A New World

ANALYTICS THAT MATTER IN 2020

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Section 1

Executive Summary

Executive Summary

Artificial Intelligence/Machine Learning and Big Data are recognized as the #1 and #2 most hyped technologies in the industrial technology landscape today. At the same time, the hype is not void of momentum, compared to the 2018 Analytics That Matter (ATM) study; there has been a dramatic increase in analytics capabilities over the past two years. LNS survey data shows that there has been a 52% increase in the share of industrial companies with a formal analytics program. There also has been a 102% increase in diagnostic capabilities and a 66% increase in predictive capabilities. That is the good news.

Unfortunately, the industry also still has significant challenges. We have only seen a 39% increase in prescriptive capabilities – well behind the increases in diagnostic and predictive. Furthermore, all of these increases in analytics capabilities have had limited impact on ultimate operational and business performance. Average Overall Equipment Effectiveness (OEE) and average On-Time Delivery show no appreciable improvement over this same two-year time period.

In this new study, LNS Research will show how analytics is a critical component of Industrial Transformation (IX) and how the enhanced decision making capabilities provided by analytics can help drive success in transformation and improve business results.

Moreover, we have identified action items followers can immediately take in order to become leaders in analytics and transformation. These important steps include:

1. **Agilely build an industrial data model.** This model will support analytics programs to ensure data quality and provide data context for improved decision making. Leaders make data a top priority, whereas followers are less likely to have the quality of data they need, making it difficult to gain insight.
2. **Focus on increasing prescriptive and prognostic analytics capabilities.** These increased capabilities will help promote a data-centric and learning-based culture. Followers often lack in this area and thereby find it difficult to take action or trust decisions.
3. **Transform the organization, don't just add tools.** This means creating a data governance council and data-specific roles to have ownership over data context and quality. Leaders invest in these roles while followers do not, often finding themselves immersed in a data swamp.
4. **Break data silos.** Use the industrial data model to derive data from additional sources and provide it to more decision-makers. Followers tend to get stuck in silos, whereas leaders take control by delivering insights back to silos and use data more effectively.

Through our survey results and critical analysis of them, we will show that companies that want to be analytics leaders have to put analytics up front and center of their Industrial Transformation (IX) programs. In particular, we recommend that executive leaders ensure that their transformation teams concentrate on data models and an operational architecture that will support today's and future analytics requirements. We will show that the key to becoming an analytics leader is people that can work together and build a trust in the veracity of analytics; to this end, defining a strong data governance team will prove invaluable.

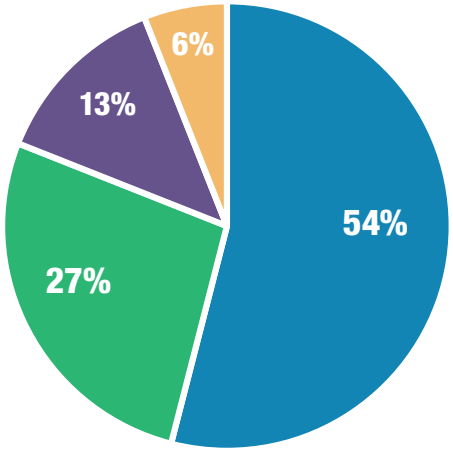
Section 2

Demographics

Demographics

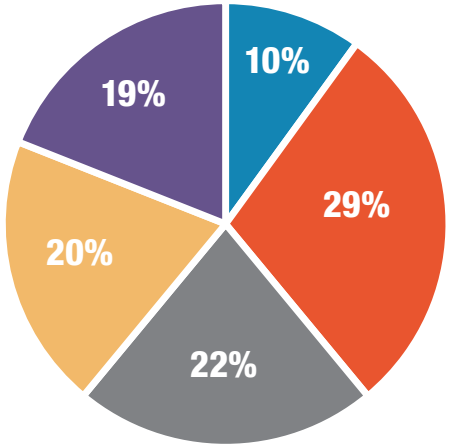
LNS Research and MESA have been working together for almost a decade to produce a biennial report on the state of measurement and analysis in manufacturing industries. Until 2018, the report was called, Metrics that Matter, and was supported by the MESA metrics working group. In 2017, LNS and MESA agreed to change the focus of the report and working group to analytics, a hot topic across industries. In 2018, we carried out our first analytics survey and produced the 2018 Analytics That Matter (ATM) report. Welcome to the second ATM, version 2020.

We always get a great cross-section from across the globe (with translations into German and Chinese). We filter non-manufacturer results to ensure we use data from valid respondents. This year's demographics show just about half are from North America, a better balance than the three-quarters we saw in 2018. The balance between industry groups is also a bit better, with a variety of industries from various types of manufacturers covered.



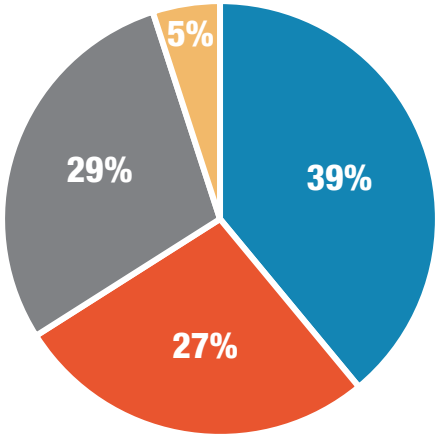
GEOGRAPHIC DISTRIBUTION

- North America
- Europe
- Asia/Pacific
- Rest of the World



COMPANY REVENUE BY SIZE

- More than $10 Billion
- $1 - $10 Billion
- $500 - $1,000 Million
- $50 - $500 Million
- Less than $50 Million



INDUSTRY TYPE

- Discrete Manufacturing
- Process & Infra Manufacturing
- Batch Manufacturing
- Others

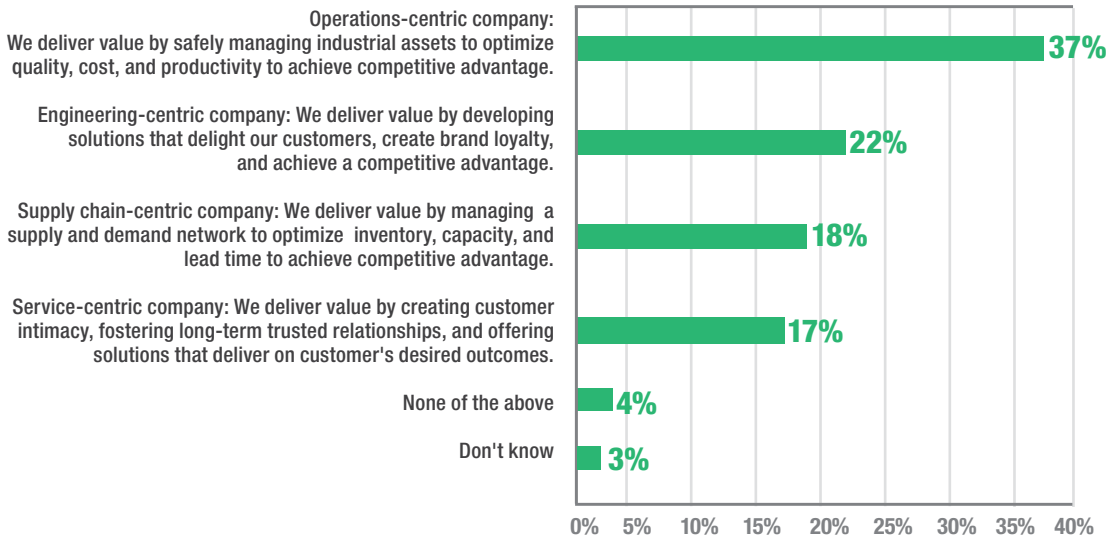
Demographics *(cont.)*

The coverage of respondents is wide and large - from the data, we can calculate that about 6,190 plants are represented by survey responses, and the companies who took the survey together employ more than 3.5 million personnel.

Being a survey about analytics, it is no surprise to see that the responses were dominated by operations-centric companies with engineering and supply chain somewhat behind. Early industrial analytics were dominated by a focus on assets and reliability. As the art and science of analytics broadens, new opportunities that deliver cost effective analytics across the industrial spectrum will accelerate.

6,190 PLANTS
are covered by the demographics and more than
3.5 MILLION EMPLOYEES

WHAT BEST DESCRIBES YOUR CORPORATE MISSION?



Section 3

Today's Challenges

1. COVID-19...
2. Everything Else

Today's Challenges

1. COVID-19...

2. Everything Else

For this newest ATM report, as we were carrying out our survey, mostly in late 2019, we were living in a time of manufacturing growth, a level of confidence not seen for a long time, especially in the United States. Then, the COVID-19 pandemic hit worldwide. Given unemployment figures never previously seen and, as we began writing in April 2020, a global collapse in manufacturing, we do not just get new answers to our survey; rather, we need to ask completely new questions about global manufacturing and value chains.

