Big data analytics for supply chain management: A literature review and research agenda

Samuel Fosso Wamba[1] and Shahriar Akter[2]
[1]NEOMA Business School, 1 Rue du Maréchal Juin, BP 215, 76825 Mont Saint Aignan Cedex, France
[2]Faculty of Business, University of Wollongong, Northfields Ave, Wollongong NSW 2522, Australia
{samuel.fosso.wamba@neoma-bs.fr, sakter@uow.edu.au}

Abstract. The main objective of this study is to provide a literature review of big data analytics for supply chain management. A review of articles related to the topics was done within SCOPUS, the largest abstract and citation database of peer-reviewed literature. Our search found 17 articles. The distribution of articles per year of publication, subject area, and affiliation, as well as a summary of each paper are presented. We conclude by highlighting future research directions where the deployment of big data analytics is likely to transform supply chain management practices.

Keywords: Big data analytics, value, adoption and use, supply chain management, review.

1 Introduction

Big data analytics (BDA) is defined as a holistic approach to manage, process and analyze the "5 Vs" data-related dimensions (i.e., volume, variety, velocity, veracity and value) in order to create actionable insights for sustained value delivery, measuring performance and establishing competitive advantages [1]. It has recently emerged as "the next big thing" in management. Some scholars and practitioners even suggest that BDA is the "fourth paradigm of science" [2, p.34], or even "the next frontier for innovation, competition, and productivity" [3, p.1], or the "new paradigm of knowledge assets" [4, p. 2]. These statements are mainly driven by the pervasive adoption and use of various tools and technologies, including social media (e.g., Facebook, Twitter), mobile devices (e.g., laptops, smartphones), automatic identification technologies enabling the Internet of Things (IoT) (e.g., radio frequency identification (RFID), Bluetooth), and cloud-enabled platforms to support intra- and inter-organizational business processes and achieve a competitive advantage. Some analysts estimate that Twitter users generate more than 250 million tweets per day, while about 50 hours of video are uploaded each minute on YouTube from around the world. The same analysts estimate that Facebook now holds more than 90 billion photos, with over 200 million photos uploaded per day [5].

For example, the consulting firm IDC predicts that 2015 will see accelerating disruption, based on expanding adoption of the 3rd Platform's cloud, mobile, social, big data, and IoT technologies [6]. In addition, worldwide IT and telecommunications spending is expected to grow by 3.8% in 2015 to more than $3.8 trillion. Virtually all of this growth in expenditures and one third of total spending will be absorbed by new technologies such as mobile, cloud, BDA and IoT. With regard to big data spending, IDC believes that spending on big-data-related software, hardware, and services worldwide will reach $125 billion in 2015 [6].

The pervasive diffusion of these tools and technologies is expected to transform the way we currently conduct business. This is particularly true of supply chain management (SCM). Prior studies of SCM have highlighted the importance of achieving a high level of integration of inter- and intra-organizational processes and information systems in order to attain a greater level of seamless coordination and reduce repeated efforts and related inefficiencies. For example, the combination of RFID-enabled intelligent products and intelligent services with the existing information and communication technologies in supply chains (SCs) should play a facilitating role – thus making products and services more visible to SC members – and in parallel should offer more opportunities for quick and efficient SC activities [7]. SC members will therefore face greater strain as they will be expected to manage not only their own activities in relation to those products and services but also the integration of upstream and downstream core business processes and inter- and intra-organizational information systems. In this context, the access to critical information for informed decision-making becomes not only a prerequisite but also a major challenge. The main objective of this paper is to contribute to this debate by examining the following research questions:

1. What is the potential of BDA in the SC?
2. Where should future development effort be directed to accelerate the adoption and use of BDA in the SC?

To address these questions, this research draws on the emerging literature on BDA and SCM, as well as an in-depth analysis of articles on BDA-enabled SC identified in SCOPUS, the largest abstract and citation database of peer-reviewed literature.

