Analytics in Supply Change Management: Is There a Dark Side?

Noushin Ashrafi and Jean-Pierre Kuilboer
University of Massachusetts Boston, 100 Morrissey blvd, Boston MA 02125, U.S.A.

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Abstract: The growing ability to collect real-time data combined with a desire to optimize efficiency and effectiveness have pushed the organizations to realize the value of analytics and intelligent supply chain. This study offers an overview of supply chain management and the critical role of analytics to enhance supply chain processes and, subsequently, performance. While efficiency and effectiveness is the ultimate measure of success for any organization, this study recommends a look at the consequences of such success in the global economy. As the world of commerce increasingly relies on outsourcing and the cheap labor market, the role of technology to expedite the exploitation of that market should be scrutinized. It is time to discuss not only the contributions of analytics to facilitate supply chain management but also its impact on exploitation through fierce competition among suppliers operating in developing countries.

1 INTRODUCTION

Rapid strides in innovation and globalization have resulted in tremendous opportunities and choices for firms and customers in the marketplace. Because of the competitive pressures, organizations are now outsourcing and manufacturing on a global scale and consequently facing complex circumstances where the active management of supply chain activities is a necessity for the sustainability of the firm. Supply chain management revolves around two important concepts: (1) every product that reaches the end user represents the cumulative effort of multiple organizations and (2) the organizations that make up the supply chain are "linked" together through physical flows and information flows. While physical flow is the most visible piece of the supply chain, Information flows allow the various supply chain partners to coordinate and control the day-to-day flow of goods and materials up and down the supply chain. In such environment, companies are increasingly recognizing the value of data and advanced analytics tools. The ultimate goal of supply chain management is to maximize customer satisfaction while sustaining a competitive advantage through effective and efficient management of the chain of activities ranging from development, sourcing, production, and logistics. These activities can benefit from a conscious effort to extract value from data and shifting from heuristics to data-driven decision making.

As the business environment is becoming highly dynamic, the organizations, to stay competitive, have to deal with the intricacy of analysing a tremendous amount of data gathered through physical flows and information flows. A typical supply chain manages an inflow of more than 100 gigabytes per day (Arunachalam et al., 2017), and the volume of digital data is expected to reach 35 Zeta bytes by 2020 (Tien, 2015). Furthermore, it is speculated that the use of RFID tags would increase rapidly to 209 billion units by 2021 (Marr, 2014; Tachizawa et al., 2015). This scenario bids the firms to increasingly recognize the value of data and advanced analytical and decision support tools. Data Analytics can assume a pivotal role in transforming and improving the functions of the supply chain as it provides the required capabilities to the various components of the supply chain and can handle the generated big data flow. It can easily handle historical data to provide insights as well as control real-time data for real-time decision-support, which can improve the agility of the organization in a business environment that is highly dynamic and competitive.

Therefore, the supply chain can benefit from information technology enabled business intelligence and analytics by providing capabilities in three essential areas: (1) managing big data that the businesses and supply chain generate, (2) offering

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analytical support to the supply chain processes and (3) managing the supply chain performance. The terms such as Supply Chain Intelligence (SCI) and Supply Chain Analytics (SCA) have become more common (Chae et al, 2013), and studies have shown organizations that can respond effectively to this information age seem to have a great deal of success and perform better. In cases where the business environments are uncertain, BA may have an even more positive impact on processes such as forecasting, designing, purchasing, production, and marketing.

This paper primarily provides an overview of supply chain management and the application of business intelligence to improve its performance. We address the notion that analytical capabilities can guide the exclusively human decisions better and even provide automated decisions in some SC processes. There is no question that Companies having better analytical capabilities with good information system tend to have better SC performance. However, it is essential to stir a discussion on another aspect of global economy triggered by the use of advanced analytics to manage supply chain activities. Intelligent supply chain creates insight and knowledge enabling companies, large and small, to realize a larger profit through the improvement of their operational efficiency and effectiveness. However, by doing so, it also widens the door for exploitation of the labor market in the developing countries. Analytics facilitates competitive pricing and optimal delivery time by its ability to drill down and obtain information across the supply chain including outsourcing partners in countries where labor exploitation is a common practice.