We have great confidence in manufacturing and believe we will get back on track before too long. Therefore, LNS Research presents our thoughts in this report assuming that there will be a turnaround. Timing is impossible to predict at the moment; we will briefly mention COVID-19 in our analysis, but will concentrate on the future of analytics and Industrial Transformation (IX).

It is impossible to overestimate the impact that COVID-19 has had on industry. Indeed, we cannot calculate the timescale nor the impact, and when we consider the long-term effects, the possibilities range from frightening to unimaginable, in both good and bad ways. Countries and states reacted at varying rates and depths to the pandemic, but we now see that the vast majority of developed countries have put considerable restrictions on their manufacturing (and other) industries. These range from almost total shutdown to enhanced protection, social distancing, and reduced shifts. Many companies, especially smaller ones, are doing everything they can to avoid infection while keeping manufacturing going. They need to balance risk and output as even a single death in a plant that has stayed open could have a huge impact on client trust and relationships after recovery.

Today's Challenges *(Cont.)*

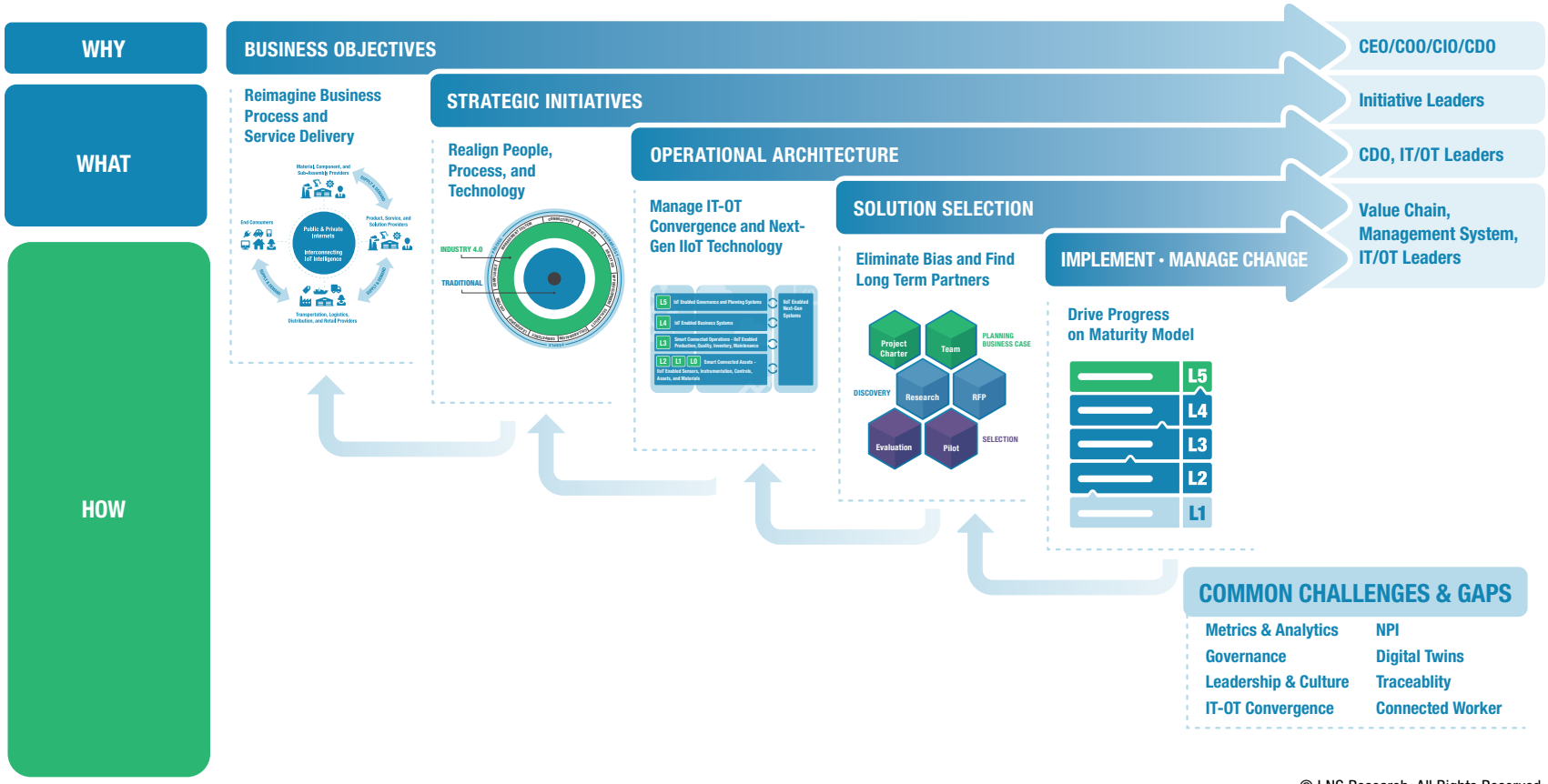
2. Everything Else, Including Industrial Transformation

What is Industrial Transformation, fondly known as IX by LNS Research, and how do we use it? Even before COVID-19, the pace of change in industrial operations around the globe was accelerating hard. Now, companies are going beyond standard practices in Continuous Improvement (CI) as they seek step-change improvement. Among them, programs go by a range of names: Digital or Industrial Transformation, Industry 4.0, Smart Manufacturing, and many others.

Whatever your company calls it, questions remain. What are the "big" things industrial companies are trying to accomplish? How are they going about it (strategically and tactically)? What are the key indicators of digital readiness? And what, if anything, is delivering significant improvement? In this ebook, we will concentrate on one of the key drivers of improvement, analytics.

IX FRAMEWORK

Industrial Transformation (IX) is the dominant strategic framework by which industrial organizations seek to re-invent themselves for competitive advantage



Today's Challenges *(Cont.)*

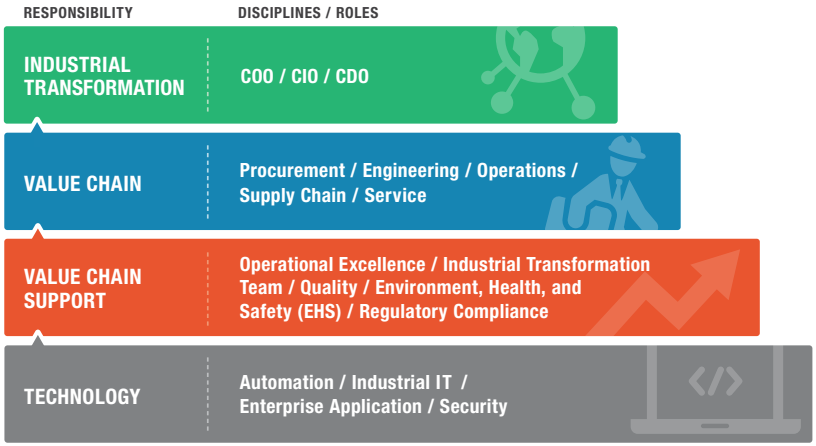
2. Everything Else, Including Industrial Transformation *(cont.)*

A key concept of the IX framework is the concept of IX Leaders. These are the companies that fall into the two most advanced groupings:

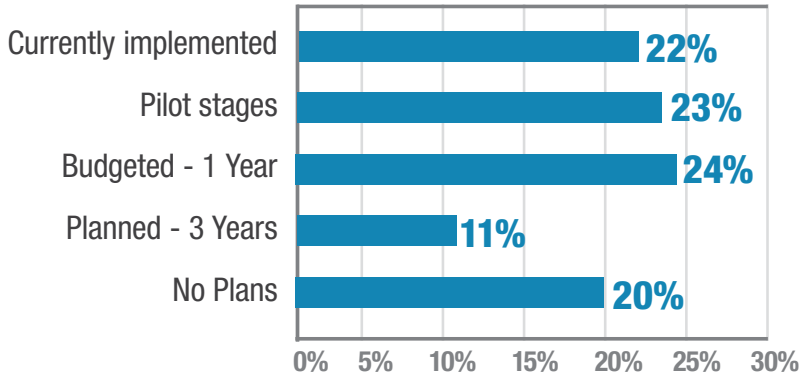
- We have made progress and the corporation is seeing value
- We are a real success, both in terms of business benefit and speed of the program's impact

Of particular note here is the clear differences between the chart below and the chart on the following page: implementing IX is not the same as being an IX leader. To become an IX leader, you need to demonstrate to your company and your peers that you are getting value from your IX investments. Indeed, the goal of executives should be to continue up the scale and become what is now an exclusive club that delivers fast value.

INDUSTRIAL TRANSFORMATION ORGANIZATIONAL STRUCTURE



WHAT IS THE STATUS OF YOUR COMPANY'S INDUSTRY 4.0, SMART MANUFACTURING, OR OTHER INDUSTRIAL TRANSFORMATION PROGRAM?



