Big data and its impact on digitized supply chain management

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Abstract

Day by day the customers demand changing rapidly, it is very difficult for a company to identify demand. Big data used in supply chain management helps to create better customer demand planning strategies by collecting, documenting & analyzing data in a real situation. Big data combined a set of data usually referred as large and complex datasets; enables the company to review real-time data flows. Digitized supply chains have the potential to dramatically lower costs, reduce lead time and increase product availability. Digitization makes the supply chain more effective, agile and responsive by sharing knowledge and collaborating complex supplier networks. As a result, this research work helps a manager to identify the current situation of their business and it will help them to take timely, fast and better decision.

Keywords: Big data; Supply chain management; Digital transformation.

1. Introduction

Today's increasing proliferation of data, on everything from material flows to customer preferences, companies highlighting the strong need for enhanced data management and analytics [russell]. The data play a very significant role on the various decisions related to supply chain and logistics operations of the business. To identify the needs and wants of the customers, companies are relying on data. The data that are used now-a-days in supply chain management are voluminous, versatile, fast as well as sensitive. These types of data are known as Big Data [ghosh].

Big data acts as a disruptive technology in today's supply chains. Big data analytics features a variety of applications within the supply chain, its impact is so great. Big data offering supplier networks with greater data accuracy, clarity, and insights, leading to more contextual intelligence shared across supply chains [colombus]. Amazon uses big data to observe, track and secure 1.5 billion items in its inventory that are laying around two hundred fulfilment centers around the world, and then relies on predictive analytics for its 'anticipatory shipping' to predict when a customer will purchase a product, and pre-ship it to a depot near the ultimatedestination [ritson]. Wal-Mart handles more than a million customer transactions each hour & generates 2.5 petabyte (1 petabyte approximately 1015 bytes) of customer transaction data every hour [sanders]. Furthermore, if Wal-Mart operates Radio Frequency Identification (RFID) on the item level, it is expected to generate 7 terabytes (1 terabyte approximately 1012 bytes) of data every day [zaslavsky]. UPS deployment of telematics in their freight segment helped in their global redesign of logistical networks [davenport].

SCM organizations are immersed with data, so much that McAfee and Brynjolfsson [mcafee] mentioned "commercial enterprise accumulates additional data than they realize what to do with".

A digital supply chain is a supply chain whose basis is constructed on internet-enabled capabilities. A digital supply chain has techniques that monitor real-time inventory levels, customer interactions with items, provider locations, and equipment and make use of this information to assist plan and execute at increased levels of overall performance. Digital supply chain technologies are supporting some companies obtain a step change in performance in more complicated areas. Amazon, as an example, offers the Dash Button, an internet-enabled gadget that customers press—while not having to log on to an account—to reorder laundry detergent, diapers, and other basic grocery items [generiwall].

Digitization has touched upon all elements of organizations, along with supply chains and working models. Today, technologies like RFID, GPS, location based informationand wireless sensors networks have enabled organizations to convert their existing hybrid (mix of paper-based and IT-supported strategies) supply chain structures into greater flexible, open, agile, and collaborative digital models. Unlike hybrid supply chain models, which have led to inflexible organizational structures, inaccessible information, and dividedrelationships with partners; digital supply chains allow business process automation, organizational flexibility, and digital management of corporate resources [capgemini].

The overall intention of this studies is to close the understanding gap between data science and supply chain management area, linking the records, technology and useful knowledge in big data applications throughout procurement, marketing, transportation and distribution centeroperations [I v roza].

Applications of big data have been visible in numerous fields including retail, drugs, finance, manufacturing, logistics, and media communications (Feng et al. 2013). Researchers (Wamba et al. 2015; Chen et al. 2012; Wang et al. 2016) have tried to discover distinctive dimensions of big data and seize the potentialbenefits to supply chain management (SCM). It is vital for supply chain managers tocomprehend the role of big data in enhancing the efficiency and profitability of a firm.

2. Digital Supply Chain Management

Supply Chain Management is outlined by Christopher (2011) as the management, across and inside a community of upstream and downstream corporations, of both relationships and streamsof material, information and assets.

