Big data for logistics and supply chain management

Zenon Michaelides

The University of Liverpool Management School, Liverpool L69 7ZH, U.K.

z.m.michaelides@liverpool.ac.uk

Abstract

Big data has been cited as "the next frontier for innovation, competition, and productivity" (Manyika et. al, 2011). However, recent research by MIT Sloan Institute/SAS Institute (2014) identifies the role of analytics as a "common path" rather than a "new path" to value, suggesting more widespread adaptation but less first-mover advantage.

Keywords: Big data, Demand networks, Internet-of-things

INTRODUCTION

The report by MIT Sloan Institute/SAS Institute (2014) suggests that the reason why big data analytics is not seen as a "new path" to value could be that analytics is becoming more mainstream, and competitive advantage is being eroded by competitors' abilities to "build the same capabilities". This suggests that an increasing number of companies and organisations are adopting big data analytics, but they are not necessarily experiencing competitive advantage without the barriers of entry being raised to even higher levels. Gartner states that by 2015, 85 percent of Fortune 500 companies "will be unable to exploit big data for competitive advantage" (Baesens, 2015).

The aim of this research is to review this phenomenon and address the above suggestion against other possible causes, such as the perceived significant steep (technical) knowledge curve required of companies to adopt data analytics in their business environments to such a degree that competitive advantage could be not be readily attained.

A hypothesis is therefore formed which argues that the reason for the perceived slow-down is the result of the inability of companies to grasp, plan or deploy analytics in their organisations at suitable (technical) levels that are needed in order to impact competitive advantage. In addition, a secondary hypothesis argues that companies' unwillingness to implement data analytics further than the level that they perceive as being value-adding is possibly withholding analytics adaptations, thus accounting for the perceived slow-down.

Today's consumers are changing:

The "always-online" consumer culture can be described as: mobile, connected, social, informed and influential (Howells, 2012). Furthermore, Howells (2014) cites recent research (EY, 2015), that forecasts a surge in the global middle class, and estimates that by 2030, three billion people are expected to enter the middle class, and "two-thirds of the global middle class will live in the Asia-Pacific region", whilst also expected to be "at the upper end of the income bracket, with impressive spending power" Currently, it is also estimated that 225 million people in Asia can already count themselves middle class (which is more than the total population of the European Union). The Financial Times (7 October 2015; p2-"IMF warns of worst growth since financial crisis") reaffirmed "[Chinas] realignment towards consumption and services". This translates to a global increase in logistics and supply chain activities.

Today's logistics supply chains are changing:

They are being transformed into 'demand networks'. Logistics plays an increasingly important role in supporting and sustaining the development of such 'demand networks', helping companies to efficiently deliver products and services and to update their business models to those that effectively leverage on the use of the latest offerings in information technology. Many successful companies and organisations, particularly in the e-business world, have integrated their logistics and supply chain operations and optimized their route to market to such an extent that they are able to source and sell vastly diverse products, entering and even dominating different markets, some of which have until recently had high barriers of entry.

DEMAND DRIVEN SUPPLY NETWORKS

The principle of demand driven supply networks (DDSN) or demand driven value networks DDVN (Gartner) is not entirely new; this has been an area of study aimed at helping us to understand the impact of data latency and aggregation, as information propagates upstream the supply chain from the source of demand to the suppliers, namely the bullwhip effect.

Demand driven supply networks tend to be different from traditional supply chains; they are highly responsive, agile, adaptable, and even predictive. According to Thalbauer (2014), as cited by Howells (2014), “the supply chains of the future will not be chains at all, but will transform into demand networks”. The term ‘chains’ has effectively been replaced with ‘networks’ which, according to Emmett and Crocker (2006), is an attempt to find new expressions that are more representative of the contemporary approach that best represents SCM practices today, focusing not just on customers, but also on customers’ customers.

Demand networks are customer-driven, and as they migrate their focus from the ‘supply’ to ‘demand’ side, they are characterised by the need and use of increasingly high levels of dynamic information, impacting almost every area of performance measurement, such as cost, quality, availability, frequency, etc. In short, demand networks aim to deliver exactly what the customer wants, when they want it and how they want it – in the most competitive way. More importantly, when integrated with big data initiatives, demand networks have the potential to support companies which may also offer *what they think their customer may want*, based on their profile data, actual purchasing history or other parameters, emanating from structured, semi-structured or unstructured data.

Such demand networks require increased levels of predictiveness, proactiveness, optimisation and resilience. They are effectively integrated, managed and controlled at every level and every node of the demand network, ranging from sourcing, product development, production, through to delivery and returns.

