IBM Global Business Services
Business Analytics and Optimization

Executive Report

In collaboration with *Saïd Business School at the University of Oxford*

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UNIVERSITY OF OXFORD

IBM Institute for Business Value

Analytics: The real-world use of big data in manufacturing

How innovative industrial manufacturers extract value from uncertain data

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IBM Global Business Services, through the IBM Institute for Business Value, develops fact-based strategic insights for senior executives around critical public and private sector issues. This executive report is based on an in-depth study by the Institute's research team. It is part of an ongoing commitment by IBM Global Business Services to provide analysis and viewpoints that help companies realize business value.
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Saïd Business School at the University of Oxford

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By Jerry Kurtz and Rebecca Shockley

"Big data" – which admittedly means many things to many people – is no longer confined to the realm of technology. Today, leveraging big data is a business imperative, and it is enabling solutions to long-standing business challenges for industrial manufacturing companies around the world. Indeed, industrial manufacturers are leveraging big data to transform their processes, their organizations and, in some cases, entire industries.

Our newest global research study, "Analytics: The real world use of big data," finds that executives are recognizing the opportunities associated with big data.[1] But despite what seems like unrelenting media attention, it can be hard to find in-depth information on what industrial manufacturing organizations are really doing with it. In this industry-specific paper, we will examine how industrial manufacturing respondents view big data – and to what extent they are using it to benefit their businesses. The IBM Institute for Business Value partnered with the Saïd Business School at the University of Oxford to conduct the 2012 Big Data @ Work Study, surveying 1,144 business and IT professionals in 95 countries, including 124 respondents from the industrial manufacturing industry, or about 11 percent of the global respondent pool.

Big data presents many promising and differentiating opportunities and challenges for industrial manufacturers, including aerospace and defense companies, auto manufacturers, heavy equipment manufacturers, electronics companies, oil and gas companies, and other organizations that produce consumer and capital goods. Like most commercial enterprises, industrial manufacturers have operational and business data about their finances, inventories, products, human resources, distributors and partners. Industrial manufacturers are poised to use big data technologies to capitalize on this and many other sources of data to optimize manufacturing and field operations and, in some cases, address key business needs by integrating the data from and into the products themselves.

Most industrial manufacturing firms have complex manufacturing processes, often with equally complex relationships across the supply chain with vendors and sub-assembly suppliers. On the shop floor, mistakes are expensive and downtime is enormously costly. Software – and, by extension, data – is an increasingly integral aspect of many of today's industrial products; the typical car or airplane has more code than a personal computer, a trend likely to grow as products become more connected and intelligent. Many manufacturers are also equipping their products with sensors, which enable product owners to use connective data technologies to monitor the health of those products from afar, creating new and immense streams of data that can be relevant for predictive maintenance, predictive quality and other supply chain applications.

Industrial manufacturers also have the opportunity to use these vast data resources to control costs, optimize consumption of resources and manage sustainability efforts amid changing regulations. So the question for many of these companies is: How do they harvest and use this information to gain competitive advantage?

We found that 53 percent of these industrial manufacturers report that the use of information (including big data) and analytics is creating a competitive advantage for their organizations, compared with 63 percent of cross-industry respondents. In the industrial manufacturing industries, the percentage of respondents reporting a competitive advantage rose from 33 percent in 2010 to 53 percent in 2012, a 61 percent jump in just two years (see Figure 1).[2]

Realizing a competitive advantage

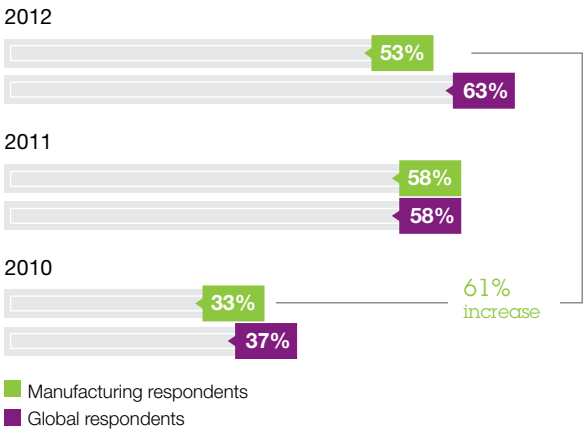

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Figure 1: **Industrial manufacturing companies are lagging behind their cross-industry peers in their ability to create a competitive advantage from analytics and information.**

Further, the study found that industrial manufacturers are taking a business-driven and pragmatic approach to big data. The most effective big data strategies identify business requirements first, and then use the existing (and evolving) infrastructure, data sources and analytics to support the business opportunities. These organizations extract new insights from both existing and newly available sources of information and define a big data strategy that gradually extends the sources of data and infrastructures over time.