Next section provides an overview of supply chain management followed by an overview of business intelligence and analytics. Section 4 looks at the role of analytics in SCM. Section 5 provides a discussion on the dark side of analytics and section 6 offers the concluding remarks.

2 SUPPLY CHAIN MANAGEMENT OVERVIEW

In the past, most organizations had focused on the effectiveness and efficiency of business functions such as purchasing, production, marketing, financing, and logistics. However, they realized that lack of connectivity among these functions could lead to a sub-optimal organizational goal and risk the main objectives of SC, which include creating net value while building a competitive infrastructure and measuring performance globally. In an organization such as a manufacturing organization, the SC includes all business functions involved in satisfying a customer request such as new product development, marketing, operations, distribution, finance, and customer service (Chopra, 2007). Lack of integration duplicates organizational efforts and resources and impedes efficiency. The failure to connect demand with supply results in poor customer service and rising costs. SCM integrates key business processes from the end-users through suppliers who provide products, services, or information while adding value to all involved. To integrate and synchronize a set of interdependent business processes there is a need to facilitate information exchange among these various business entities like suppliers, manufacturers, distributors, third-party logistics providers, and retailers (Min, 2015).

The two main businesses processes in an SC are inbound logistics (materials management) and outbound logistics (physical distribution). Material management is the process of acquiring and storing raw materials, parts, and supplies and therefore supports the flow of materials from purchasing, controlling production materials, planning and scheduling work-in-process, warehousing, shipping, and distributing the finished products. The physical distribution includes all logistics for providing service to the customer, which include receiving and processing the order, deploying the inventory, and other related activities. While the SC is a combination of these two business functions, it is not merely a linear representation of one-to-one business relationships. It is rather a network of multiple business relationships, which brings about a complexity requiring analytical capabilities to guide the management and decision-making process.

3 BUSINESS INTELLIGENCE AND ANALYTICS OVERVIEW

Business Intelligence (BI) consists of the strategies and technologies used by the enterprise to collect, integrate, analyze, and present business information. The purpose of Business Intelligence is to support a wide range of business decisions at operational and strategic levels. Operating decisions include product positioning or pricing while strategic decisions involve priorities, goals, and guidelines at the broadest level. BI technologies help identify new opportunities and implement an effective strategy

based on insights. The ultimate goal of BI is to improve business decision-making and provide actionable information in the right form for decision makers at the right time and location (Sabherwal and Becerra-Fernandez, 2011).

BI has a centric approach to data and therefore relies heavily on various advanced data collection, extraction, and analysis technologies. Experts often consider data warehousing as the foundation of BI. Organizations use dashboards for business performance management (BPM) making it easy to analyze and visualize various performance metrics. The latest phenomenon, Business Intelligence 2.0 (BI 2.0) allows organizations to gather information from both enterprise databases and the Web. The querying of real-time corporate data is in contrast to previous proprietary querying tools that characterize previous BI software.

Web analytics tools such as Google Analytics can analyze logs containing customer's clickstream data, which provide information about the trail of the user's online activities, thereby revealing the browsing and purchasing patterns of the user. Organizations can use web analytics for better website design, use heat maps for optimizing product placement, analyze the customer transactions better, and enable better product recommendations. Organizations are also capable of organizing and visualizing data by using multilingual retrieval techniques such as knowledge mapping.