These networks have moved as close as ever to the end customer on the one hand, and to intra/entra-company operations, such as marketing and customer service or new product development on the other. They are driven by data such as predictive data and big data analytics, enabled by smart technologies such as sensors and the Internet of things (IoT), and delivered by new paradigms in logistics in many sectors, such as retail and services.

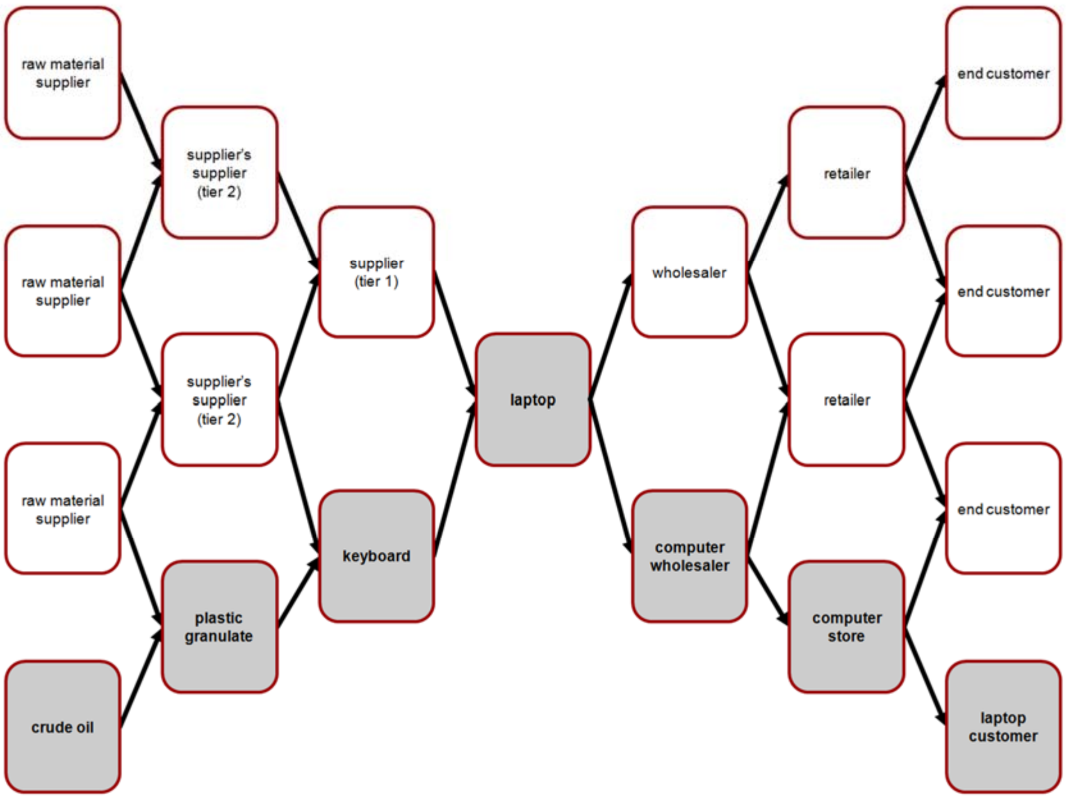

Figure 1. Example of complex and dynamic supply and demand network (Wieland and Wallenburg, 2011)

Technologies for demand driven supply networks

A key enabler to optimising logistics for demand driven supply networks is a wide array of technologies which may be integrated directly with various enterprise management information systems, such as enterprise resources planning (ERP), customer relationship management (CRM) systems, inventory and warehouse management systems (WMS), advanced planning and scheduling (APS) or other internet-enabled systems and applications.

Some systems incorporate technologies which incorporate advances in the area known as the Internet of things (IoT), which use various sensing and tracking devices, such as radio frequency identification (RFID), location enabling technologies, such as global positioning systems (GPS), geographic information systems (GIS) and other route optimization software.

The common theme of Logistics demand networks and its reliance on the above IS technologies is their ***dynamic on-demand*** nature. In a recent study reviewing the performance of IT systems (ERP in particular), under dynamic market requirements (Tenhiala and Helkio, 2015), it is stated that the use of appropriate software is crucial for “exploiting dynamic market conditions” (Sambamurthy et al, 2003). This ability is termed “market capitalizing agility” in IS literature (Lu and Ramamurthy, 2011) and “dynamic capabilities” in management literature (Teece et al, 1997).