Organizations are being practical about big data

Our Big Data @ Work survey confirms that most organizations are currently in the early stages of big data planning and development efforts. Industrial manufacturers are on par with the global pool of cross-industry counterparts (see Figure 2).

Big data activities

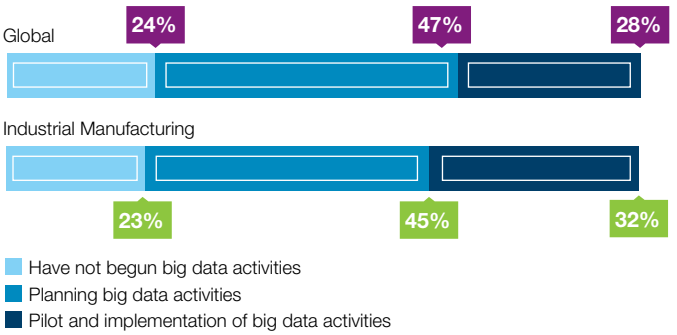

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Figure 2: **Three-quarters of industrial manufacturing companies have either started developing a big data strategy or piloting and implementing big data projects, on par with their cross-industry peers.**

While 23 percent of industrial manufacturers are focused on understanding the concepts (compared with 24 percent of global organizations), the majority are either defining a roadmap related to big data (45 percent), or have big data pilots and implementations already underway (32 percent), although many companies are working simultaneously on a roadmap and first set of pilots or implementations.

In our global study, we identified five key findings that reflect how organizations are approaching big data. For an in-depth discussion of each of these findings, please refer to the full study, "Analytics: The real-world use of big data."[3]

In this industry analysis, we examine how industry-specific challenges affect these global findings for industrial manufacturing organizations, and we provide our top-level recommendations to address the needs of industrial manufacturers.

1. Customer and operational analytics are driving big data initiatives

When asked to rank their top three objectives for big data, 44 percent of the industrial manufacturing industry respondents with active big data efforts identified customer-centric objectives as their organization's top priority, compared to 49 percent of cross-industry respondents (see Figure 3). This is consistent with what we see in the marketplace, where industrial manufacturing organizations are seeking to deliver new products and services to seize market opportunities with predictable costs. The nature of these customer-focused data initiatives naturally varies based on a company's unique

Big data objectives

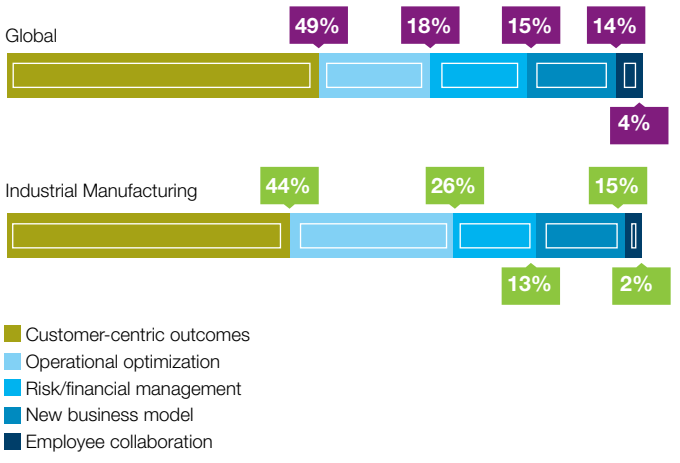

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Figure 3: **Industrial manufacturing companies are using emerging technologies to compensate for the lack of integrated and scalable data infrastructures.**

business priorities. For example, while a military aircraft manufacturer may have deep data integration with government clients to fulfill complex engineering requirements, an auto manufacturer may be looking to customer data to improve relationships with millions of drivers.

