About Big Data and its Challenges and Benefits in Manufacturing

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The aim of this article is to show the importance of Big Data and its growing influence on companies. It also shows what kind of big data is currently generated and how much big data is estimated to be generated. We can also see how much are the companies willing to invest in big data and how much are they currently gaining from their big data. There are also shown some major influences that big data has over one major segment in the industry (manufacturing) and the challenges that appear.

Keywords: *Big Data, manufacturing, challenges, benefits*

1 About Big Data

Big data is a new power that changes everything it interacts with and it is considered by some to be the electricity of the 21st century.

It was in the early 21st century when we first heard about the concept of big data. It was the first time when attributes like too large, too unstructured and too fast-moving where used for describing the nature of the data.

Big data's first main attribute is the volume. Some quantified data by counting there records, transactions, tables or file, but some found it more useful to quantify big data in terms of time. For example, in the U.S. some prefer to keep data available for legal analysis for seven years which is statute of limitations.

The second attribute is the variety of data. This happens because data come from a variety of sources like logs, streams, social media, text data, semi-structured data from B2B processes.

The last attribute of big data is the velocity which refers to the low-latency, real-time speed at which analytics need to be applied.

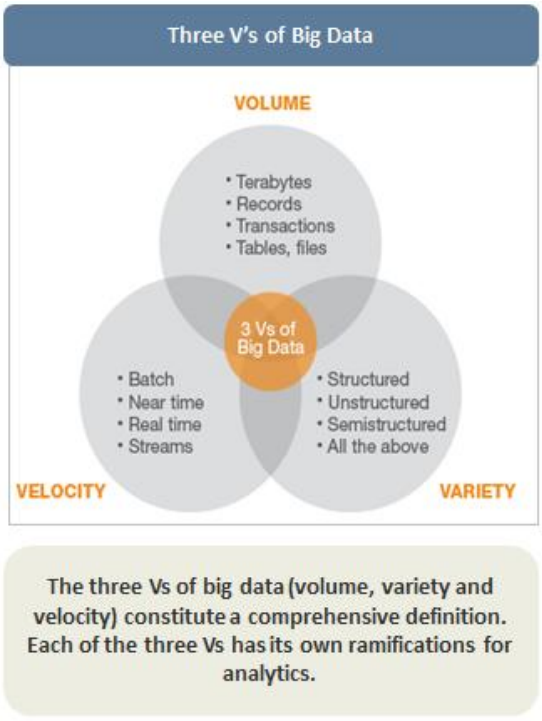

Fig.1. The three V's of Big Data [1]

Big data involves more than simply the ability to handle large volumes of data.

Firms like Google, eBay, LinkedIn and Facebook were the first organizations to embrace it, and were built from the beginning around big data. These firms had huge amounts of data in a new and less structured format (click streams, web server logs, social network relationships) and had

no choice but to implement new technologies and management approaches.

These companies were not the only ones facing such problems, in the travel industry everybody had the same issues. Every airline reservation, hotel stay, rental car or train reservation leaved a data trail, and that data over the years adds up to hundreds of terabytes or petabytes of structured transaction data.

Many research teams were assembled to gather information and study the total amount of data generated, stored, and consumed in the world. Though they had different estimates purposes and therefore their result vary, all point to an exponential growth in the future years. [2] MGI estimates that enterprises globally stored more than 7 exabytes of new data on disk drives in 2010, while consumers stored more than 6 exabytes of new data on devices such as PCs and notebooks. One xabyte of data is the equivalent of more than 4,000 times the information stored in the US Library of Congress [3]. Indeed, we are generating so much data today that it is physically impossible to store it all. [4]

Nowadays every sector in the global economy faces the big data problem. By 2009, nearly all sectors in the US economy had at least an average of 200 terabytes of stored data per company with more than 1,000 employees.

In total, European organizations have about 70% of the storage capacity of the entire United States at almost 11 exabytes.

According to Reuters [5], Big Data will grow from $3.2 billion in 2010 to reach a $25 billion industry by 2015.