The rest of this paper is structured as follows. Section 2 reviews BDA in the SC. Section 3 describes the research methodology. Section 4 presents the results and discusses the key findings. Finally, Section 5 provides the conclusion including future research directions.

2 BDA-ENABLED SUPPLY CHAIN

A supply chain has been defined as "a bidirectional flow of information, products and money between the initial suppliers and final customers through different organizations"; SCM includes planning, implementing and controlling this flow [8]. In the current digital economy, SCs have been viewed as key levers for competitive advantage. That is probably why some scholars argue that competition within the market space [9] has evolved from "firm versus firm" towards "supply chain versus supply chain" [10]. In this context, the adoption and use of innovative IT has been considered as a critical resource for SC optimization. For example, SCM plays an important role in minimizing a company's overall risk of fraud, bribery, and corruption [11]. Prior studies identified numerous benefits related to IT-enabled SC optimization, including end-to-end information sharing among SC stakeholders [12-

15]; intra- and inter-organizational business process transformation (e.g., cancellation, redesign, automation) [7, 16]; improved decision-making within the SC [17]; improved operational efficiency [18, 19]; and increased revenue [14].

BDA is expected to take SC transformation to a level of transformation never before achieved. For example, BDA represents a critical source of meaningful information that may help SC stakeholders to gain improved insights they can use for competitive advantage [4, 11]. In addition, BDA could help SC stakeholders to reduce their exposure to various risks including the risk of fraud and other malfeasance [11]. In the context of SC execution, BDA could lead to increased efficiency and profitability in the SC by maximizing speed and visibility, improving SC stakeholders' relationships, and enhancing SC agility [20]. BDA could result in faster time to market and the potential for superior revenue recognition [5]. However, some analysts argue that the deluge of data threatens to "break the existing data supply chain" [5, p. 3].

3 Methodology

For this study, a hybrid approach derived from work by Ngai and Wat [22] and Fosso Wamba et al. [21, 22] was used. This approach consisted in a search using the following keywords: "Big data" AND "supply chain" within the SCOPUS database. SCOPUS is the largest abstract and citation database of peer-reviewed literature. This bibliographic database holds more than 19,000 peer-reviewed journals, over 1,800 "open access" journals, more than 600 trade publications, 350 book series, and content from over 435 million web pages. The search was conducted on Friday 30 January 2015, and we found 17 articles on the topic [23-39].

4 Results and Discussion

The section below presents and discusses the findings of big-data-related SC articles identified in SCOPUS [23-39], with the summary presented in the Appendix A.

Table 1 presents the distribution of articles by the year of publication. We can see a jump in big-data-related SC publications in 2013 (7 articles or 41%), with a small increase in 2014 (8 articles or 47%). On 30 January 2015, we already had 1 article (or 6%) on big-data-related SC topics in 2015, which is the equivalent of the whole year's publication on the same topic in 2012.

Table 1. Distribution of publications by year

	Number of papers	%
2015	1	6%
2014	8	47%
2013	7	41%
2012	1	6%
Total	17	100%

The distribution of articles by subject area is presented in Table 2. It is clearly appears that the vast majority of articles identified in our review are from “Business, Management and Accounting” (8 articles, 25.8%), and “Computer Science” (7 articles, 22.6%), followed by “Decision Sciences” and “Engineering” with 6 articles each (or 19.4% of all publications). Surprisingly, no article was identified for the “Multidisciplinary” and “Psychology” subject areas. Clearly, more studies are needed in these two subject areas.

Table 2. Distribution of publications by subject area

	Number of papers	%
Business, Management and Accounting	8	25.8%
Computer Science	7	22.6%
Decision Sciences	6	19.4%
Engineering	6	19.4%
Agricultural and Biological Sciences	1	3.2%
Arts and Humanities	1	3.2%
Economics, Econometrics and Finance	1	3.2%
Materials Science	1	3.2%
Multidisciplinary	0	0%
Psychology	0	0%
Total*	31	100%

*Some articles are counted more than once because they cover more than one subject area.