Digital supply chain is a smart value driven network that leverages new procedures & techniques with technology and information analytics to make value and revenue [digital Accenture].Digital supply chains have the capability for broad data accessibility and advanced collaboration that leadto enhanced responsibility, agility and effectiveness [digital capegedamini].

The ultimate intention of the digital supply chain is to enable insights for enhanced efficiencies, removing waste and facilitating greater earnings. Companies with a digital supply chain are highercapable of move people, property, assets and inventory to where they are required at any given time with a purpose to lessen costs by responding proactively to transportation and production risks. The potential payoffs of a completely acknowledged digital supply chain incorporate savings in every area, from assets, time, and money to a discounted environmental footprint [what is].

Digitization brings into question the basic commandments of how we contend in commercial enterprise. Preferably, a digital supply chain has approaches that monitor real-time inventory levels, customer collaborations with items, transporter locations, and equipment and uses this information to assist design and execute at improved stages of overall performance [rouse]. Digitization of the supply chain has the capability to dramatically decrease costs, growth product availability, and even create new markets unknown or unavailable prior to the provision of key technologies [shrener].

Digital business flows are ongoing and outside-in. Traditional supply chain processed are inside-out and based on historic transactions. As outlined in table 1, there are some vital distinctions.

Table 1. Comparison of Traditional supply chain process and digital supply chain process

Basis for comparison	Characteristics of traditional supply chain process	Characteristics of digital supply chain process
Data	Structured	Structured & unstructured
Data latency	Data latency of hours, days & weeks	Real time data; they are updated on regular basis.
Deployment	Within the organization	Cloud based to synchronize inter and intra-enterprise flows
Process flows	Inside out	Outside in
Visualization	Rows, columns and graphs	Simulation and digital representation of outcomes
Response	Response based on history	Sensing based on internet of things

Source: Lora Cecere, Embracing the Digital Supply Chain.

3. Benefits of digitally transformed supply chain

Leading companies are utilizing digital supply chain technologies to upgrade their working models and go-to-market techniques in order to generate enormous growth in revenues and margins [bcg three]. With the right organizational layoutand governance, they can enable advanced collaboration and communication across digital platforms leading to enhanced reliability, agility and effectiveness. This performance distinction will force organizations with traditional supply chains to adjust to the brand new digital realities or run the risk of falling behind competition [capemini]. Digitization of information & material flows allows real time analysis of the company. Nowadays, 9 out of 10 users buy online.We're already seeing disruption inside the supply chain. Examples of winning digital disruption: Uber: world's largest taxi company owns no taxis; Airbnb: world's largest accommodation provider owns no real estate; Alibaba: world's most valuable retailer owns no inventory and many more.

4. Big data

Data are flooding in at rates never seen before—doubling every 18 months—as a result of greater access to customer data from public, proprietary, and purchased sources, as well as new information gathered from web communities and newly deployed smart assets. These trends are broadly known as "big data" [bughin mckincy].

Manyika et al. (2011) defined Big Data as the "datasets whose size is beyond the ability of typical database software tools to capture, store, manage and analyses". This definition is not confined to data size, since data sets will increase in the future. It highlights the necessity of technology to cope up with the rapid growth in available data. Big data has recently emerged as "the next big thing" in management [wamba]. Some researchers and practitioners even recommend that big data analysis is the "fourth paradigm of science" [strawn], or may be "the next frontier for innovation, competition, and productivity" [maniyaka], or the "new paradigm of knowledge resources" [hagstom]. McAfee and Brynjolfsson (2012) viewed Big Data as an approach that transforms decision making processes by enhancing the visibility of firms' operations and improving the performance measurement mechanisms.

Companies rely on massive set of extensive versatile and rapid data for their prompt steps in the zone of supply chain and logistics management. In case of E-commerce giants like Amazon, Flipkart, Snapdeal and so forth need to accumulate lot data related to customers, orders, inventory etc. The success of the E-commerce companies depends a lot on how those companies capture, store and utilize that information in an efficient manner.