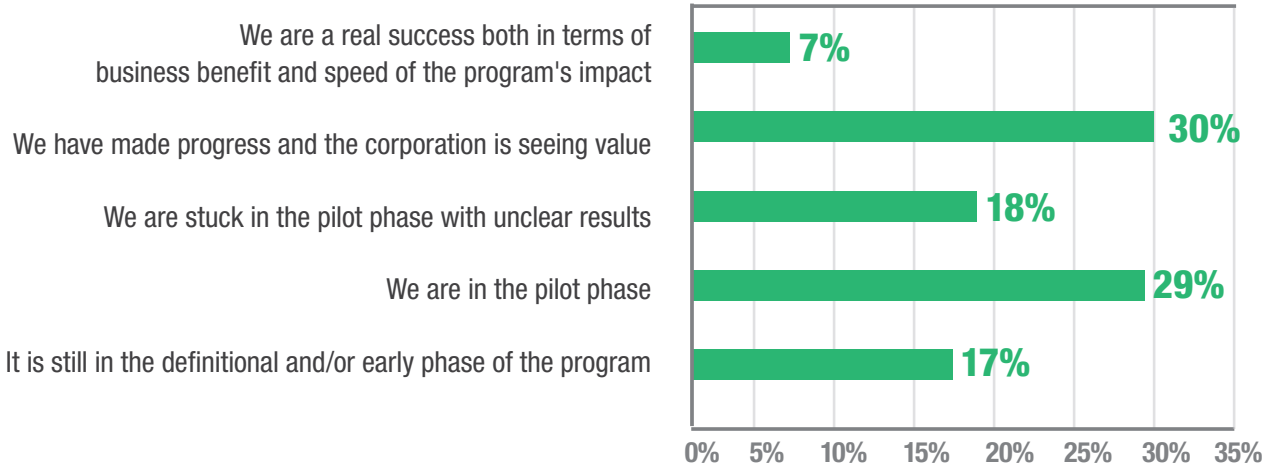
Today's Challenges *(Cont.)*

Opportunities and Obstacles to Growth

In early 2019, when we first measured them, IX Leaders made up 28% of manufacturing companies, and that has now risen to 37%, more than a third. This should not be a static target, so we keep it the same as before for now – we use it often to compare leading and following manufacturers in many metrics and analytics; having a baseline from just a year ago is valuable.

IX Leaders
have now risen to **37%**
from **28%** in 2019

WHAT IS THE GENERAL PERCEPTION OF YOUR INDUSTRIAL TRANSFORMATION PROGRAM?



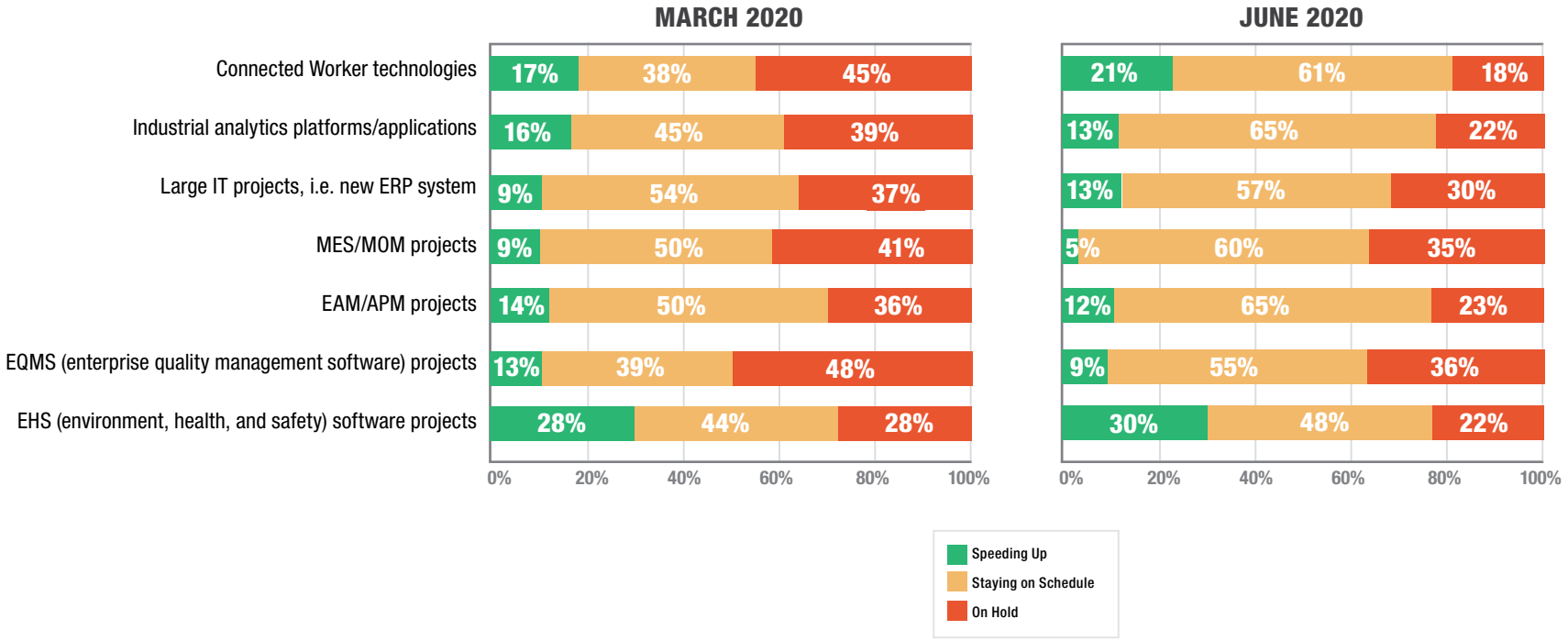
Today's Challenges *(Cont.)*

Opportunities and Obstacles to Growth *(cont.)*

The pre-COVID-19 ATM survey asked some general questions about the state and future of manufacturing confidence and reasons for them. The top answer (respondents could give multiple answers) of overall market growth is probably going to take the biggest COVID-19 hit – with global demand taking a dive in the short to medium term. The others in the top five all can be addressed by the post-COVID-19 restart plan and, indeed, as we see in this chart from our brief COVID-19 survey, many are not shutting down key programs during the crisis.

Keep key projects going or TRANSFORM THEM IN TO PROGRAMS THAT MAKE BEST USE OF TALENTED STAFF with reduced current commitments

COVID-19 TRANSFORMATION PROJECTS



Today's Challenges *(Cont.)*

Opportunities and Obstacles to Growth *(cont.)*

When we look at obstacles to growth, the current number one is clearly COVID-19 and it is impossible to predict beyond lock-down and early restart efforts.

However, in the bullish economy that preceded COVID-19, there were still some serious challenges facing manufacturers.

WHAT DO YOU SEE AS THE BIGGEST OBSTACLE(S) TO YOUR COMPANY'S GROWTH NEXT YEAR?

	FOLLOWERS	IX LEADERS
Supply chain disruption	0%	38%
New competitors	65%	38%
Company culture	12%	31%
Lower-cost competitors	24%	31%
Weak demand outside the US	18%	23%
Shortage of skilled workers	18%	23%
Inability to take advantage of new technology	18%	23%
None of the above	6%	15%
NAFTA/ USMCA	18%	15%
Tariffs	29%	15%
Weak demand among US customers	18%	15%
Shortage of capital	24%	15%
Security risks	12%	8%
Environmental factors	24%	8%
Regulation	12%	8%
Other. Please specify:	0%	0%

Competition stands out as the clear concern for manufacturing companies, with three other topics of real concern to manufacturing executives that are unlikely to go away. Indeed, shortage of skilled workers, and in particular in analytics, might remain after COVID-19. One common thread we have seen through media coverage of the crisis is the increased trust put in scientists and especially data experts. We have talked often of a lack of data scientists – their value should increase considerably after COVID-19 due to the high esteem in which their work is held. It is time, during this quiet period, to train your best engineers in "data engineering." We are not suggesting they can learn to be data scientists in a few months, but starting to use and understand the value of analytics will be indispensable.

