**Figure 1: Data collection procedure**

We then sent the candidate journal list to 65 highly published scholars, associate editors, and editors-in-chief of OSCM related journals[3], requesting their judgments on the importance

[3] The list included EICs for JOM, TR-Part E, IJPR, IJLM, EJOR, IJPDLM, POM, Interfaces, JBL, IJOPM, DSJ, and Omega, plus department, senior, and associate editors for DSJ, POMS, JSCM, JBL, JOM, IISE

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of the journals, as well as suggestions for additional journal inclusion, given the stated objective of our investigation. Thirty scholars responded, some recommending the addition of *Manufacturing and Service Operations Management*. Next, we compared our revised journal list with the lists present in 16 published journal ranking papers; these rankings include a wide variety of perspectives and methods within OSCM (Meredith, Steward, & Lewis, 2011; Petersen, Aase, & Heiser, 2011; and Watson & Montabon, 2014 provide meta-analyses of these studies). An examination of the top 20 ranked OSCM-focused journals in each of the 16 published analyses confirmed the journals included in our initial list, while leading us to add eight more journals.

Table 1 provides the final list of 31 journals. The list includes a substantial mix of methodologically and topically diverse outlets. By our reckoning, almost half of the journals primarily publish research that employs analytical and mathematical modeling methods, while the others publish a mix of methods, with a few exceptions such as JOM and JSCM that are purely dedicated to empirical research. The list includes journals focused on specific functional disciplines such as scheduling, transportation, purchasing, and production planning, along with broader multi-functional journals (e.g. POM, MSOM, IJOPM, IJPE, JOM) and multi-disciplinary journals (e.g. MS, DS). As specified in the foregoing rankings articles, all of the most influential OSCM "dedicated" journals are represented, as well as many of the important "reference" journals (as defined in Meredith et al., 2011). Overall, we feel confident that the journal identification process produced a representative and robust sample of the OSCM field. By combining inputs from five different types of sources (WoS, initial convenience sample of experts, 15 literature review articles, broader sample of

Transactions, NRL, and Omega. We also included about 20 highly published scholars who were personal contacts of the authors.

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editorial members, and 16 journal ranking articles), the process corrected for biases inherent in a single source. Moreover, the findings of our study do not appear to be sensitive to the journal sample. We analyzed the data both before and after adding the final eight journals with no appreciable differences in the results. Changes in the constituencies of top-ranked documents were minimal. Changes in the relative co-citation shares for topics were mostly less than 1% and no larger than 5%. Rankings and relative influences of topics were unchanged.

We collected all bibliographical data (full record and cited references) available for these 31 journals from both WoS and SCOPUS (data collection completed early 2020). Utilizing both databases minimizes the impacts of limitations of either database (Meho & Yang, 2007). The oldest journal in our list is the "Journal of the Operational Research Society" (previously Operational Research Quarterly), first published in 1950. Accordingly, we chose the analysis coverage to be from 1950 to 2019.

The co-citation data are from the reference lists of research articles only; we exclude all other documents such as book reviews, editorial materials, letters, errata, corrections, etc. In total, the data include 96,125 records (published documents) and 1,047,468 cited references. Two researchers conducted the data extraction from WoS and SCOPUS independently and simultaneously on two different computers; both extraction processes produced exactly the same data.

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**Table 1: Final journal list**

| | **Journal Name** – in alphabetical order (*step in which journal was added to the list)* | **First Published** |
|---|---|---|
| 1 | Annals of Operations Research (AOR) – *List 4* | 1984 |
| 2 | Computers and Operations Research (C&OR) – *List 4* | 1974 |
| 3 | Decision Sciences (DS) – *List 2* | 1970 |
| 4 | European Journal of Operational Research (EJOR) – *List 1* | 1977 |
| 5 | IISE Transactions (formerly: IIE Transactions, AIIE Transactions) – *List 1* | 2016 (1982, 1969) |
| 6 | Interfaces (INF) – *List 1* | 1970 |
| 7 | International Journal of Logistics Management (IJLM) – *List 2* | 1990 |
| 8 | International Journal of Logistics-Research and Applications (IJL-RA) – *List 2* | 1998 |
| 9 | International Journal of Operations and Production Management (IJOPM) – *List 2* | 1980 |
| 10 | International Journal of Physical Distribution and Logistics Management (formerly: International Journal of Physical Distribution & Materials Management, International Journal of Physical Distribution) (IJPDLM) – *List 2* | 1990 (1978, 1971) |
| 11 | International Journal of Production Economics (formerly: Engineering Costs & Production Economics, Engineering and Process Economics) (IJPE) – *List 1* | 1991 (1980, 1976) |
| 12 | International Journal of Production Research (IJPR) – *List 1* | 1961 |
| 13 | Journal of Business Logistics (formerly: Council of Logistics Management) (JBL) – *List 2* | 2001 (1979) |
| 14 | Journal of Operations Management (JOM) – *List 1* | 1980 |
| 15 | Journal of Purchasing and Supply Management (formerly: European Journal of Purchasing & Supply Management) (JPSM) – *List 2* | 2003 (1994) |
| 16 | Journal of Scheduling (JSCHED) – *List 4* | 1998 |
| 17 | Journal of Supply Chain Management (formerly: International Journal of Purchasing and Materials Management, Journal of Purchasing and Materials Management, Journal of Purchasing) (JSCM) – *List 2* | 1999 (1994, 1974, 1965) |
| 18 | Journal of the Operational Research Society (formerly: Operational Research Quarterly) (JORS) – *List 1* | 1978 (1950) |
| 19 | Management Science (MS) – *List 1* | 1954 |
| 20 | Manufacturing & Service Operations Management (MSOM) – *List 3* | 1999 |
| 21 | Mathematics of Operations Research (MOR) – *List 4* | 1976 |
| 22 | Naval Research Logistics (formerly: Naval Research Logistics Quarterly) (NRL) – *List 4* | 1972 (1954) |
| 23 | Omega-International Journal of Management Science (OMEGA) – *List 1* | 1973 |
| 24 | Operations Research (formerly: Journal of the Operations Research Society of America) (OR) – *List 1* | 1956 (1952) |
| 25 | Operations Research Letters (ORL) – *List 4* | 1981 |
| 26 | Production and Inventory Management (PIM) – *List 4* | 1970 |
| 27 | Production and Operations Management (POM) – *List 1* | 1992 |
| 28 | Production Planning & Control (PPC) – *List 1* | 1990 |
| 29 | Supply Chain Management: An International Journal (SCM-IJ) – *List 2* | 1996 |
| 30 | Transportation Research Part E-Logistics and Transportation Review (formerly: Logistics & Transportation Review) (TR: LTR) – *List 1* | 1997 (1978) |
| 31 | Transportation Science (TS) – *List 4* | 1967 |

Figure 2 illustrates the growth in journals and the total number of OSCM articles published over the past seven decades. The field has shown steady growth, with over 35,000

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articles published in the last decade alone. As shown, nine of the OSCM journals in our list originated in the 1990s, yet the overall collection of important journals has remained constant since 2000. Concerns could be raised regarding the omission of influential references published in non-OSCM outlets (e.g. *Academy of Management Journal, Harvard Business Review*, etc.). It is important to remember that the 31 journals serve as the *sources* for co-citations, while the co-cited documents themselves represent a much broader set of publication outlets. Many of the most highly co-cited documents identified in our analysis are published in journals not included in our list. For example, an article by Fisher (1997) published in *Harvard Business Review* (*What is the right supply chain for your product?*) is a highly co-cited reference. Books and a wide range of general management and other journals also often appear as influential publication outlets in our results.

## 1.3 Knowledge Mapping and Discovery Software

Advancements in computer science and graphical tools have simplified the process of thoroughly analyzing a knowledge domain. In this research, we use a Java-based scientific visualization software package – *CiteSpace* 5.7R1 – to run co-citation analyses. *CiteSpace* combines data mining algorithms, information visualization methods, and bibliometrics tools. It is considered one of the most comprehensive science mapping tools in quantitative literature reviews and meta-analytical examinations (Cobo, López- Herrera, Herrera-Viedma, & Herrera, 2011).

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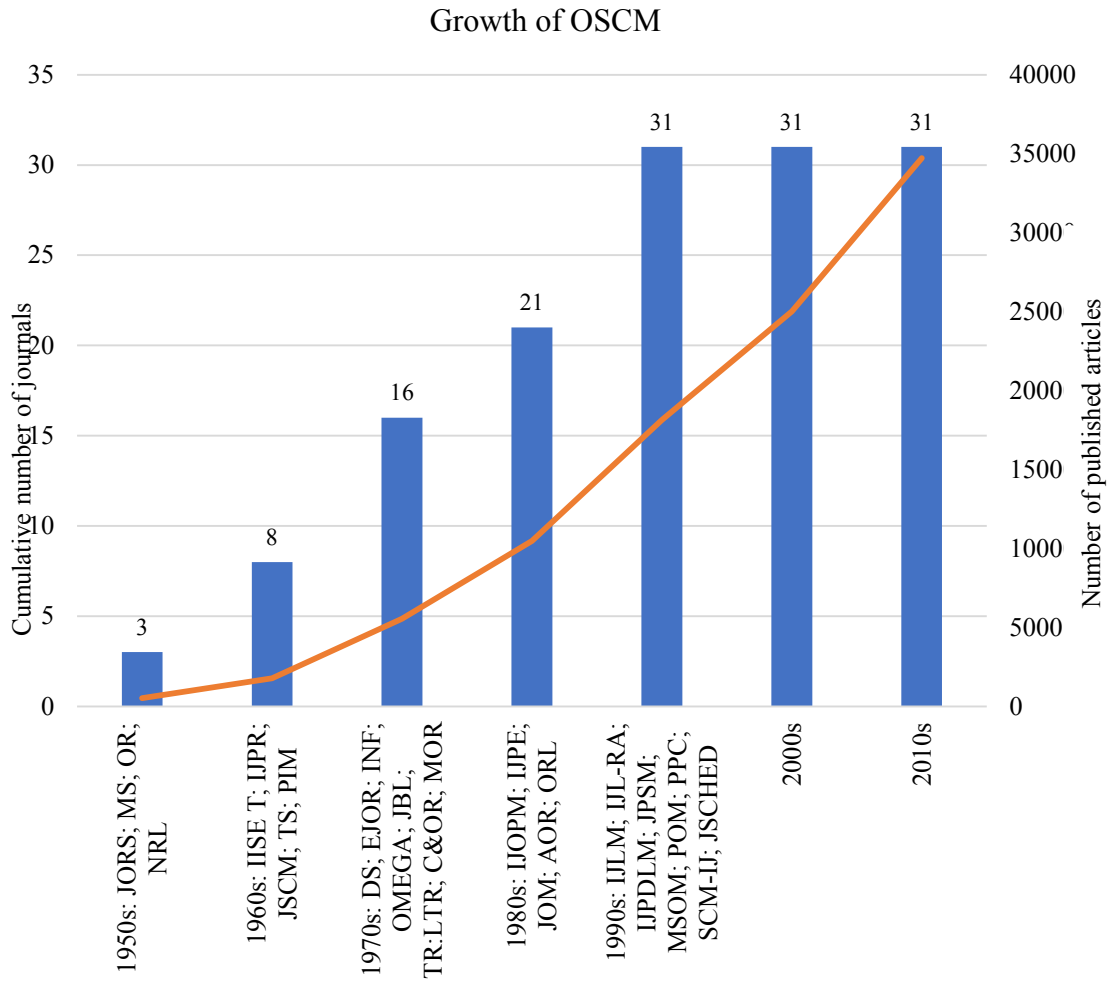


**Figure 2: Journal and publication growth of OSCM**

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# Results

## 1.4 Document Co-Citation Analysis

### 1.4.1 A Topical Map of Co-cited Documents in OSCM

Results for document co-citation analysis can produce the network of co-cited references, thus providing insight into the fundamental structure of a discipline. Documents with a high co-citation frequency point to breakthrough ideas that have shaped the intellectual structure and development of a field of study (Small, 1973; 1980; 2003). The CiteSpace system applies color-coded nodes and edges to distinguish between combined networks that describe

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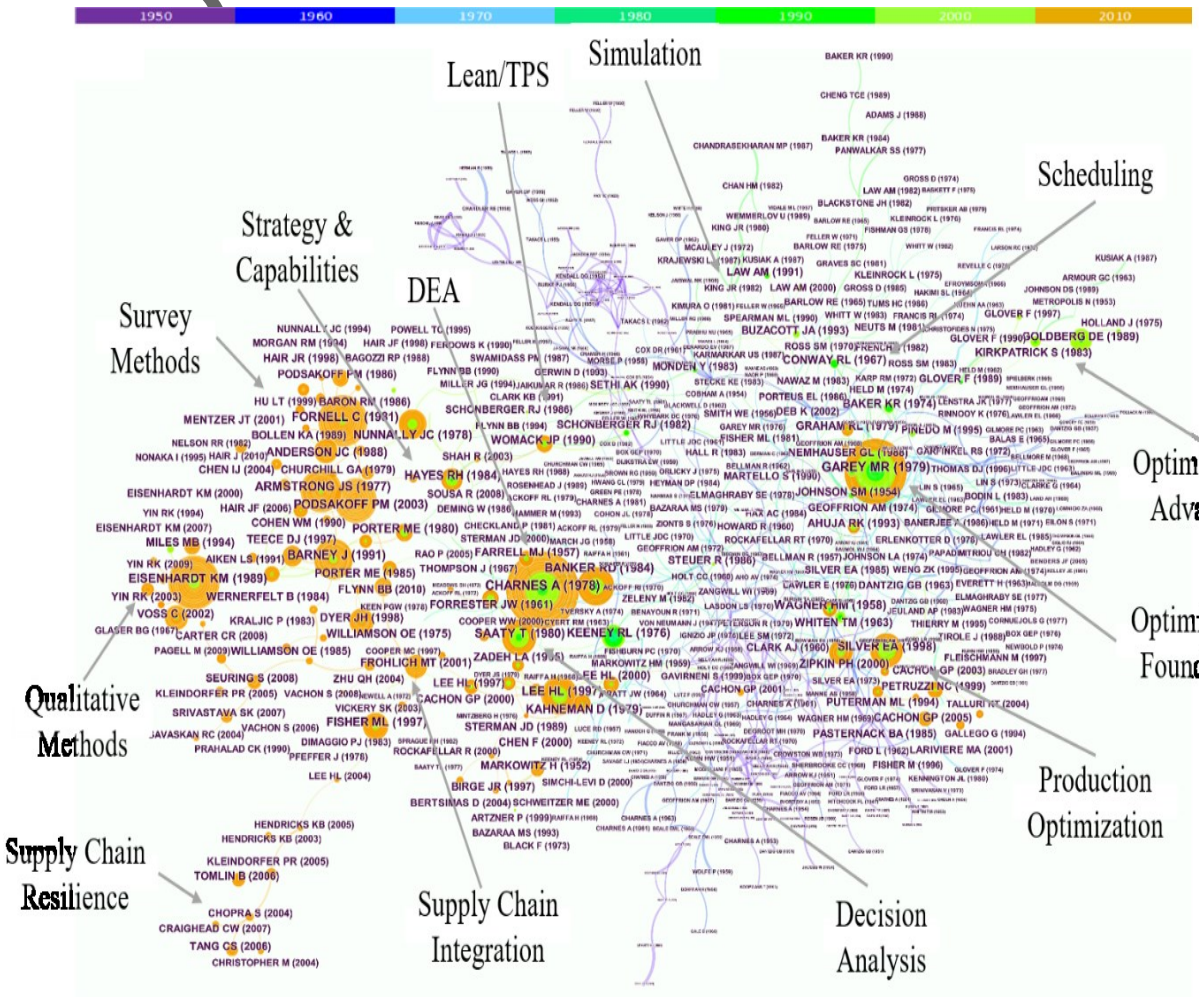
knowledge domains for a field. Figure 3 illustrates these networks for OSCM documents included in our analysis. Upon close visual inspection, one finds numerous references to early contributors in operations research and research methods, yet contributors in empirical research, supply chain research, and even more practice-oriented documents (e.g. Schonberger, 1986; Womack, Jones, & Roos, 1990) are also well represented. As mentioned earlier, the network includes a substantial number of references to documents not published in our list of journals (e.g. Kraljic, 1983; Wernerfelt, 1984; Eisenhardt, 1989), thus lending confidence that important topics are comprehensively included.