In 2012, The Human Face of Big Data accomplished as a global project, which is centering in real time collect, monitor and analyze massive amounts of data. According to this media project many statistics are derived[sagi].Facebook has 955 million monthly active accounts using 70 languages, 140 billion photos uploaded, 125 billion friend connections, every day 30 billion pieces of content and 2.7 billion likes and comments have been posted; about 48 hours of video are uploaded each minute on YouTube; Google support many services as both monitories 7.2 billion pages per day and processes 20 petabytes (1 petabyte: 1015 bytes) of data daily also translates into 66 languages;Twitter users generate more than 1 billion tweets every 72 hours, 571 new websites are created every minute of the day [wamba][sagi]. This presents the importance of big data in the current research world.

4.1 Defining Big data via 3v's

Big data depicts a method of gathering, handling and analyzing massive amounts of data. Therefore, big data is mostly characteristics with the three Vs. They are defined as volume, velocity and variety.

The volume characterizes the large amounts of data stored within the IT infrastructure. Data is now vast in the amount such as Petabyte (1 PB: 1015bytes), Exabyte (1 EB: 1018 bytes), Zettabyte (1 ZB: 1021 bytes) and Yottabyte (1 YB: 1024 bytes) etc.

Velocity describes the large amounts of data that generated at an excessive speed. Velocity is needed not only for big data, but also all processes.

Varietymeans big data comes from a great variety of sources and generally has in three kinds: structured, semi structured and unstructured. Structured data inserts a data warehouse already tagged and easily sorted. Unstructured data is random and hard to analyze. Semi structured data does not conform to fixed fields but includesvarious structure ofinformation handled within the big data surroundings.

[Mishra agri] Besides the "3Vs", three other characteristics, that is, veracity, variability and value have been introduced.

The value of big data is reflects the financial benefits from big data [forrester];related to the reality that the data needs to be processed and analyzed for further usage.

Veracityconsists of two aspects: data consistency (or certainty) and data reliability. White (2012) indicates that veracity deals with data quality and its significance, as well as the level of trust accorded to a source of data.

Variability refers to data changes during processing. Increasing variety and variability additionally increases the attractiveness of data and the potentiality in presenting unexpected, hidden and valuable information.

5. Data sources

Big data comes from a wide range of sources:

-Today's technologies and social platforms allow businesses to get direct customer feedback in the form of ratings, reviews and blog comments.

-Data from mobile, social platforms and e-commerce are being integrated with data from enterprise systems.

-Manufacturing is changing from event-based planning to real-time sensing with the introduction of the Internet of Things and machine-to-machine communication.

-Evolved sensor technology provides real-time equipment and product conditions data resulting in automated maintenance and process adjustments.

6. Big data in SCM

[Mishra] It has been argued that the competition is no longer between firms, but between wholesupply chains. As a final result of increasing attention on SCM, managers are now pressured to reassess their competitive strategies (Zacharia et al. 2011). Since both technology and data are available; it is essential for companies to decide how to use them to win (Hopkins et al. 2010). Supply chain managers are getting increasingly dependent upon data for gaining visibility on expenditure, identifying trends in prices and performance, and for supporting system manipulate, inventory tracking, manufacturing optimization, and process improvement efforts. As a matter of fact, there are several companies that are flooded with data and try to capitalize on information analysis in an attempt to achieve competitive advantage (Davenport 2006). Having a capacity to exploit data, firms like Google, Amazon outperform their competitors by developing potential business models. Barton and Court (2012) highlighted that via big data, firms can change the way they work together and deliver performance gains similar to the ones achieved in 1990s when companies updated their core processes. They also pointed out that the adoption of data-driven strategies will soon emerge as a significant point of competitive differentiation. McAfee and Brynjolfsson (2012) observed that productivity rates and profitability of companies can be enhanced by 5–6 % if they consolidate big data into their operations.

[Isacc] Big data solves problems in a variety of business domains, but sales and operations are in the lead. The study conducted by Forrester Research Inc. On How Forrester Clients are Using Big Data, September 2011. Indicated some of the key points about business domains where Big Data has the greater influences. This view is indicated in the table 1.