MAKE DATA ENGINEERING AN OPPORTUNITY FOR TALENTED WORKFORCE

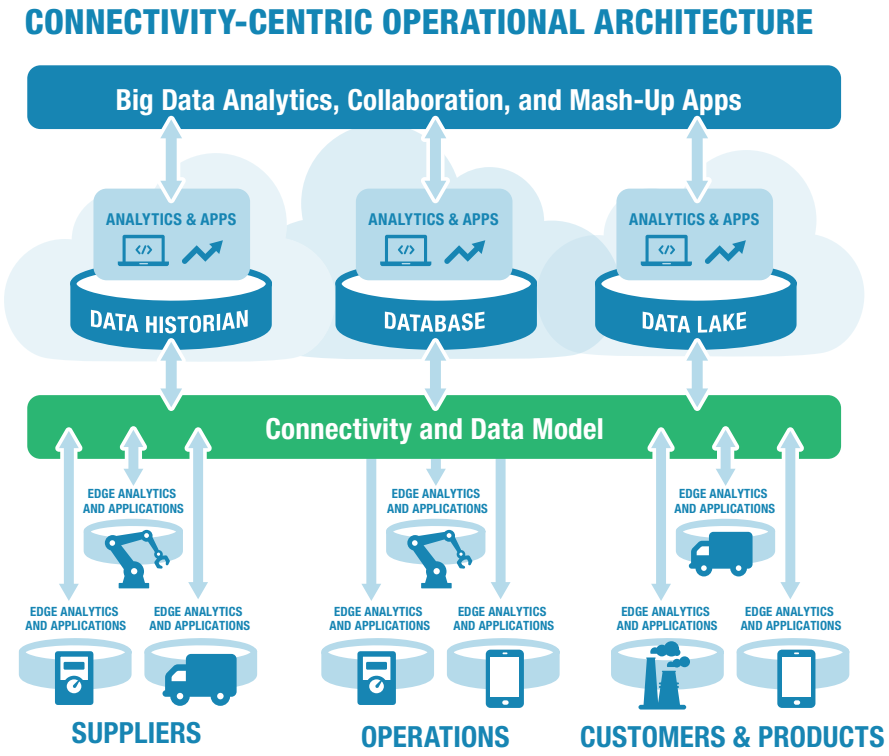
Hang out a carrot for new opportunities in the future of manufacturing

Today's Challenges *(Cont.)*

Change Your Supply Chain World

A quick glance when we split between IX Leaders and followers shows some interesting differences. For example, followers are almost twice as likely to fear new competitors while they have no worries at all about supply chain disruption. There is no doubt that this will fly up the list of concerns after COVID-19. There is clearly risk of a future spike and the need for supply chain resilience is unquestionable. We have already seen this in the Japanese earthquake and tsunami of 2011 when the electronics industry was badly disrupted due to a shutdown of semiconductor plants. Did we learn? Apparently not enough. Already we have seen a newly reopened car factory being closed due to a lack of parts. If manufacturers only take one thing away from COVID-19, it should be to develop flexible and cooperative supply chains with their suppliers and customers.

It is not just about having multiple potential suppliers but, more importantly, the culture of relationships – working together to build long-term resilience rather than the typically combative relationships we often see today between suppliers and clients. Post-COVID-19, we would bet on IX leaders, seeing that they are concerned about company culture – a prerequisite to supply chain collaboration.

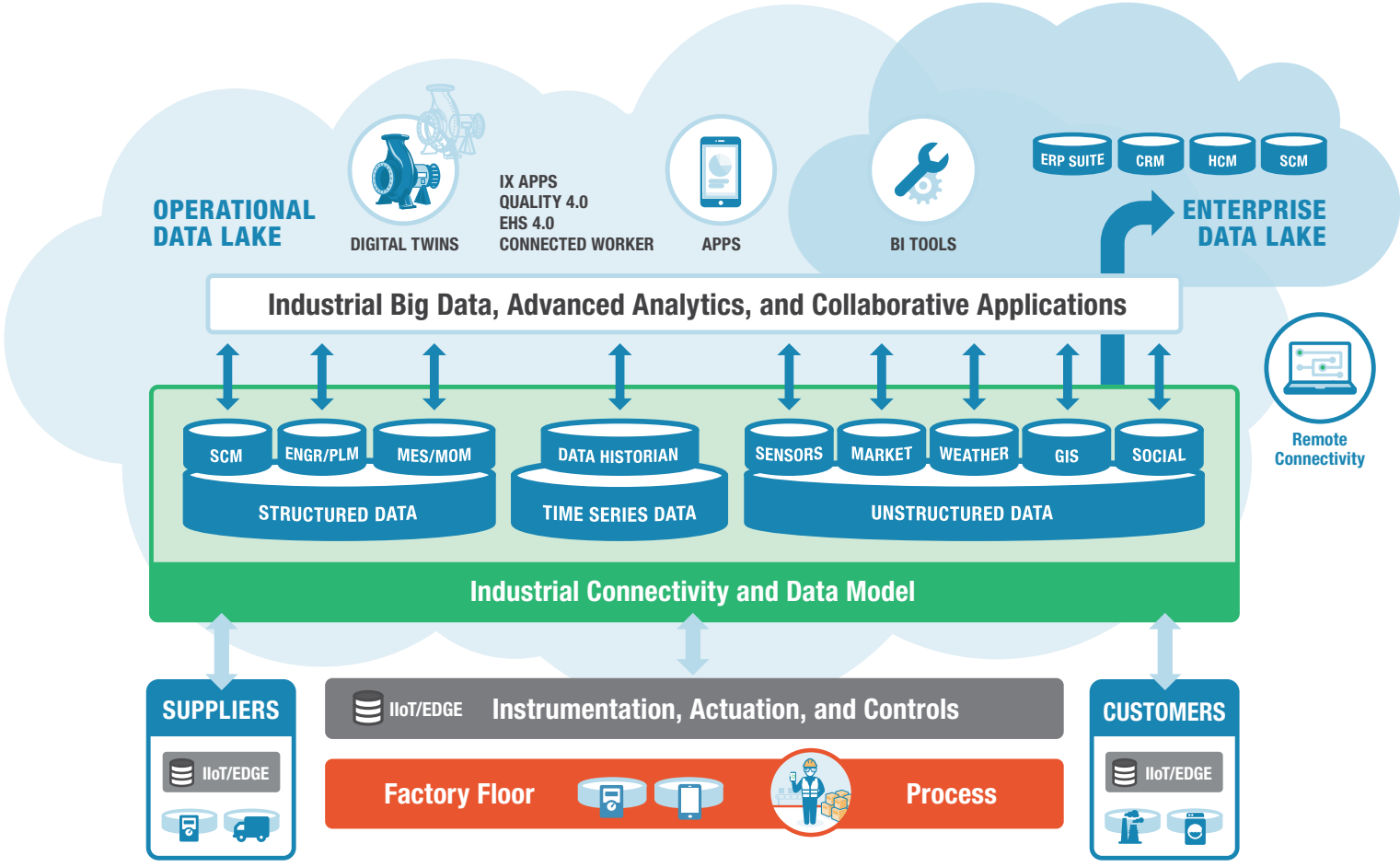


Today's Challenges *(Cont.)*

Operational Architecture in IX

The success of evaluating performance between IX leaders and followers has led us to understand the importance of building enterprise-wide programs that define where an enterprise is headed. One of the keys to success is to build an Operational Architecture (OA) that will support all the programs. This will clearly be both unique to your enterprise and to the value chain in which it works.

As we saw earlier in the description of Industrial Transformation (IX), there are many apps and functions supported by the operational architecture and they will need to support the data needs of everything. It is certainly not the case that an entire OA will be built at the outset, but the data models will need to be well-considered so that they meet current needs and can be (seamlessly) extended to meet future extensions.



Today's Challenges *(Cont.)*

Metrics and Analytics, A Changing World

The use of metrics in business and manufacturing goes back as far as manufacturing itself. Over the last 30 years or so, displaying these metrics to those that need them to do their jobs have become a norm in some industries and is becoming all-pervasive in others. Other ways to manage performance, like Lean and Six Sigma, have been tremendously successful. When we look at the use of metrics across enterprises, there is a very interesting correlation between the use of metrics and Industrial Transformation (IX).

In comparison to our 2018 research, it is worth noting that the use of metrics has remained consistent over the last few years; the resulting data has remained quite similar. As such, having a good base of common metrics is a good starting point for kicking off analytics.

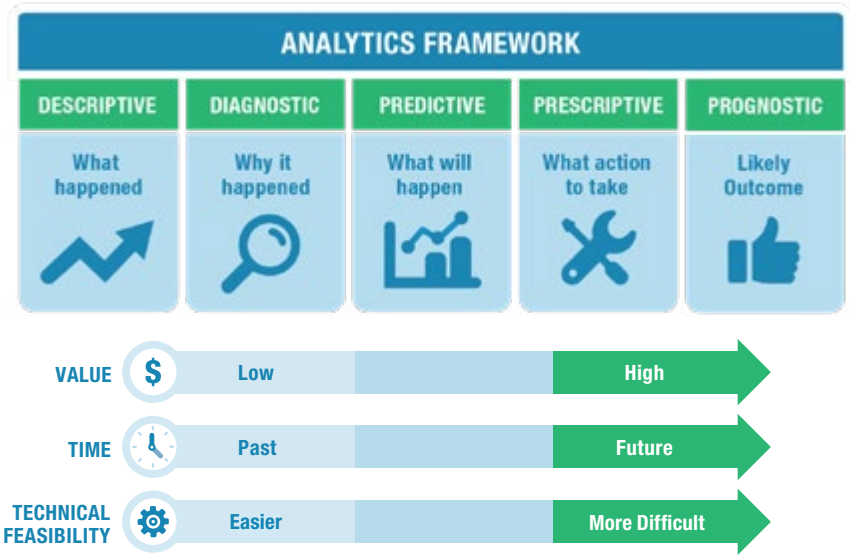
As we can see, IX Leaders track many more metrics than followers. The only two cases where followers lead what could be termed as negative or reactive metrics are workplace injuries and unplanned downtime. The leaders are just good at these metrics as part of their everyday life so they have less need to track them. Rather, they focus on proactive metrics that they have can control in advance of trouble. The advent of COVID-19 will reinforce the need to focus on what you can influence, such as making the supply chain more resilient; something that is much more likely to come from IX leaders that understand how to use metrics to maximum benefit.