**Note: Colors represent the year of co-citation. For example, the gold color highlights co-citations that occurred during the years 2010 to 2019.**

**Figure 3: Document Co-citation in OSCM literature**

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Considering the network map illustrated in Figure 3 as a "landscape" of OSCM, one can easily identify major themes. Near the center of the map is a large grouping of documents representing data envelopment analysis (DEA), system dynamics, analytical hierarchy process, and other mathematical techniques (e.g. Forrester, 1961; Charnes, Cooper, & Rhodes, 1978; Saaty, 1980). Moving eastward on the map one encounters many applications of optimization and other operation research methods. Many references in the southeast quadrant represent resource allocation and assignment problems in OM, whereas in the northeast quadrant more scheduling and inventory management studies appear. References in the western quadrants represent more theoretical and empirical studies. In the northwest, empirical and statistical methods articles are prominent. Documents shown in the far west region include a mix of business strategy and case study methods seminal works. Manufacturing strategy articles and a host of books and articles addressing lean, quality management, and related topics occupy the middle northern region. Supply chain topics are most prominently represented in the references positioned in the southwest quadrant.

### 1.4.2 Classification of Functional OSCM Topics

In following sections, we examine the most co-cited documents in different eras. In order to examine evolving research trends addressing specific OSCM problems, topics, and contexts, the authors created a consolidated list of all highly co-cited documents and categorized each document according to its primary topical focus. We omitted highly co-cited documents that make *general methodological contributions.* These documents are purely methodological in nature; each one's primary contribution is to develop a method for general uses, rather than applying the method to a specific OSCM problem or topic area (examples would include a text on linear programming or statistics, a tutorial on empirical methods, development of an estimation technique, or an article addressing strengths and weaknesses of a particular

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statistical method). While omitting these types of documents, we retained any document that extends or applies a given method to a specific problem or context (e.g. developing an algorithm to solve a facility location problem); we considered such documents to make specific functional contributions.

The scheme for categorization was developed iteratively by first examining document titles and abstracts for the top 100 most co-cited documents. One author initially classified the documents, then refinements were made based on reviews and discussions with the other two authors. Each document was assigned to a single topical category. We then adjusted and validated the reliability of the final categorization scheme through subsequent analysis of the super-set of documents, inclusive of all subsamples of highly co-cited documents collected for each of the eras we study. Two of the authors independently categorized all the documents. Initial agreement between the two authors' inputs was 86%. Differences in categorizations were easily resolved through author team discussion, which led to the articulation of decision guidelines and produced sharper definitions of the categories. For example, studies of sequencing and prioritization of orders, jobs, or tasks were classified as "scheduling" contributions, whereas studies of the scheduling of inventory replenishments or allocations were classified as "inventory". We used a functional orientation to allocate documents to various groups. For example, though vehicle routing and scheduling studies could be assigned to "scheduling", we placed these documents in the broad category of "logistics", as these decisions are typically made by managers in logistics functional areas. Overall, we initially categorized each document based on the type of decision or problem it addresses, rather than the *industrial context* of the research (e.g. services, manufacturing, re-manufacturing, projects, humanitarian settings). We considered contextual refinements and other specific problem refinements in subsequent sub-topic classifications.

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Several of the less frequently co-cited articles were not clearly identifiable to common OSCM topic areas (e.g. an article on sales response to advertising expenditures), suggesting that our collection of documents had reached a saturation point in identifying highly co-cited articles that are directly relevant to OSCM. The authors categorized these few documents after deeper analysis of their contents and their citing documents.

**Table 2: Categorization of functional topic areas**

| |
|---|
| General text: Textbook that covers more than one of the topics below |
| Inventory management: Research of lot sizing, replenishment, and allocation decisions (includes newsvendor, economic order quantity, multi-echelon, etc.) |
| Logistics: Research of locational decisions and patterns (traffic and transportation, facility location, distribution design, networks, warehousing, vehicle routing and scheduling) |
| Organizational issues: Research of design and interaction of organizational units and people within a firm (includes vertical integration decisions, behavioral issues) |
| Pricing: Research of decisions related to pricing goods and services (demand and revenue management, and auctions) |
| Process improvement: Research of paradigms, approaches, and techniques guiding the improvement of internal operational activities (lean, quality management, productivity factors, facility layout, product innovation, organizational learning) |
| Queuing: Research of waiting lines, arrival and service processes, service system design. |
| Scheduling: Research of decisions regarding the prioritization and sequencing of orders, jobs, and tasks across resources (includes scheduling of production, workforce, projects) |
| Strategy: Research of competitive structure and sources of advantage (including capabilities) |
| Supply management: Research of inter-organizational structures and relationships (design, integration, governance, risk, and sustainability) |

The documents are grouped into ten broad classifications: *general texts* (books that cover multiple topics), *inventory management, logistics, organizational issues, pricing, process improvement* (e.g. documents addressing lean, JIT, quality management, and productivity factors), *queuing*, *scheduling, strategy,* and *supply management*. While we recognize that other categorization schemes are possible, we sought to balance the competing needs of granularity (enough discrimination to obtain interesting insights) and parsimony (avoiding conceptual overlap and complexity from too many categories). After making the initial assignment to the top-level categories, we identified sub-topics within each category

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and assigned documents to each sub-topic, respectively. The creation of these sub-topics allows more fine-grained analysis and potentially addresses concerns that some top-level categories (such as "process improvement") are so broad that they obscure important developments in the field. Table 2 provides definitions and examples for each of the topic categories.

### 1.4.3 OSCM Documents Ranked in the Top 100 Most Co-cited

Appendix A lists the documents ranked in the top 100 most co-cited OSCM documents across the entire 70-year time horizon[4]. Table 3 provides descriptive statistics by category. Collectively, the 101 documents have been co-cited 37,739 times. One-third of the top 101 most co-cited documents are books; four of these are general texts (Nahmias, 1989; Hopp & Spearman, 1996; Vollmann, Berry, & Whybark, 1997; Silver, Pyke, & Peterson, 1998), while the remainder are focused on specific topics. For example, the most co-cited item of all is Pinedo's (1995) book on scheduling, with 981 co-citations. Interestingly, the frequency of books in the most co-cited documents has declined over time (only nine of the top 100 most co-cited documents in 2015-2019 are books).

**Table 3: Descriptive statistics of most co-cited documents by category**

| | Number | Co-citations | Co-citations/Doc |
|---|---|---|---|
| Inventory | 9 | 4186 | 465.1 |
| Scheduling | 10 | 4579 | 457.9 |
| General Textbooks | 4 | 1669 | 417.3 |
| Strategy | 16 | 6434 | 402.1 |
| Supply Management | 29 | 10771 | 371.4 |
| Queuing | 2 | 674 | 337.0 |
| Logistics | 11 | 3533 | 321.2 |
| Process Improvement | 9 | 2766 | 307.3 |
| Organizational Issues | 5 | 1422 | 284.4 |
| Pricing | 6 | 1705 | 284.2 |

[4] The list contains 101 documents – two documents are tied for 100th rank. Please contact authors to obtain the full list of references cited in the appendices.

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As shown in Table 3, inventory research documents have received the most co-citations per document on average in our top list of documents, followed by scheduling, general textbooks and strategy. Almost one-third of documents in the list belong to the supply management category, receiving over 370 co-citations on average, followed by queueing, logistics, process improvement, organizational issues, and pricing.

### 1.4.4 OSCM Research Trends

In order to develop a more detailed view of trends in OSCM research, we now dig deeper into frequently co-cited documents, and parse the analysis using various time horizons. While providing a more penetrating probe into prevalent topics in each era, this approach also mitigates some of the challenges of comparing research interests across methodological and functional topics. First, we recognize that citation norms may vary across different types of research. For example, empirical research articles typically contain more references than mathematical modeling research articles. To address this issue, our analysis of specific functional topics trends is methodologically agnostic. Published research studies addressing a given functional topic (e.g. logistics) may apply mathematical models or empirical models, or both. Our comparisons across functional topics are based on all types of co-citations regardless of the method employed by a given co-cited document. Also, we focus on trends over time, rather than comparisons made at a given point in time. Thus, it is unlikely that our findings are biased by differences in citation norms. Second, the total number of co-citations across all topics has grown over the years. To create more valid comparisons, we trace trends in proportions of total co-citations to documents representing each topic in our categorization scheme. Using this proportional approach effectively standardizes the data by time period, while examining changes (trends) in proportions provides a basis for comparing relative emphases across and within topics over time. We note that comparing both numbers of co-

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citations and numbers of highly co-cited articles across topics yield similar results, thus the findings appear to be robust to the metric used.

## 1.5 Research Across the Decades

To analyze trends, we extracted documents ranked in the top 50 most co-cited references in each decade; Appendix B provides the references list. Figure 4 depicts the topic share of total co-citations to the top 50 ranked co-cited documents in each decade. Again, the pattern of co-citations can be viewed as an illustration of the prevalent conversations among OSCM researchers across the decades.

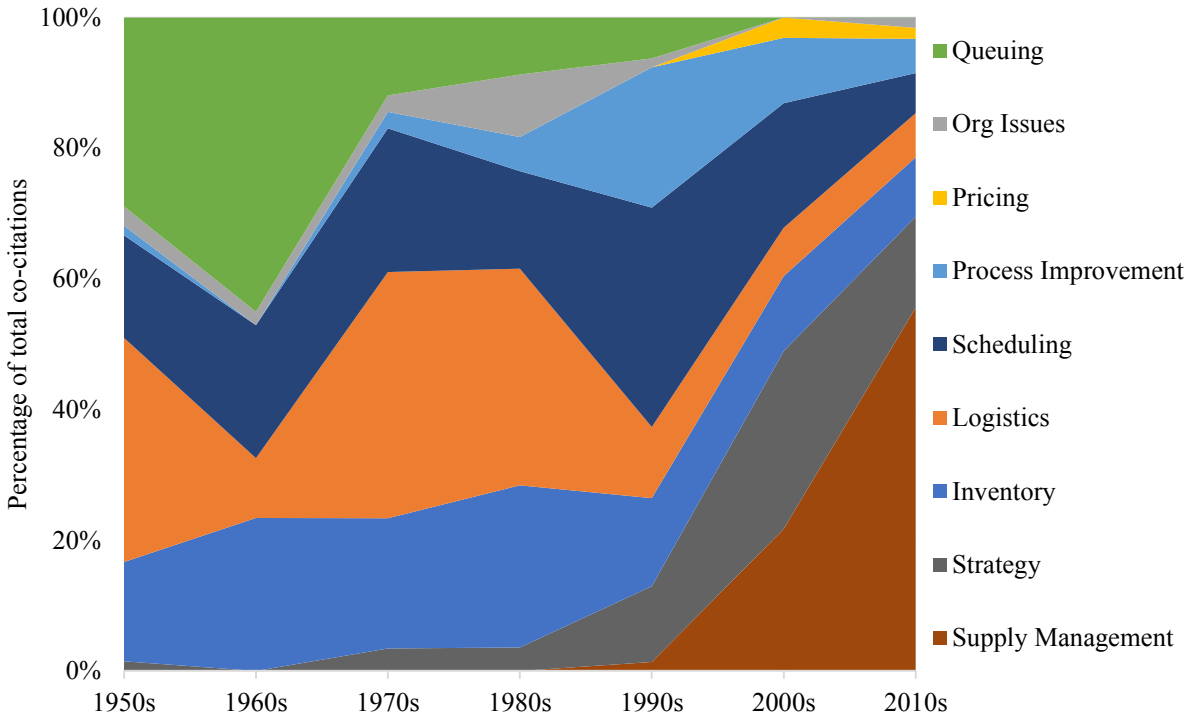


**Figure 4: OSCM topical trends: Co-citation share for the top 50 co-cited documents in each decade, 1950-2019**

Dominant OSCM conversations have substantially changed over the decades. Logistics research owned a substantial share of topical focus in the 1950s and again in the 1970s and 1980s. Queueing research loomed large in the 1960s, and inventory research maintained a somewhat steady share (10-25%) of total co-citations until the 1990s. Process improvement research attracted around 20% of functional research attention in the 1990s, yet this focus has

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dropped sharply in recent years. Research that cites seminal strategy articles, starting in the 1970s has grown to represent a 14% share of co-citations today. Supply management, starting in the 1990s, has grown to dominate the overall conversation in recent decades. In the most recent decade, supply management research accounts 54% of total co-citations to functional topics research.

## 1.6 Enduring Research Contributions

Scanning across the lists of documents in Appendix B reveals 338 unique references that have been highly co-cited (in the top 50) within any of the seven decades. We were interested in identifying "enduring" references, which we define as a document appearing in the top 50 co-cited items in at least three different decades. Table 4 shows each of the 18 documents that satisfied this criterion and lists the percentage of total co-citations each document accrued in each decade in which it was highly co-cited. Collectively, the timings of co-citations to these enduring works provide another snapshot of popular topics across the decades. These works can be considered "seminal"; they have received significant attention from researchers over long periods. Interestingly, even the most seminal works appear to have limited life spans of prominence.

## 1.7 Research Trends in the 21st Century

To uncover finer details of current trends, we next focus on the post 2000 data and analyze co-citations by topic area across the last twenty years. In addition to providing a more recent analysis, this approach provides a look at trends given a stable mix of journals containing co-citing articles (the journal mix has remained constant since 2000). We probe the data by extracting documents ranked in the top 100 most co-cited references in each 5-year sub-period (see Appendix C). Figure 5 displays the trends in percentage share of total co-citations for each functional topic.