Table 2: Business domain big data

Business Domain	Big Data Contribution (%)
Marketing	45
Operations	43
Sales	38
Risk Management	35
IT Analytics	33
Finance	32
Product Development	32
Customer Service	30
Logistics	22
HR	12
Other	12
Brand Management	8

Source: Forrester Research Inc. How Forrester Clients are Using Big Data, September 2011.

The potential of big data is not limited to manufacturing companies; retailers, service providers, healthcare professionals, and governments, among others, also see big data potential. McKinsey Global Institute specified the potential of big data in five main topics:

- Healthcare: clinical decision support systems, individual analytics applied for patient profile,

personalized medicine, performance based pricing for personnel, analyze disease patterns, improve public health.

- Public sector: creating transparency by accessible related data, discover needs, improve

performance, customize actions for suitable products and services, decision making with automated systems to decrease risks, innovating new products and services.

- Retail: in store behavior analysis, variety and price optimization, product placement design, improve performance, labor inputs optimization, distribution and logistics optimization, web based markets.

- Manufacturing: improved demand forecasting, supply chain planning, sales support,

developed production operations, web search based applications.

- Personal location data: smart routing, geo targeted advertising or emergency response, urban planning, new business models.

Following the Gartner survey [20], nowadays around 26-28% of manufacturing companies and retailers invest in big data solutions. In the transportation sector only 20% of the

asked companies have already invested, but with 50% there is the highest value of planned invests within the next two years. The problem addressed with big data (summarized over all industries) is about 32% in improving risk management.

7. Levers in the big data driven supply chain

Big data can tremendously affecteach of the supply chain levers (mentioned below) and can add value to the overall supply chain operations using improving operating efficiency based on the result of analysis.For instance, marketing captures and tracks demand through Point of Sale (PoS) data,transportation creates records from GPS transponders, RFID data identifies stored goods and electronic data interchange sends automatic buying orders.

Marketing- Marketingis the traditional supply chain lever seen with big data which can transformed customer understanding into an agile system that sends hugeamount of information flowing upstream in the chain (Jüttner et al., 2010). Intimacy with customers can be accomplished by analyzing customer data, and at this lever, data sources that encompass social media, mobile apps, or loyalty programs can be found; all of them are the enablers for the sentiment analysis, location based marketing and in-store behavior analysis.

Procurement- Procurement manage the relationships at the upstream supply chain. Data complexities on this side may emerged from globalized purchasing strategies with thousands of transactions. In this lever, a strong connection with internal finance reporting led to adopt measures on spend visibility data, to gain granular levels on aggregated procurement patterns. The procurement needs to activatethe data sources not only for spending data management process, but also for the wholeprocurement function.

Warehouse management- (Especially inventory management) has been greatly modifiedby modern identification systems after successful introduction of RFID. Within this group, the largest groups of data are associated with an automated sensing capability, particularly as the Internet of Things(IoT) and extended sensors, connectivity and intelligence to material handling and packaging systems applications evolved.

Manufacturing- A number of company's report using big data analytics for inventory management, optimization of stock ranges, maintenance optimization, and some in facility location. Some are considering use in the workforce productivity assessment in addition to study of capacity constraints.

Transportation-Transportation analysis making use of operational research models has been greatly utilized for location, network design or vehicle routing using origin and destination (OND) and logistics networktopology.

8. How digital scm use big data

Davenport mention, "Businesses across many industries spend millions of dollars employing advanced analytics to control and improve their supply chains. Organizations look to analytics to help with sourcing raw materials more efficiently, enhancing manufacturing productivity, optimizing inventory, minimizing distribution cost, and other related goals." As business leaders recognize, the speed at which businesses operate today is frequently measured in minutes or seconds. Manual processes simply can't perform at those paces; which is the reason cognitive computing systems are being utilized at the heart of digital supply chains.