Table 3. Distribution of publications by country

	Number of papers	%
United States	12	63.2%
China	4	21.1%
Germany	1	5.3%
Latvia	1	5.3%
Netherlands	1	5.3%
Total*	19	100%

*Some articles are counted more than once because their authors come from more than one country.

Table 3 shows the classification of articles by country. So far, most published articles on BDA in the SC come from the United States (12 articles, 63.2%), trailed by China (4 articles, 21.1%), and Germany, Latvia and Netherlands with 1 article each (5.3%). Clearly, the United States is leading in research on BDA in the SC. The impact of BDA in emerging economies and less developed countries should be part of future research directions.

With regard to authors, the ones with the largest number of publications are S.E. Fawcett and M.A. Waller, with 4 articles each on BDA-related SC topics.

5 CONCLUSION AND FUTURE RESEARCH DIRECTIONS

In this paper, we used a hybrid approach derived from two earlier studies [21, 22] to conduct a review of articles on big data in the SC in SCOPUS. Our review found 17 articles on the topic. Distributions of articles by year of publication, subject area, and country, as well as the summary of each article were presented. Our review showed that the vast majority of articles appeared in the fields of "Business, Management and Accounting," "Computer Science," "Decision Sciences" and "Engineering." Therefore, more research needs to be done to assess the impact of big data on others subject areas including "Agricultural and Biological Sciences," "Arts and Humanities," "Economics, Econometrics and Finance," "Materials Science," "Multidisciplinary," and "Psychology."

How we deploy new tools and technologies to support BDA projects for high-level business value realization at the firm and SC levels is another interesting avenue for future research. Indeed, early studies on BDA argue that, in order to close the "gap between what the data knows and what we know as individuals," organizations must develop and deploy new technologies that integrate the impressive amount of data collected across the organization as well as "provide smarter tools for analysis, visualization and access" [4, p. 2]. In addition, Hagstrom [4] identifies the collection and storage of data in silos as a problem, which may make analysis quite difficult. Thus, the impact of BDA technologies on the firm and the SC level when these technologies are used only in a localized portion of the SC should be a focus of future research. In addition, it would be interesting to examine the impact of BDA on overall firm IT spending. Indeed, some scholars posit that BDA may create a data deluge "that further accelerates IT expenditures and hinders rather than helps. (…) [as] Adding to data is not so important; it is what you take away from the data that matters" [4, p. 3]. Furthermore, future research must be conducted to assess BDA's ability to enhance intra- and inter-firm efficiency and effectiveness (e.g., identification of bottlenecks, improved predictive maintenance, and scenario building for improved quality control). What is the cost of the complementary resources (e.g., IT, HR, trust) needed to capture the value from BDA at the firm and SC levels? For example, analysts estimate that big data drove $34 billion in IT spending in 2013 [40]. Also, how easily will data become a valuable asset within the SC? If it does, how can we develop a new business monetization model with data as an asset [5]? Assessing the cost related to the digitization of big data should be included in future research programs. Developing new strategies, tools and technologies that will foster data quality and the cleaning of big data represents an interesting challenge. Indeed, analysts estimate that the cost of poor data quality within a typical firm is between 8% and 12% of revenues [5]. What will be the best big data management strategy at the firm and SC levels? Should we develop internal data centers at the firm level or move toward a cloud-based architecture at the firm and SC levels for data storage? In the latter case, who owns the data? The answers to these questions should be included in future research avenues. Evaluating the impact of big data on the structure of traditional SCs and various industries should also be a future research topic. Consequently, it would be useful to investigate the potential of big-data-enabled new business models and new industry structures.