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**Table 4: Co-citation share for enduring references (top 50 in three or more decades)**

| Title | Author (first only) | Year | 1950s | 1960s | 1970s | 1980s | 1990s | 2000s | 2010s |
|---|---|---|---|---|---|---|---|---|---|
| Priority assignment in waiting line problems | Cobham A | 1954 | 1.4% | 4.6% | 1.5% | | | | |
| Planning production, inventories, and work force | Holt CC | 1960 | | 3.4% | 3.1% | 1.9% | | | |
| A heuristic program for locating warehouses | Kuehn AA | 1963 | | 1.7% | 2.8% | 1.4% | | | |
| Organizations | March JG | 1958 | | 1.9% | 2.4% | 1.9% | | | |
| Optimal two- and three- stage production schedules with setup times included | Johnson S M | 1954 | | 1.9% | 1.8% | | 2.1% | 1.6% | |
| Dynamic version of the economic lot size model | Wagner HM | 1958 | | 1.9% | 3.2% | 4.7% | 3.1% | 2.4% | 1.6% |
| Facility layout and location: an analytical approach | Francis RL | 1974 | | | 1.7% | 3.4% | 1.8% | | |
| Computer solutions of the traveling salesman problem | Lin S | 1965 | | | 2.0% | 1.9% | 1.4% | | |
| Introduction to sequencing and scheduling | Baker K | 1974 | | | 1.5% | 4.0% | 5.5% | 1.9% | |
| Optimal policies for a multi-echelon inventory problem | Clark AJ | 1960 | | | | 1.3% | 1.3% | 1.6% | |
| Theory of scheduling | Conway R L | 1967 | | | | 4.8% | 4.2% | 1.7% | |
| Complexity of machine scheduling problems | Lenstra J K | 1977 | | | | 1.3% | 1.7% | 1.6% | |
| Competitive strategy: techniques for analyzing industries and competition | Porter M E | 1980 | | | | 2.0% | 2.4% | 2.5% | |
| Scheduling of vehicles from a central depot to a number of delivery points | Clarke G | 1964 | | | | 2.3% | 1.3% | 1.5% | 1.7% |
| Optimization and approximation in deterministic sequencing and scheduling: a survey | Graham R L | 1979 | | | | | 2.0% | 3.0% | 3.3% |
| Competitive advantage: Creating and sustaining superior performance | Porter ME | 1985 | | | | | 2.4% | 2.5% | 1.9% |
| The economic institutions of capitalism: firms, markets, relational contracting | Williamson OE | 1985 | | | | | 1.3% | 2.2% | 2.2% |
| Machine that changed the world | Womack JP | 1990 | | | | | 2.2% | 2.5% | 1.7% |

Each entry is the percentage share of total co-citations generated by the top 50 documents in that decade.

Similar to the prior decade-oriented analysis, the results illustrated in Figure 5 reveal a dramatic change in topical focus.[5] In the 2000-2004 period, research appears to have been fairly evenly spread across a larger set of topics; five of the nine topic categories each received at least 10% of the total co-citation share, with the largest categories being strategy, scheduling, and process improvement. In contrast, the data provide clear evidence of the growing preeminence of co-citations to supply management research; this topic commanded more than 61% of all top document co-citations in the 2015-2019 sub-period. None of the other topic areas have grown substantially, while the co-citation share of process improvement research has declined dramatically, from a 20% share in the early 2000s to only a 3% share in the most recent 5-year period. The share of co-citations received by scheduling

[5] We note that similarities between the results of the analyses using 50 documents per decade and 100 documents per 5-year period provide a robustness check. The results do not seem to be sensitive to choices regarding time bucket or depth of highly ranked documents included.

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research has similarly declined, from 21% to 4%. Strategy co-citations share has declined from 22% to 10%.

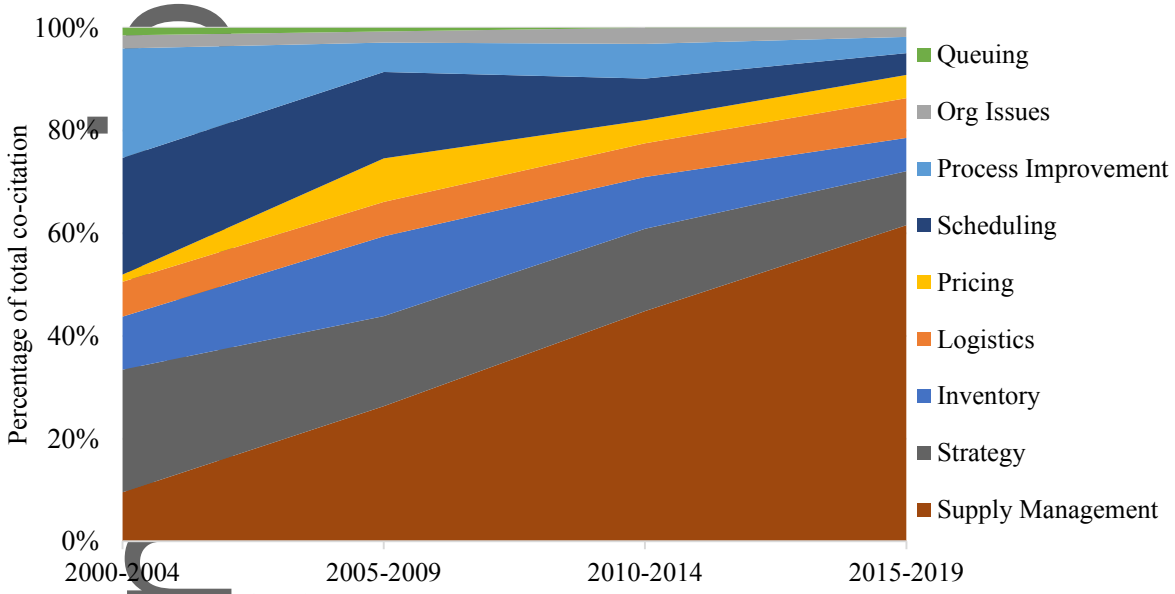


**Figure 5: Recent OSCM Trends: Share for top 100 co-cited documents in each 5-year period, 2000-2019**

Figure 6 illustrates trends in co-citation shares for eight sub-topics within supply management, including supply network design, governance, integration, sustainability, risk management, remanufacturing, and other topics. Whereas integration appears to have gathered much of the scholarly attention in the first decade of the millennium (especially 2005-2009), it has given way to growing interests in sustainability and risk in the most recent period. The co-citation share of research addressing supply relationship governance has also declined, from attracting about 35% of co-citations in the early 2000s to 13% in the most recent period.

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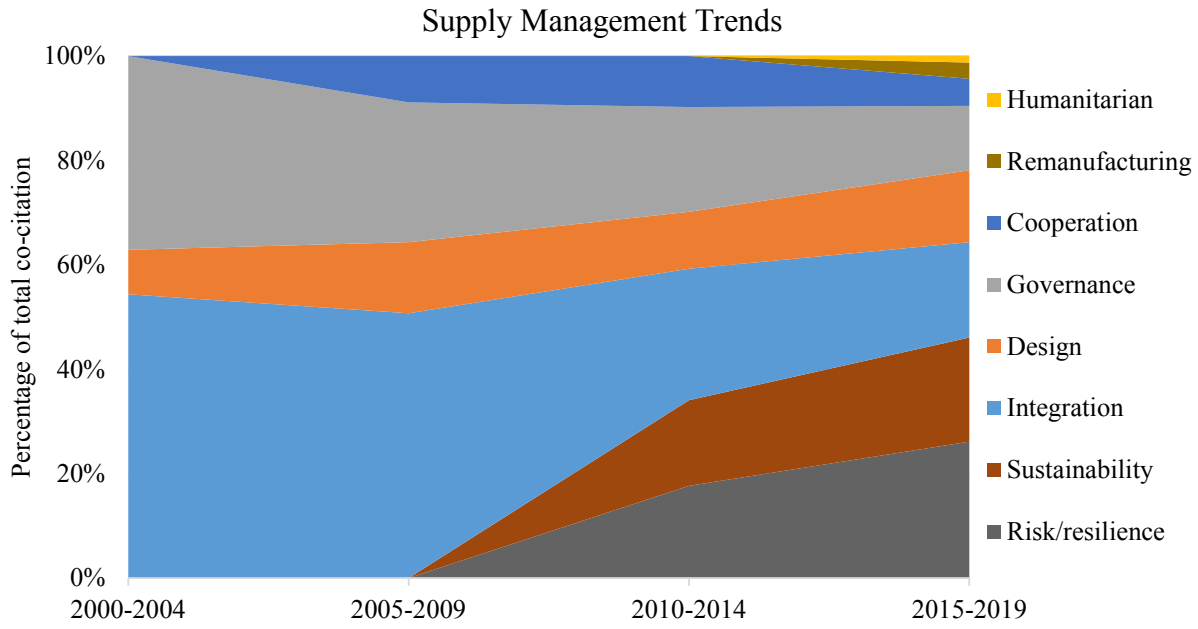


**Figure 6: Recent Trends in Supply Management Sub-topics**

## 1.8 Current OSCM Research: 2015-2019

As a final cut of the data, we develop a snapshot of current OSCM research by extracting documents ranked among the 300 most co-cited references in the last five years (2015-2019 – see Appendix D). These documents were collectively co-cited 26,615 times, with a mean of 85.3 co-cites per document. In the same five-year period, our journal set contains a total of 67,693 co-citations to 23,211 documents (including co-citations to general methods documents). Thus, co-citations to these 311 functionally-oriented sources[6] (1.3% of all co-cited items) account for almost 40% of all co-citations. Such highly concentrated distributions of co-citations are also evident in the other document samples we collected across various time horizons.

Table 5 provides a detailed breakdown of the co-citation frequencies and percentages for categories and sub-topics represented in the top 300 ranked documents. To the extent that this

[6] The list contains 311 documents, as 17 documents tied for the 300th rank.

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sample is representative, it provides a cross-section of current research conversations in OSCM.

**Table 5: Topic Areas of Documents Ranked in the Top 300, 2015-2019**

| Contribution Category | # Documents | # Co-Cites | % Co-Cites |
|---|---|---|---|
| Supply Management | 158 | 14186 | 53% |
| Sustainability | 31 | 2936 | 21% |
| Risk/resilience | 33 | 2895 | 20% |
| Integration | 32 | 2778 | 20% |
| Design | 25 | 2127 | 15% |
| Governance | 20 | 1882 | 13% |
| Cooperation | 2 | 388 | 3% |
| Performance measurement | 4 | 257 | 2% |
| Remanufacturing | 2 | 233 | 2% |
| Review article (literature) | 2 | 186 | 1% |
| Supply chain theory | 3 | 186 | 1% |
| Textbook | 2 | 163 | 1% |
| Humanitarian | 2 | 155 | 1% |
| Logistics | 41 | 3137 | 12% |
| Vehicle routing/scheduling | 18 | 1507 | 48% |
| Humanitarian | 7 | 478 | 15% |
| Location | 6 | 427 | 14% |
| Warehouse management | 3 | 235 | 7% |
| Review article (container terminal ops) | 3 | 188 | 6% |
| Reverse logistics | 2 | 172 | 5% |
| Sustainability | 2 | 130 | 4% |
| Strategy | 27 | 2430 | 9% |
| Competitive Advantage | 9 | 771 | 32% |
| Resource-Based View | 6 | 758 | 31% |
| Remanufacturing | 3 | 224 | 9% |
| Dynamic Capability | 2 | 195 | 8% |
| Flexibility | 3 | 180 | 7% |
| Review article (contingency theory) | 1 | 125 | 5% |
| Sustainability | 2 | 115 | 5% |
| Servitization | 1 | 62 | 3% |
| Inventory | 20 | 1744 | 7% |
| Newsvendor | 8 | 766 | 44% |
| Lot sizing | 3 | 273 | 16% |
| Textbook | 2 | 241 | 14% |
| Perishable inventory | 3 | 197 | 11% |
| Multi-echelon | 2 | 135 | 8% |
| Financing | 1 | 67 | 4% |
| Sustainability | 1 | 65 | 4% |
| Pricing | 20 | 1577 | 6% |
| Dynamic pricing | 10 | 828 | 53% |
| Channel management | 5 | 355 | 23% |
| Other | 2 | 173 | 11% |
| Textbook | 1 | 81 | 5% |
| Remanufacturing | 1 | 80 | 5% |
| Review article | 1 | 60 | 4% |
| Process Improvement | 21 | 1482 | 6% |
| Lean | 5 | 396 | 27% |
| Knowledge/learning | 4 | 319 | 22% |
| Analytics | 3 | 172 | 12% |
| Improvement theory | 2 | 128 | 9% |

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| | | | | | | |
|---|---|---|---|---|---|---|
| Layout/line balancing | | 2 | | 127 | | 9% |
| NPD | | 1 | | 84 | | 6% |
| Capacity | | 1 | | 69 | | 5% |
| Flexibility | | 1 | | 63 | | 4% |
| Equipment replacement | | 1 | | 62 | | 4% |
| Review article (call center ops) | | 1 | | 62 | | 4% |
| Scheduling | 10 | | 1027 | | 4% | |
| Review article | | 4 | | 441 | | 43% |
| Shop scheduling | | 5 | | 362 | | 35% |
| Textbook | | 1 | | 224 | | 22% |
| Organizational Issues | 10 | | 727 | | 3% | |
| Organization structure | | 6 | | 465 | | 64% |
| Behavioral operations | | 4 | | 262 | | 36% |
| General Text | 2 | 2 | 155 | 155 | 1% | |
| Queuing | 2 | 2 | 150 | 150 | 1% | |
| **Total** | **311** | | **26615** | | **100%** | |

Regarding co-citations to specific functional contributions, again supply management constitutes the largest number of co-cited documents and percentage of total co-citations (53%). Within supply management, remanufacturing and humanitarian supply management are relatively nascent in co-citation allotments (2% and 1% of co-citations), while sustainability, risk (including research on resilience), integration, and design (supply network structure) topics appear to be more extensive, each accounting for 15% to 21% of total supply management co-citations. Interestingly, supply relationship governance, a venerable topic going back to Williamson in the 1970s and earlier, received only a modest 13% of co-citations to supply management studies in the most recent five years.

Perhaps the biggest differences between these results describing current research and those describing earlier periods is the rise of co-citations to research in logistics and pricing. Logistics research accounts for 12% of total co-citations, driven primarily by a resurgence in studies of vehicle routing and scheduling. The resurgence parallels the growth in e-commerce and "last mile" delivery services in recent years. The pricing research category comprises six percent of the total co-citations for the sample group and period. Readily identifiable pricing sub-topics include dynamic pricing and markdowns in the presence of strategic consumers, coordinating pricing across channels, and pricing new versus remanufactured products. A

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notable change in scheduling research is the growth of co-citations to studies of patient scheduling in hospitals and clinics (included in the "shop scheduling" category).

Strategy research accounts for nine percent of all co-citations included in our sample. Topics related to competitive advantage and the resource-based view (RBV, KBV, and dynamic capabilities) collectively have captured most (63%) of the co-citations to strategy research documents. Remanufacturing represents an emerging topic in strategy, with a co-citation share of 9%.

Inventory and process improvement topics also own significant shares of co-citations at 7% and 6%, respectively. Studies of newsvendor problem issues appears to dominate current inventory research (44% of inventory co-citations). Lean manufacturing and organizational learning are the leading topics in process improvement (49% of co-citations combined). However, a new category, analytics, comprises 12% of co-citations. Subsequent analyses below identify this as a rapidly growing area of research.