Noha Tohamy argues in a recent Gartner Research report that it is 'progressively unrealistic' for supply chain organizations at big companies to think they can function without advanced analytic solutions. Only with these types of solutions will companies be able to examine huge sets of structured or unstructured data to acquire deep insights, make expectations, or generate recommendations." Deborah Abrams Kaplan clarifies, utilizing large data sets for analysis and

planning purposes, those in the supply chain can react quicker to changes at different points along the chain. There are many ways big data and advanced analytics are being used today to make digital supply chains a reality. They are:

Real-time monitoring-Add in big data originating from social sources (e.g., Facebook, Twitter), news, events and weather, businesses can better predict and plan future inventory instead of relying on ancient data. For example, a store running a weekend promotion can track sales on a real-time basis, versus once daily. Taking into account current sales, along with social media responses to the promotion and potential weather events, the company can quickly alter their supplies and warehouse shipping plans.

Supplier sourcing- Maintaining large data sets enables companies to more easily track their suppliers and make adjustments quickly.

Customer segmentation- Using big data, companies can segment their buyers and markets, offering each store with specific items of interest to their customers.

Knowledge sharing- Big data is changing the nature of supply chain management by creating opportunity for knowledge sharing. Rather than depending on a linear chain of knowledge, we now have access to 360° data – from sources in every industry and in every geography – in actual time.

Forecasting demand- Companies can now integrate fast-moving data from clients, machinery, suppliers, environmental factors and contextual factors, such as pricing, competitor activity and geopolitical impacts. BCG [] estimates that companies who are able to predict the future more precisely can diminish their inventory by 20-30% while expanding the 'fill rate', which is the effectiveness of inventory to satisfy demand, by 3-7%.

Simplifying distribution- With such broad analytical capabilities, big data can possibly breakdown company's distribution networks and can feature areas to streamline them.

9. Benefits of big data driven supply chain

Big data is more useful than many people fully realize.Companies wanting to increase efficiency and profitability in supply chain execution should take note of big data[sander].

Improved visibility across supply chain- Planning and scheduling are perhaps the most crucial part of any supply chain. So much money can be lost or expended with scheduling and planning. Using big data, firms can truly optimize this process. With the use of big data firms can gain end to end visibility so that managers know that where itemsare at all times, firm can also attain high-quality decisionsupport which can be crucial if something goes wrong a splitsecond decision does not have to go without support.

- **Improve customer experience**- Analysis of more different data types, including social media data, can be used to improve the customer experience.
- **Increase accuracy in demand forecasting**- Another benefit is that a firm can really predict and satisfy demand. With big data, helps to predict and determine whatitems are going to be needed as it pertains to demand.
- **Better manufacturing efficiencies**- Big data helps to expedite order picking and order fulfillment by analyzing data from different sources likehistorical orders, item inventory, warehouse layout andhistorical picking times. It also improves product and servicetraceability. Identification of potential problem suppliers aswell as identify problems

for suppliers executed in better way.It uncovers defects in products/services in the supply chain,give early warning and avoid recalls Minimize inventory andsupply chain risk using big data analytics.

- **Opportunities to solve more complex distribution network problems**- Most complex distribution networks have developed organically over time into an almost impenetrable web of factories, warehouses and distribution hubs which can struggle to adapt quickly to changing patterns of demand. Companies can deal with this complexity more easily than in the past with the use of big data analysis. Big data provides the opportunity to solve much more complex distribution network problems by modelling outcomes in more detailed scenarios than ever before.

- **Better inventory planning & development**- this is another benefit as big data allows users to plan, forecast, and truly optimize their inventory so that they do not waste space or waste money with items that may or may not be working the way they should.

- **Develop greater collaboration in supply chain stakeholders**- Big data helps to better visibility which can translate into better collaborations with vendors, suppliers, carriers, distributers, warehouses, and customers.

