Big data and analytics in operations and supply chain management: managerial aspects and practical challenges

Thanos Papadopoulos
Kent Business School, University of Kent.
Sail and Colour Loft, The Historic Dockyard, Chatham, Kent ME4 4TE, UK
Email: a.papadopoulos@kent.ac.uk

Angappa Gunasekaran,
Charlton College of Business
University of Massachusetts Dartmouth
North Dartmouth, MA 02747-2300, USA
E-mail: agunasekaran@umassd.edu

Rameshwar Dubey
Montpellier Business School
Montpellier Research in Management
2300 Avenue des Moulins, 34000 Montpellier France
E-mail: rameshwardubey@gmail.com

Samuel FOSSO WAMBA
Toulouse Business School,
Toulouse University
20 Boulevard Lascrosses,
31068 Toulouse, France
E-mail: fossowam@gmail.com

1. Introduction

'Big Data & Analytics' (BD&A) has become increasingly important over the last years in both academic and practitioner worlds. Organizations are trying to harness the benefits of BD&A, defined as "as the techniques, technologies, systems, practices, methodologies, and applications that analyze critical business data to help an enterprise better understand its business and market and make timely business decisions" (Chen et al., 2012: p. 1166). Scholars define Big Data using the notion of "V", referring to 'Volume', that is, the amount of data; 'Velocity', referring to the frequency or speed of data generation and delivery;

'Variety', referring to the different sources that Big Data can be obtained from; 'Veracity' referring to the quality data and their extraction from trustworthy sources; and Value' that highlights the importance of the economic benefits of Big Data (Fosso Wamba et al., 2015a).

Literature highlights the potential benefits from BD&A, including, for instance, increase of 15-20% in ROI (Perrey et al., 2013), enhancing productivity and competitiveness and creating surplus for customers (Manvika et al., 2011), and allowing for performance measurement mechanisms (McAfee and Brynjolfsson, 2012). Within operations and supply chains BD&A also has potential (Dubey et al., 2015). At the strategic level, BD&A can drive decision-making with regard to future activities and processes such as strategic sourcing, supply chain network design, and product design and development. At the operational level, it can help in improving the visibility, flexibility, and integration of supply chains while managing volatility and cost fluctuations (Langley, 2014). In a recent report by Accenture (2014), more than one third of the respondent companies reported being engaged in deploying BD&A in logistics and supply chains, and three out of ten were currently implementing analytics.

However, despite the potential benefits, relatively little is known about applying BD&A within operations and supply chain management (OSCM). Contemporary concerns within OSCM literature, such as sustainability (Carter and Rogers, 2008; Seuring and Müller, 2008; Siegel, 2009), involve, inter alia, navigating through voluminous and unstructured data environments to facilitate business process monitoring, supply chain visibility, and improved manufacturing, automation, and efficiency (Davenport et al., 2012; Fosso Wamba et al., 2015b). Therefore, there is a growing need to understand the managerial processes, practical aspects and challenges, and business effects when utilising BD&A tools and techniques in organizations and supply chains. This need gave us the impetus for the SI. Therefore, in this SI we invited OM scholars and practitioners to present novel solutions to the managerial processes, practical aspects and challenges, and business effects related to BD&A within OSCM. The special issue aims at sharing best practical experiences to benefit readers, and to provide clear evidence of the role of BD&A within OSCM. In the following section of this editorial note we provide an overview of the eleven articles we have included in the SI after a rigorous review process.

2. Contributions to the Special Issue

The response to our call for papers (CFP) for this SI was tremendous. However, some of the papers did not have a good fit to the SI, no matter if they were exceptional pieces of work; these had to be rejected. The rest of the papers were reviewed by two reviewers at least. On the basis of the reviewers' comments, authors had been invited to revise and resubmit their papers, and after three rounds of reviews we finally selected ten papers for the SI.

In the first paper Lamba and Singh provide an overview of the current status of Big Data in three domains, that is, procurement, manufacturing, and logistics, which are at the core of OSCM. Of the three categories, they suggest that manufacturing is the area where most research has focused, whereas procurement is at the other end of spectrum with limited research carried out so far. Demand forecasting and quality control are popular topics amongst OSCM researchers but still these works are mainly theoretical and do not contribute greatly on building mathematical models that apply Big Data for better decision making. Furthermore, based on their extensive literature review, Lamba and Singh propose three theoretical frameworks that illustrate the use of Big Data for decision making optimisation focusing on the problems of facility layout, procurement and supplier selection. These frameworks need to be further tested in order to assist managers in understanding and considering the role and impact of Big data for better decision making within OSCM.