Research in organization issues and queuing round out the research topics represented in the documents ranked among the 300 most co-cited over the last five years; highly co-cited articles in these domains cover familiar topics. Organization issues' share of co-citations has remained fairly constant over the decades, suggesting that it continues to play a small but perhaps foundational role for studies of supply management and strategy. In contrast, the relatively small co-citation shares of inventory, logistics, scheduling, and queuing, which were quite large in the 1960s-1990s, suggest that the OSCM field has migrated away from these once central topics, with the exceptions of the specialized emerging topics mentioned above.

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## 1.9 OSCM Research: Looking Forward

To project future trends in popular research topics, we close our study with two additional analyses. First, we conduct a burst analysis to identify highly active documents in the most recent five years. Burst detection algorithms identify sudden increases in growth and intensity of co-citations to a given document, thus indicating a sustained surge in scholarly attention for a specific period (Chen, 2006; 2014; Feng, Zhang, Du, & Wang, 2015). Current knowledge frontiers and trends detected using burst analysis signal hot topics and suggest how a discipline is evolving. A "burst" is indicated by sharp increases in co-citation frequency of a document, relative to other peer documents examined over a given period of time (Kleinberg, 2003). Following the approach of prior researchers, we derive burst detection results using Kleinberg's algorithm, set at the default criteria (Zhu, Song, Zhu, & Johnson, 2019). Kleinberg's algorithm models time-dependent data using an infinite-state automaton in which bursts appear as state transitions (Small et al., 2014). This algorithm uses a probabilistic automaton method, states of which correspond to the frequencies of individual entities (co-citation frequencies). State transitions correspond to points in time around which the frequency of an event changes significantly (Olmeda-Gómez, Ovalle-Perandones, & Perianes-Rodríguez, 2017). It is analogous to queuing theory for bursty traffic networks (for more detailed technical explanation of burst detection model please see Kleinberg, 2003).

Using documents ranked among the top 500 most co-cited sources in the 2015-2019 period, we identify currently active bursts in co-citations. Table 6 lists the 13 articles that are receiving on-going bursts in attention, in order of burst strength. We describe the core topic addressed by each document by examining the title, co-cited articles, and most recent citing articles.

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Four of the 13 articles, including the three receiving the strongest bursts, address data analytics as a research topic. The topic most closely associated with four of the other documents is supply risk management. Humanitarian logistics and supply networks are also represented in the list, as well as are documents addressing sustainability and supply chain metrics. These results suggest that data analytics and humanitarian supply chain management are likely to attract significant and growing portions of co-citation shares over the next few years.

**Table 6. Active Citation Bursts Among Top 500 Ranked Documents: 2015-2019**

| Reference (first only) | Published | Burst Strength | Title | Source | Topic Area |
|---|---|---|---|---|---|
| Wamba SF | 2015 | 12.5827 | How 'big data' can make big impact: Findings from a systematic review and a longitudinal case study | Intl J. Production Economics | Big data, Data science, Analytics |
| Hazen BT | 2014 | 9.6636 | Data quality for data science, predictive analytics, and big data in supply chain management: An introduction to the problem and suggestions for research and applications | Intl J. Production Economics | Big data, Data science, Analytics |
| Waller MA | 2013 | 9.3802 | Data science, predictive analytics, and big data: A revolution that will transform supply chain design and management | J. Business Logistics | Big data, Data science, Analytics |
| Ho W | 2015 | 6.8187 | Supply chain risk management: a literature review | Intl J. Production Research | Supply chain risk |
| Artzner P | 1999 | 5.8987 | Coherent measures of risk | Math. Finance | Risk measurement |
| Balcik B | 2010 | 5.6048 | Coordination in humanitarian relief chains: Practices, challenges and opportunities | Intl J. Production Economics | Humanitarian supply chain |
| Chen HC | 2012 | 4.2504 | Business intelligence and analytics: From big data to big impact | MIS Quarterly | Big data, Data science, Analytics |
| Rockafellar R | 2000 | 4.0001 | Optimization of conditional value-at-risk | Journal of Risk | Risk |
| Holguin-Veras J | 2012 | 3.1578 | On the unique features of post- disaster humanitarian logistics | J. Operations Management | Humanitarian logistics |
| Campbell JF | 2012 | 2.3673 | Twenty-five years of hub location research | Transportation Science | Service/facility networks |
| Gunasekaran A | 2001 | 2.2339 | Performance measures and metrics in a supply chain environment | Intl. J. Operations and Prodn. Mgt. | Supply chain metrics |
| Brandenburg M | 2014 | 2.1299 | Quantitative models for sustainable supply chain management: Developments and directions | Eur. J. Operations Research | Sustainable supply chain |
| Gunasekaran A | 2004 | 1.806 | A framework for supply chain performance measurement | Intl J. Production Economics | Supply chain metrics |

As another method for projecting future interests going forward, we adopt an *interest analysis* approach that seeks to compare the relative attention paid to topics in practitioner and academic publications, respectively. Baskerville and Myers (2009) developed a simple

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"interest index" that uses document counts to estimate the proportional interest levels in a given topic at a given time. They apply this method to analyze "fashion waves" within information systems research and practice. We employ the same approach to identify topical interest trends reflected in OSCM publications.

We first identified all articles listed in EBSCO Business Source Complete database[7] from 1998-2019[8] that contained the terms "operations management" or "supply chain management" anywhere in the article text. Doing so establishes an inclusive population of articles potentially addressing OSCM topics. We then repeatedly searched within this population for articles that contained topic phrases identified in our most recent cross-sectional and burst analyses (Tables 5 and 6), in both practitioner publications and academic publications (as identified by Business Source Complete). To be counted, an article must have contained a variant of the topic phrase in its title, subject terms, or abstract.

Figure 7 presents trends in proportions of article counts (percentages of total practitioner or academic articles) for 16 topical phrases. The graphs are presented in order of decreasing trend slopes. These data suggest several interesting phenomena. First, some topic titles appear to be more familiar to academics than to practitioners. Terms such as remanufacturing, resource-based view, and vehicle routing (scheduling) appear to have found little purchase in practitioner articles. Second, periods of growth and decline in the popularity of topics are more clearly evident in the practitioner literature, whereas most of the topics continue to exhibit positive trends in the academic literature. For a number of the topics, the trend graphs

[7] The Business Source Complete database is considered superior to the ProQuest database in terms of content coverage and searchability (Nolan, 2009). Tests using the ProQuest data yielded essentially the same trend results.

[8] While the proportion of all academic articles that contained "operations management" or "supply chain management" has stayed relatively steady for at least three decades, the number of practitioner articles containing these terms grew rapidly from 1990-1997, before stabilizing in 1998. Thus, we analyze the data from 1998 to avoid proportional differences in earlier periods.

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suggest that academics and practitioners followed near parallel periods of early growth in interest, followed by a divergence, as practitioner interest declined and academic interest continues to grow (e.g. big data, sustainable supply chain, innovation, supply risk). This pattern may reflect the greater tendency for OSCM scholars to continuously extend and refine topical knowledge, even after practitioner popularity begins to wane.

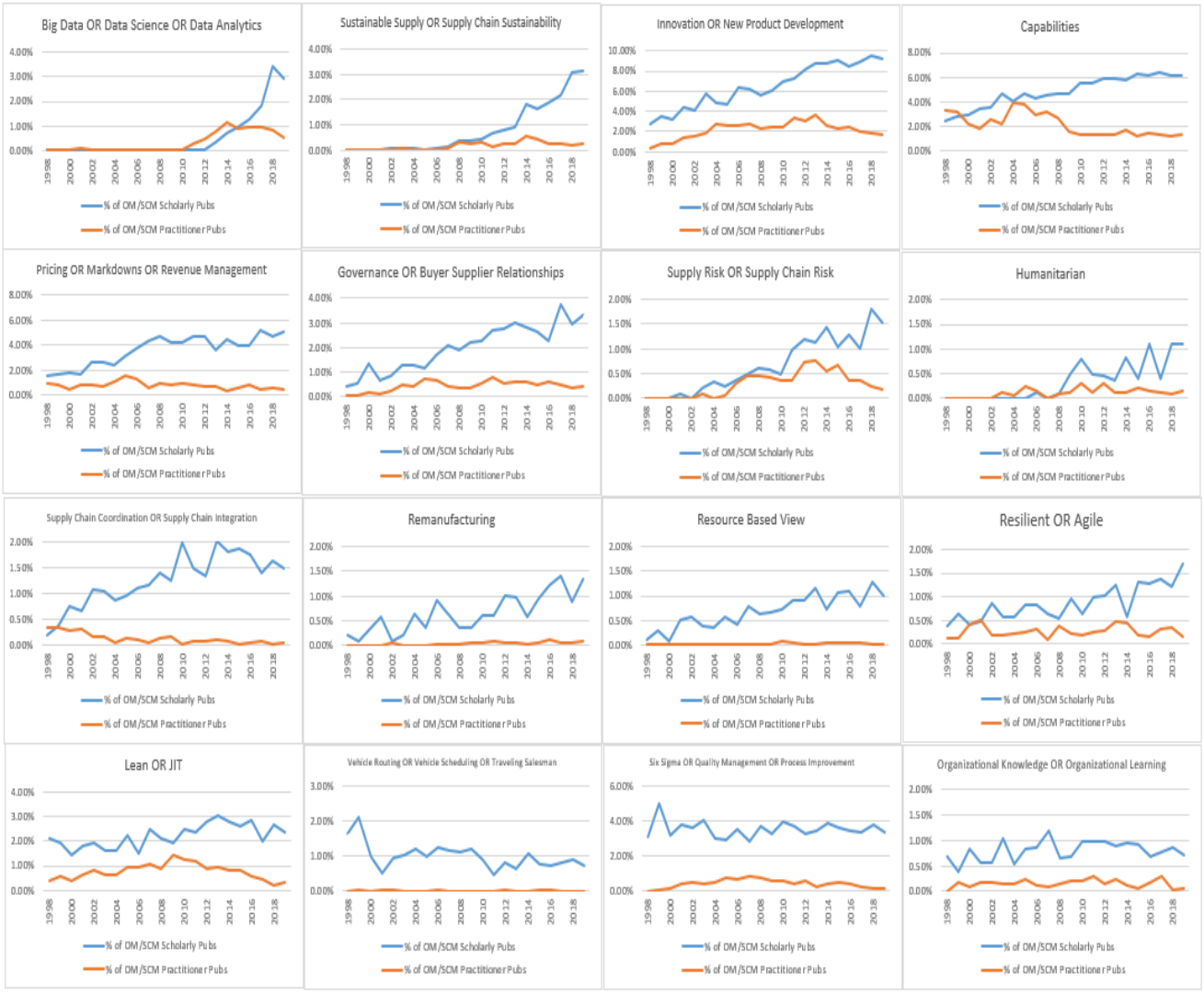


**Figure 7: Interest index trends in OSCM scholarly and practitioner publications**
**Starting with the population of all articles containing "operations management" or "supply chain management" anywhere in the document's text, each figure shows the percentage of these articles that also contain each topic term or phrase in the document's title, subject terms, or abstract.**

The trends indicated in this broader analysis of all published OSCM articles are largely consistent with the topic popularities and trends revealed in our more focused co-citation

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analyses. Big data/analytics, supply risk, and humanitarian issues are evidencing recent growth in attention, though these topics still account for relatively small proportions of the total OSCM literature. A bit more surprising is the finding that longer-lived topics such as innovation, supply relationship governance, capabilities, and pricing continue to show growth trends, though the latter two topics appear to be flattening out. Innovation is hardly a new topic, for example, yet the proportion of academic OSCM articles addressing innovation has quadrupled over the last 20 years. However, only 1 innovation article in the last five years is among the 300 top ranked articles (Table 5). Similarly, other older topics such as lean and process improvement continue to contribute consistent proportions of publications to the total OSCM academic literature, yet they have received relatively little recent attention as primary conversation drivers present in our lists of top co-cited documents (again see Table 5). Vehicle routing appears to be the only topic included in Figure 7 that shows indication of a slight decline.

## Discussion

It is important for scholars to examine how their work fits into larger patterns of progress within a field (Kuhn, 1962; Small, 1980). Researchers have noted that OSCM scholars tend to congregate according to shared perspectives (e.g. problem solving vs theory building/testing) and methodological preferences (e.g. analytical/OR vs empirical; qualitative vs quantitative). Further, these groupings vary across institutions (schools and societies) and geographical regions (Theoharakis, Voss, Hadjinicola, & Soteriou, 2007; Maloni, Carter, & Kaufmann, 2012; Saladin, Shang, Fry, & Donohue, 2015). Specialization and social grouping may be important contributors to research productivity, as they engender centers of excellence. However, a more generalized awareness can also be useful, as it promotes more

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integrated and holistic views of a specialized research agenda, clarifying its place in the larger field.

Using a sample of 31 scholarly journals, we analyzed co-citations of over 95,000 articles containing more than one million references, applying ranking, burst, interest, and periodic analyses to identify, classify, and visualize underlying intellectual foundations and trends in OSCM. These findings quantify changes in the relative magnitudes of OSCM research conversations over time. As engaged scholars, many of us probably feel that we have a sense of who the strongest contributors and what the "hot" topics are, but it is difficult to know their true prevalence in the grander scheme. For example, the data from Table 5 indicate that about 12% of all co-citations of the most co-cited 311 functionally-oriented articles in the last 5 years addressed sustainability in one of four of the major OSCM topic areas. Similarly, studies of risk and resilience in supply management accrued almost another 11% of all co-citations. In contrast, a venerable topic such as "lean" accounts for only 1.6% of co-citations. Such comparisons enable us to answer the question, *where are OSCM researchers concentrating their efforts?* Moreover, this information prompts a potentially more important question, *where should researchers concentrate their efforts?* Given the current challenges faced by OSCM managers and society as whole, does the portfolio of research emphases represented in Table 5 present an appropriate research profile for our field? Answering this question will require debate that combines economic, practical, and ethical perspectives. We offer the findings of this study as a benchmark to support such a debate.

As authors, we found that the trends we uncovered in some cases supported and in other cases challenged our prior perceptions of how the field has developed. Each of us, owing to the biases inherent in our own specialized areas of focus, were surprised that certain authors

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familiar to us were absent from top co-cited lists[9]. Similarly, it was interesting to discover that recent seminal works seem to have replaced older ones as key source documents. No single article appears seminal for the 70-year life of OSCM. Moreover, several of the documents with the most enduring co-citation records were not authored by OSCM researchers (e.g. March & Simon, 1958; Kuehn & Hamburger, 1963; Porter, 1980; 1985; Williamson, 1985). Other formerly long-popular documents have dropped from the most co-cited lists in recent years. These results are likely a product of the recent, rapid expansion of OSCM research.

## 1.10 The Evolution of OSCM

Our analysis evidences significant growth in the richness and variety of problem types and research questions addressed by OSCM researchers. Pioneering studies from the 1950s and 1960s conducted by Bellman, Johnson, Wagner, and Dantzig, etc., provide leading examples of relatively finely scoped developments, with strict limiting assumptions, that established core foundations for decades of future development. Some of these foundational studies developed methods, such as dynamic programming, or formulated models for focused problems, such as inventory optimization. Interestingly, traffic dynamics (e.g. Reuschel, 1950; Dantzig, 1954) formed a prominent part of the early research conversation. Later studies focused on queuing, capacity and aggregate planning, scheduling, inventory policies, and numerous other resource allocation problems such as location/allocation and transportation optimization algorithms; all of these are essentially single-issue problems.