6 References

1. Fosso Wamba, S., et al., *How 'big data' can make big impact: Findings from a systematic review and a longitudinal case study.* International Journal of Production Economics, 2015. **0**(0): p. xx-xx.
2. Strawn, G.O., *Scientific Research: How Many Paradigms?* EDUCAUSE Review, 2012. **47**(3): p. 26.
3. Manyika, J., et al., *Big data: the next frontier for innovation, competition and productivity*, 2011, McKinsey Global Institute.
4. Hagstrom, M., *High-performance analytics fuels innovation and inclusive growth: Use big data, hyperconnectivity and speed to intelligence to get true value in the digital economy.* Journal of Advanced Analytics, 2012(2): p. 3-4.
5. Sethuraman, M.S., *Big Data's Impact on the Data Supply Chain*, in *Cognizant 20-20 Insights*2012, Cognizant: New Jersey.
6. IDC, *IDC Predictions 2015: Accelerating Innovation — and Growth — on the 3rd Platform*, 2015.
7. Fosso Wamba, S., et al., *Exploring the impact of RFID technology and the EPC network on mobile B2B eCommerce: A case study in the retail industry.* International Journal of Production Economics, 2008. **112**(2): p. 614-629.
8. Nurmilaakso, J.-M., *Adoption of e-business functions and migration from EDI-based to XML-based e-business frameworks in supply chain integration.* International Journal of Production Economics, 2008. **113**(2): p. 721-733.
9. Gunasekaran, A. and E.W.T. Ngai, *Information systems in supply chain integration and management.* European Journal of Operational Research, 2004. **159**(269-295).
10. Ketchen, D.J.J. and G.T.M. Hult, *Bridging organization theory and supply chain management: the case of best value supply chains.* Journal of Operations Management, 2007. **25**: p. 573-580.
11. Kenny, J. *Big data can have big impact on supply chain management: The use of data analytics is underused in supply chain management to minimize risk exposure*. IC Inside Counsel 2014 [cited 2015 February 17]; Available from: http://www.insidecounsel.com/2014/04/23/big-data-can-have-big-impact-on-supply-chain-manag.
12. Sahin, F. and E.P. Robinson, *Flow Coordination and Information Sharing in Supply Chains: Review, Implications, and Directions for Future Research.* Decision Sciences, 2002. **33**(4): p. 505-536.
13. Saeed, K.A., M.K. Malhotra, and V. Grover, *Examining the Impact of Interorganizational Systems on Process Efficiency and Sourcing Leverage in Buyer–Supplier Dyads*. Decision Sciences, 2005. **36**(3): p. 365-396.
14. Rai, A., R. Patnayakuni, and N. Seth, *Firm performance impacts of digitally enabled supply chain integration capabilities.* MIS Quarterly, 2006. **30**(2): p. 225-246.
15. Eric, T.G.W. and W. Hsiao-Lan, *Interorganizational Governance Value Creation: Coordinating for Information Visibility and Flexibility in Supply Chains*.* Decision Sciences, 2007. **38**(4): p. 647-674.
16. Fosso Wamba, S., *Achieving Supply Chain Integration using RFID Technology: the Case of Emerging Intelligent B-to-B e-Commerce Processes in a Living Laboratory.* Business Process Management Journal, 2012. **18**(1): p. 58-81.
17. Asoo, J.V., *e-Business and supply chain management* Decision Sciences, 2002. **33**(4): p. 495-504.
18. Johnston, H.R. and M.R. Vitale, *Creating competitive advantage with inter-organizational information systems.* MIS Quarterly, 1988. **12**(2): p. 153-165.