Today's Challenges *(Cont.)*

Defining Analytics

Looking at metrics in a standalone way is useful to find out what has been happening in our companies and plants, but this is a narrow approach and one of the main reasons that we changed this report from metrics that matter to Analytics That Matter in 2018. In that report, we noted that the traditional point solutions used in factories were gradually being replaced with Manufacturing Operations Management (MOM) systems. We also looked at the impact of IIoT on the business. If we had defined the concept of IX leader at that time, only 21% would have been considered leaders as opposed to 37% today, a dramatic change and demonstration that life is moving quickly past the concept of point solutions, and even IIoT, onto Industrial Transformation (IX), Smart Manufacturing, and Industry 4.0.

As we transform our businesses, the need for an integrated approach to data and operations leads us to our main topic – analytics. With the help of our IX solutions, analytics allows us to bring together data from plants, operations, business, and the entire value chain, and to combine it into sophisticated and useful information.

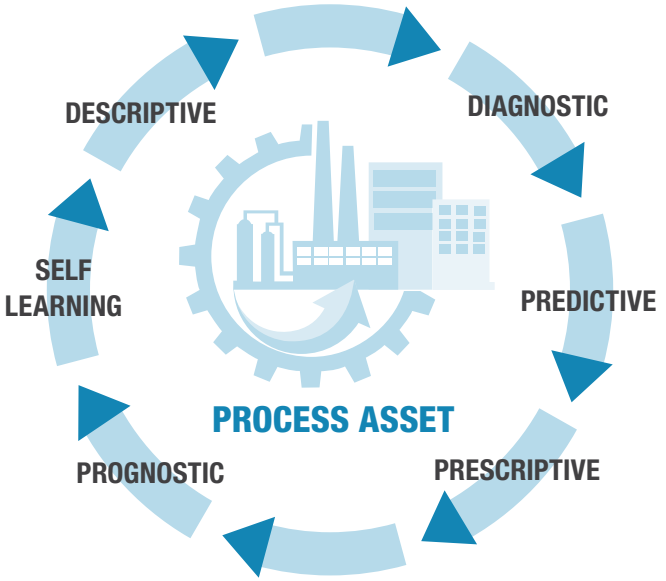


We define differing levels of analytics from descriptive to prognostic; any solution could include multiple types of analytics, but it is easier to consider them separately for simplicity.

The difference between metrics and analytics is that we add information and get better feedback than with simple metrics (or measurements):

Analytics collects, combines, calculates, and delivers information to help run the enterprise

The key is to add value to data when it is converted into information and commands. It is a feedback loop of ever-increasing sophistication and can be seen as a primary driving force of Industrial Transformation (IX).



Today's Challenges *(Cont.)*

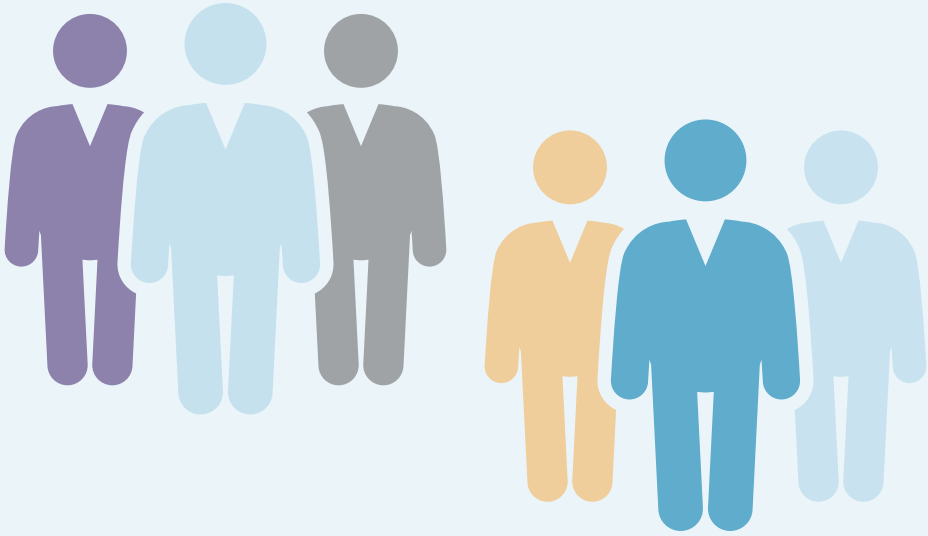
Defining Analytics *(cont.)*

One of the early analytics questions in our survey asked the respondents to: "Please indicate how the use of analytics is impacting your business today." The potential answers were:

1. Don't understand/know about analytics
2. We are still investigating the impact
3. We understand/are aware but see no impact at this time
4. We understand/are aware and we see value to our operations
5. We understand/are aware and our customer demands are driving us
6. We understand/are aware and have and have already seen dramatic impact

The increasing importance and sophistication of analytics in an enterprise leads us to define Analytics Leaders as those who fall into the last two categories. Today, that is 23% of respondents. Like the IX Leaders (now at 37%), this percentage will increase as analytics become more mainstream. It is also clear that the threshold needed to become a leader will also rise as the market matures. You might be the best today, but you have to keep running to stay ahead of the pack.

Another simple measure of the best in analytics is those who claim to have completed their analytics implementation, currently 32%. However, this is a bit more difficult to refine in the long-term, so we will base most of our comparisons on Analytics Leaders and Followers. It is also comparable to our headline IX Leaders designation we introduced earlier.