10. Challenges of big data driven supply chain management

The successful utilization of big data techniques presents great advantages in economy transformation, but also raises many challenges, including, among others, troubles in data capture, storage, searching, analysis and visualization. These challenges need to overcome with a purpose to exploit capabilities of big data. Moreover, the amount of information increases exponentially. This has a massive impact on limitation of real-time values discovery from big data. Another challenge associated with the big data analysis includes data inconsistence and incompleteness scalability, timeliness and informationsecurity. Reskilling workforce, handling integration of new types data is also considering important challenge in big data driven supply chain. Hence, data must be correctly constructed and a number of preprocessingtechniques, for example, data cleaning, data integration, data transformation and data reduction need to be implemented in order to alleviate noise and correct inconsistencies.

11. Conclusion

This study explored the impact of big data in supply chain management. The use of big data in digitized supply chain management is promising and novel; research in these areas is still a work in process. More efforts from diverse fields of expertise need to be concernedin order to more effectively exploit all hidden values in vast datasets. There are numerous difficulties and challenges to address, such as data quality, privacy, technical feasibility, among others, before big data can obtain widespread influence in the supply chain management. In the long run, these difficulties are likely to be solved, considering venturesome character of big data. With the help of big data timely, rapid and effective decisions can be taken in businesses. Organizations can make better decision with the help of precise analysis of data. Thus, better decision means greater operational efficiencies, improve customer experience and reduced risk.

References

I. V. Rozados and B. Tjahjono, "Big data analytics in supply chain management: Trends and related research," in 6th Internafional Conference on Operafions and Supply Chain Management, 2014.

D. Mishra, A. Gunasekaran, T. Papadopoulos, and S. J. Childe, "Big Data and supply chain management: a review and bibliometric analysis," Annals of Operations Research, pp. 1–24, 2016.

D. Ghosh, "Big Data in Logistics and Supply Chain management-a rethinking step," in Advanced Computing and Communication (ISACC), 2015 International Symposium on, pp. 168–173, 2015.

Zaslavsky, A., C. Perera and D. Georgakopoulos, ''Sensing as a service and big data'', Proceedings of the International Conference on Advances in Cloud Computing (ACC), Bangalore, India, pp: 1-8, 2012.

J. Leveling, M. Edelbrock, and B. Otto, "Big data analytics for supply chain management," in Industrial Engineering and Engineering Management (IEEM), 2014 IEEE International Conference on, 2014, pp. 918–922.

A. Ganeriwalla, G. Walter, L. Kotlik, Robert, "Three Paths to Advantage with Digital Supply Chains" [Online]. Available: https://www.bcgperspectives.com/content/articles/supply-chain-management-technology-digital-three-paths-advantage-digital-supply-chains/ [Accessed: 01-Sep-2017].

M. Ritson, "Amazon has seen the future of predictability," Marketing Week, 22-Jan-2014.

Manyika, J., Chui, M., Brown, B., Bughin, J., Dobbs, R., Roxburgh, C., et al. ''Big Data: The Next Frontier for Innovation. McKinsey Global Institute: Competition and Productivity'' 2011.

B. Feng, T. Yao, B. Jiang, and S. Talluri, "How to motivate vendor's RFID adoption beyond mandate? A retailer's perspective," International Journal of Production Research, vol. 52, no. 7, pp. 2173–2193, 2014.

A. McAfee and E. Brynjolfsson, "Big data: the management revolution," Harvard business review, vol. 90, no. 10, pp. 60–68, 2012.

H. Chen, R. H. Chiang, and V. C. Storey, "Business intelligence and analytics: From big data to big impact.," MIS quarterly, vol. 36, no. 4, 2012.

B. Mikavicaa, A. Kostić-Ljubisavljevića, and V. Radonjić, "Big data: challenges and opportunities in logistics systems," in 2nd Logistics Intl. Conference, 2015, pp. 185–90.

G. O. Strawn, "Scientific Research: How Many Paradigms?.," Educause Review, vol. 47, no. 3, p. 26, 2012.

A. Markim, "7 Benefits Using Big Data to Optimize Supply Chains," Transportation Management Company | Cerasis, 02-Jun-2015. [Online]. Available: http://cerasis.com/2015/06/02/big-data-supply-chain/. [Accessed: 05-Sep-2017].

"Digital Supply Chain - Accenture Strategy." [Online]. Available: https://www.accenture.com/us-en/insight-your-supply-chain-growth-engine. [Accessed: 31-Aug-2017].