Not surprisingly, the use of big data to address operational optimization was a strong second-place objective among industrial manufacturers. Twenty-six percent of respondents identified it as a top big data goal, reflecting the industry's focus on optimizing supply chain and manufacturing operations. Big data solutions aimed at predictive asset maintenance and predictive quality are prime examples of how manufacturers are using data to optimize asset performance and related operations.

Innovative manufacturers are using big data technologies to focus simultaneously on customers and operations. On the customer side of things, a successful Japanese tire manufacturer rarely evaluated the effectiveness of its marketing activities. With the goal of reducing costs to improve the company's operating profit ratio, the marketing department set out to improve sales campaign effectiveness by employing better marketing methods.

This tire maker can now make changes to its campaigns based on speedy analysis of key, unstructured data content in social media postings. The company uses this greater consumer insight to increase sales and improve its image by developing a more flexible and cost-effective marketing strategy in the short term and by making improvements and changes to its products based on customer feedback in the longer term. Largely as a result, it has achieved 120 percent sales growth, 190 percent operating profit growth and 160 percent profit rate growth compared with a similar period three years earlier.

2. Big data is dependent upon a scalable and extensible information foundation

The promise of achieving significant, measurable business value from big data can be realized only if organizations establish an information foundation that supports the rapidly growing volume, variety and velocity of data. We asked respondents with current big data projects to identify the state of their big data infrastructures. Industrial manufacturers lagged behind their cross-industry counterparts in the integration of their data and the scalability of the storage, but appear to be compensating with newer technologies (see Figure 4).

Manufacturing respondents differed greatly from the cross-industry group in using Hadoop/MapReduce technology, registering at 75 percent versus the cross-industry's 42 percent. These technologies, along with NoSQL (50 percent for manufacturers), are designed to manage unstructured or streaming data – from sensors, actuators and the like – enabling industrial manufacturers to analyze that data.

Unlike many other industries, manufacturing respondents reported strong data security and governance, a key infrastructure component given the quantity of external data used. Industrial manufacturers also reported, at 60 percent, higher use of workload optimization and scheduling platforms, reflecting the necessity to keep factory floors and field operations productive and optimized.

Big data infrastructure

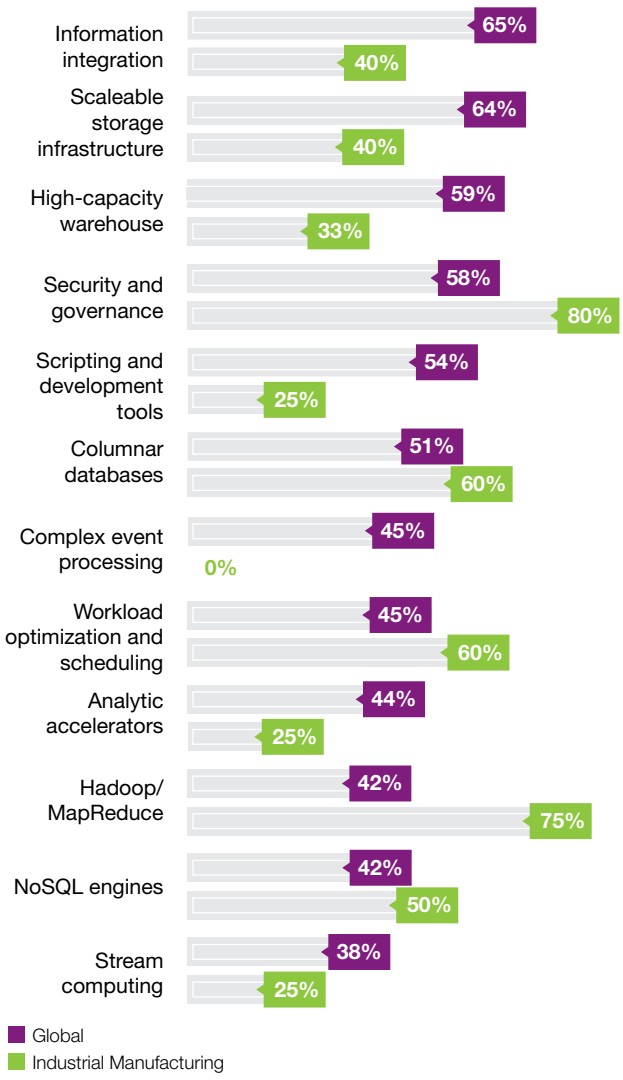

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Figure 4: **Industrial manufacturing companies are using emerging technologies to compensate for the lack of integrated and scalable data infrastructures.**

3. Initial big data efforts are focused on gaining insights from existing and new sources of internal and external data

Most early big data efforts are targeted at sourcing and analyzing internal data, and we find this is also true for industrial manufacturers. According to our survey, an overwhelming majority of industrial manufacturing respondents reported internal data as the primary source of big data within their organizations. This suggests that industrial manufacturers are taking a practical approach to adopting big data and also that there is tremendous untapped value still locked away in these internal systems (see Figure 5).