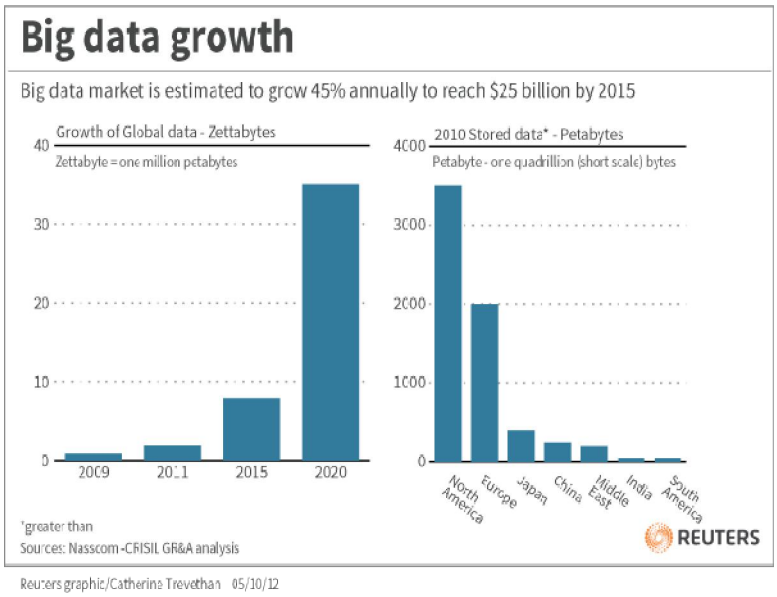

Fig.2. Big Data Growth [5]

2. The Structure Of Big Data

Companies are using different types of data, therefore this data has been categorized based on the dimension of the data structure and on the dimension of the data source.

Based on the dimension of data structure, we distinguish structured (the data from fixed fields – spreadsheets or relational databases), unstructured (the data that does not reside in fixed fields – text from articles, email messages, untagged audio or video data, etc) and semi-structured data (the data that does not reside in fixed fields but uses tags or other markers to capture elements of the data – XML, HTML-tagged text).

Based on the dimension of data source, we distinguish internal data (gathered from a company's sales, customer services, employee records, etc.) and external data (gathered from sources outside a company such as third-party data providers, public social media sites, etc.).
Studies results across the globe shows as that 51% of data is structured, 27% of data is unstructured and 21% of data is semi-structured. [6]

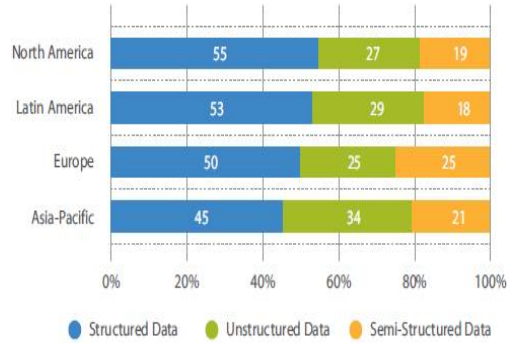

Fig.3. Data Structure Graphic [6]

Same reports reveal us that less than a quarter of the data was external.

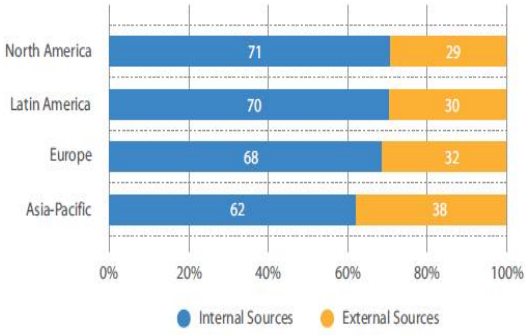

Fig.4. Data Sources Graphic [6]

3. The Value of Big Data

Using big data can be a key factor for companies in outperforming their competitors. It is estimated that a retailer embracing big data has the potential to increase its operating margin by more than 60 percent. More than that, big data creates new growth opportunities and entirely new categories of companies, such as those that aggregate and analyze industry data. Many of these will be companies that sit in the middle of large information flows where data about products and services, buyers and suppliers, and consumer preferences and intent can be captured and analyzed.
Many companies have access to valuable pools of data generated by their products and services. Networks will even connect physical products, enabling those products to report their own serial numbers, ship dates, number of times used, and so on.
It is important that all companies take big data seriously. In most industries, established competitors and new entrants alike will leverage data-driven strategies to innovate, compete, and capture value.
Based on analysis on the gathered data companies can design products that better match the needs of their customers.
Some executives are seeking data the organization has that might be of value to another organization, and from which the firm might be able to profit. That's the opportunity side. In 2012, about one-quarter of the companies surveyed by experts (27%) were capitalizing on this opportunity: selling their digital data. U.S. companies profited least from such data, with only 22% doing so. In contrast, half the Asia-Pacific companies sell their digital data. About one-quarter of European and Latin American companies sold their digital data in 2012.