ARE YOU AN IX OR ANALYTICS LEADER?
MAKE GETTING THERE A STRATEGIC OBJECTIVE

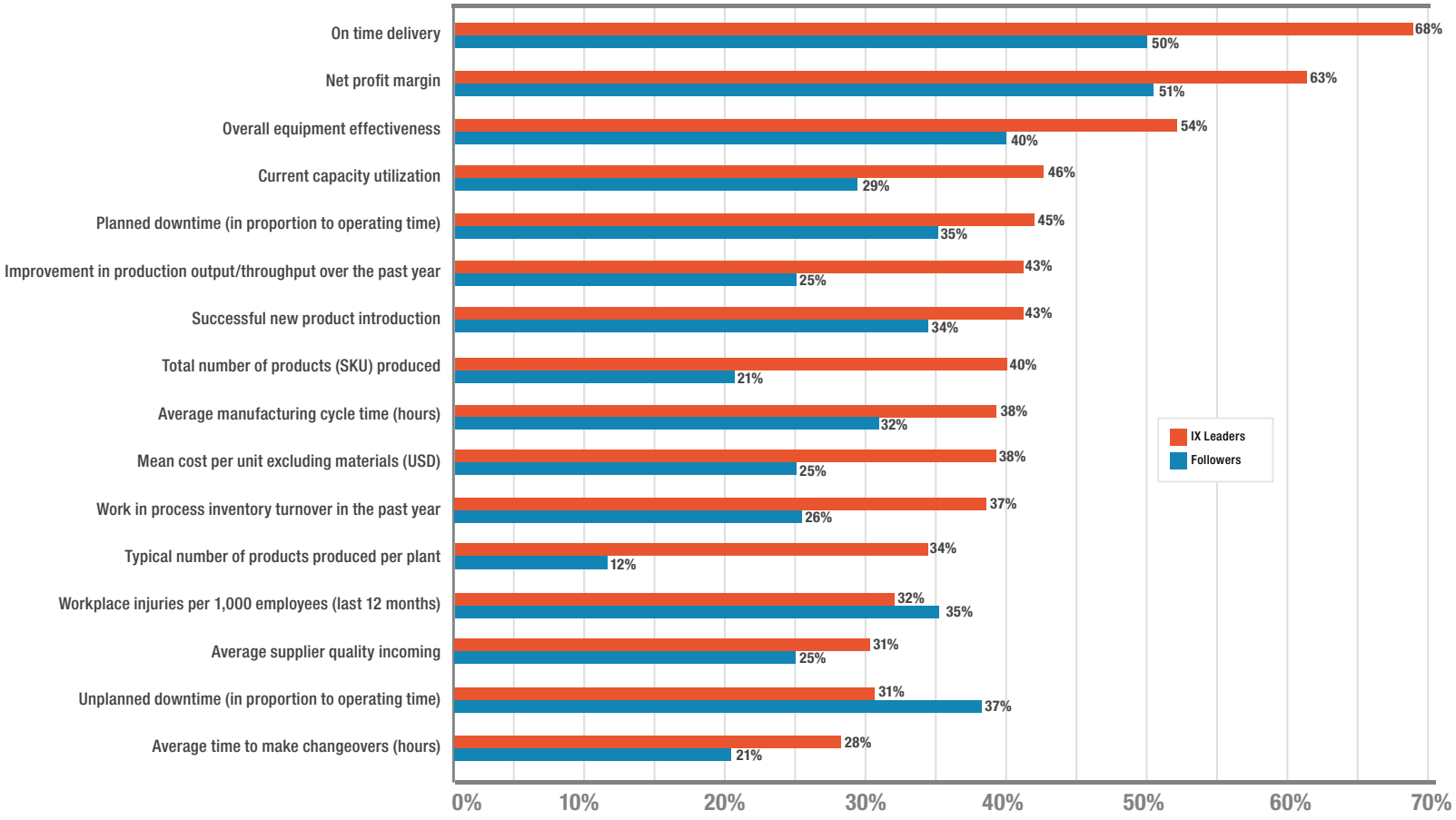
Today's Challenges *(Cont.)*

Defining Analytics *(cont.)*

Similar to IX leaders, with analytics leaders, we see an equally dramatic gap between leaders and followers. The shape of these graphs can be seen time and time again in the survey responses. Being an IX or Analytics Leader, or both, is an essential characteristic if you want to remain competitive and on a growth path.

We do not encourage manufacturers to try to become Leaders in IX or analytics, but rather to develop corporate behaviors that will naturally bring them to that leadership role among their peers and competitors. Measuring lots, and being sure the measurements are important and can be used as inputs to new analytics, is a key starting point; going from viewing measured data to delivering insight and actions from complex information demonstrates the beginning of success in analytics leadership.

WHICH OF THE FOLLOWING METRICS DOES YOUR COMPANY TRACK?

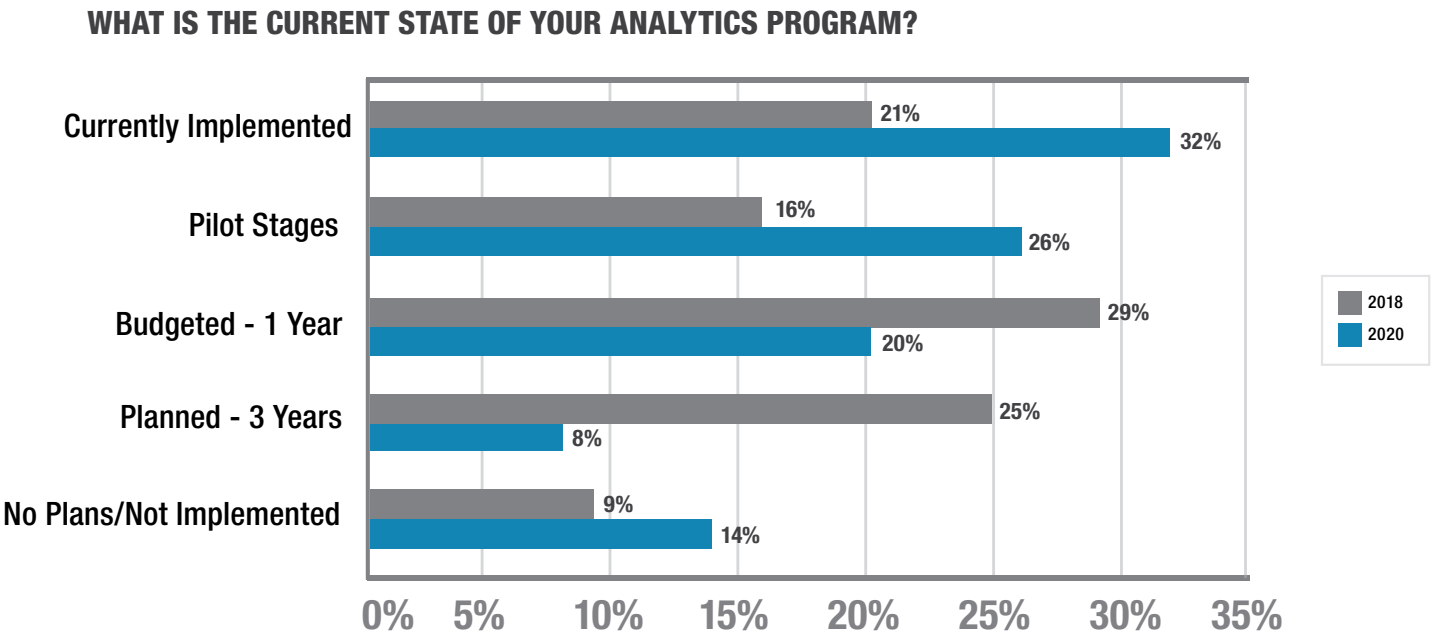


Today's Challenges *(Cont.)*

Beyond Point Solutions, Deploying Analytics

It is pleasing to study this chart and see that the promise of budgeted plans in a year (in 2018) led to a clear increase in the percentage of companies that have implemented an analytics program. Fully implemented has moved from 21% to 32%, a cause for optimism, and something that can help overcome disruption; available analytics solutions will enable companies to make the right enterprise-level decisions based on real data from across the value chain and beyond.

During the disruption of COVID-19, we have seen far too much uneducated speculation about lockdowns, loosening lockdowns, and social distancing. A few brave scientists have stood firm by using scientific fact and rigorous analytics to formulate a strategy. Perhaps, and the confidence level is low, manufacturers will learn a lesson and analytics will become one of the primary tools available to optimize the value chain. Building an IX program that supports ongoing analytics needs is vital to your future.



Today's Challenges *(Cont.)*

Platforms for Analytics, Broad Needs

As we have seen, analytics can be deployed anywhere and used by anyone or any system. We have categorized by complexity of application – descriptive through diagnostic, predictive, prescriptive, and prognostic. We can also look at the level of system in which they are used. For example, a pump might run analytics on its performance and planned maintenance, and at the other end of the scale, we may look at predicted share price based on many data inputs from within and beyond the enterprise. One of the different characteristics of prescriptive analytics is the time taken to provide feedback. In our pump, there might be responses every fraction of a second, while the corporation might make decisions monthly.

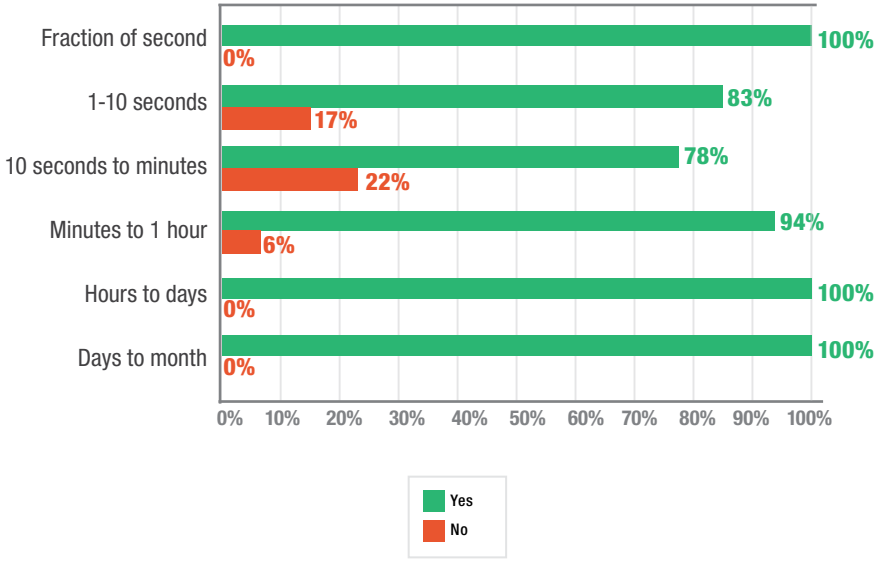
LAYER	PLATFORM	APPLICATION	TARGET USERS
Self-Service	On-Premise SaaS optional	Unit/Equipment Performance Continuous Improvement, e.g., Lean Sigma	Process Engineer Reliability Engineer
Systematic	Potential mix of on-premise, Edge, and Cloud	Multiple assets and processes in a plant, e.g., pumps, valves, heat transfer, etc.	Operations Maintenance Reliability EHS
Global/Cross Functional	Cloud	Multi-plant Supply Chain Enterprise Performance Management Customer Experience	Division Corporate Supply Chain Value Chain

Today's Challenges *(Cont.)*

Platforms for Analytics, Broad Needs *(cont.)*

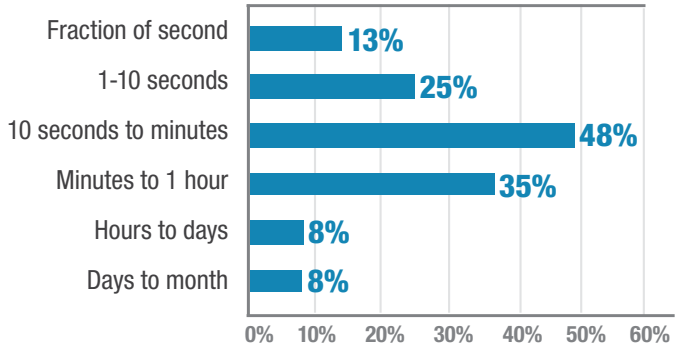
Speed is very nice but accuracy and confidence in results (and hence actions, this being a prescriptive example), may be more important. When we look at achievement of the timing goal, we see an interesting pattern – the very fast are very reliable and so are the very long. The chart shows that the middle speeds are less reliable.