19. Devaraj, S., L. Krajewski, and J.C. Wei, *Impact of eBusiness technologies on operational performance: The role of production information integration in the supply chain.* Journal of Operations Management, 2007. **25**(6): p. 1199-1216.
20. Vasan, S. *Impact of Big Data and Analytics in supply chain execution*. Supply Chain Digital 2014 [cited 2015 February 13]; Available from: http://www.supplychaindigital.com/logistics/3382/Impact-of-Big-Data-and-Analytics-in-supply-chain-execution.
21. Ngai, E.W.T. and F.K.T. Wat, *A literature review and classification of electronic commerce research.* Information & Management, 2002. **39**(5): p. 415-429.
22. Fosso Wamba, S., A. Anand, and L. Carter, *A literature review of RFID-enabled healthcare applications and issues.* International Journal of Information Management, 2013. **33**(5): p. 875-891.
23. Brandau, A. and J. Tolujevs, *Modelling and analysis of logistical state data.* Transport and Telecommunication, 2013. **14**(2): p. 102-115.
24. Fattah, A., *Going beyond data science toward an analytics ecosystem: Part 3.* IBM Data Management Magazine, 2014(3).
25. Fawcett, S.E. and M.A. Waller, *Supply chain game changers-mega, nano, and virtual trends-and forces that impede supply chain design (i.e., Building a Winning Team).* Journal of Business Logistics, 2014. **35**(3): p. 157-164.
26. Fawcett, S.E. and M.A. Waller, *Can we stay ahead of the obsolescence curve? On inflection points, proactive preemption, and the future of supply chain management.* Journal of Business Logistics, 2014. **35**(1): p. 17-22.
27. Groves, W., et al., *Agent-assisted supply chain management: Analysis and lessons learned.* Decision Support Systems, 2014. **57**(1): p. 274-284.
28. Hazen, B.T., et al., *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.* International Journal of Production Economics, 2014. **154**: p. 72-80.
29. Huang, Y.Y. and R.B. Handfield, *Measuring the benefits of erp on supply management maturity model: A "big data" method.* International Journal of Operations and Production Management, 2015. **35**(1): p. 2-25.
30. Jin, Y. and S. Ji, *Partner choice of supply chain based on 3d printing and big data.* Information Technology Journal, 2013. **12**(22): p. 6822-6826.
31. Kumar, A., F. Niu, and C. RÉ, *Hazy: Making It Easier to Build and Maintain Big-Data Analytics.* Communications of the ACM, 2013. **56**(3): p. 40-49.
32. Li, Y., N. Ren, and M. Cao, *WBS data analysis method based on information supply Chain.* Journal of Applied Sciences, 2013. **13**(12): p. 2355-2358.
33. Sonka, S., *Big data and the ag sector: More than lots of numbers.* International Food and Agribusiness Management Review, 2014. **17**(1): p. 1-20.
34. Tien, J.M., *The next industrial revolution: Integrated services and goods.* Journal of Systems Science and Systems Engineering, 2012. **21**(3): p. 257-296.
35. Waller, M.A. and S.E. Fawcett, *Data science, predictive analytics, and big data: A revolution that will transform supply chain design and management.* Journal of Business Logistics, 2013. **34**(2): p. 77-84.
36. Waller, M.A. and S.E. Fawcett, *Click here for a data scientist: Big data, predictive analytics, and theory development in the era of a maker movement supply chain.* Journal of Business Logistics, 2013. **34**(4): p. 249-252.
37. Wu, J., Y.H. Ni, and Y. Lv, *Ontology-driven approach for distributed information processing in supply chain environment.* Zhejiang Daxue Xuebao (Gongxue Ban)/Journal of Zhejiang University (Engineering Science), 2014. **48**(11): p. 2017-2024.
38. Yesudas, M., G. Menon, and V. Ramamurthy, *Intelligent operational dashboards for smarter commerce using big data.* IBM Journal of Research and Development, 2014. **58**(5-6).

39. Zhang, Q., et al., *A case study of sensor data collection and analysis in smart city: Provenance in smart food supply chain.* International Journal of Distributed Sensor Networks, 2013. **2013**.
40. Brock, J., et al., *Big Data's Five Routes to Value: Opportunity Unlocked*, in *FOCUS*2013, The Boston Consulting Group: London.
41. Hazen, B.T., et al., *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*. International Journal of Production Economics, 2014. **154**(0): p. 72-80.