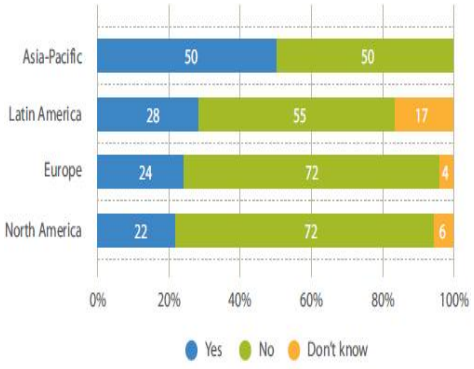

Fig.5. Big Data Selling Graphic [6]

For the approximately one-quarter of companies that sell their digital data, the annual revenue from selling such data was not trivial. In 2012, on an average, selling digital data contributed $21.6 million to the revenue of companies.

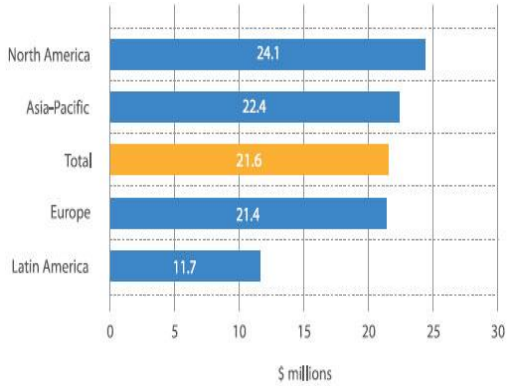

Fig.6. Big Data Revenue Graphic [6]

So clearly, some companies are profiting from their data. However, of the 73% of companies that did not sell such data, 22% said they do plan to sell such data by 2015; 55% don't; and 23% did not know. That means by 2015, 43% of companies will sell their digital data (the 27% that already do today, plus the 22% of the 73% that don't today) [6].

4. Investing in Big Data

According to researches the investments company made in Big Data were sizable. These investments were measured in two ways: by the median and the average survey respondent. The median spending on Big Data was $10 million, which was 0.14% of revenue (based on median revenue of survey respondents: $6.9 billion). The average survey respondent spending on Big Data was $88 million in 2012, which was 0.5% of average revenue (of $19 billion).

In 2012, 15% of the companies invested at least $100 million apiece on Big Data initiatives. About half of them (7%) invested at least $500 million each. However, on the other end of the spectrum were the 24% of companies that spent relatively little on Big Data – less than $2.5 million each.

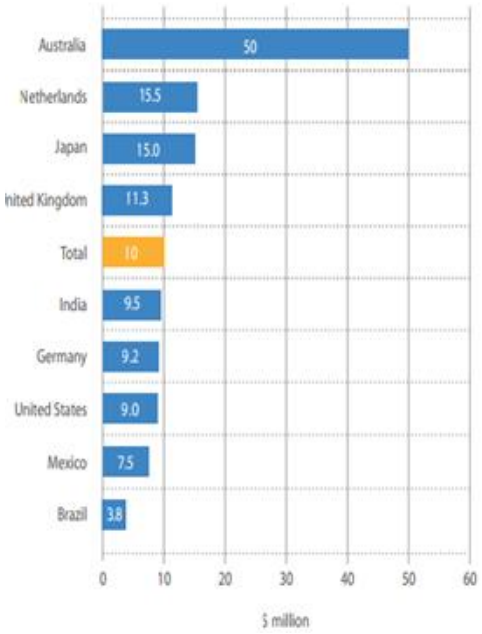

Fig.7. Big Data Investments Graphic [6]

According to the same report [6], by the year 2015, companies across the surveyed regions expect to spend 75% more on Big Data, with Australia and U.K. companies projecting the highest spending per company. Median spending across all countries is projected to increase by 75% to $17.5 million.