Business Analytics (BA) is the practice of iterative, methodical exploration of an organization's data, with an emphasis on statistical analysis. Companies committed to data-driven decision-making use business analytics. Data management is the key infrastructure of BA. BA finds intelligence within the organization's large volumes of data about its products, services, customers, manufacturing, sales, purchasing, and so on. Thus, the data stored in the various corporate databases serve as inputs to BA activities. Most of these data in the databases are transaction oriented, which is not suitable for analysis and report unless some processes manage the data. Thus, the organization's data from various sources go through integration or transformation through ETL (extract, transform, and load) process and the organizations often load this data into a data warehouse, which is a centralized storage location of data. The organization now has to use the stored data to create business value, which requires data mining or knowledge discovery techniques and analytical techniques like mathematical optimization. These techniques help the analysis of data and enable finding useful information such as sales forecasts, business constraints, and others. The data mining techniques can be predictive modeling, clustering, and association. Predictive modeling or analytics uses statistical regression or artificial intelligence based technologies for predicting future events upon historical data. Prescriptive analytics, on the other hand, involves mathematical optimization, simulation, and so on. All these predictive and optimization analytics are available in analytical supply chain planning technologies such as advanced planning scheduling (APS). Business process management (BPM), which is similar to feedback in open systems and a crucial component of BA, enables monitoring, reporting, and correcting, which are the three broad sets of business activities. Companies use KPIs and other metrics to monitor the SC performance. While seemingly similar, there is a major difference between business intelligence vs. business analytics: BI uses past and current data to optimize the present operation while BA uses the past and analyzes the present to prepare companies for the future. Since both depend heavily on data analytics, one can combine business intelligence and analytics (BIA) as the preferred combined term.

Furthermore, SCM needs information technology (IT) for coordination, monitoring, and optimization of SC performance. It also needs management processes like identifying metrics, objectives, goals, parameters, targets, planning, defining communication methods, reporting, and feedback. These functions are available as part of different information system environments including SAP and Oracle. Organizations, using IT, could institute performance measurement processes, which could help decision-makers to increase the effectiveness and efficiency of their SC by focusing on the appropriate metrics (Cai et al., 2009). In general, performance measurement is vital in SCs. Gunasekaran and Kobu (2007) argued that performance measurement could help the organization identify the needs of the customer and increase the product or service fulfillment as the bottlenecks and opportunities are detected and improved. The bottom line is making decisions based on data, and enhancing process communication and coordination is the key to success in SCM (Lim et al., 2013). So, what is business analytics?

4 APPLICATION OF ANALYTICS IN SCM

SCM developed quickly over time from traditional procurement and supply management to the integration from raw materials to end user management. Analyzing large amounts of data and

information within the SC has become essential for identifying financial conditions, information sharing, and decision-making capabilities. The western countries developed BI in the mid-twentieth century to enforce this capability. BI is a decision driven integrated technology by data analysis to help companies improve their business processes. BI helps in optimizing SC integration by including supply-demand management, resource selection management, product definition, production management, inventory management, sales management, relationship management, and decision-making the analysis. BI enables real-time information gathering and analysis using a collection of analytical software and solutions to help users make better business decisions. BIA includes techniques for data extraction and transformation, database management, data mining and recovery, data reporting and visualization, and multidimensional analysis.

Processes such as OLAP are critical to the concept of BI. By adopting BI techniques, organizations can perform real-time estimations of key performance measures such as material quantity, delivery cost, cost of goods, inventory turnover rate. This can enable organizations to make better decisions on business activities. Improving customer and supplier relationship management and increasing SC flexibility ensure minimization of overall costs and maximization of overall profits. BI can help companies achieve an SC that maintains a balance between normal production and supply, enabling better cash flow. BI supports information sharing that enables better SC integration so that organizations can perform real-time data analysis for predicting more accurate customer demands, supply chain activities, and evaluation of the performance of participants in the SC with a focus on suppliers. By the high level of supply chain integration, the organization can accrue advantages that are more competitive and maximize the benefits for all the stakeholders, especially in a complex and dynamic environment. SCA is the application of BI techniques on the SC, and it integrates the different management processes such as planning, sourcing, making, and delivery for analysis of SC performance. SCA aims to extract massive real-time data collected by the SC system for generating meaningful information for decision-makers in the SC (Sahay and Ranjan, 2008).

Figure 1 shows how BI supports the business operations. The first step involves subjecting the data from different departments such as operations, manufacturing, distribution and logistics, sales and marketing, finance and human resources to four main steps of processing. They are extract, clean, transform and load. After loading the data into a data warehouse, BA converts the data to information for user consumption.