Appendix A. Summary of articles

Study	Context	Key findings
[29]	ERP selection and implementation.	• ERP users are more mature than non-ERP users in three key indicators: strategic sourcing, category management, and supplier relationship management. • SAP ERP users are more mature than non-ERP users in strategic sourcing, category management, and supplier relationship management.
[35]	Exploration of opportunities for research where SCM intersects with data science, predictive analytics, and big data.	• BDA has significant implications for operations and SCM, and presents an opportunity and a challenge to our research and teaching approach. • It is easy to see how data science and predictive analytics apply to SCM but sometimes more difficult to see the direct connection of big data to SCM. • Call for more research on BDA including for *Journal of Business Logistics*.
[36]	Discussion about big data, predictive analytics, and theory development in the era of a maker movement SC.	• Predictive analytics can be part of the theory building process, even when a given study does not produce or test a specific theory. • Points to the need for strong predictive analytics applications and theory because the disintermediation of the traditional supply chain channels means that consumer behavior has become an integral part of both production and demand. • Call for more research on BDA including for *Journal of Business Logistics*.
[26]	Discussion of the impact of emerging concepts and technologies (e.g., 3D printing, BDA) on future of SCM.	• All these new concepts and technologies are changing the SCM world. • However, very few firms are proactively managing renewal well. The authors argued that "Paradoxically, past successes often stand in the way, undermining rejuvenation" (p. 21). • Call for more research on these concepts and technologies including for *Journal of Business Logistics*.
[25]	Exploration of SC game changers.	• Exploration of five emerging "game changers" that represent potential supply chain design inflection points: (1) big data and predictive analytics, (2) additive manufacturing, (3) autonomous vehicles, (4) materials science, and (5) borderless supply chains. • Consideration of four forces that impede transformation to higher levels of value co-creation: (1) supply chain security, (2) failed change management, (3) lack of trust as a governance mechanism, and (4) poor understanding of the "luxury" nature of corporate social responsibility initiatives. • Conclusions: how well managers address sociostructural and sociotechnical issues will determine firm survivability and success (p. 157).
[31]	Exploration of the potential of big data with the latest statistical and machine-learning techniques via the discussion of the Hazy project.	• The high-profile success of many recent BDA-driven systems, also called trained systems, has generated great interest in bringing such technological capabilities to a wider variety of domains. A key challenge in converting this potential to reality is making these trained systems easier to build and maintain.
[33]	Examination of the potential for BDA application in the agricultural sector.	• Integration of data and analysis across business and government entities will be needed for successful implementation (p. 1). • The eventual impact of BDA within the agricultural sector will likely require both organizational and technological innovation (p. 1).
[27]	Exploration of BDA analysis in the context of SCM, followed by a proposal for the use of agent-based competitive simulation as a tool to develop complex decision-making strategies and to stress test them under a variety of market	• When automating business processes, designers should be concerned with business agility and particularly with how the automated process will respond to situations where the standard assumptions of the market may be violated (p. 283). • The use of KPIs may facilitate the process by providing characteristics to measure across the automated SC, and realistic simulation techniques provide rich data sets with which to accurately measure behavior in different situations (p. 283).