Industrial manufacturing respondents with active big data efforts are analyzing transactions (78 percent) and log data (65 percent). This machine-generated data records the details of every operational transaction and automated function performed within the industrial manufacturers' business or information systems – data that has outgrown the ability to be stored and analyzed by many traditional systems. As a result, in many cases this data has been collected for years, but not necessarily analyzed.

The majority of industrial manufacturing respondents cited using analytics for sensors (53 percent) and geospatial data (53 percent) within their operations. Unlike the broader group, industrial manufacturers more often used e-mail (76 percent compared to 57 percent), social media (56 percent compared to 43 percent of the cross-industry group) and external feeds, likely from supply chain partners (67 percent compared to 42 percent).

Big data sources

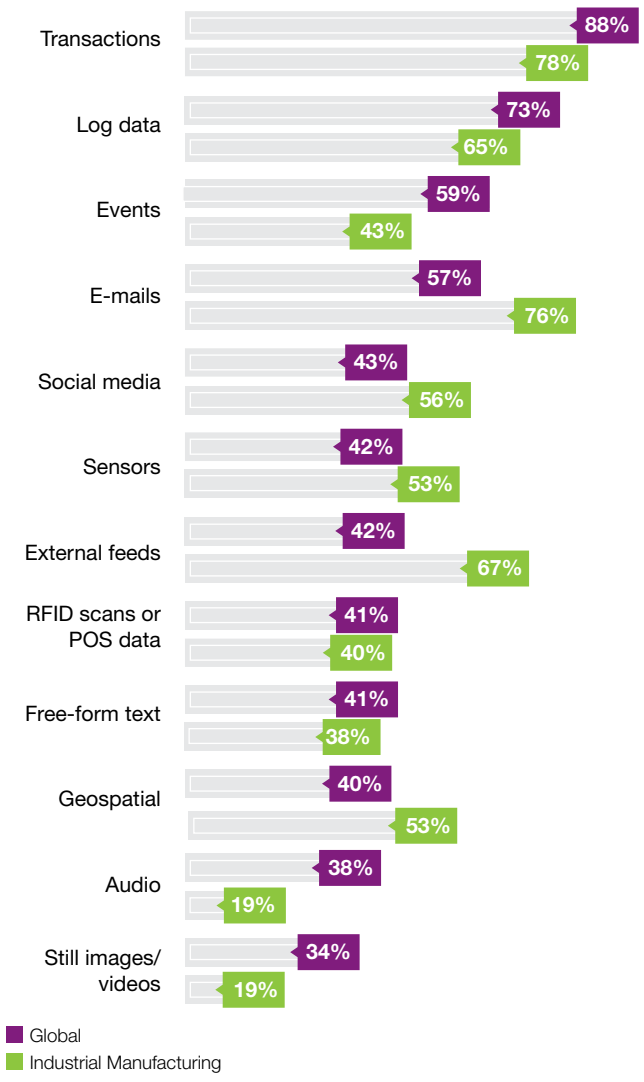

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Figure 5: **Industrial manufacturing companies are focusing initial big data efforts on transactional and log data, both key internal sources.**

One leading copper miner's internal data flow reached the limits of the company's technology. Equipment-use plans, procurement and financial reporting all suffered from a lack of visibility into key operating and financial data. The company sought to implement a centralized and automated financial planning and reporting system that would give it greater insight into its business and ultimately improve its competitive position.

The system – imbued with advanced analytics capabilities – gives the mining company comprehensive visibility into its operations, making it operate more efficiently and improving the outcomes of its mining and pricing decisions. Largely as a result, the company reduced procurement spending on equipment by 50 percent while increasing productivity. The company was also able to reopen at least two closed mines through the use of algorithms to help optimize the use of its mining equipment. It analyzed numerous pieces of equipment and mining operation parameters to select the most suitable equipment for each job and help ensure its effective use.