Tenhiala and Helkio (2015) state “it is not clear what kind of software is appropriate for organisations that face dynamic market requirements”. Yet, the vast majority of current organisations are subjected to dynamic market conditions, as a result of economic volatility of global markets, or other socio-political events. The dynamisms’ of market requirements is further emphasised through the generation and accrual of vast amounts of data, emulating from several diverse sources, including sensor technology and Internet of things (IoT), web analytics and social media.

INTERNET OF THINGS (IOT)

The IoT is a giant network of connected “things” (which also includes people). The relationship will be between people-people, people-things, and things-things (Morgan, 2014). Recent advances in areas such as the Internet of things (IoT) and big data are raising challenging questions as to how such disruptive developments are going to impact business, and in particular how we offer logistics ‘services’ in the future. Since demand signals can originate from IoT-incorporated systems utilising connected devices and sensors, research questions can be raised as to the potential of achieving higher levels of visibility, responsiveness and pro-activeness through their use.

Such connected systems/devices enable organizations to work smarter, plan better and foster more intelligent decision-making processes (Shankar 2015). Whilst highlighting the key role that IoT will play in future supply chains, Shankar also cites recent research from Gartner, which suggest a thirty-fold increase in Internet-connected physical devices or sensors by the year 2020.

Gartner, Inc. forecasts that 4.9 billion connected 'things' will be in use in 2015, up 30 percent from 2014, and will reach 25 billion by 2020. The Internet of Things (IoT) has become a powerful force for business transformation, and its disruptive impact will be felt across all industries and all areas of society (Gartner, 2015).

Although the number of 'things' or devices presently connected to the Internet outnumber humans Marr, B. (2015), the exponential growth of the Internet of things is set to widely increase that gap. The information technology research and advisory company Gartner Inc. states that 6.4 billion connected 'things' will be in use in 2016, up 30 percent from 2015. Gartner further indicates the market for Internet of things devices is poised to reach nearly 21 billion connected devices by 2020 (Gartner, 2015b). The International Telecommunication Union (ITU), a United Nations body, predicts that 3.2 billion people will be online. The population currently stands at 7.2 billion.

Shankar (2015) states that key to in-transit visibility are cloud-based GPS and Radio Frequency Identification (RFID) technologies, which provide identity, location, and other tracking information, which are "the backbone of IoT as it relates to the supply chain". According to Gartner (2015), IoT will "significantly alter how the supply chain operates" and specifically that the impact will relate to "how supply chain leaders access information", among other things, to enhance *in-transit visibility*.

Though the integration of such technologies we are able to address the issue of dynamic capabilities by more accurately generate real-time shipping and delivery information, such as confirming/ predicting the time of arrival, monitor important details such as temperature control, and manage the impact of service and quality of products in-transit.

Closer Relationships with Suppliers and Customers

Over the last years the trend is for the extended supply chain to have fewer members, which are responsible for managing increasingly more areas, (and arguably more critical aspects) of the overall demand process. Many suppliers of services and goods provision achieved the elevated status of 'partners' in recognition of their contribution and commitment. The success of supply chain members in managing such operations is reflected in the widely accepted belief that competitive advantage has effectively moved from within enterprise boundaries to the extended supply chain domain.

However, competitive supply chains are not new; these were a feature of the last decade. But what makes companies more competitive today is their ability not only to effectively manage demand, but also to firstly *understand present demand* and secondly *know future demand*, i.e. where demand will be coming from up ahead. According to Howells (2012), "what is needed is the ability to sense *actual* product demand signals and indicators across the entire network".

In order to enable the above and deliver on it, demand networks are utilizing the power of Big Data.

BIG DATA

The full impact of the application of big data in logistics and supply chains is not yet fully realised, however the potential is clearly apparent. The role of Big Data in demand networks and logistics supply chains is broad, with new applications being re-imagined at a considerable rate. Big Data analytics can be applied to a range of diverse data sources to create effective predictions of future demand; such synchronous and asynchronous data sources include: Inter organizational historic data, regional and national economic data, industry specific data, demographic and target market specific data. All of which can be collated from third party analysis or as part of an extra-organizational effort on part of a specific 'demand network'. Big data analytics can be applied in conjunction with other application of big data analytics which had previously been considered 'logically separate' such as logistics specific analytics, geo-political analytics and human resource applications of big data.

We can therefore consider that a 'demand network' that utilises multiple areas of emergent big data applications would be able to effectively predict and articulate future demand.

Due to its pivotal role in the extended supply chain, the logistics function is in the best position to address emergent demand signals and effectively address them.

Future competitive advantage for the logistics and supply chain sector could be enabled through the application of demand networks that utilise big data sources through connected IoT devices. "Smart, connected products require that companies build an entirely new technology infrastructure, consisting of a series of layers known as a 'technology stack," explains Michael E. Porter of the Harvard Business Review.