In the second paper Weerakkody et al. discuss the importance of big open data in improving supplier and distribution netwroks and creating resilient supply chains that improve the efficiency of public services. They suggest that acceptance of big open data has not been addressed by the literature and to address this gap, they are based on the Technology Acceptance Model to examine those factors that influence the behavioural intention of users towards accepting big open data. A total of four hypotheses were formed to determine the effects of perceived usefulness, perceived ease of use, and social approval on users' behavioural intentions and their perceptions of usefulness of open data. The findings suggested that users may not be sure about what big open data actually is and whether it brings transparency. Therefore, it is vital to understand the perception of citizens on big open data and its effect on the creation of supply chains for the delivery of efficient public services. Users should therefore be educated on the usefulness of big open data that provides transparency and allows them to participate in policymaking and governmental decision making, delivering efficient services to citizens.

In the third paper, Chavez et al. focus on data-driven supply chains (DDSC). They claim that although research on big data in OSCM has investigated their benefits and potential as well as the relationship between characteristics of big data and multiple manufacturing capability dimensions, the relationship between DDSC and multiple manufacturing capability dimensions, that is, flexibility, delivery, quality, and cost that lead to customer satisfaction improvement has not been in-depth investigated. To address this gap, Chavez et al. created and tested empirically a model based on survey data from the Chinese manufacturing sector. Their results suggested that DDSC are positively associated with multiple manufacturing capability dimensions (i.e., quality, delivery, flexibility and cost), which in turn, lead to customer satisfaction improvement. While delivery appears to have no significant effect on customer satisfaction, quality, flexibility and cost are significantly and positively associated with customer satisfaction. Their study provides useful lessons to managers in that efforts should be targeted on creating the appropriate strategic capabilities such as quality, flexibility, and cost as the impact on satisfaction. Delivery is not a strategic capability, it is however important for firms to remain in the market.

In the fourth paper Subramanian and Abdulrahman focus on big data from a cloud computing lens. They examine the inter-organizational benefits of cooperative resilience between cloud computing (CC) and logistics service providers in terms of both capability and trust vulnerability factors. They are based on innovation diffusion theory (IDT) within a supply-chain risk assessment framework whereas they use 236 Chinese logistics companies' perceptions of CC adoption. Their results highlight that, for Chinese small and medium-sized logistics companies, managers should aim at maintaining the relationship between the CC services and the providers' capabilities in terms of security and vulnerability towards trust for their business.

Roden et al. in the fifth paper investigate the role of big data in delivering strategic and transformational change, in particular its use within organizations and the way it is enabling change at the core operations models of organizations. Based on scholars suggesting that Big Data needs further conceptualization and contextualization, Roden et al. provide a framework that explains how big data can transform operations models, acknowledging the value of big data as technology-based advantage that influences decision-making processes and is used to guide operations management and new product development.

In the sixth paper Mishra et al. focus on food and in particular in beef supply chains. They review the literature on social media big data and supply chains in order to identify those factors that influence consumers' beef purchasing decisions. They then explore the

interrelationships between these factors using Big Data as supplemented with Interpretive Structural Modelling (ISM) and Fuzzy MICMAC analysis. Their study highlights, inter alia, the role of traceability and packaging variables within the supply chain of beef retailers in alluring customers. Furthermore, managers should consider the tradeoffs between price and quality, taste, food safety, nutrition, colour while purchasing the beef products. Therefore, this study provides insights into developing consumer-centric beef supply chains based on big data by attending not only to price and quality, but also traceability, which has been found as greatly influencing consumers' buying behaviour.

Liu et al. in the seventh paper adopt a big data approach to understand the role of online reviews and reviewer characteristics in predicting product sales. They use amazon.com data captured using big data architecture, and conduct neural network analysis and sentiment analysis to measure the sentiment strength and polarity of review content. Their findings suggest that quantitative characteristics of online reviews such as the valence, volume, number of people who find reviews helpful and rating of the most helpful positive review to be important predictors of online sales. Among these variables, review volume and review valence are significantly and positively related to product sales. Managers should therefore pay attention to review volume and valence in order to make accurate predictions of sales and inventory and therefore manage their supply chains more effectively.

In the eighth paper, Song et al. look into the role of big data in environmental efficiency evaluation. These scholars are driven by firstly the need to improve environmental efficiency evaluation under big data and secondly by the challenges related to the use of Data Envelopment Analysis (DEA) under the big data lens. To address these gaps, they discuss evaluation approaches of environmental efficiency in the context of big data, challenges for evaluation that related to the huge amount of complex information, dynamic unstructured information, lack of accuracy and stability of data, and repeated use of inputs, and provide specific recommendations to managers on the use of evaluation.