	conditions. The authors also propose an extensive set of key performance indicators and apply them to analyze market dynamics.	
[39]	A case study of sensor data collection and analysis in smart city with a focus on smart food supply chain.	• One of the important application areas of the IoT in cities is the food industry. • IoT systems help to monitor, analyze, and manage the food industry in cities. • The proposed smart sensor data collection strategy for IoT has the ability to improve the efficiency and accuracy of provenance (e.g., tracing contamination source and back-tracking potentially infected food in the markets) and minimize the size of the data set at the same time.
[38]	Review of the current research on OI that uses streaming data and proposes an approach to design intelligent operational dashboards for SCM systems.	• With the BDA advantage, live streaming data can be processed to build intelligent dashboards providing insights for management teams (p. 9).
[34]	Discussion of the third industrial revolution.	• The Third Industrial Revolution (TIR) is based on the confluence of three major technological enablers: big data analytics, adaptive services and digital manufacturing (p. 257). • These three major technological enablers underpin the integration or mass customization of services and/or goods. • The TIR potential: o is about the integration of services and goods into "servgoods"; o is about the integration of demand and supply chains; o requires more big data analytics, adaptive services, digital manufacturing, mass customization and other white-collar professionals; o minimizes the need for outsourcing and offshoring; and o can subsume mass production within its broader mass customization framework. • As for concerns, TIR: o makes uneducated or undereducated men and women jobless; o aggravates cybersecurity, privacy and confidentiality problems; o aggravates the economic and social divide between the rich and poor within a country; and o aggravates the economic and social divide between the have and have-not countries (p. 293).
[37]	An ontology-driven approach for distributed information processing in SC environments.	• Using supply chain event ontology based on the ABC and SCOR models, the study shows that automatic access rules on local ontology and the use of ontology mapping could facilitate the realization of heterogeneous data integration, and thus foster facilitate distributed decision-making.
[24]	Analysis of the extended analytics ecosystem.	• The extended analytics ecosystem includes individuals and groups who use analytics functions, and involves several key roles and elements including: executive sponsors (e.g., chief marketing officer (CMO), chief financial officer (CFO), or chief operating officer (COO)), data owners, subject-matter experts, business users, external analytics ecosystem places the organization within the wider data supply chain (e.g., incorporate data from the SC network to multiply the value generated or provide focal firm data and analytics to other firms in the SC network), customers, external data providers, external data consumers, cloud analytics platform and business analytics as services, and big data analytics vendors and consultants. • Analytics is a game changer that will revolutionize how individuals, businesses, and society can use technology. However, the full value of analytics can be realized only when applied to integrated data from multiple sources and when insights are immediate and actionable. • Analytics should be explored gradually to understand what value can be gained from it, but this exploration should be done in a way that

		enables it to grow so more value can be obtained. • "Viewing big data analytics as an ecosystem provides the understanding of how to chart the way to start small while enabling growth to achieve advanced levels of maturity and value. By observing the success or failure in building a big data analytics capability in small and large organizations, several recommendations can be adopted" (p. 5).
[32]	Work breakdown structure method based on information SC.	• Using the guiding ideology of the MapReduce programming model, historical data, maps and reduce operations, the authors argue that it is possible to trace the source of an SC's unstable link.
[30]	Selection strategies related to the problem of partnership choice of SC in the context of 3D printing and BDA based on analytic hierarchy process and fuzzy synthetic evaluation.	• Analytic hierarchy process and fuzzy synthetic evaluation may reduce the influence of subjective factors on partner choice, enhance the accuracy and reliability of partner choice and strengthen the competitiveness of SC enterprises.
[23]	Introduction to a general concept to model and analyze logistical state data, in order to find irregularities and their causes and dependences within SCs.	• To perfectly manage an efficient and effective supply chain with a continuous and undisturbed flow of goods, it is possible to use data mining methods on logistical state data to filter irregularities and their causes.
[41]	Introduction to problems and benefits of data quality for data science, predictive analytics, and big data in SCM.	• The growing importance of data to SC managers should lead to an amplified awareness and sensitivity to their need for high-quality data products. • The results of decisions based on poor quality data could be costly. o SC managers should begin to view the quality of the data products they depend upon for decisions in much the same way they view the quality of the products their SC delivers. o Managers who appreciate the value of data products that are accurate, consistent, complete, and timely should consider the potential for using control methods to improve the quality of data products, much as these methods improved the quality of manufactured products (p. 78).