Into the 1980s and 1990s, researchers armed with growing computational capacity developed more complex models using powerful optimization algorithms, Markov models, and multicriteria models. Empirical methods grew during this period as well, supported by

[9] Only first authors' names are listed in the appendices, for brevity.

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methods including simulation, structural equation modelling, and other multivariate analytic techniques. These developments addressed manufacturing strategies in addition to operational decisions, and ultimately considered inter-organizational relationships, supply chain designs, and higher order factors such as risk and sustainability.

This evolution from narrow problem focus to broader organizational issues reflects contemporaneous real-world developments. Beginning in the 1980s, rapid globalization and technology advances challenged 'inward facing' operations executives to think about operations more holistically and strategically, and to pursue value creation opportunities with partners in supply networks (Sprague, 2007; Swink et al., 2020, Ch. 1). Such changes called for scholarship that views internal processes more broadly and addresses inter-organizational issues that align with supply chain management opportunities. In the late 1980s, qualitative methods began to be adopted and extended by Eisenhardt, Yin, and others. At the same time, OSCM began to apply more integrative theories from economics and organizational design (e.g. transaction cost economics, resource dependency theory, information processing theory, resource-based view), as well as from popular paradigms in practice (e.g. TQM, six sigma, TPS, lean). These approaches stimulated scientific inquiry of even broader and more complex phenomena. It was recognized from the 1990s in professional practice, and then in research studies of those practices, that even if firms optimized their internal operations, they left significant value on the table if they neglected inter-organizational improvement opportunities. Hence, supply chains were acknowledged as a 'new' unit of analysis to be examined, improved, and optimized. This encouraged the adaptation and application of additional theories to address behavioral and relationship management issues (e.g. social capital theory, social network theory, risk and contracting concepts, and others). Simultaneously, the continued precipitous growth of data storage capacity and computational

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processing power over this period enabled the development of powerful new optimization models that captured progressively more and more of the complexities of inter- as well as intra-organizational operating processes.

## 1.11 OSCM Today and Tomorrow

Today, supply management and strategy dominate the OSCM conversation. The complex and dynamic nature of these domains will likely continue to drive research that further applies and extends theories to integrate strategic, tactical, and behavioral elements of supply chain design and execution. The more granular portions of our analyses suggest ways in which current trends may play leading roles in OSCM. The burst analysis (Table 6), snapshot of current research (Table 5), and broader interest analyses (Figure 7) indicate that sub-topics within supply management (e.g. sustainability and risk) and process improvement (e.g. analytics) are receiving increasing levels of attention today. While these trends may be apparent to observers of journal publications and conference presentations, ours is the first study to quantify them. Documents in these areas collectively account for 37% of 37,739 co-citations of the top 100 most co-cited works over the 70-year study period. They include 39 of these 100 most co-cited articles, which is remarkable given their emergence only recently as prominent streams in the OSCM literature. Interestingly, since 2015, documents addressing supply management make up 62 of the 100 top co-cited articles and command 61% of all co-citations of these top 100 articles.

Studies of integration dominated supply management research in the first decade of this millennium, mostly driven by efforts to quantify the impacts of coordination (Cachon & Lariviere, 2005), information sharing, and its distortion (bullwhip effect) (Lee, Padmanabhan, & Whang, 1997; Chen, Drezner, Ryan, & Simchi-Levi, 2000), but also including the development of broader cross-functional and inter-organizational integration concepts

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(Frohlich & Westbrook, 2001; Flynn, Huo, & Zhao, 2010). In some ways this stream of research reflects and perhaps even presages industrial moves toward greater technology-enabled supply chain integration. However, it is readily apparent that few supply chains have yet achieved the levels of integration envisioned in these academic studies.

Recent trends suggest that supply risk and sustainability have become dominant research topics. Definitional, early studies of supply risk management appearing in the last decade (e.g. Kleindorfer & Saad, 2005; Tang, 2006; Tomlin, 2006) provide foundational frames current researchers are using to apply theories to risk identification and mitigation techniques (e.g. Wiengarten, Humphreys, Gimenez, & McIvor, 2016; Scheibe & Blackhurst, 2018). Similarly, foundational works in supply chain sustainability (Zhu & Sarkis, 2004; Carter & Rogers, 2008; Seuring & Müller, 2008) are supporting subsequent empirical studies (e.g. Chaabane, Ramudhin, & Paquet, 2012). Again, these trends seem to be highly consistent with larger business trends. Rising perceptions of environmental, economic, and geo-political uncertainties, punctuated by natural disasters, a major recession (2008), slowdowns in globalization, and a pandemic have heightened managers' sensitivity to disruptions and longer-term consequences of global supply chain design choices. In addition, as stakeholders increasingly encourage managers to consider objectives beyond short-term profits, OSCM appears to be responding with increasing study of environmental outcomes of operations, social consequences, and new topics such as reverse and humanitarian logistics. An informal survey of recent journal special issue announcements reflects these growing interests; in-progress special issue developments address areas of public policy (e.g. economic inequality, mobility, climate change, globalization, international relations), supply management (e.g. disruptions and pandemics, innovation networks), technology management (big data/analytics, digital transformation, technologies such as blockchain and additive

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manufacturing), and strategy (e.g. platform and sharing economies, sustainability and social responsibility).

For brevity, we omit discussion of other topics highlighted in our data and findings, many of which appear to be in decline as a proportion of total research co-citations. A small but notable exception is pricing research. Twenty documents (6.4%) of the top 311 most co-cited documents in the last five years address pricing policies as the primary research issue. Only five pricing research documents make the top 100 most co-cited references for the last five years, yet collectively pricing studies represent a substantial and growing area of research. Top co-cited contributions in the last five years address product/quality effects on pricing and revenue management strategies (Mussa & Rosen, 1978; Talluri, Van Ryzin, & Ryzin, 2004); as well as analytical models of inventory pricing under various considerations (e.g. Elmaghraby & Keskinocak, 2003). The sub-topics identified in Table 5 indicate a growing integration of pricing decisions with consumer behavior models, as well as a broadening of pricing applications to special circumstances (e.g. remanufactured products). As the sophistication of analytical modelling and empirical methods continues to evolve, it seems likely that OSCM researchers will increasingly study higher levels of integration of factors including pricing, product mix, and other marketing factors with decisions affecting supply chain design and execution.

### 1.12 Opportunities

The interest index analysis results depicted in Figure 7 indicate that academic publications in some venerable OSCM research areas continue to grow, even though they do not account for substantial portions of academic co-citations (Table 5), and attention in the practitioner press appears to have waned. Do we OSCM scholars tend to hang on too long to pet topics? Given that the setup costs of research (e.g. learning the literature and relevant theories) are high, we

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would expect that scholars are incentivized to squeeze every bit of publication potential from a given research stream. A more sanguine view is that scholars are more attuned to the nuances and contingencies associated with a given practice or business trend, thus their attention lasts well beyond that of practitioners who may be more susceptible to "fads" (Baskerville & Myers, 2009). Even so, such findings raise the larger question regarding the relevance of OSCM research. If we define relevance as "being consistent with issues that are of practical (practitioner) concern," the evidence from our study suggests that OSCM scholars are not as responsive to changes in practical concerns as we might wish. Further, our persistence with topics popular in the past could limit our ability to lead, rather than lag, in terms of relevance. Most OSCM empirical studies are based on data related to existing models and phenomena; rarely do they attempt to look over the horizon. Indeed, such speculation is difficult to publish; our research methods and rigor standards almost guarantee a lagging position for research. Journal editors might create special issues with relaxed methodological constraints to encourage forward-looking research that focuses more on next generation factors rather than current events. In the larger frame, our findings suggest that OSCM researchers might make their work more relevant by seeking to address larger, newer problems and questions rather than explicating the details of older ones. Of course, this approach to research entails greater risks; incentives and rewards will need to be adjusted accordingly.

Another interesting opportunity uncovered in our study stems from the absence of new journals[10]. Assuming our journal identification process was inclusive, one notes that not a single important journal has been introduced in OSCM in more than twenty years. Given the growing interest in, and presumed importance of, topics such as sustainability, healthcare

[10] We thank one of the anonymous reviewers for identifying this opportunity.

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operations, and risk, why are focused journals in these areas scarce, and why are they assigned lower importance? Interestingly, even journals addressing long-standing topics like quality management and service management failed to reach prominence in either our surveys or in existing rankings studies. Moreover, with the exception of *Interfaces,* more explicitly practice-oriented journals are also absent from our list of journals identified as "important" by OSCM academics and prior surveys. Given the probable increasing reliance that professional schools such as business and engineering will have on funding from commercial sources, perhaps it is time to consider realignments in research and journal quality metrics.

Service operations research does not figure largely in our research findings. A paper introducing the "SERVQUAL" model (Parasuraman, Zeithaml, & Berry, 1988) is the only top 100 (number 83) co-cited services-focused (excluding retail services) document in the 2000s. A review of telephone call centers research (Gans, Koole, & Mandelbaum, 2003) is the only top 100 co-cited service research document in the 2010s. Our OSCM journal list includes no service focused journals, yet it remains telling that none of the OM journals (JOM, MSOM, POMS, MS) seem to heavily cite services-focused research. These journals are not necessarily manufacturing focused by design; they appear to have just evolved this way. There may be an opportunity for scholars to consider ways to incentivize and reward publications in manifestly relevant areas such as services, sustainability, and others.

An exception to the dearth of topically oriented journals exists in supply chain management. In recent years, journals that were formerly focused on specific functions (e.g. logistics, internal operations, and purchasing) have become broader in addressing more integrative supply chain management issues. Moreover, SCM appears to have become a dominant, umbrella perspective for viewing and positioning various operations management

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topics. An opportunity for OSCM scholars is to conceive and implement new ways of organizing research topics and questions under this perspective. In some ways, this opportunity involves challenges similar to those faced by firms who seek to reorganize operations away from functional organizations toward more integrated forms located under chief supply chain officers. Perhaps more capability or process-oriented views of operations management will emerge from this evolution.

A final opportunity emerges from our finding that co-citations tend to be highly concentrated. For example, we estimate that about 2% of all functionally-oriented documents co-cited by our journal set over the last 5 years account for almost 65% of co-citations to all functional contributions in that period. It would be interesting to discover whether such levels of concentration are typical across different fields. Even more interesting would be to uncover the traits of these relatively few highly co-cited articles that make them so influential (e.g. Antonakis, Bastardoz, Liu, and Schriesheim (2014), analyze traits of highly cited articles in *The Leadership Quarterly*). One possibility is that researchers continue to cite prominent sources, creating a kind of momentum. For example, the average publication year of the 311 documents co-cited in the 2015-2019 period is 2002; only 82 are post-2010. Conversely, researchers might explore the roles that articles that receive few co-citations play in the progress of OSCM. Do these works provide momentum, do they serve as foundational stocks for innovation (akin to failed experiments), or do they represent unproductive uses of resources?

## Limitations and Conclusion

The knowledge landscape developed in our study includes but supersedes the "knowledge groups" identified in Pilkington and Meredith's (2009) focused OM study. The differences in our findings can be attributed to differences in methods of analysis and a much larger sample

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of records (31 journals over 70 years versus three journals over 20 years). However, a number of important niches are still notably absent. Topics such as service operations and other contextually focused research topics (e.g. health care, government) are not prominently represented, potentially because they are relatively recent areas of focus that have not had time to build a strong corpus of co-citations. Other limitations to this research should also be considered. First, there is typically a significant time lag between an article's publication and its citation. This likely produces a bias in co-citation counts toward articles published earlier; the impact of recently published work requires further study over time. For this reason, some of our findings are based on extrapolations of backward-looking data. Second, we employ an admittedly modern perspective in identifying and assigning topical classifications. For example, thirty years ago researchers would not likely have used "supply management" as a term by which to organize research topics. Further, some degree of subjectivity is unavoidably present when creating topical categories for article classification. However, we suggest that for trend analysis, *consistent application* of the classification scheme is the most important objective. Our inter-rater comparisons demonstrate an acceptable level of consistency, using conventional standards. We are confident that long-time OSCM researchers will find at least a few differences between our categorization scheme and their views of the field. Indeed, differences in the authors' individual perspectives served as a primary motivation for this type of study. We trust that such differences will lead to constructive debates and a richer understanding of the perspectives and frames with which we can describe our field. Third, we acknowledge that services focused journals are omitted from our analysis. As we discussed earlier, they were not identified by the WoS, surveyed experts, or in the journal ranking articles engaged in our list building process.

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Noted American historian, Carter Godwin Woodson, is reported to have said, "Knowing the past opens the door to the future" (Bunch, 2018). We trust that the contributions of our study will be useful for researchers who want to better understand how their research interests fit into the larger historical and knowledge structure landscapes of the OSCM discipline. In addition to providing a benchmark against which researchers can compare their perceptions of the field's progress, we expect the findings to be useful for journal editors who want to understand how the topics covered in their journal map against the popularity of topics more broadly in the field. The findings should be also helpful in updating the scope and boundaries of OSCM, stimulating debates about trends that are shaping the field, and identifying desirable paths forward. PhD students may find our analysis useful in helping them study for comprehensive field examinations and in knowing how their research choices fit into the larger scheme of things. Lastly, we hope that our study may at least indirectly affect practice by helping researchers to better appreciate the scope and potential of OSCM's contributions to document and drive improvements in operations and supply chain management.