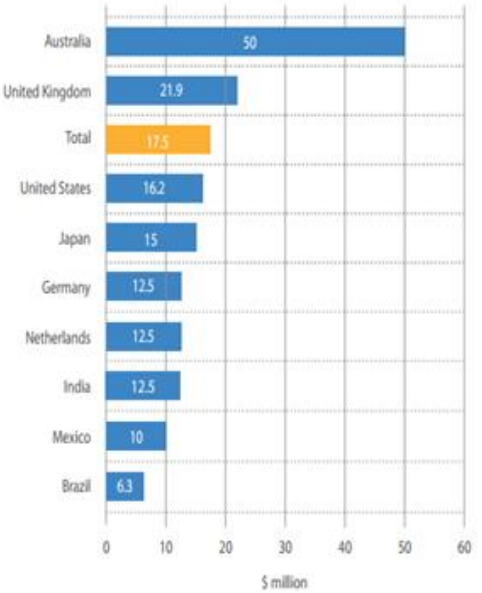

Fig.8. Big Data Spending Projecting Graphic [6]

5. Big data in manufacturing

The manufacturing sector was an early and intensive user of data to drive quality and efficiency, adopting information technology and automation to design, build, and distribute products since the dawn of the computer era. In the 1990s, manufacturing companies racked up impressive annual productivity gains because of both operational improvements that increased the efficiency of their manufacturing processes and improvements in the quality of products they manufactured.

The manufacturing sector has been the backbone of many developed economies.

Increasingly global and fragmented manufacturing value chains create new challenges that manufacturers must overcome to sustain productivity growth. In many cases, technological change and globalization have allowed countries to specialize in specific stages of the production process.

To continue achieving high levels of productivity growth, manufacturers will need to leverage large datasets to drive efficiency across the extended enterprise and to design and market higher-quality products. The "raw material" is readily available; manufacturers already have a significant amount of digital data with which to work. Manufacturing stores more data than any other sector—close to 2 exabytes of new data stored in 2010. This sector generates data from a multitude of sources, from instrumented production machinery (process control), to supply chain management systems, to systems that monitor the performance of products that have already been sold (e.g., during a single cross-country flight, a Boeing 737 generates 240 terabytes of data).

And the amount of data generated will continue to grow exponentially. The number of RFID tags sold globally is projected to rise from 12 million in 2011 to 209 billion in 2021. IT systems installed along the value chain to monitor the extended enterprise are creating additional stores of increasingly complex data, which currently tends to reside only in the IT system where it is generated.

Manufacturers will also begin to combine data from different systems including, for example, computer-aided design, computer-aided engineering, computer-aided manufacturing, collaborative product development management, and digital manufacturing, and across organizational boundaries in, for instance, end-to-end supply chain data.

According to McKinsey Global Institute [7] analysis the following big data levers across the manufacturing value chain have been identified:

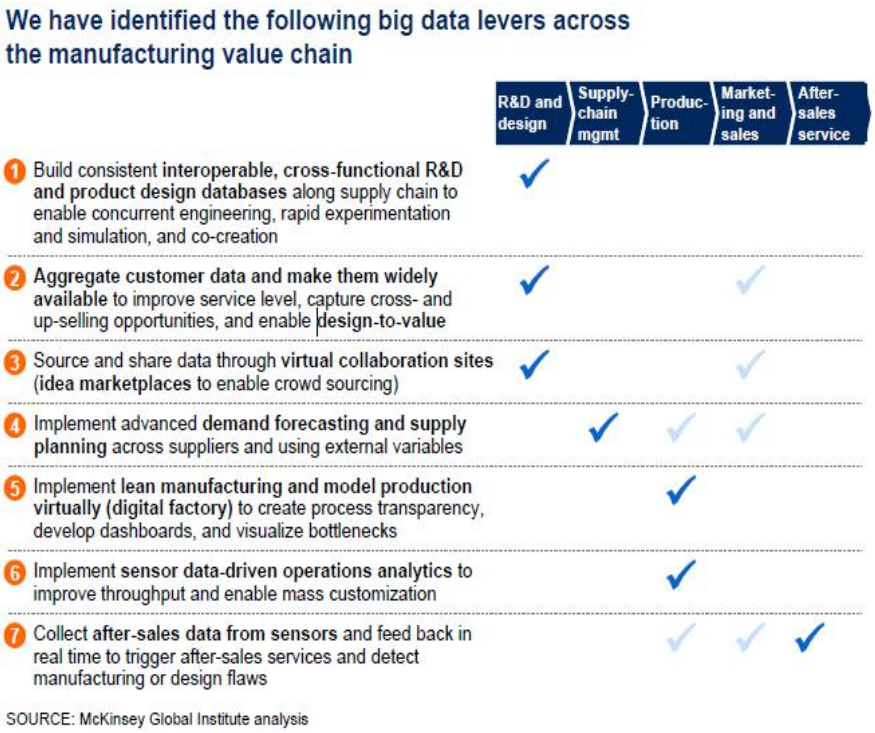

Fig.9. Big Data Levers [7]

- Research and development and product design

The use of big data offers further opportunities to accelerate product development, help designers home in on the most important and valuable features based on concrete customer inputs as well as designs that minimize production costs, and harness consumer insights to reduce development costs through approaches including open innovation.

a. Product lifecycle management. Over decades, manufacturing companies have implemented IT systems to manage the product lifecycle including computer aided-design, engineering, manufacturing, and product development management tools, and digital manufacturing. However, the large datasets generated by these systems have tended to remain trapped within their respective systems. Manufacturers could capture a significant big data opportunity to create more value by instituting product lifecycle management (PLM) platforms that can integrate datasets from multiple systems to enable effective and consistent collaboration.

b. Design to value. While obtaining customer input through market research has traditionally been a part of the product design process, many manufacturers have yet to systematically extract crucial insights from the increasing volume of customer data to refine existing designs and help develop specifications for new models and variants. Best-in-class manufacturers conduct conjoint analyses to determine how much customers are willing to pay for certain features and to understand which features are most important for success in the market.

c. Open innovation. To drive innovation and develop products that address emerging customer needs, manufacturers are relying increasingly on outside inputs through innovative channels. With the advent of Web 2.0, some manufacturers are inviting external stakeholders to submit ideas for innovations or even collaborate on product development via Web-based platforms. Consumer goods companies such as Kraft and Procter and

Gamble invite ideas from their consumers as well as collaborate with external experts, including academics and industry researchers, to develop new products.

- Supply chain

Manufacturers, especially those producing fast-moving consumer goods, have significant additional opportunities to improve demand forecasting and supply chain planning. The volatility of demand has been a critical issue for manufacturers. Their retailing customers have pushed hard for increased flexibility and responsiveness from suppliers, given the diverging and ever-changing preferences of consumers. Other trends, such as the increasing use of promotions and tactical pricing, have only magnified volatility issues facing suppliers.

Manufacturers can improve their demand forecasting and supply planning by the improved use of their own data. But as we've seen in other domains, far more value can be unlocked when companies are able to integrate data from other sources including data from retailers, such as promotion data (e.g., items, prices, sales), launch data (e.g., specific items to be listed/delisted, ramp-up/ramp-down plans), and inventory data (e.g., stock levels per warehouse, sales per store). By taking into account data from across the value chain (potentially through collaborative supply chain management and planning), manufacturers can smooth spiky order patterns. The benefits of doing so will ripple through the value chain, helping manufacturers to use cash more effectively and to deliver a higher level of service.

- Production

Big data are driving additional efficiency in the production process with the application of simulation techniques to the already large volume of data that production generates. The increasing deployment of the "Internet of Things" is also allowing manufacturers to use real-time data from sensors to track parts, monitor machinery, and guide actual operations. [8]

a. Digital factory. Taking inputs from product development and historical production data (e.g., order data, machine performance), manufacturers can apply advanced computational methods to create a digital model of the entire manufacturing process.

b. Sensor-driven operations. The proliferation of Internet of Things applications allows manufacturers to optimize operations by embedding real-time, highly granular data from networked sensors in the supply chain and production processes. These data allows ubiquitous process control and optimization to reduce waste and maximize yield or throughput. They even allow for innovations in manufacturing that have not been possible thus far, including nano-manufacturing.