"Digital Transformation of Supply Chains | Capgemini Consulting Worldwide." [Online]. Available:https://www.capgemini-consulting.com/digital-transformation-of-supply-chains. [Accessed: 01-Sep-2017].

"Big Data Analytics and Its Impact on the Supply Chain | Newsroom," Russell Reynolds Associates. [Online]. Available: http://www.russellreynolds.com/newsroom/big-data-analytics-and-its-impact-on-the-supply-chain. [Accessed: 30-Aug-2017].

L. Columbus, "Ten Ways Big Data Is Revolutionizing Supply Chain Management," Forbes. [Online]. Available: http://www.forbes.com/sites/louiscolumbus/2015/07/13/ten-ways-big-data-is-revolutionizing-supply-chain-management/. [Accessed: 30-Aug-2017].

G. Wang, A. Gunasekaran, E. W. Ngai, and T. Papadopoulos, "Big data analytics in logistics and supply chain management: Certain investigations for research and applications," International Journal of Production Economics, vol. 176, pp. 98–110, 2016.

H. Agrahri, F. Ahmed, V. K. Verma, and J. K. Purohit, "Benefits of Implement Big Data Driven Supply Chain Management: An ISM Based Model," International Journal of Engineering Science, vol. 11426, 2017.

M. Christopher and M. Holweg, "'Supply Chain 2.0': managing supply chains in the era of turbulence," International Journal of Physical Distribution & Logistics Management, vol. 41, no. 1, pp. 63–82, 2011.

J. Bughin, M. Chui, and J. Manyika, "Clouds, big data, and smart assets: Ten tech-enabled business trends to watch," McKinsey Quarterly, vol. 56, no. 1, pp. 75–86, 2010.

G. Shnerer, "The Supply Chain of the Future: The Role of Digitization in Supply Chain Logistics," Medium, 21-Apr-2017.

M. White, "Digital workplaces: Vision and reality," Business information review, vol. 29, no. 4, pp. 205–214, 2012.

L. Cecere, "Embracing the Digital Supply Chain," Supply Chain Shaman, 16-Feb-2016. Available: http://www.supplychainshaman.com/demand/demanddriven/embracing-the-digital-supply-chain/ [accessed: 07-Sep-2017].

M. Fitzgerald, N. Kruschwitz, D. Bonnet and M. Welch, "Embracing Digital Technology - MIT Sloan Management Review." [Online]. Available: http://ebooks.capgeminiconsulting.com/CC-MIT-SMR-Research-Embracing-Digital-Technology/ [Accessed: 02-Sep-2017].

T. H. Davenport and D. J. Patil, "Data Scientist: The Sexiest Job of the 21st Century," Harvard Business Review, 01-Oct-2012. [Online]. Available: https://hbr.org/2012/10/data-scientist-the-sexiest-job-of-the-21st-century. [Accessed: 30-Aug-2017].

M. Hagstrom, "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, vol. 2, pp. 3–4, 2012.

S. F. Wamba and S. Akter, "Big data analytics for supply chain management: A literature review and research agenda," in Workshop on Enterprise and Organizational Modeling and Simulation, pp. 61–72, 2015.

M. Rouse, "What is digital supply chain? - Definition from WhatIs.com." [Online]. Available: http://searcherp.techtarget.com/definition/digital-supply-chain. [Accessed: 31-Aug-2017].

N. R. Sanders, Big data driven supply chain management: A framework for implementing analytics and turning information into intelligence. Pearson Education, 2014.

P. Russom, "Big data analytics," TDWI best practices report, fourth quarter, vol. 19, p. 40, 2011.

S. Sagiroglu and D. Sinanc, "Big data: A review," in Collaboration Technologies and Systems (CTS), 2013 International Conference on, 2013, pp. 42–47.

D. Dev and R. Patgiri, "A survey of different technologies and recent challenges of big data," in Proceedings of 3rd International Conference on Advanced Computing, Networking and Informatics, 2016, pp. 537–548.