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Appendix A: Documents ranked in the top 100 most co-cited, 1950-2019

| Freq* | Author (first only) | Year | Title | Source | Topic Area | Highly Co-cited With |
|---|---|---|---|---|---|---|
| 981 | Pinedo M | 1995 | Scheduling: Theory, algorithms, and systems | *Book* | Scheduling | Johnson SM (1954); Graham RL (1979) |
| 808 | Barney J | 1991 | Firm resources and sustained competitive advantage | Journal of Management | Strategy/Comp Adv | Teece, Pisano, and Shuen (1997); Wernerfelt (1984) |
| 794 | Hadley G | 1963 | Analysis of inventory systems | *Book* | Inventory | Silver et al. (1998); Silver and Peterson (1985) |
| 753 | Wagner H | 1958 | Dynamic version of the economic lot size model | Management Science | Inventory | Silver and Peterson (1985); Elmaghraby (1978) |
| 741 | Lee Hl | 1997 | Information distortion in a supply chain: The bullwhip effect | Management Science | SC/Coordination | Chen, Drezner, Ryan, and Simchi-Levi (2000); Sterman (1989) |
| 708 | Silver E | 1998 | Inventory management and production planning and scheduling | *Book* | Inventory | Khouja (1999); Hadley and Whitin (1963) |
| 664 | Conway R | 1967 | Theory of scheduling | *Book* | Scheduling | Baker (1974); Blackstone (1982) |
| 648 | Holland J | 1975 | Adaptation in natural and artificial systems: An introductory analysis with applications to biology, control, and artificial intelligence | *Book* | Org Theory | Goldberg (1989) |
| 639 | Baker K | 1974 | Introduction to sequencing and scheduling | *Book* | Scheduling | Johnson (1954); Conway et al. (1967) |
| 624 | Porter M | 1985 | Competitive advantage: Creating and sustaining superior performance | *Book* | Strategy/Comp Adv | Barney (1991); Porter (1980) |
| 622 | Hayes R | 1984 | Restoring our competitive edge: Competing through manufacturing | *Book* | Strategy/Comp Adv | Skinner (1969); Swamidass (1987) |
| 573 | Zipkin P | 2000 | Foundations of inventory management | *Book* | Inventory | Clark and Scarf (1960); Puterman (1994) |
| 571 | Williamson O | 1985 | The economic institutions of capitalism | *Book* | SC/GOV | Dyer and Singh (1998); Williamson (1975) |
| 570 | Kahneman D | 1979 | Prospect theory: An analysis of decision under risk | Econometrica | SC/Risk | Schweitzer (2000); Pratt (1964) |
| 570 | Womack J | 1990 | Machine that changed the world | *Book* | Process improvement | Shah (2003); Ohno (1988) |
| 564 | Porter M | 1980 | Competitive strategy: Techniques for analyzing industries and competition | *Book* | Strategy/Comp Adv | Porter (1985); Hayes and Wheelwright (1984) |
| 563 | Fisher M | 1997 | What is the right supply chain for your product? | Harvard Business Review | SC/Design | Lee (2002); Frohlich and Westbrook (2001) |
| 515 | Clarke G | 1964 | Scheduling of vehicles from a central depot to a number of delivery points | Operations Research | Scheduling | Solomon (1987); Lin (1973) |
| 504 | Monden Y | 1983 | Toyota production system: An integrated approach to just-in-time | *Book* | Process improvement | Schonberger (1982); Spearman (1990) |
| 497 | Dyer J | 1998 | The relational view: Cooperative strategy and sources of interorganizational competitive advantage | Academy of Management Review | Strategy/Comp Adv | Barney (1991); Williamson (1985) |
| 496 | Cachon G | 2003 | Supply chain coordination with contracts | Handbooks in Operations Research and Management Science | SC/GOV | Cachon (2005); Cachon (2001) |
| 491 | Teece D | 1997 | Dynamic capabilities and strategic management | Strategic Management Journal | Strategy/Comp Adv | Barney (1991); Eisenhardt (2000) |
| 471 | Frohlich M | 2001 | Arcs of integration: An international study of supply chain strategies | Journal of Operations Management | SC/Coordination | Flynn, Huo, and Zhao (2010); Vickery (2003) |
| 468 | Williamson O | 1975 | Markets and hierarchies: Analysis and antitrust implications: A study in the economics of internal organization | *Book* | SC/GOV | Williamson (1985); Coase (1937) |
| 449 | Hill T | 1985 | Manufacturing strategy: Text and cases | *Book* | Strategy/Comp Adv | Hayes; Porter, Womack |
| 436 | Wernerfelt B | 1984 | A resource- based view of the firm | Strategic Management journal | Strategy/Comp Adv | Barney (1991); Prahalad and Hamel (1990) |
| 431 | Cachon G | 2005 | Supply chain coordination with revenue-sharing contracts: Strengths and limitations | Management Science | SC/Coordination | Lee et al. (2000); Frohlich and Westbrook (2001) |
| 429 | Clark A | 1960 | Optimal policies for a multi-echelon inventory problem | Management Science | Inventory | Zipkin (2000); Sherbrooke (1968) |
| 422 | Solomon M | 1987 | Algorithms for the vehicle routing and scheduling problems with time window constraints | Operations Research | Logistics | Clarke G (1964); Lin s (1965) |
| 418 | Lee Hl | 2000 | The value of information sharing in a two-level supply chain | Management Science | Inventory | Gavirneni (1999); Cachon and Fisher (2000) |
| 416 | Petruzzi N | 1999 | Pricing and the newsvendor problem: A review with | Operations | Inventory | Khouja (1999); |

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|---|---|---|---|---|---|---|
| | | | extensions | Research | | Elmaghraby (2003) |
| 408 | Christopher M | 1992 | Logistics and supply chain management: Creating value-adding networks | *Book* | SC/Design | Chopra S (2001); Mentzer |
| 400 | Kleinrock L | 1975 | Queuing systems | *Book* | Queuing | Neuts (1981); Buzzacott (1993) |
| 388 | Nawaz M | 1983 | A heuristic algorithm for the *m*-machine, *n*-job flow-shop sequencing problem | Omega | Scheduling | Garey MR (1976); Johson SM (1954) |
| 386 | Hopp W | 1996 | Factory physics: Foundation of manufacturing management | *Book* | Process improvement | Monden; Buzzacott |
| 383 | Cohen W | 1990 | Absorptive capacity: A new perspective on learning and innovation | Administrative Science Quarterly | Process improvement | Kogut (1992); March (1991) |
| 378 | Flynn B | 2010 | The impact of supply chain integration on performance: A contingency and configuration approach | Journal of Operations Management | SC/Coordination | Frohlich and Westbrook (2001); Podsakoff et al. (2003) |
| 373 | Chopra S | 2001 | Supply chain management | *Book* | SC/Design | Fisher (1997); Lee et al., (1997) |
| 373 | Lenstra J | 1977 | Complexity of machine scheduling problems | Annals of Discrete Mathematics | Scheduling | Garey MR (1976); Graham RL (1979) |
| 372 | Garey M | 1976 | The complexity of flowshop and jobshop scheduling | Mathematics of Operations Research | Scheduling | Nawaz M (1983); Lenstra JK (1977) |
| 368 | Schonberger R | 1982 | Japanese manufacturing techniques: Nine hidden lessons in simplicity | *Book* | Process improvement | Monden (1983a); Schonberger (1986) |
| 353 | Lee HL | 1997 | The bullwhip effect in supply chains | Sloan Management Review | Inventory | Chen et al. (2000) |
| 350 | Seuring S | 2008 | From a literature review to a conceptual framework for sustainable supply chain management | Journal of Cleaner Production | SC/Risk | Carter (2008); Zhu (2004) |
| 350 | Thompson JD | 1967 | Organizations in actions | *Book* | Org Theory | Williamson (1985); Frohlich and Westbrook (2001) |
| 340 | Mentzer J | 2001 | Defining supply chain management | Journal of Business Logistics | SC/Design | Cooper (1997); Chen and Paulraj (2004) |
| 339 | Pfeffer J | 1978 | The external control of organizations: A resource dependence perspective | Book | Org Theory | Dyer (1998); Williamson (1985) |
| 339 | Cachon GP | 2000 | Supply chain inventory management and the value of shared information | Management Science | SC/Integration | Cachon (2005); Pasternack (1985) |
| 331 | Chen F | 2000 | Quantifying the bullwhip effect in a simple supply chain: The impact of forecasting, lead times, and information | Management Science | SC/Integration | Lee (1997); Lee (2000) |
| 330 | Gallego G | 1994 | Optimal dynamic pricing of inventories with stochastic demand over finite horizons | Management Science | Pricing | Bitran (2003); Elmaghraby (2003) |
| 330 | Tomlin B | 2006 | On the value of mitigation and contingency strategies for managing supply chain disruption risks | Management Science | SC/Risk | Dada (2007); Kleindorfer (2005) |
| 328 | Yano Ca | 1995 | Lot sizing with random yields: A review | Operations Research | Inventory | Henig (1990); Dada (2007) |
| 325 | Baker KR | 1990 | Sequencing with earliness and tardiness penalties: a review | Operations Research | Scheduling | Cheng (1989); Lawler (1977) |
| 320 | Lariviere MA | 2001 | Selling to the newsvendor: An analysis of price-only contracts | Manufacturing & Service Operations Management | Inventory | Cachon (2004); Cachon (2003) |
| 317 | Gilmore PC | 1961 | A linear programming approach to the cutting-stock problem | Operations Research | Scheduling | Gilmore (1963); Gilmore (1965) |
| 315 | Lin S | 1973 | An effective heuristic algorithm for the traveling-salesman problem | Operations Research | Logistics | Lin (1965); Clarke (1964) |
| 313 | Chen IJ | 2004 | Towards a theory of supply chain management: the constructs and measurements | Journal of Operations Management | SC/Review | Frohlich (2001); Paulraj (2008) |
| 313 | Tang CS | 2006 | Perspectives in supply chain risk management | International Journal of Production Economics | SC/Risk | Kleindorfer (2005); Chopra (2004) |
| 312 | Tirole J | 1988 | The theory of industrial organization | Book | Strategy/Comp Adv | Spengler (1950); Mussa (1078) |
| 306 | Nahmias S | 1989 | Production and operations management | Book | *Book* | Hadley (1963); Silver (1998) |
| 304 | Morgan RM | 1994 | The commitment-trust theory of relationship marketing | Journal of Marketing | SC/GOV | Dwyer (1987); Dyer (1998) |
| 301 | Simchi-Levi D | 2000 | Designing and managing the supply chain | *Book* | SC/Textbook | Chopra (2001); Lee (1997) |
| 297 | Prahalad CK | 1990 | The core competence of the corporation | Harvard Business Review | Strategy/Comp Adv | Wernerfelt (1984); Barney (1991) |
| 295 | Kleindorfer PR | 2005 | Managing disruption risks in supply chains | Production and Operations Management | SC/Risk | Chopra (2004); Craighead (2007) |
| 294 | Talluri KT | 2004 | The theory and practice of revenue management | *Book* | Pricing | Bitran (2003); McGill (1999) |
| 294 | Black F | 1973 | The pricing of options and corporate liabilities | Journal of Political Economy | Pricing | Dixit (1994); Markowitz (1952) |
| 292 | Porteus EL | 1986 | Optimal lot sizing, process quality improvement and setup cost reduction | Operations Research | Inventory | Rosenblatt (1986); Yano (1995) |
| 292 | Lin S | 1965 | Computer solutions of the traveling salesman problem | AT&T Technical Journal | Org Theory | Lin (1973); Clarke (1964) |
| 290 | Francis RL | 1974 | Facility layout and location: an analytical approach | *Book* | PI | Amour (1963); Tompkins (1984) |
| 288 | Schonberger RJ | 1986 | World class manufacturing enterprise strategy | *Book* | PI | Schonberger (1982); Hayes (1984) |
| 286 | Fisher M | 1996 | Reducing the cost of demand uncertainty through accurate response to early sales | Operations Research | Strategy/Comp Adv | Iyer (1997); Donohue (2000) |
| 285 | Pasternack BA | 1985 | Optimal pricing and return policies for perishable commodities | Marketing Science | Pricing | Emmons (1998); Tsay (1999) |
| 281 | Sherbrooke | 1968 | METRIC: A multi-echelon technique for recoverable item | Operations | Inventory | Graves (1985); Clark |

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|---|---|---|---|---|---|---|
| | CC | | control | Research | | (1960) |
| 279 | Fleischmann M | 1997 | Quantitative models for reverse logistics: A review | European Journal of Operational Research | Logistics | Theirry (1995); Guide (2000) |
| 278 | Ferdows K | 1990 | Lasting improvements in manufacturing performance: in search of a new theory | Journal of Operations Management | PI | Skinner (1969); Miller (1994) |
| 274 | Little JDC | 1961 | A proof for the queuing formula: L= λw | Operations Research | Queuing | Spearman (1990); Hopp (1996) |
| 274 | Hakimi SL | 1964 | Optimum locations of switching centers and the absolute centers and medians of a graph | Operations Research | Logistics | Toregas (1971); Daskin (1995) |
| 273 | Clark K B | 1991 | Product development performance: Strategy, organization, and management in the world auto industry | *Book* | PI | Ulrich (1995); Krishnan (2001) |
| 269 | Vollman TE | 1988 | Manufacturing planning and control systems | *Book* | *Book* | Orlicky (1974); Johnson (1974) |
| 267 | Srivastava SK | 2007 | Green supply- chain management: a state- of- the- art literature review | International Journal of Management Review | SC/SUS | Seuring (2008); Rao (2005) |
| 265 | Bodin L | 1983 | Routing and scheduling of vehicles and crews, the state of the art | Computers & Operations Research | Logistics | Fisher (1981); Laporte (1992) |
| 265 | Miller JG | 1994 | A taxonomy of manufacturing strategies | Management Science | Strategy/Comp Adv | Ferdows (1990); Swamidass (1987) |
| 265 | Cachon GP | 2001 | Contracting to assure supply: How to share demand forecasts in a supply chain | Management Science | SC/Integration | Cachon (2003); Cachon (2004) |
| 263 | Nelson RR | 1982 | An evolutionary theory of economic change | *Book* | Strategy/Comp Adv | Cyert (1963); Kogut (1992) |
| 263 | Shah R | 2003 | Lean manufacturing: context, practice bundles, and performance | Journal of Operations Management | PI | Shah (2007); Womack (1990) |
| 263 | Zhu QH | 2004 | Relationships between operational practices and performance among early adopters of green supply chain management practices in Chinese manufacturing enterprises | Journal of Operations Management | SC/SUS | Rao (2005); Vachon (2006) |
| 263 | Taillard E | 1993 | Benchmarks for basic scheduling problems | European Journal of Operational Research | Scheduling | Nawaz (1983); Tillard (1990) |
| 262 | Geoffrion AM | 1974 | Multicommodity distribution system design by Benders decomposition | Management Science | Logistics | Benders (2005); Erlenkotter (1978) |
| 257 | Adams J | 1988 | The shifting bottleneck procedure for job shop scheduling | Management Science | Scheduling | Panwalkar (1977); Tillard (1993) |
| 255 | Tompkins JA | 1984 | Facilities planning | *Book* | PI | De Koster (2007); Armour (1963) |
| 255 | Gerwin D | 1993 | Manufacturing flexibility: a strategic perspective | Management Science | Strategy/Comp Adv | Sethi (1990); Swamidass (1987) |
| 255 | Elmaghraby W | 2003 | Dynamic pricing in the presence of inventory considerations: Research overview, current practices, and future directions | Management Science | Pricing | Bitran (2003); Gallego (1994) |
| 254 | Daskin MS | 1995 | Network and discrete location: Models, algorithms, and applications | *Book* | Logistics | Shen (2003); Hakimi (1964) |
| 254 | Flynn BB | 1994 | A framework for quality management research and an associated measurement instrument | Journal of Operations Management | PI | Saraph (1989); Powell (1995) |
| 254 | Chopra S | 2004 | Supply-chain breakdown | Sloan Management Review | SC/Risk | Kleindorfer (2005); Craighead (2007) |
| 253 | Carter CR | 2008 | A framework of sustainable supply chain management: moving toward new theory | International J. of Physical Distribution & Logistics Mgmt. | SC/SUS | Seuring (2008); Pagell (2009) |
| 251 | Rogers EM | 1983 | Diffusion of innovation | *Book* | PI | Bass (1969); Dimaggio (1983) |
| 247 | Jeuland AP | 1983 | Managing channel profits | Marketing Science | Pricing | Weng (1995); McGuire (1983) |
| 247 | Eisenhardt KM | 2000 | Dynamic capabilities: What are they? | Strategic Management Journal | Strategy/Comp Adv | Teece (1997); Barney (1991) |
| 247 | Erlenkotter D | 1978 | A dual-based procedure for uncapacitated facility location | Operations Research | Logistics | Cornuejols (1977); Kuehn (1963) |
| 247 | Dimaggio PJ | 1983 | The iron cage revisited: Institutional isomorphism and collective rationality in org. fields | American Sociological Review | Org Theory | Sarkis (2011); Barney (1991) |
| 247 | Kraljic P | 1983 | Purchasing must become supply management | Harvard Business Review | SC/Design | Choi (2006); Weber (1991) |
| 246 | Savaskan RC | 2004 | Reverse channel design: the case of competing retailers | Management Science | SC/Design | Debo (2005); Ferguson (2006) |
| 244 | Galbraith JR | 1973 | Designing complex organizations | *Book* | Org Theory | Daft (1986); Thompson (1967) |
| 242 | Lawrence PR | 1969 | Organization and environment | *Book* | Org Theory | Burns (1961); Thompson (1967) |
| 242 | Swamidass PM | 1987 | Manufacturing strategy, environmental uncertainty and performance: a path analytic model | Management Science | Strategy/Comp Adv | Gerwin (1993); Hayes (1984) |