DO YOU ACHIEVE YOUR TIMING GOAL FOR THE FEEDBACK LOOP?



SPEED IS VERY NICE, BUT ACCURACY AND CONFIDENCE IN RESULTS, MAY BE MORE IMPORTANT.

PRESCRIPTIVE ANALYTICS, WHAT IS THE TYPICAL TIMING GOAL OF THE FEEDBACK?



TYPES OF ALGORITHMS

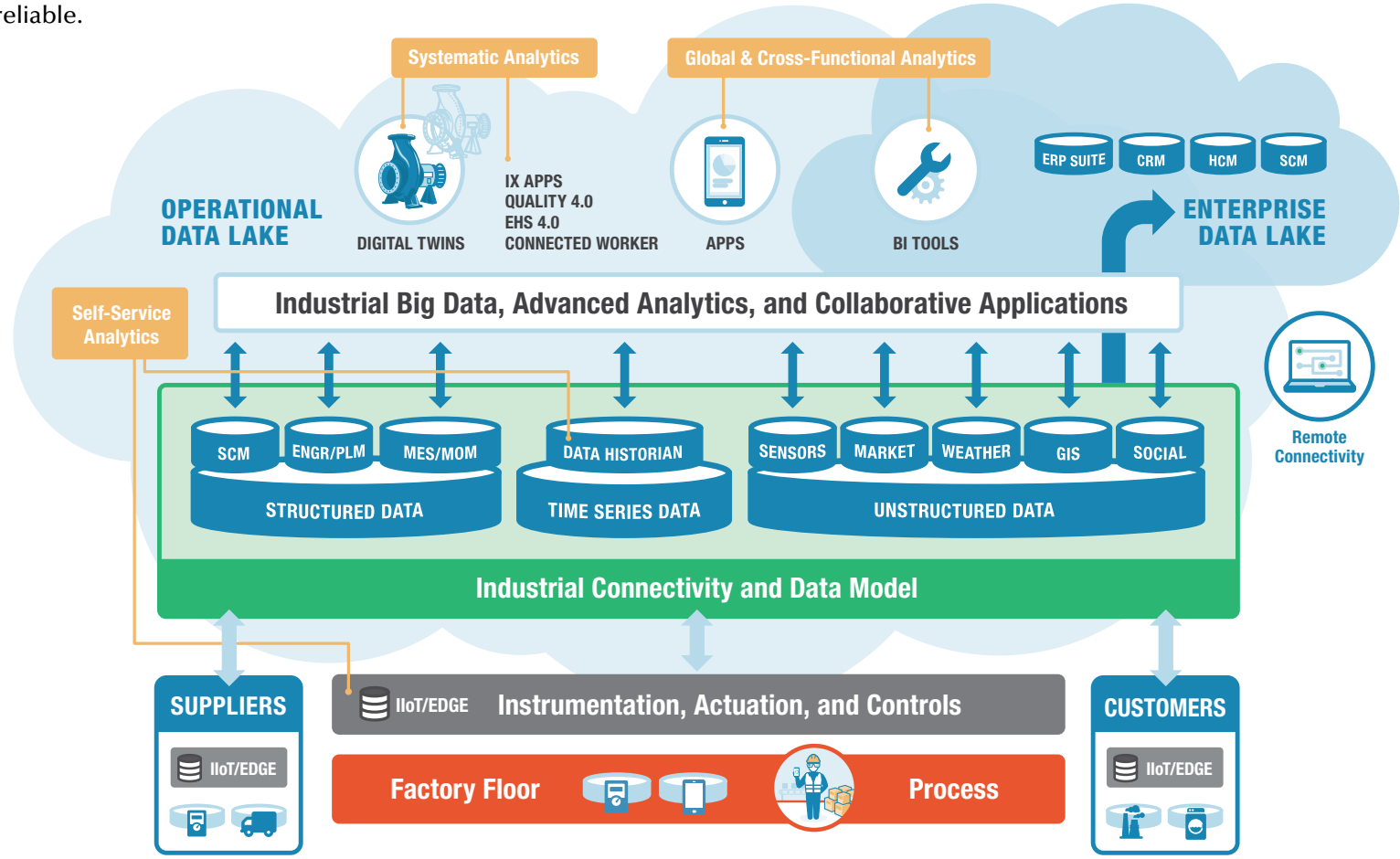
- Data visualization
- Predictive modeling
- Optimization
- Simulation
- Trend analysis
- Statistical distribution analysis
- Data mining algorithms
- Statistical process control
- Condition-based monitoring
- Correlation analysis
- Sentiment analysis

Today's Challenges *(Cont.)*

From Machine to People

One could argue that machine-generated and used analytics are, by necessity, extremely accurate, and analytics giving actions to management over their typical timelines must be correct. The vast majority of analytics falls into the timings in between these extremes and are handled by operations staff. Their reliability is less perfect but that is probably not a large issue since there are mostly humans in the data flow to check things out. As we move to be ever more reliant on intelligent software, the timing and functional goals will become more reliable.

As we move to using data for analytics, we must not forget the power users of apps and data sources. We can see here self-service analytics with direct access to a data historian and edge data. The same is applicable to tools such as MOM and PLM: data will be cleansed and aggregated for use in analytics, but direct access with the native tools will still be available for engineers and other experts.



Section 4

IX Leaders and Improvement: Traditional Metrics and Analytics

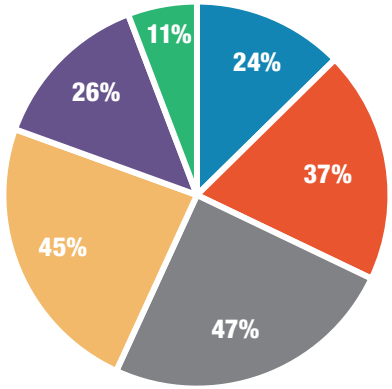
IX Leaders and Improvement

Analytics Types and Opportunities

Having taken a first glance at Operational Architecture for IX and analytics, along with some of the issues regarding feedback loops (for prescriptive analytics), let's consider data flow in analytics.

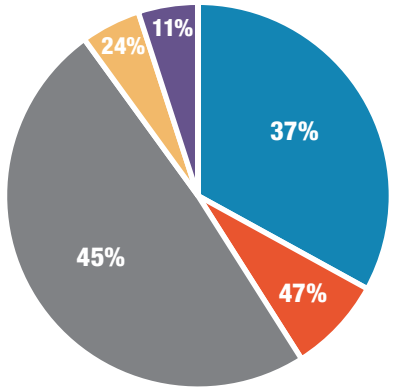
Where does my data come from and go to?

In many ways, answering the "whence data" question unties the whole power of analytics. Since automation became widespread in manufacturing and since business systems spread globally, one constant fight for power has been data ownership or master data management. Today, we should be talking data availability – how can a plant manager make sure that everyone has access to data that is needed, and that analyzed data has become useful information to run the company better? Everyone has to have the same ethos, especially data experts, that we will discuss later.



WHERE DO YOU RUN YOUR ANALYTICS?

- Data Lakes
- Public Cloud
- Private Cloud
- Corporate Data Center
- Plant Data Center
- Edge Device/ Asset



FOR DATA THAT LEAVES THE PLANT, WHO OWNS & CONTROLS ACCESS TO IT?