The volume variety, velocity and veracity of big data is indeed growing exponentially. Every day, we create 2.5 quintillion bytes of data — so much that 90% of the data in the world today has been created in the last two years alone (IBM, 2013; Baesens, 2014). This data comes from everywhere: sensors used to gather climate information, posts to social media sites, digital pictures and videos, purchase transaction records, and cell phone GPS signals to name a few (IBM, 2015). According to SAS Institute Inc.:

- Every minute, we send 204 million emails, generate 1.8 million Facebook likes, send 278 thousand tweets, and upload 200 thousand photos to Facebook.
- 12 million RFID tags (used to capture data and track movement of objects in the physical world) were sold in 2011. By 2021, it's estimated this number will increase to 209 billion.
- The big data industry is expected to grow from US$10.2 billion in 2013 to about US$54.3 billion by 2017.

CONCLUSIONS

The challenges associated with being able to coherently and usefully integrate this torrent of data are vast. However, the use of Big Data analytics in logistics demand networks and its application in supply chain management are both promising and novel; research in these areas is still a work in process. The anticipated benefits have the potential to create new sources of competitive advantage and to create opportunities and insights that will potentially enable not only the early adaptors to achieve good returns on investment. Competitive advantage therefore may not only be limited to first-to-market movers, and given the scale of information being continuously generated, may still be available to subsequent adopters.

Bibliography

Baesens, B., (2014), Analytics in a big data world; the essential guide to data science and its applications, Whiley and Sons Inc.

Emmett, S., and Crocker, B., (2006), The relationship-driven supply chain: creating a culture of collaboration throughout the chain, Aldershot, Hampshire, England.

EY (2015), Middle class growth in emerging markets, Hitting the sweet spot, on-line resource accessed on 19/8/2015 from: http://www.ey.com/GL/en/Issues/Driving-growth/Middle-class-growth-in-emerging-markets

Gartner, (2015), Gartner Says 4.9 Billion Connected "Things" Will Be in Use in 2015, Newsroom online resource accessed on 20/08/2015 from: http://www.gartner.com/newsroom/id/2905717

Gartner, (2015b), Gartner Says 6.4 Billion Connected "Things" Will Be in Use in 2016, Up 30 Percent From 2015, Newsroom online resource accessed on 20/08/2015 from: http://www.gartner.com/newsroom/id/3165317

Howells, R. (2012), A 360 Degree Perspective On Customer Engagement, Forbes Business, online resource accessed on 20/08/2015 from: http://www.forbes.com/sites/sap/2012/11/13/a-360-degree-perspective-on-customer-engagement/

Howells, R. (2014), The emergence of the demand network, SAP Business Trends, on-line resource accessed 20/09/2015 from: http://scn.sap.com/community/business-trends/blog/2014/02/03/the-emergence-of-the-demand-network

IBM, (2013), Bringing Big Data to the Enterprise, on-line resource accessed 20/12/2015 from: http://www.ibm.com/big-data/us/en

IBM, (2015), Bringing Big Data to the Enterprise, on-line resource accessed 20/09/2015 from: https://www-01.ibm.com/software/data/bigdata/what-is-big-data.html

Manyika, J., Chui, M., Brown, B., Bughin, J., Dobbs, R., Roxburgh, C., and Byers, AH., (2011) Big Data: the next frontier for innovation, competition and productivity, McKinsey global Institute(MGI) , McKinsey & Company.

Marr, B. (2015), Big Data; using smart big data analytics and metrics to make better decisions and to improve performance, John Wiley & Sons, pp. 18.

Morgan, J, (2014) A Simple Explanation Of 'The Internet Of Things', Forbes Leadership, on-line resource accessed 29/09/2015 from: http://www.forbes.com/sites/jacobmorgan/2014/05/13/simple-explanation-internet-things-that-anyone-can-understand/

Shankar, U. (2015), How the Internet of Things Impacts Supply Chains, Inbound Logistics, on-line resource accessed 29/09/2015 from: http://www.inboundlogistics.com/cms/article/how-the-internet-of-things-impacts-supply-chains/

Thalbauer, H. (2014), The Time to Move to a Demand Network Has Come, on-line resource accessed 20/9/2015 from: http://www.sap.com/bin/sapcom/downloadasset.the-time-to-move-to-a-demand-network-has-come-pdf.bypassReg.html

Wieland, A. and Wallenburg, C. M. (2011), Supply-Chain-Management in stürmischen Zeiten. Berlin