- Marketing and sales/after-sales support

As we have described, manufacturing companies are using data from customer interactions not only to improve marketing and sales but also to inform product development decisions. Increasingly, it is economically feasible to embed sensors in products that can "phone home," generating data about actual product usage and performance. Manufacturers can now obtain real-time input on emerging defects and adjust the production process immediately.

There are also many opportunities to leverage large datasets in the marketing, sales, and after-sales service activities. As we can observe in many sectors, opportunities range from the segmentation of customers to applying analytics in order to improve the effectiveness of sales forces. An increasingly important application for manufacturers is using sensor data from

products once they are in use to improve service offerings.

6. Manufacturing/operations – Benefits and challenges

Manufacturing and production managers believe the greatest opportunities of Big Data for their function are to detect product defects and boost quality, and to improve supply planning. Better detection of defects in the manufacturing/production processes is next on the list.

A $2 billion industrial manufacturer said that analyzing sales trends to keep its manufacturing efficient was the main focus of its Big Data investments. The company's products are largely engineered to order. Understanding the behavior of repeat customers is critical to delivering in a timely and profitable manner. Most of its profitability analysis is to make sure that the company has good contracts in place. The company says its adoption of analytics has facilitated its shift to lean manufacturing, and has helped it determine which products and processes should be scrapped.

They see far less opportunity in using Big Data for mass customization, simulating new manufacturing processes, and increasing energy efficiency.

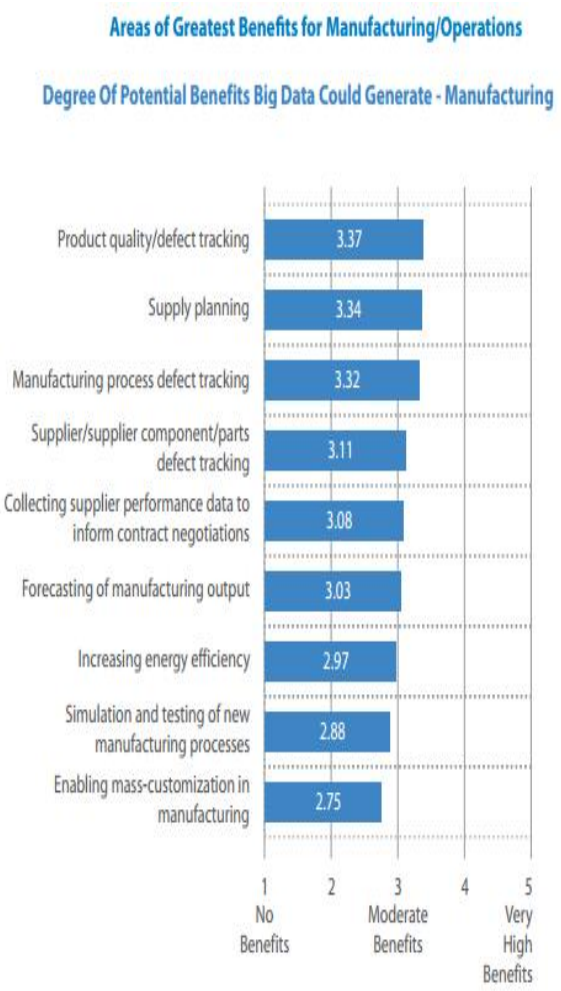

Fig.10. Greatest Benefits Areas for Manufacturing [7]