4. Big data requires strong analytics capabilities

Big data itself, of course, does not create value until it is employed to solve business challenges. This requires access to more and different kinds of data across organizational silos, as well as strong analytics capabilities that include both software tools and the skills to use them.

We find that the industrial manufacturing sector generally followed the same mix of capabilities that the cross-industry group chose, but was ahead of the full respondent sample in every category. Examining those industrial manufacturers engaged in big data activities indicates they start with a strong core of analytics capabilities designed to address structured data, such as basic queries, data visualization, predictive modeling and data mining.

Industrial manufacturers are also ahead of their cross-industry peers in the use of geospatial analytics (63 percent of industrial manufacturers compared to 43 percent in other industries), reflecting the industry's advanced analysis of supply chains and asset locations (see Figure 6).

For example, with a mission to improve safety and promote an accident-free automotive society, an automobile manufacturer is pursuing not only automobile-specific technology, but also technology that will let automobiles benefit society. The company is now using advanced statistical methods to analyze the data previously collected from cars involved in traffic incidents to improve the safety of the automobiles it manufactures.

An algorithm used for traffic simulation can be bundled with an integrated traffic analysis solution. The result is often the prevention of future traffic accidents and incidents, through early warnings and alerts when situations similar to those analyzed in the research are encountered by drivers. These statistical and analytical methods contributed to a 20 percent improvement in early-warning precision, compared with the previous method developed.

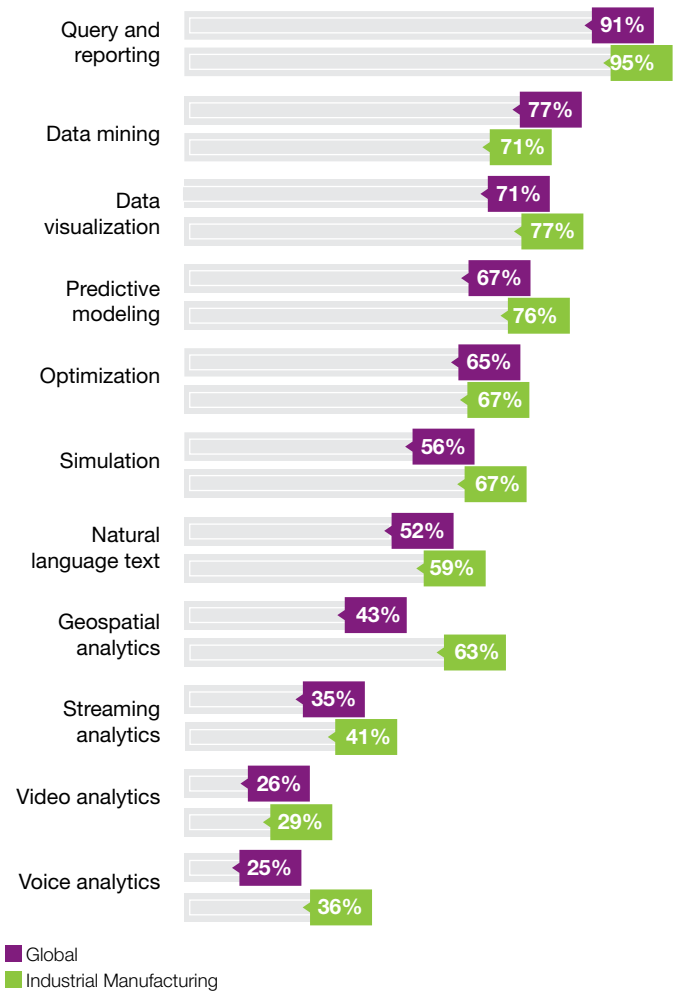

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Figure 6: **Industrial manufacturing companies outpace their cross-industry peers in almost all analytics capabilities.**

5. The current pattern of big data adoption highlights industrial manufacturers' hesitation, but confirms interest too

To better understand the big data landscape, we asked respondents to describe the level of big data activities in their organizations today. The results suggest four main stages of big data adoption and progression along a continuum that we have identified as Educate, Explore, Engage and Execute (see Figure 7). For a deeper understanding of each adoption stage, please refer to the global version of this study.[4]

- **Educate** (building a base of knowledge): 29 percent of industrial manufacturing respondents
- **Explore** (defining the business case and roadmap): 42 percent of industrial manufacturing respondents
- **Engage** (embracing big data): 25 percent of industrial manufacturing respondents
- **Execute** (implementing big data at scale): 4 percent of industrial manufacturing respondents.