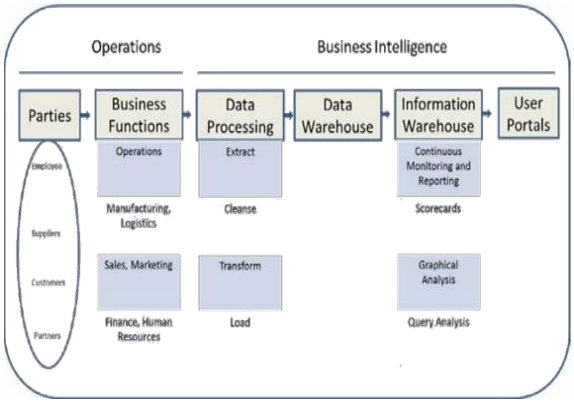

Figure 1: Business Intelligence Infrastructure Source: (Sahay and Ranjan, 2008).

BI involves customer support, market research, distribution channels, product profitability, inventory, and logistics analysis, statistical analysis, and multidimensional reports. Data sources may be enterprise resource planning (ERP), SCM and customer relationship management (CRM) system, customers, suppliers, manufacturing processes, new product testing and development, market price forecasting, customer demographical allocation, and many others. Furthermore, after the development of BI and IT and complex SCs, organizations have become interested in big data real-time analytics, and predictive analytics. In a study that surveyed companies in the U.S., 57 percent of companies preferred using their general company data warehouses to support their SCA applications, while 43 percent preferred using a separate SCA-based data warehouse. Big data predictive analytics involves quantitative analysis, patterns and relationships between a large amount of data, and precise analyses based on hypothetical assumptions. In the SCA, predictive analysis using BI has applications in predicting timely inventory quantity, new product failure rate, mean time to product failure, stock on the road, monthly customer demands and orders, relationships between different KPIs and supplier strategies. SCM predictive analytics using big data for both quantitative and qualitative methods can improve SC performance by using historical data to estimate future levels of business processes (Waller and Fawcett, 2013).

While efficiency and effectiveness is the ultimate measure of success for any organization, we believe

there is a need for a forum to discuss not only the contributions of analytics to facilitate supply chain management but also its impact on exploitation through fierce competition among suppliers operating in developing countries.

5 DISCUSSION AND FUTURE RESEARCH

In today's global economy with the abundant volume of available data and advancement in technology, companies are most likely to use analytics (Trkman et al., 2010) to improve companies' efficiency and effectiveness and maximizing customer satisfaction. However, while companies and customer are the beneficiaries of such phenomenon, the suppliers are at a disadvantage as large companies have the knowledge and consequently the power to pressure them to compete and offer better deals. But, these deals come at a cost to the unprivileged workers in the third world. Perhaps not a new phenomenon, but the application of analytics makes the exploitation more common and more frequent. Increasing efficiency sometimes goes too far such that as the saying goes attempts 'to cut the fat reaches the bone.' While we can find a great deal of literature about the benefits of the application of analytics in supply chain management, little has been said about its impact on the understanding of the economic, political, and cultural environments in the countries in which they intend to outsource and operate.

Supply Chain managers while pursuing efficiency and effectiveness should feel the responsibility to improve the practice of global business and to make a better global expansion. The role of analytics to impend or encourage such proposition must be explored. This study describes the extensive role of analytics to benefit firms and their customers and then strives to extend the conversation to include the supplier and examine the impact of analytics on the suppliers who are rightfully part of the global economy and in control of the well-being of cheap labor, specifically in developing companies. The intention of this study is not to dampen the hype about the analytics, rather, draw attention to another perspective that includes the holistic role of analytics to better our global society. The answer is not straightforward, no research has been conducted, and there is no evidence of any publication to draw the attention of the developers and users of intelligent technology.