* = co-citation frequency, co-citations for books include cites to all editions

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Appendix B: Documents ranked in the top 50 most co-cited, by decade

| 1950s | | | | 1960s | | | | 1970s | | | | 1980s | | | | 1990s | | | | 2000s | | | | 2010s | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FQ | % | Author (first only) | Year | FQ | % | Author (first only) | Year | FQ | % | Author (first only) | Year | FQ | % | Author (first only) | Year | FQ | % | Author (first only) | Year | FQ | % | Author (first only) | Year | FQ | % | Author (first only) | Year |
| 17 | 6 | Koopmans T | 1951 | 5 | 21 | Little JDC | 1961 | 11 | 8 | Conway RW | 1967 | 1 5 | 2 | Hadley G | 1963 | 2 6 | 9 | Baker K | 1974 | 3 9 | 9 | Silver EA | 1998 | 5 8 | 4 | Barney J | 1991 |
| 15 | 2 | Whitin TM | 1953 | 5 | 19 | Cobham A | 1954 | 8 | 9 | Hadley G | 1963 | 1 5 | 0 | Conway RL | 1967 | 2 4 | 6 | Conway RL | 1967 | 3 8 | 9 | Pinedo M | 1995 | 4 6 | 1 | Graham RL | 1979 |
| 15 | 0 | Hitchcock FL | 1941 | 4 | 15 | Gaver DP | 1962 | 3 | 0 | Srinivasan V | 1972 | 1 5 | 8 | Wagner HM | 1958 | 2 0 | 3 | HedleyG | 1963 | 4 3 | 0 | Lee HL | 1997 | 2 1 | 6 | Cachon G | 2003 |
| 3 | 7 | Dvoretzky A | 1952 | 3 | 14 | Holt CC | 1960 | 3 | 9 | Wagner HM | 1958 | 1 9 | 2 | Kleinrock k L | 1975 | 2 7 | 8 | Monden Y | 1983 | 4 4 | 9 | Hayes RH | 1984 | 4 0 | 6 | Dyer JH | 1998 |
| 3 | 6 | Chandler r RE | 1958 | 3 | 13 | Arrow KJ | 1951 | 2 | 9 | Cox DR | 1961 | 1 9 | 1 | Baker K | 1974 | 2 7 | 0 | Schonberger RJ | 1982 | 4 4 | 0 | Graham RL | 1979 | 3 0 | 0 | Lee HL | 1997 |
| 3 | 6 | Pipes LA | 1953 | 3 | 12 | Kendall DG | 1953 | 3 | 8 | Holt CC | 1960 | 1 7 | 7 | Francis RL | 1974 | 2 6 | 5 | Wagner HM | 1958 | 3 3 | 2 | Hill T | 1985 | 3 7 | 8 | Flynn BbB | 2010 |
| 3 | 6 | Kendall DG | 1953 | 3 | 12 | Miller RG | 1960 | 3 | 6 | Takacs L | 1962 | 1 8 | 3 | Peterson R | 1979 | 2 6 | 5 | Hayes RH | 1984 | 3 5 | 2 | Hedley G | 1963 | 3 7 | 5 | Pinedo M | 1995 |
| 2 | 5 | Arrow KJ | 1951 | 3 | 12 | Saaty TL | 1961 | 3 | 5 | Kuehn AA | 1963 | 1 6 | 1 | Erlenkotter er D | 1978 | 3 4 | 7 | Kleinrock k L | 1975 | 3 2 | 0 | Womack JP | 1990 | 3 6 | 3 | Zipkin PH | 2000 |
| 2 | 5 | Dantzig GB | 1954 | 3 | 11 | Brown RG | 1959 | 3 | 4 | Glover F | 1974 | 1 9 | 3 | Eilon S | 1971 | 2 3 | 3 | French S | 1982 | 3 1 | 2 | Porter ME | 1980 | 3 6 | 2 | Cachon GP | 2005 |
| 2 | 5 | Jacobs W | 1954 | 2 | 10 | Takacs L | 1962 | 3 | 3 | Revelle C | 1970 | 1 9 | 3 | Orlicky J | 1975 | 2 3 | 2 | Baker KR | 1990 | 3 1 | 2 | Porter ME | 1985 | 3 5 | 3 | Frohlich MT | 2001 |
| 2 | 5 | Orden A | 1956 | 2 | 10 | Kelley JE | 1961 | 2 | 2 | Bellmore M | 1968 | 1 4 | 2 | Cyert RM | 1963 | 2 3 | 2 | Bodin L | 1983 | 3 1 | 2 | Wagner HM | 1958 | 3 5 | 3 | Seuring S | 2008 |
| 2 | 5 | Jackson RRP | 1954 | 2 | 9 | Scarf H | 1963 | 2 | 2 | Little JDC | 1963 | 1 2 | 2 | Clarke G | 1964 | 3 1 | 2 | Porter ME | 1985 | 3 1 | 2 | Monden Y | 1983 | 4 9 | 3 | Teece DJ | 1997 |
| 2 | 4 | Dvoretzky A | 1952 | 2 | 9 | Burke PJ | 1956 | 2 | 2 | March JG | 1958 | 1 9 | 2 | Hakimi SL | 1964 | 2 8 | 2 | Porter ME | 1980 | 3 1 | 2 | Barney J | 1991 | 4 4 | 2 | Fisher ML | 1997 |
| 2 | 4 | Cahn AS | 1948 | 2 | 9 | Cox DR | 1961 | 2 | 1 | Held M | 1962 | 1 8 | 2 | Geoffrion AM | 1974 | 1 6 | 1 | Womack JP | 1990 | 2 1 | 2 | Zipkin PH | 2000 | 3 4 | 0 | Tomlin B | 2006 |
| 2 | 4 | Lighthill MJ | 1955 | 2 | 9 | Gaver DP | 1959 | 2 | 0 | Efroymson MA | 1966 | 1 6 | 2 | Bodin L | 1983 | 2 4 | 1 | Johnson SM | 1954 | 3 1 | 2 | Fisher ML | 1997 | 3 0 | 2 | Williams on OE | 1985 |
| 15 | 2 | Reuschel l A | 1950 | 2 | 9 | Keilson J | 1960 | 2 | 9 | Geoffrion AM | 1974 | 1 6 | 2 | Porter ME | 1980 | 2 1 | 2 | Schonberger ger RJ | 1986 | 3 0 | 2 | Hopp WJ | 1960 | 3 0 | 2 | Silver EA | 1998 |
| 2 | 4 | Bailey NTJ | 1954 | 2 | 9 | Kendall DG | 1951 | 2 | 8 | Little JDC | 1961 | 1 5 | 2 | Silver EA | 1973 | 2 1 | 1 | Hax AC | 1984 | 2 0 | 1 | Christoph er M | 1992 | 3 0 | 2 | Tang CS | 2006 |
| 2 | 4 | Burke PJ | 1956 | 2 | 9 | Lomnicki i ZA | 1965 | 2 | 8 | Lin S | 1965 | 1 4 | 2 | Holt CC | 1960 | 2 6 | 1 | Graham RL | 1979 | 3 5 | 2 | Williams on OE | 1985 | 3 5 | 2 | Wernerfelt B | 1984 |
| 2 | 4 | Kendall DG | 1951 | 2 | 9 | Muth J | 1963 | 2 | 7 | Francis RL | 1974 | 1 3 | 2 | Handler GY | 1979 | 2 4 | 0 | Hall R | 1983 | 3 8 | 1 | Baker KR | 1974 | 3 4 | 2 | Mentzer JT | 2001 |
| 2 | 4 | Leavitt HJ | 1951 | 2 | 8 | Ford LR | 1957 | 2 | 7 | Zangwill WI | 1969 | 1 3 | 2 | Lin S | 1973 | 2 7 | 9 | Lawler EL | 1985 | 3 7 | 2 | Williams on OE | 1975 | 3 5 | 2 | Lee HL | 2000 |
| 2 | 4 | Manne AS | 1956 | 2 | 8 | Wagner HM | 1958 | 2 | 7 | Prabhu NU | 1965 | 1 3 | 2 | Held M | 1970 | 2 7 | 9 | Gross D | 1985 | 3 4 | 2 | Chen F | 2000 | 4 4 | 2 | Chen IJ | 2004 |
| 2 | 4 | Modigliani F | 1955 | 2 | 8 | Takacs L | 1955 | 2 | 6 | Ackoff RI | 1970 | 1 3 | 2 | Thompson n J | 1967 | 2 6 | 9 | Hill T | 1985 | 3 5 | 2 | Lee HL | 2000 | 3 4 | 2 | Kleindorfer er PR | 2005 |
| 1 | 3 | Holt CC | 1955 | 2 | 8 | Takacs L | 1964 | 2 | 6 | Hillier F | 1966 | 1 3 | 2 | March JG | 1958 | 2 5 | 9 | Francis RL | 1974 | 3 4 | 2 | Conway RL | 1967 | 3 6 | 2 | Srivastava a SK | 2007 |
| 1 | 3 | Ford LR | 1957 | 2 | 8 | White H | 1958 | 2 | 6 | Srinivasan V | 1973 | 1 3 | 2 | Lin S | 1965 | 2 4 | 9 | Lenstra JK | 1977 | 3 4 | 2 | Simchi-Levi D | 2000 | 3 5 | 2 | Porter ME | 1985 |

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| | | | | | 1<br>1 1 19<br>9 % Gerwin D 93 | |

Appendix C: Documents ranked in the top 100 most co-cited, by 5-year period: 2000-2019