At each stage, the most significant obstacle reported by industrial manufacturing firms is the gap between the need and the ability to articulate measurable business value. Executives must understand the potential or realized business value from big data strategies, pilots and implementations. Organizations must be vigilant in articulating the value – forecasted based on detailed analysis when needed and tied to pilot results where possible – for executives to embrace the investment in time, money and human resources necessary to create business value from big data.

Big data adoption

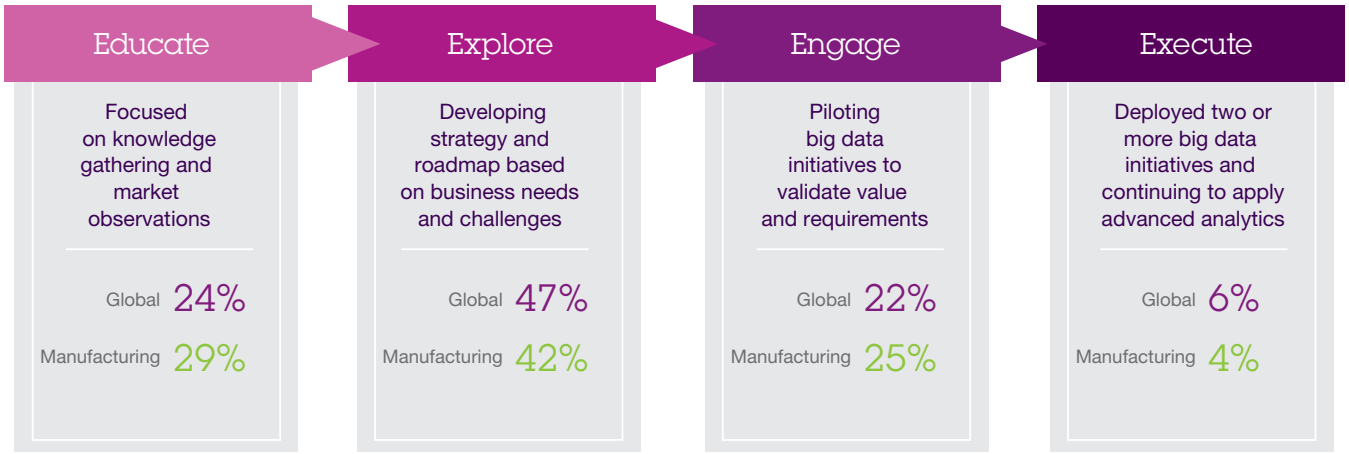

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Figure 7: **Most industrial manufacturing companies are developing either big data strategies or pilots, but few have moved to embedding those analytics into operational processes.**

However, it should be noted that while there is a single stage for roadmap development as we have defined it, an organization's analytics roadmap is dynamic and should be updated as new capabilities are added to the organization and as additional organization/governance decisions are made. Therefore, many industrial manufacturers will fall into more than one stage simultaneously, such as continuing to expand and refine the big data roadmap as new technologies are being piloted and implemented.

Recommendations: Cultivating big data adoption

IBM analysis of our Big Data @ Work Study findings provided new insights into how industrial manufacturers at each stage are advancing their big data efforts. Driven by the need to solve business challenges, and in light of both advancing technologies and the changing nature of data, industrial manufacturers are starting to look closer at big data's potential benefits. To extract more value from big data, we offer a broad set of recommendations tailored to industrial manufacturing organizations as they proceed down the path of big data.

Commit initial efforts to the most pressing business challenge

It is imperative that organizations focus big data initiatives on areas that can provide the most value to the business. For most industrial manufacturers, this will mean beginning with client, customer and distributor analytics. Such analytics can enable them to connect into their customers' procurement systems, sense demand signals, collaborate with customers directly and often provide "analytics as a service" as the products they sell report maintenance and other data back to the manufacturer. Big data can also help sales forces become more intelligent and productive. For those companies that market directly to consumers, customer analytics can be a source to improve marketing and sales performance and customer experiences and to drive loyalty and new revenues.