Ramanathan et al. in the ninth paper of this SI discuss the issues that retail firms face when they engage in a business analytics (BA) project to improve business performance. Their study is based on the paucity of the literature in understanding the factors behind the successful implementation of BA and its impact on business performance. Following the tenets of Technology-Organisation-Environment (TOE) framework, the study suggests that apart from these factors, business performance (including environmental performance) as well as integration and trust are important in understanding BA and its

impact on business performance. Furthermore, the level of adoption and integration of IT influences the link between the TOE factors and performance. From a managerial perspective, firms who integrate TOE factors, integration, and trust will benefit significantly from implementing BA; those who are sluggish and are still dealing with their legacy systems will be hindered significantly from benefiting from BA.

Sushil, in the tenth paper of this SI, focuses on methodological challenges. He provides a discussion of the role of big data in valuation of flexibility initiatives. The paper answers the question: "How the interpretive methods can be effectively used for multi-criteria flexibility valuation and how can it be made more evidence-based using big data?" To answer this question the paper illustrates the use of integrated Total Interpretive Structural Modelling- Interpretive ranking process (TISM-IRP) with weights of benefits as well as costs for flexibility valuation of multiple initiatives. Sushil suggests a big data framework in terms of variables, data sources, collection and collation, mining, clustering and association methods, and finally the interpretation with expert involvement. The paper highlights the advantages for managers when using this method for flexibility valuation.

Finally, the paper by Wamba et al. completes our SI with a focus on the methodological challenges underpinning the analysis of Big Data. Wamba et al. extend quality modelling in big data following the resource based theory lens and discuss the suitability of the partial least squares (PLS) approach to SEM (PLS-SEM) in estimating a complex model drawing on the philosophy of verisimilitude and the methodology of soft modelling assumptions. The results confirm the utility of PLS-SEM as a promising tool to estimate a complex, hierarchical model in the domain of big data analytics quality. Managers could use this method to explain, for instance, how big data analytics can improve business value and satisfaction as well as business analytics quality.

We would like to express their sincere thanks the Editor-in-Chief for giving us an opportunity to organize the SI on this emerging theme. Furthermore, we would like to thank our reviewers who have spent their time reviewing and providing quality inputs to the articles included. Finally, we would like to thank the editorial staff of PPC for their continuous support during this process. Thank you All!

References:

Accenture Global Operations Megatrends Study. 2014. "Big Data Analytics in Supply Chain: Hype or Here to Stay?" http://www.accenture.com/us-

en/Pages/insight-global-operations-megatrends-big-data-analytics.aspx. Accessed by December 7, 2014.

Carter, C. R., and D. S. Rogers. 2008. "A framework of sustainable supply chain management: moving toward new theory." *International Journal of Physical Distribution & Logistics Management 38* (5): 360-387.

Chen, H., R. Chiang, and V. C. Storey. 2012. "Business intelligence and analytics: from big data to big impact." *MIS Quarterly* 36 (4): 1165-1188.

Davenport, T. H., P. Barth, and R. Bean. 2012. "How Big Data Is Different". *MIT Sloan Management Review* 54 (1): 43-46.

Dubey, R., A. Gunasekaran, S. J. Childe, S. F. Wamba, and T. Papadopoulos. 2015. "The impact of Big Data on World Class Sustainable Manufacturing". *International Journal of Advanced Manufacturing Technology* DOI: 10.1007/s00170-015-7674-1

Fosso Wamba, S, S. Akter, A. Edwards, G. Chopin, and D. Gnanzou. 2015a. "How 'big data' can make big impact: Findings from a systematic review and a longitudinal case study." *International Journal of Production Economics* 165: 234–246.

Fosso Wamba, S., S. Akter, T. Coltman, and E.W.T. Ngai. 2015b. Guest editorial: information technology-enabled supply chain management. *Production Planning & Control* 26 (12): 933-944.

Langley, J. C. J. 2014. "2014 Third-Party Logistics Study: The State of Logistics Outsourcing." Capgemini Consulting.

Manyika, J., M. Chui, B. Brown, J. Bughin, R. Dobbs, C. Roxburgh, and A.H. Byers. 2011. "Big data: The next frontier for innovation, competition, and productivity." Report by McKinsey Global Institute.

McAfee,A., and E. Brynjolfsson. 2012. "Big data: the management revolution." *Harvard Business Review* October: 61-68.

Perrey, J., D. Spillecke, and A. Umblijs. 2013. "Smart analytics: how marketing drives short-term and long-term growth." *McKinsey Quarterly*.

Seuring, S., and M. Müller. 2008. "Core issues in sustainable supply chain management–a Delphi study." Business strategy and the environment 17 (8): 455-466.

Siegel, D. S. 2009. "Green management matters only if it yields more green: An economic/strategic perspective." *Academy of Management perspectives* 23 (3): 5-16.