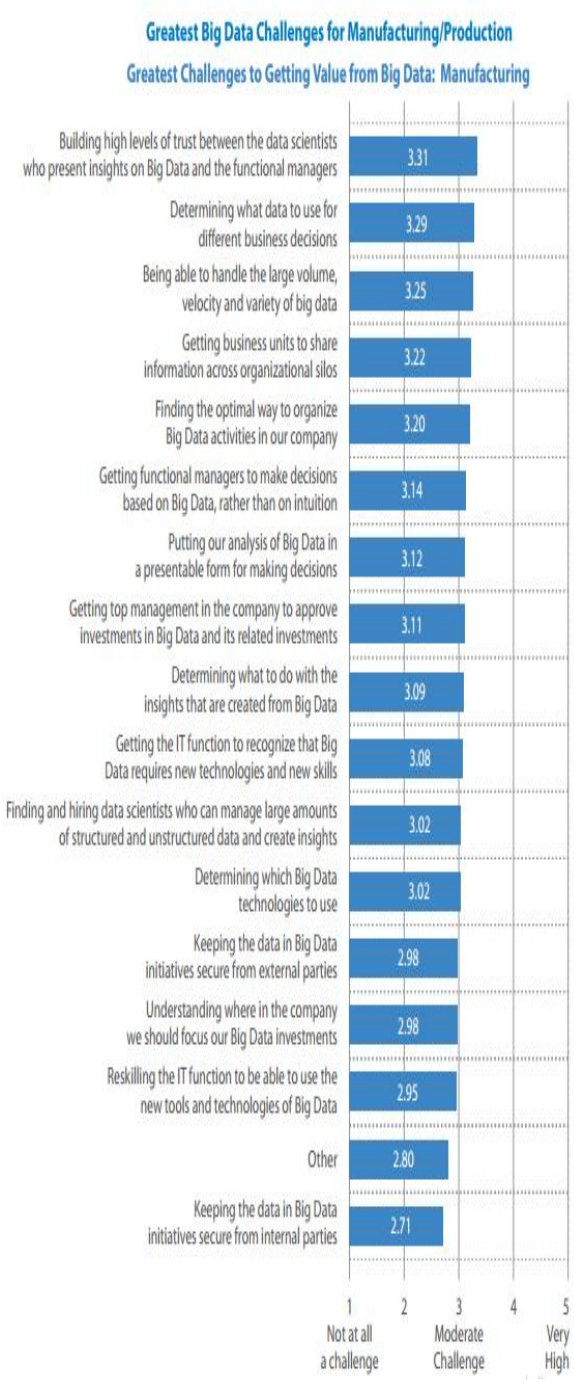

Fig.11. Big Data Challenges for Manufacturing [7]

Many of the levers also require access to data from different players in the value chain. To optimize production planning, data from various tiers of suppliers will be necessary. Demand planning will require customer data from retailers.

Manufacturing companies will also need to build the capabilities needed to manage big data. Despite the fact that the sector has been dealing with large datasets for two decades, the rising volume of data from new sources along the supply chain and from end markets requires a new level of storage and computing power and deep analytical expertise if manufacturers are to harvest relevant information and insights. There is a shortage of talent with the right experience for managing this level of complexity. Manufacturers will need not only to recruit new talent but also to remove organizational obstacles that today prevent such individuals from making maximum contributions.

Finally, where big data applications touch consumers and other end users, there are privacy issues. One of the most promising ideas is using product sensor data to create finely targeted after-sales services or cross-selling. But wielding this lever will be possible only if consumers don't object to suppliers monitoring how they use their products. Manufacturers must therefore address privacy concerns proactively, in collaboration with policy makers, and communicate with end users about choices and data transparency.

7. Conclusions

Big data allows organizations to create highly specific segmentations and to tailor products and services precisely to meet those needs. This approach is well-known in marketing and risk management but can be revolutionary elsewhere

Big data enables companies to create new products and services, enhance existing ones, and invent entirely new business models. Manufacturers are using data obtained from the use of actual products to improve the development of the next generation of products and to create innovative after-sales service offerings.

Manufacturers have tremendous potential to generate value from the use of large datasets, integrating data across the extended

enterprise and applying advanced analytical techniques to raise their productivity both by increasing efficiency and improving the quality of their products. In emerging markets, manufacturers can begin to build competitive advantage that goes beyond their (thus far) relatively low labor costs. In developed markets, manufacturers can use big data to reduce costs and deliver greater innovation in products and services.

For manufacturers, opportunities enabled by big data can drive productivity gains both through improving efficiency and the quality of products. Efficiency gains arise across the value chain, from reducing unnecessary iterations in product development cycles to optimizing the assembly process. The real output value of products is increased by improving their quality and making products that better match customers' needs.

Data have become an important factor of production today—on a par with physical assets and human capital—and the increasing intensity with which enterprises are gathering information alongside the rise of multimedia, social media, and the Internet of Things will continue to fuel exponential growth in data for the foreseeable future. Big data have significant potential to create value for both businesses and consumers.

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