The significant size and breadth of the operations found in most global manufacturers indicate there are a multitude of processes that could benefit from optimization. These efforts tend to drive value through cost efficiencies that impact the bottom line, as opposed to customer-driven impacts to the top line.

Industrial manufacturers are likely to find that many of their most pressing business challenges occur within their operational processes where they directly intersect with customers, clients and distributors. Thus, industrial manufactures may want to balance customer-centric analytics with operational optimization, effectively targeting analytics at revenues and expenses simultaneously. Optimization of the underlying operational processes often result, almost as a by-product, in improvements to the customer, client and distributor experience. With the key focus on value, it is at these intersections where industrial manufacturers are likely to find the most compelling business cases.

Define big data strategy with business-centric blueprint

A blueprint encompasses the vision, strategy and requirements for big data within an organization. It is critical to aligning the needs of business users with the IT implementation roadmap. A blueprint defines what organizations want to achieve with big data to help ensure pragmatic acquisition and use of resources.

An effective blueprint defines the scope of big data within the organization by identifying the key business challenges involved, the sequence in which those challenges will be addressed and the business process requirements that define how big data will be used. It is not meant to outline the complete solution, but rather to serve as the basis for understanding the needed data, tools and hardware, as well as the relevant dependencies. The blueprint will guide the organization to develop and implement its big data solutions in practical ways that create sustainable business value.

For industrial manufacturers, one key step in the development of the blueprint is to engage business executives early in the development process, ideally while the company is still in the Explore stage. Most manufacturers, which tend to be relatively diversified companies, will want to tap a small group of executives from different key parts of the company to develop a blueprint that reflects a holistic view of the company's challenges and synergies.

Start with existing data to achieve near-term results

To achieve near-term results while building the momentum and expertise to sustain a big data program, it is critical that industrial manufacturers take a practical approach. As our respondents confirmed, the most logical and cost-effective place to start looking for new insights is within the organization's existing data store, using the skills and tools already available.

Looking internally first allows organizations to use their existing data, software and skills, and to deliver near-term business value. They can also gain important experience as they then consider extending existing capabilities to address more complex sources and types of data. While most organizations will need to make investments that allow them to handle either larger volumes of data or a greater variety of sources, this approach can help reduce investments and shorten the timeframes needed to extract the value trapped inside the untapped sources. It can help accelerate the speed to value and enable organizations to take advantage of the information stored in existing repositories while infrastructure implementations are underway. Then, as new technologies become available, big data initiatives can be expanded to include greater volumes and variety of data.

Build analytics capabilities based on business priorities

The specific priorities of each company should guide the organization's development of big data capabilities, especially given the margins and specific production and distribution challenges that most industrial manufacturing firms face today. The upside is that many big data efforts can concurrently help reduce costs and help increase revenues, a duality that can bolster the business case and offset necessary investments.

For example, many manufacturers are pursing extensive product lifecycle management programs where they collaborate and share data extensively with the multitude of suppliers and sub-assembly manufacturers they encounter. While the day-to-day data is used procedurally, analytics can also be applied to identify improvements in the development and creation of new products.

Other manufacturers are using predictive-maintenance and condition-monitoring analytics on their key assets to keep operations "up and running" by identifying problems before they occur. Others are finding data applications in safety and sustainability management, thus reducing the number of incidents on the manufacturing floor and improving environmental outcomes.

Create a business case based on measurable outcomes

To develop a comprehensive and viable big data strategy and the subsequent roadmap requires a solid, quantifiable business case. Therefore, it is important to have the active involvement and sponsorship of one or more business executives throughout this process. Equally important to achieving long-term success is strong, ongoing business and IT collaboration.

Getting on track with the big data evolution

An important principle underlies each of these recommendations: business and IT professionals must work together throughout the big data journey. The most effective big data solutions identify the business requirements first, and then tailor the infrastructure, data sources, processes and skills to support that business opportunity.

To compete in today's data-driven economy, it is increasingly clear that industrial manufacturers are well advised to use their information assets to gain a comprehensive understanding of markets, customers, products, distribution channels, competitors, suppliers, employees and more. Industrial manufacturers can realize value by effectively managing and analyzing the rapidly increasing volume, velocity and variety of new and existing data, and putting the right skills and tools in place.

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July 2013
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