Transportation Research Part E xxx (2017) xxx–xxx

Contents lists available at ScienceDirect

Transportation Research Part E

journal homepage: www.elsevier.com/locate/tre

Understanding big data analytics capabilities in supply chain management: Unravelling the issues, challenges and implications for practice

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ARTICLE INFO

Article history:
Received 31 May 2016
Received in revised form 21 December 2016
Accepted 3 April 2017
Available online xxxx

Keywords:
Supply chain management
Big data analytics
Capabilities
Maturity model

ABSTRACT

In the era of Big Data, many organisations have successfully leveraged Big Data Analytics (BDA) capabilities to improve their performance. However, past literature on BDA have put limited focus on understanding the capabilities required to extract value from big data. In this context, this paper aims to provide a systematic literature review of BDA capabilities in supply chain and develop the capabilities maturity model. The paper presents the bibliometric and thematic analysis of research papers from 2008 to 2016. This paper contributes in theorizing BDA capabilities in context of supply chain, and provides future direction of research in this field.

1. Introduction

The concurrence of events such as growth in adoption of supply chain technologies, data inundation and a shift in management focus from heuristics to data-driven decision making have collectively led to the rise of big data era. As a valuable asset for decision-making, Big Data Analytics (BDA) can play a pivotal role in transforming and improving the functions of supply chain. In this changing business environment, business leaders prefer to take decisions bearing in mind the data-driven insights rather than relying on their intuitions (Davenport, 2006). Due to the perceived benefits of BDA, organisations are highly motivated to develop their technical and organisational capabilities to extract value from data. Yet, practitioners face extreme difficulties in understanding the required capabilities to transform data into value. The core aspects of generating value depend on organisation's ability to capture, store and analyse a large volume of complex data generated in real or near real-time with the support of advanced analytics (Yesudas et al., 2014). Although the phenomenon of 'Big Data' is considered as the latest sensation worldwide, it has not essentially emerged impulsively. Last decade has seen a tremendous increase in adoption of a variety of Information and Communication Technologies (ICT) for Supply Chain Management (SCM), (e.g. RFID, Enterprise Resource Planning (ERP) to Internet of Things (IoT)). This has triggered huge data generation in the supply chain. Our continuous efforts to create more sophisticated technology to collect data at different stages of supply chain have resulted in the new era of big data.

The concept of supply chain signifies flow of information along with material and financial flow (Souza, 2014). Due to the adoption of ICT technologies, supply chains are enabled to monitor the information flow and inclined towards collecting and analysing a variety of data for efficient management (Chae and Olson, 2013). A typical supply chain has to manage the inflow

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http://dx.doi.org/10.1016/j.tre.2017.04.001
1366-5545/

of more than 100 gigabytes of data every day (The Economist, 2010). In fact, about 90% of data that are available today are generated by humankind in the last couple of years (Fawcett and Waller, 2014). It is estimated that the usage of RFID tags would increase rapidly to 209 billion units by 2021 (Marr, 2014; Tachizawa et al., 2015). The number of networked sensors used in automotive, retail and transportation have increased at the rate of 30% per year (Manyika et al., 2011), with the perception that the sensor-based technology could substantially reduce the operational cost by 10–25% (Hahn and Packowski, 2015). The volume of digital data is growing exponentially and expected to reach 35 Zeta bytes by 2020 (Tien, 2015). In this current scenario, companies are increasingly recognising the value of data and advanced analytics tools. BDA has the potential to govern Third Industrial Revolution (TIR), along with digital manufacturing, mass customisation and adaptive services (Tien, 2015). Adoption of BDA technologies could improve organisation capabilities in today's rapidly changing dynamic market environment (Meredith et al., 2012). However, to effectively deal with the diffusion of BDA technologies into the supply chain, organisational and behavioural issues related to adoption and practice has to be addressed. This paper finds very few empirical studies discussing the impact of BDA capabilities on SCM. Despite its popularity within the industry, many organisations are reluctant to invest in BDA technology due to the ambiguity in recognising potential benefits. Further, research on BDA capabilities in supply chain is very limited, and therefore, a comprehensive investigation of BDA capabilities is required to exploit the benefits of big data.

