Data Analytics in the Global Product Development Supply Chain

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INTRODUCTION

As more and more manufacturing business operational activity is digitized, a new source of data and ever-cheaper equipment combine (known as software system technology) to usher manufacturers into a new business world in which vast amounts of digitized data exist on virtually any topic of interest to regular operation. Web-based ordering, online shopping, digital communication, and instrumented machinery generate torrents of data as a by-product of their day in day out operations. Each of these is now a dynamic data creator. The data available are often unstructured, not organized in a database, and unwieldy, but there is a massive amount of unwanted information in it, simply waiting to be released. Besides, analytics brought rigorous decision-making techniques, and big data is more straightforward and robust. In this way, SST, particularly *data analytics*, significantly impacts the manufacturing industry. However, manufacturing professionals have been slow to exploit the full potential of SST. Instead of using SST to maximize productivity and revenue-generation ability, SSTs have been used mainly for *enterprise resource planning* (e.g., accounting, inventory management, human resource management) purposes within the manufacturing industry. As a result, the manufacturing industry has not yet exploited data analytics-based SST as an effective tool.

In addition, the advantage of globalization has simulated different initiatives in global product manufacturing and marketing business activities. For example, in the 1980s, the "*quick response*" strategy was developed to maintain a competitive advantage (Porter, 1985) for the domestic manufacturing of products. Technological innovations have made fast electronic communication a global phenomenon (Pal, 2022), and the rapid acquisition of technical skills in various countries has meant that many professional tasks could be outsourced (quality control, raw materials purchasing, sample making). Researchers (Gereffi, 1999) (Pal & Yasar, 2020) identified some of the trends for the manufacturing business. Also, the globalization trends have continued, and the radical social reform idea of making more from fewer resources (known as *Gandhian Engineering*) (Prahalad & Mashelkar, 2010) has become the business rule in today's global market. Also, operational planning – and appropriate information system (IS) – drives the whole business, where customers play a pivotal role.

With the technological advances, manufacturing companies regularly employ data mining techniques to explore the contents of data warehouses looking for trends, relationships, and outcomes to enhance their overall operations and discover new patterns that allow companies to serve their customers better. This way, manufacturing organizations rely on business processes related data to formulate strategy and succeed under value-based reimbursement models. The new paradigm requires data-driven insights that can help operational managers reduce unnecessary variation in business and make more informed service-line decisions across the enterprise. In this way, intelligent data processing plays a key role.

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This chapter presents some of these issues identifying in particular: (i) the concept of big data, (ii) data gathering, (iii) data processing, and (iv) the broader research dilemmas. Hence, the central theme of this chapter is to expose the reader to some of the more interesting insights into how data and information systems (IS) to help run manufacturing supply chain management.

Evolution in computer processing power and storage capacity has enabled organizations to develop data-rich IS for daily operations, and therefore, there has been tremendous growth for data stored. In addition, business data collection itself has progressed from the transcription of paper-based records via manual data-entry processes to the use of smart cards, mobile phones (Location Data, GPS), Internet of Things (IoT) (e.g., radio frequency identification (RFID) tags, sensors), webcasting and Internet users' mouse clicks. In turn, this data generation has generated a need for new techniques and technologies that can transform these data into appealing and valuable information and knowledge.

Today, big data is generated by web applications, social media, intelligent machines, sensors, mobile phones, and other intelligent hand-held devices, bacterized by velocity, volume, and variety it produces along the supply chain. Such decision-support software applications employ pure mathematical and artificial intelligence techniques and sometimes use both methods to perform analytical operations that uncover relationships and patterns within the manufacturing supply chain generated Big Data.

Business processes along the supply chain must balance to provide customer service at no additional cost or workload. It also requires trade-offs throughout the supply chain. Therefore, it is necessary to consider a single interconnected chain rather than narrow functional business processes when considering practical mechanisms, which help find acceptable solutions at the time of need.

Real-time supply chain decision-making and coordination are essential in the international marketplace, shortening product life cycles and fast-changing trends. Technological evolution and the latest information-sharing techniques make real-time decision-making and coordination easier than in the recent past. In addition, the importance of integrating and coordinating supply chain business partners have been appreciated in many manufacturing industries (Pal, 2016).

Manufacturing supply chain managers are seeking ways to manage Big Data sources effectively. There are many examples of manufacturing business operations using Big Data solutions that highlight the wealth of business process enhancement scopes available through the clever use of data:

- Big Data-based applications, which help integrate strategic business planning, are recently assisting manufacturing businesses to coordinate more susceptible supply chains as they better apprehend operating market tendencies and customer desires. It forms the triangulation of a range of marketing and operating business environment data (e.g., social media discussion forums, demographic information, other static and dynamic data from diverse sources), giving the ability to forecast and proactively formulate strategies for manufacturing supply chain businesses.
- Software-defined machines, data-driven predictive analyses, Internet of Things (IoT), and soft-computing based machine learning mechanisms are ushering in a new industrial revolution. These new breeds of computing power are being used in predictive asset maintenance to avoid unplanned downtimes in the manufacturing shop floor.
- IoT can provide real-time telemetry data to reveal the details of production processes. In addition, machine learning algorithms are used to analyze the data to reveal the details of production processes that can correctly forecast near future machine failures and appropriate actions.
- Big Data-based solutions are helping avoid delivery delays and create pollution-reduced environments by analyzing Global Positioning Systems (GPS) data with the help of traffic and meteorological data, which actively plan and find cost-effective delivery routes.