| 2000-2004 | | | 2005-2009 | | | 2010-2014 | | | 2015-2019 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| FQ | Author (first only) | Year | FQ | Author (first only) | Year | FQ | Author (first only) | Year | FQ | Author (first only) | Year |
| 156 | Hayes RH | 1984 | 248 | Silver EA | 1998 | 275 | Pinedo M | 1995 | 305 | Barney J | 1991 |
| 150 | Silver EA | 1998 | 224 | Pinedo M | 1995 | 275 | Barney J | 1991 | 284 | Cachon GP | 2003 |
| 145 | Pinedo M | 1995 | 221 | Lee HL | 1997 | 241 | Graham RL | 1979 | 264 | Flynn BB | 2010 |
| 132 | Hill T | 1975 | 177 | Zipkin PH | 2000 | 223 | Lee HL | 1997 | 227 | Seuring S | 2008 |
| 116 | Monden Y | 1983 | 164 | Graham RL | 1979 | 201 | Silver EA | 1998 | 224 | Pinedo M | 2012 |
| 114 | Womack JP | 1990 | 143 | Barney J | 1991 | 191 | Dyer JH | 1998 | 220 | Graham RL | 1979 |
| 109 | Lee HL | 1997 | 134 | Hopp WJ | 1996 | 187 | Zipkin PH | 2000 | 215 | Dyer JH | 1998 |
| 103 | Hadley G | 1963 | 132 | Wagner HM | 1958 | 184 | Fisher ML | 1997 | 212 | Cachon GP | 2005 |
| 103 | Porter ME | 1985 | 129 | Christopher M | 1998 | 181 | Frohlich MT | 2001 | 186 | Tomlin B | 2006 |
| 100 | Graham RL | 1979 | 126 | Fisher ML | 1997 | 168 | Teece DJ | 1997 | 181 | Teece DJ | 1997 |
| 96 | Porter ME | 1980 | 122 | Hadley | 1963 | 166 | Williamson OE | 1985 | 177 | Lee HL | 1997 |
| 94 | Baker KR | 1974 | 122 | Williamson OE | 1985 | 154 | Porter ME | 1985 | 176 | Zipkin PH | 2000 |
| 93 | Conway RL | 1967 | 121 | Porter ME | 1985 | 153 | Lee HL | 2000 | 176 | Frohlich MT | 2001 |
| 83 | Wagner HM | 1958 | 118 | Chen F | 2000 | 150 | Cachon GP | 2005 | 160 | Fisher ML | 1997 |
| 80 | Schonberger RJ | 1982 | 118 | Hayes RH | 1984 | 148 | Talluri KT | 2004 | 157 | Ropke S | 2006 |
| 79 | Schonberger RJ | 1986 | 115 | Lee HL | 2000 | 147 | Womack JP | 1990 | 157 | Tang CS | 2006 |
| 78 | Christopher M | 1992 | 115 | Porter ME | 1980 | 146 | Chopra S | 2004 | 157 | Carter CR | 2008 |
| 75 | Hopp WJ | 1996 | 107 | Cachon GP | 2000 | 142 | Wernerfelt B | 1984 | 154 | Petruzzi NC | 1999 |
| 73 | Johnson S M | 1954 | 107 | Simchi-Levi D | 2000 | 141 | Chen IJ | 2004 | 151 | Kleindorfer PR | 2005 |
| 73 | Williamson OE | 1985 | 106 | Petruzzi NC | 1999 | 137 | Mentzer JT | 2001 | 147 | Mentzer JT | 2001 |
| 71 | Lenstra JK | 1977 | 106 | Womack JP | 1990 | 137 | Srivastava SK | 2007 | 144 | Savaskan RC | 2004 |
| 68 | Flynn BB | 1994 | 102 | Chopra S | 2001 | 136 | Petruzzi NC | 1999 | 143 | Wernerfelt B | 1984 |
| 68 | Sethi AK | 1990 | 100 | Hill T | 1975 | 133 | Christopher M | 2005 | 140 | Lariviere MA | 2001 |
| 68 | Barney J | 1991 | 99 | Teece DJ | 1997 | 133 | Cohen WM | 1990 | 136 | Williamson OE | 1985 |
| 67 | Williamson OE | 1975 | 91 | Pasternack BA | 1985 | 133 | Tang CS | 2006 | 136 | Cao M | 2011 |
| 67 | Swamidass PM | 1987 | 91 | Monden Y | 1998 | 132 | Cachon GP | 2003 | 135 | Solomon MM | 1987 |
| 66 | Clark KB | 1991 | 90 | Clarke G | 1964 | 131 | Williamson OE | 1975 | 135 | Chiang WYK | 2003 |
| 66 | Prahalad CK | 1990 | 90 | Nawaz M | 1983 | 124 | Cachon GP | 2000 | 133 | Zhu QH | 2004 |
| 64 | Nahmias S | 1989 | 90 | Frohlich MT | 2001 | 123 | Seuring S | 2008 | 133 | Guide VDR | 2009 |
| 63 | Nelson RR | 1982 | 90 | Williamson OE | 1975 | 122 | Wagner HM | 1958 | 131 | Pagell M | 2009 |
| 61 | Clark AJ | 1960 | 88 | Lee HL | 1997 | 120 | Solomon MM | 1987 | 130 | Clarke G | 1964 |
| 61 | Miller JG | 1994 | 87 | Gallego G | 1994 | 117 | Allahverdi A | 2008 | 130 | Chopra S | 2004 |
| 60 | Gerwin D | 1993 | 82 | Clark AJ | 1960 | 116 | Hadley G | 1963 | 129 | Christopher M | 2004 |
| 60 | Wernerfelt B | 1984 | 82 | Daskin MS | 1995 | 116 | Lee HL | 1997 | 126 | Srivastava SK | 2007 |
| 59 | Spearman ML | 1990 | 82 | Dyer JH | 1998 | 114 | Flynn BB | 2010 | 125 | Schweitzer ME | 2000 |
| 58 | Hammer M | 1993 | 81 | Fleischmann M | 1997 | 113 | Kleindorfer PR | 2005 | 125 | Sousa R | 2008 |
| 57 | Thompson J | 1967 | 78 | Potts CN | 2000 | 112 | Hopp WJ | 2000 | 124 | Melo MT | 2009 |
| 56 | Ferdows K | 1990 | 78 | Wernerfelt B | 1984 | 112 | Clarke G | 1964 | 123 | Cohen WM | 1990 |
| 56 | Lawler EL | 1993 | 77 | Mcgill JI | 1999 | 111 | Zhu QH | 2004 | 123 | Chen IJ | 2004 |
| 55 | Cohen WM | 1990 | 77 | Gavirneni S | 1999 | 108 | Porter ME | 1980 | 123 | Craighead CW | 2007 |
| 55 | Baker KR | 1990 | 74 | Allahverdi A | 1999 | 106 | Shah R | 2003 | 122 | Altay N | 2006 |
| 55 | Nawaz M | 1983 | 74 | Baker K R | 1974 | 106 | Vickery SK | 2003 | 122 | Kleindorfer PR | 2005 |
| 54 | Porteus EL | 1986 | 73 | Lenstra JK | 1977 | 106 | Tomlin B | 2006 | 121 | Dimaggio PJ | 1983 |
| 54 | Senge PM | 1990 | 73 | Tirole J | 1988 | 106 | Hayes RH | 1984 | 119 | Shah R | 2003 |
| 54 | Garey MR | 1976 | 72 | Weng ZK | 1995 | 103 | Clark AJ | 1960 | 119 | Sarkis J | 2011 |
| 54 | Hayes RH | 1988 | 72 | Solomon MM | 1987 | 102 | Gans N | 2003 | 116 | De Koster R | 2007 |
| 53 | Adams J | 1988 | 71 | Vollmann TE | 1997 | 101 | Chen F | 2000 | 115 | Govindan K | 2015 |
| 50 | Deming W | 1986 | 71 | Yano CA | 1995 | 101 | Prahalad CK | 1990 | 115 | Vachon S | 2008 |
| 50 | Powell TC | 1995 | 71 | Lariviere MA | 2001 | 100 | Lariviere MA | 2001 | 112 | Lee HL | 2000 |
| 48 | Vollmann TE | 1997 | 70 | Johnson SM | 1954 | 99 | Eisenhardt KM | 2000 | 112 | Wong CY | 2011 |
| 48 | Saraph JV | 1989 | 70 | Thomas DJ | 1996 | 98 | Pasternack BA | 1985 | 112 | Hendricks KB | 2005 |
| 47 | Fleischmann M | 1997 | 69 | Banerjee A | 1986 | 98 | Chopra S | 2004 | 111 | Yano CA | 1995 |
| 47 | Cyert RM | 1963 | 69 | Elmaghraby W | 2003 | 97 | Kraljic P | 1983 | 109 | Eisenhardt KM | 2000 |
| 47 | Vickery SK | 1993 | 69 | Black F | 1973 | 94 | Kleindorfer PR | 2005 | 107 | Cachon GP | 2001 |
| 46 | Tompkins JA | 1993 | 69 | Garey MR | 1976 | 94 | Simchi-Levi D | 2003 | 106 | Wagner HM | 1958 |
| 46 | Hall NG | 1996 | 69 | Brucker P | 2001 | 93 | Carter CR | 2008 | 106 | Ho W | 2010 |
| 45 | Fisher M | 1996 | 69 | Cachon GP | 2005 | 93 | Rao P | 2005 | 105 | Braunscheidel MJ | 2009 |
| 44 | Dantzig GB | 1963 | 68 | Gans N | 2003 | 92 | Fleischmann M | 1997 | 105 | Porter ME | 1985 |
| 44 | Clarke G | 1964 | 68 | Tsay AA | 1999 | 92 | Sousa R | 2008 | 104 | Miller CE | 1960 |
| 44 | Lee HL | 1997 | 68 | Sethi AK | 1990 | 90 | March JG | 1991 | 104 | Mussa M | 1978 |
| 43 | Morton TE | 1993 | 67 | Nahmias S | 2001 | 89 | Yano CA | 1995 | 104 | Choi TY | 2006 |
| 43 | Weber CA | 1991 | 67 | Emmons H | 1998 | 89 | Glover F | 1989 | 104 | Carter CR | 2011 |
| 42 | Weng ZK | 1995 | 66 | Khouja M | 1999 | 88 | Coase RH | 1937 | 103 | Shah R | 2007 |
| 42 | Webster S | 1995 | 65 | Jeuland AP | 1983 | 88 | Rogers EM | 1995 | 102 | Chopra S | 2013 |

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| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 42 | Arntzen BC | 1995 | 65 | Talluri KT | 2004 | 88 | Nawaz M | 1983 | 101 | Pfeffer J | 1978 |
| 41 | Banerjee A | 1986 | 64 | Gilmore PC | 1961 | 88 | Cachon GP | 2001 | 101 | Lee HL | 1997 |
| 41 | Daskin MS | 1995 | 64 | Fisher M | 1996 | 88 | Grant RM | 1996 | 101 | Benjaafar S | 2013 |
| 41 | Glover F | 1986 | 63 | Cooper MC | 1997 | 87 | Carr AS | 1999 | 100 | Elmaghraby W | 2003 |
| 41 | Solomon MM | 1987 | 63 | Carr AS | 1999 | 87 | Eisenhardt KM | 2007 | 100 | Choi TY | 2001 |
| 41 | Black F | 1973 | 62 | Taillard E | 1993 | 86 | Melo MT | 2009 | 99 | Silver EA | 1998 |
| 41 | Nonaka I | 1995 | 62 | Prahalad CK | 1990 | 86 | Pfeffer J | 1978 | 99 | Krause DR | 2007 |
| 41 | Dallery Y | 1992 | 62 | Miller JG | 1994 | 86 | Gallego G | 1994 | 98 | Gallego G | 1994 |
| 41 | Kleinrock L | 1975 | 61 | Baker KR | 1990 | 85 | Kogut B | 1992 | 97 | Kraljic P | 1983 |
| 41 | Teece DJ | 1997 | 61 | Cachon GP | 2001 | 84 | Schweitzer ME | 2000 | 97 | Hendricks KB | 2003 |
| 40 | Bellman R | 1957 | 59 | Cohen WM | 1990 | 84 | Pisinger D | 2007 | 97 | Vachon S | 2006 |
| 40 | Womack JP | 1996 | 59 | Gerwin D | 1993 | 84 | Krause DR | 2007 | 96 | Aviv Y | 2008 |
| 40 | Brucker P | 1999 | 59 | Thierry M | 1995 | 84 | Vachon S | 2006 | 96 | Brandenburg M | 2014 |
| 39 | Hax AC | 1984 | 57 | Ferdows K | 1990 | 84 | Vachon S | 2008 | 95 | Tang C | 2006 |
| 39 | Lee HL | 1986 | 56 | Clark K B | 1991 | 83 | Lee HL | 2004 | 94 | Lee HL | 2004 |
| 39 | Wemmerlov U | 1989 | 56 | Nelson RR | 1982 | 83 | Kaplan RS | 1992 | 94 | Morgan RM | 1994 |
| 39 | Flynn BB | 1995 | 55 | Lu L | 1995 | 83 | Garey MR | 1976 | 94 | Schoenherr T | 2012 |
| 39 | Ahire SL | 1996 | 55 | Gendreau M | 1994 | 83 | Fisher M | 1996 | 93 | Van Wassenhove LN | 2006 |
| 39 | Parasuraman A | 1988 | 55 | Spengler JJ | 1950 | 81 | Elmaghraby W | 2003 | 93 | Swink M | 2007 |
| 39 | Gavirneni S | 1999 | 55 | Pfeffer J | 1978 | 81 | Hill TJ | 1989 | 91 | Rao P | 2005 |
| 39 | Simchi-Levi D | 2000 | 55 | Thompson J | 1967 | 80 | Potts CN | 2000 | 89 | Pisinger D | 2007 |
| 39 | Thierry M | 1995 | 55 | Conway RL | 1967 | 80 | Linton JD | 2007 | 89 | Santoso T | 2005 |
| 38 | Rosenblatt MJ | 1986 | 55 | Lambert DM | 2000 | 79 | Buzacott JA | 1993 | 89 | Souza GC | 2013 |
| 38 | Bodin L | 1983 | 55 | Donohue KL | 2000 | 79 | Cooper MC | 1997 | 89 | Grant RM | 1996 |
| 38 | Galbraith JR | 1973 | 54 | Federgruen A | 1999 | 79 | Taylor TA | 2002 | 88 | Williamson OE | 1975 |
| 38 | Francis R | 1992 | 54 | Flynn BB | 1994 | 79 | Petersen KJ | 2005 | 88 | Taylor TA | 2002 |
| 38 | Kolisch R | 1995 | 54 | Kleinrock L | 1976 | 79 | Swink M | 2007 | 88 | Ferguson ME | 2006 |
| 38 | Thomas DJ | 1996 | 53 | Bozarth CC | 1999 | 79 | Craighead CW | 2007 | 87 | Womack JP | 1990 |
| 38 | Lee HL | 2000 | 53 | Hill RM | 1997 | 79 | Hart SL | 1995 | 87 | Nawaz M | 1983 |
| 37 | Lee HL | 1993 | 53 | Goyal SK | 1988 | 78 | Thompson J | 1967 | 87 | Hendricks KB | 2005 |
| 37 | Monahan JP | 1984 | 52 | Porteus EL | 1986 | 78 | Tsay AA | 1999 | 86 | Nyaga GN | 2010 |
| 37 | Gallego G | 1994 | 52 | Hall NG | 1996 | 78 | Weber CA | 1991 | 86 | Teece DJ | 2007 |
| 37 | Yelle LE | 1979 | 52 | Taylor TA | 2002 | 78 | Dwyer FR | 1987 | 86 | Debo LG | 2005 |
| 37 | Gilmore PC | 1963 | | | | 77 | Monden Y | 1993 | 85 | Cachon GP | 2009 |
| 37 | Uzsoy R | 1992 | | | | 77 | Hendricks KB | 2003 | 85 | Linton JD | 2007 |
| 37 | Potts CN | 2000 | | | | | | | 84 | Tsay AA | 2004 |
| 37 | Blackstone JH | 1982 | | | | | | | 84 | Koufteros X | 2005 |
| 37 | Tirole J | 1988 | | | | | | | 84 | Vickery SK | 2003 |

## Appendix D: Documents ranked in the top 300 most co-cited, 2015-2019

| FQ | Author (first only) | Year | Title | Source |
|---|---|---|---|---|
| 305 | Barney J | 1991 | Firm resources and sustained competitive advantage | Journal of Management |
| 284 | Cachon GP | 2003 | Supply chain coordination with contracts | Handbook of Operations Research |
| 264 | Flynn BB | 2010 | The impact of supply chain integration on performance: A contingency and config. approach | Journal of Operations Management |
| 227 | Seuring S | 2008 | From a literature review to a conceptual framework for sustainable supply chain management | Journal of Cleaner Production |
| 224 | Pinedo ML | 2012 | Scheduling: Theory, algorithms, and systems | *Book* |
| 220 | Graham RL | 1979 | Optimization and approximation in deterministic sequencing and scheduling: A survey | Annals of Discrete Mathematics |
| 21 | Dyer JH | 1998 | The relational view: Cooperative strategy and sources of interorganizational competitive advantage | Academy of |

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| | | | | |
|---|---|---|---|---|
| 5 | | | | Management Review |
| 2 | Cachon GP | 2005 | Supply chain coordination with revenue-sharing contracts: strengths and limitations | Management Science |
| 1 | Tomlin B | 2006 | On the value of mitigation and contingency strategies for managing supply chain disruption risks | Management Science |
| 1 | Teece DJ | 1997 | Dynamic capabilities and strategic management | Strategic Management Journal |
| 1 | Lee HL | 1997 | Information distortion in a supply chain: The bullwhip effect | Management Science |
| 1 | Zipkin PH | 2000 | Foundations of Inventory Management | *Book* |
| 1 | Frohlich MT | 2001 | Arcs of integration: An international study of supply chain strategies | Journal of Operations Management |
| 1 | Fisher ML | 1997 | What is the right supply chain for your product? | Harvard Business Review |
| 1 | Ropke S | 2006 | An adaptive large neighborhood search heuristic for the pickup and delivery problem with time windows | Transportation Science |
| 1 | Tang CS | 2006 | Perspectives in supply chain risk management | International Journal of Production Economics |
| 1 | Carter CR | 2008 | A framework of sustainable supply chain management: moving toward new theory | International J. of Physical Distribution & Logistics Mgt. |
| 1 | Petruzzi NC | 1999 | Pricing and the newsvendor problem: A review with extensions | Operations Research |
| 1 | Kleindorfer PR | 2005 | Managing disruption risks in supply chains | Production & Operations Management |
| 1 | Mentzer JT | 2001 | Defining supply chain management | Journal of Business Logistics |
| 1 | Savaskan RC | 2004 | Closed-loop supply chain models with product remanufacturing | Management Science |
| 1 | Wernerfelt B | 1984 | A resource- based view of the firm | Strategic Management Journal |
| 1 | Larivier e MA | 2001 | Selling to the newsvendor: An analysis of price-only contracts | Manufacturing & Service Operations Management |


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| | | | | |
|---|---|---|---|---|
| 1 | William | 19 | The economic institutions of capitalism: firms, markets, relational contracting | *Book* |
| 3 | son OE | 85 | | |
| 6 | | | | |
| 1 | Cao M | 20 | Supply chain collaboration: Impact on collaborative advantage and firm performance | Journal |
| 3 | | 11 | | of |
| 6 | | | | Operatio |
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