The conversation should be around unrealistic assumptions about a business model that uses intelligent SC successfully and profitably but seem to fail to account for real and salient shortcomings that may negatively impact the global economy. To the best of our knowledge, there is no research to contemplate the dark side of analytics in this perspective. Perhaps it is the time to begin such conversation.

6 CONCLUSION

The main objective of SC is to enhance the operational efficiency, increase profitability, and improve the competitive advantage of the organization and its partners. This is partly achieved by applying data analytics to supply chain management. The utmost advantage is providing the employees of an organization and its stakeholders easy and timely access to the information and better use and analysis of data. Analytics provide the critical insights that organizations need to make informed decisions and facilitates the scrutiny of all aspect of business operations to make meaningful inferences or discern unusual behaviors. Using traditional and real-time BI, SCM can derive operational efficiency, promote agility, and assist managers in reducing uncertainty. All in all, analytics drives operational efficiency and effectiveness hence enforcing an upward jump to more profit. However, to improve the practice of global business and to make better global expansion decisions managers need a more sophisticated understanding of the economic, political, and cultural environments in the countries in which they intend to operate. They must appreciate how nations behave in response to the pressure of competition and incorporate those differences in their decision-making process.

REFERENCES

Arunachalam, D., Kumar, N. and Kawalek, J.P., 2017. Understanding big data analytics capabilities in supply chain management: Unravelling the issues, challenges and implications for practice. *Transportation Research Part E: Logistics and Transportation Review* (in press).

Tien, J. M. 2015. Internet of connected servgoods: considerations, consequences and concerns. *Journal of Systems Engineering*, 24 (2), pp. 130-167.

Marr, B. 2014. "Big data: 25 amazing need-to-know facts", available at: http://smartdatacollective.com/bernard marr/277731/big-data-25-facts-everyone-needs-know.

Tachizawa, E.M., Alvarez-Gil, M.J. and Montes-Sancho, M.J., 2015. How "smart cities" will change supply chain management. Supply Chain Management: An International Journal, 20(3), pp.237-248.

Chae, B. K., and Olson, D. L. 2013. Business Analytics for supply chain: A dynamic-capabilities framework. *International Journal of Information Technology & Decision-Making, 12*(1), pp. 9-26. http://cbafiles.unl.edu/public/cbainternal/facstaffuploads/ijitdm2013.pdf

Chopra, S., and Meindl, P. 2007. *The supply chain management: Strategy, planning, and operation.* Upper Saddle River, NJ: Pearson Education, Inc.

Min, H. 2015. *The essentials of supply chain management: New business concepts and applications.* Upper Saddle River, NJ: Pearson Education Ltd.

Cai, J., Liu, X., Xiao, Z., and Liu, J. 2009. Improving supply chain performance management: A systematic approach to analyzing iterative KPI accomplishment. *Journal of Decision Support Systems, 46,* pp. 512-521.

Gunasekaran, A., and Kobu, B. 2007. Performance measures and metrics in logistics and supply chain management: A review of recent literature (1995-2004) for research and applications. *International Journal of Production Research, 45*(12), pp. 2819-2840.

Lim, P. E., Chen, H., and Chen, G. 2013. Business intelligence and analytics: Research directions. *ACM Transactions on Management Information Systems, 3*(4), pp. 1-10.

Sabherwal, R. and Becerra-Fernandez, I. 2011. Business Intelligence: Practices, Technologies, and Management, Wiley, 2011, ISBN: 978-0-470-46170-9.

Sahay, B. S., and Ranjan, J. 2008. Real-time business intelligence in supply chain analytics. *Journal of Information Management & Computer Security, 16*(1), pp. 28-48.

Waller, M. A., and Fawcett, S. E. 2013. Data science, predictive analytics, and big data: A revolution that will transform supply chain design and management. *Journal of Business Logistics, 34*(2), pp. 77-84.

Trkman, P., McCormack, K., Oliveira, M. P., and Ladeira, M. B. 2010. The impact of business analytics on supply chain performance. *Decision Support Systems, 49*, pp. 318-327. doi:10.1016/j.dss.2010.03.007