This paper adopts a systematic literature review approach to understand multiple dimensions of BDA capabilities in supply chain. Most of the academic studies have focused on exploring potential benefits of BDA from an investment perspective, but very little is known about key BDA capabilities for SCM. This paper begins with demystifying the concept of BDA in order to understand the evolution of big data. Then, through a structured search of literature between 2008 and 2016 with appropriate key words, 82 peer-reviewed journal papers and 13 maturity models are selected, to analyse and compile existing research in this domain; to define key BDA capabilities and maturity model specific to the supply chain context; and to address the challenges and issues of practising BDA. These research papers are critically reviewed to conceptualise the dimensions of BDA capabilities. Both bibliometric and thematic analysis techniques are used for the literature review. A maturity model is conceptualised to explain five dimensions of BDA capabilities, namely data generation capability, data integration and management capability, advanced analytics capability, data visualisation capability, and data-driven culture. Finally, the paper discusses the challenges and implications of BDA practice, and identifies the future direction of research in this field.

2. Business Intelligence (BI), Business Analytics (BA) and Big Data Analytics (BDA)

Data, according to Oxford English Dictionary (OED), is defined as "facts and statistics collected together for reference or analysis" or "the quantities, characters, or symbols on which operations are performed by a computer, which may be stored and transmitted in the form of electrical signals and recorded on magnetic, optical, or mechanical recording media." (Oxford Dictionary, 2016). In line with the first definition, data are mainly facts and numbers collected for further analysis. The analysis of such data can be performed with less effort using traditional statistical methods and mathematical tools without the need of a computer. Whereas, the second definition encompasses 'characters' and 'symbols', emphasising the usage of the computer to perform analysis, and also the utilisation of additional medium to transfer and store data in various forms. Similarly, the term 'Big data' is defined by OED as "an extremely large data sets that may be analysed computationally to reveal patterns, trends, and associations, especially relating to human behaviour and interactions." These definitions have simplified the delineation and comparison of traditional data analysis with big data analysis. BDA uses more sophisticated computational techniques to handle complex data that has been increasing on a large scale, and unable to be processed using traditional methods.

Until recently, Business Intelligence (BI) was considered as an umbrella term which includes tools, techniques, and activities that converts raw data into useful information and support decision-making at different levels (Operational, tactical, and strategic) (Gudfinnsson et al., 2015). According to Sahay and Ranjan (2008), "BI refers to the use of technology to collect and effectively use information to improve business potency." Decision support, statistical analysis, data mining, forecasting, and OLAP are the key capabilities of BI, and four main components of BI are data sources, data marts, data warehouse and query and reporting tools (Sahay and Ranjan, 2008). Data warehouse is central to any BI solutions; data from internal and external sources are extracted and loaded into the data warehouse (Gudfinnsson et al., 2015). Another terminology that has been in practice is Business Analytics (BA), business users consider 'Business Analytics' as essential for providing data, information, and knowledge to support decision making (Acito and Khatri, 2014; Chen et al., 2012; Laursen and Thorlund, 2010), and its scope supposedly extends beyond traditional BI reporting. In literature, BI and Business Analytics (BA) terms are used interchangeably. Chae et al. (2014a, 2014b), referred BA as " the application of a broad range of analytical techniques and methods and data-driven analytic methodologies to different business domains." However, Laursen and Thorlund (2010, p. 12) defined BA as "delivering the right decision support to the right people at the right time." Further, a related term called 'Decision Support Systems (DSS),' which arguably emerged during 1970s, also widely used in this context to indicate the usage of technological solutions to support decision-making problems (Shim et al., 2002). Bartlett (2013, as cited in Mortenson et al. (2015) considers BI as an amalgamation of Business Analytics and Information Technology. Gudfinnsson et al. (2015) also supported the argument of considering Business analytics (BA) as an integral part of BI. However, several researchers have a contrasting opinion and argued that BI is a division of analytics, and a new acronym 'BI&A' as

Please cite this article in press as: Arunachalam, D., et al. Understanding big data analytics capabilities in supply chain management: Unravelling the issues, challenges and implications for practice. Transport. Res. Part E (2017), http://dx.doi.org/10.1016/j.tre.2017.04.001