- Business
- Plant
- Corporate
- Customer
- Supplier

SOURCE OF DATA FOR ANALYTICS

	CORPORATE FINANCE	PRODUCT DEVELOPMENT	OPERATIONS	SERVICE
Structured	70%	53%	61%	57%
Semi-Structured	22%	38%	31%	33%
Unstructured	17%	19%	21%	20%
Do Not Know	8%	8%	4%	8%

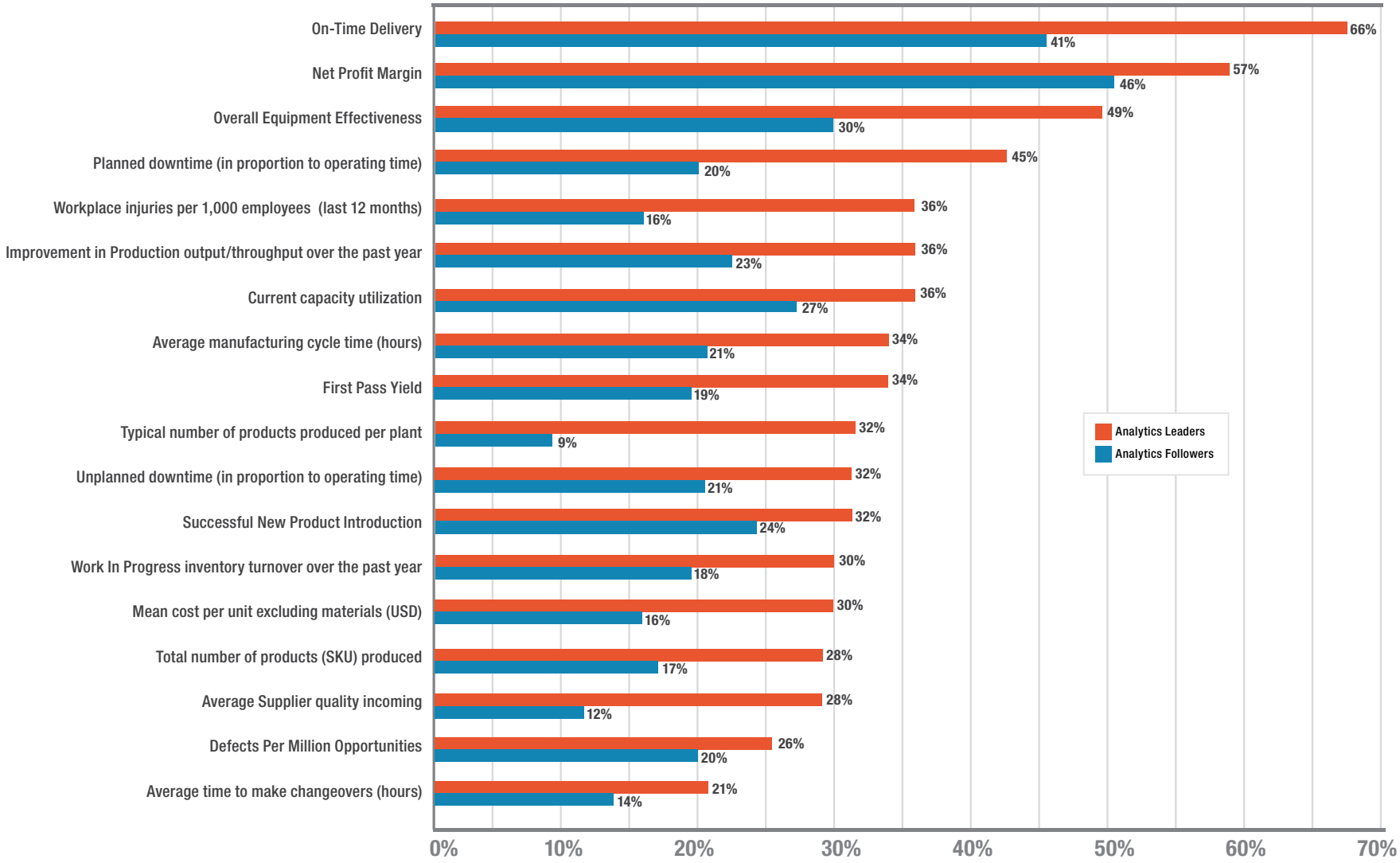
*NOTE: Percentages based on 150%

IX Leaders and Improvement *(cont.)*

Analytics Types and Opportunities *(cont.)*

As we can see from the charts on this and the next page, traditional metrics are still very important to analytics and IX leaders. Here we see that the use of common manufacturing metrics by leaders far outweighs the followers. Building solid data management and applying simple tools to support broad metrics are simple steps to analytics leadership.

WHICH OF THESE METRICS HAVE YOUR COMPANIES TARGETED FOR IMPROVEMENT AS PART OF YOUR INDUSTRIAL TRANSFORMATION (IX) PROGRAM?

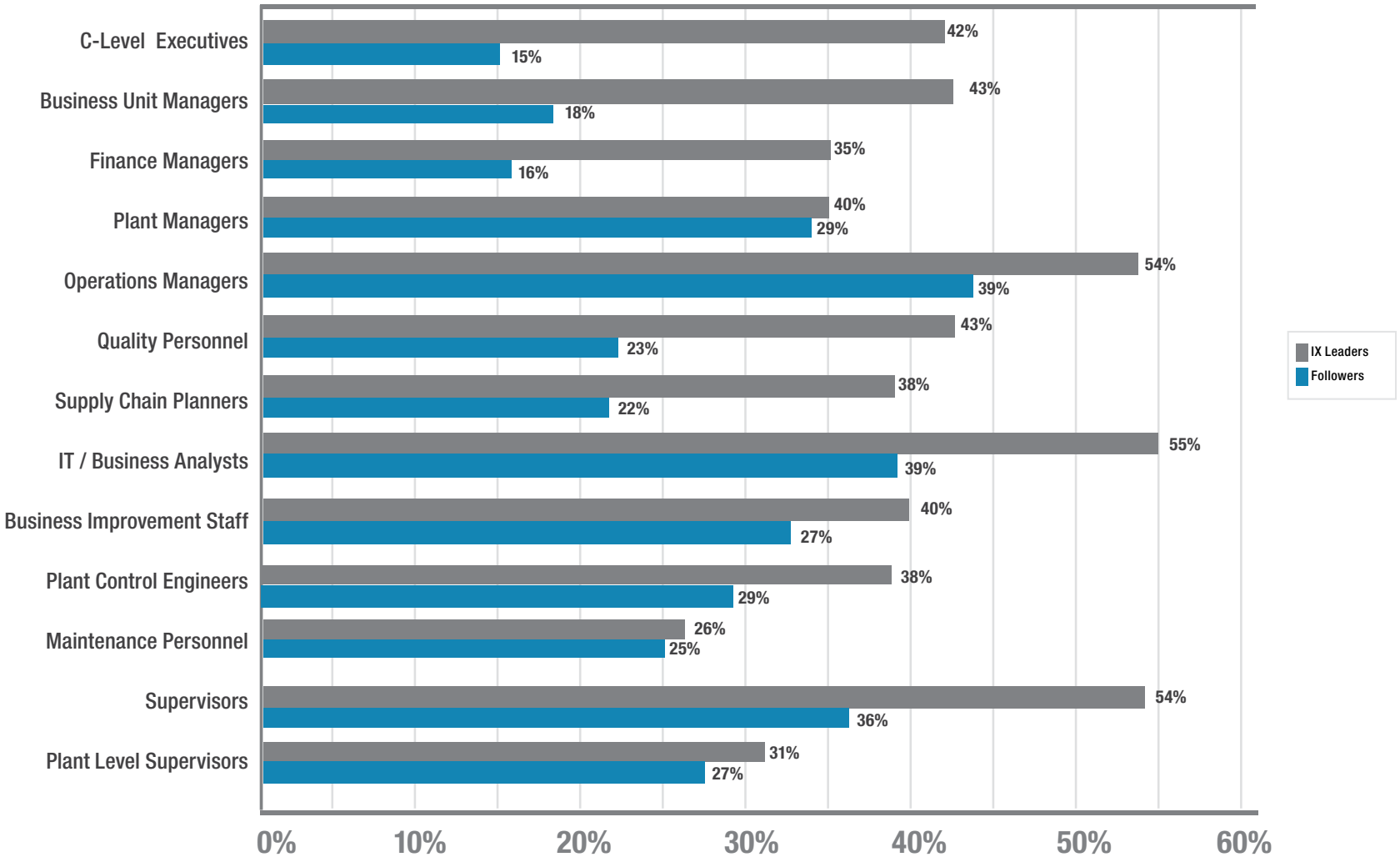


IX Leaders and Improvement *(cont.)*

Analytics Types and Opportunities *(cont.)*

We can look at a very different set of data and a similar outcome. As we have said, a fundamental of IX and analytics is data. But data is not helpful until it is put to good use, and here we see one example of useful data: accurate information delivered to the right person at the right time. We do not talk about real-time data as every recipient has a different perception of reality when it comes to time. People are happy if the information is there when they need it, and we see that IX leaders are much happier than the followers in this case.

WHICH ROLES HAVE ACCESS TO ANALYZED INFORMATION FROM THE PLANT WITHIN THE TIME-FRAME NECESSARY TO MAKE APPROPRIATE DECISIONS?



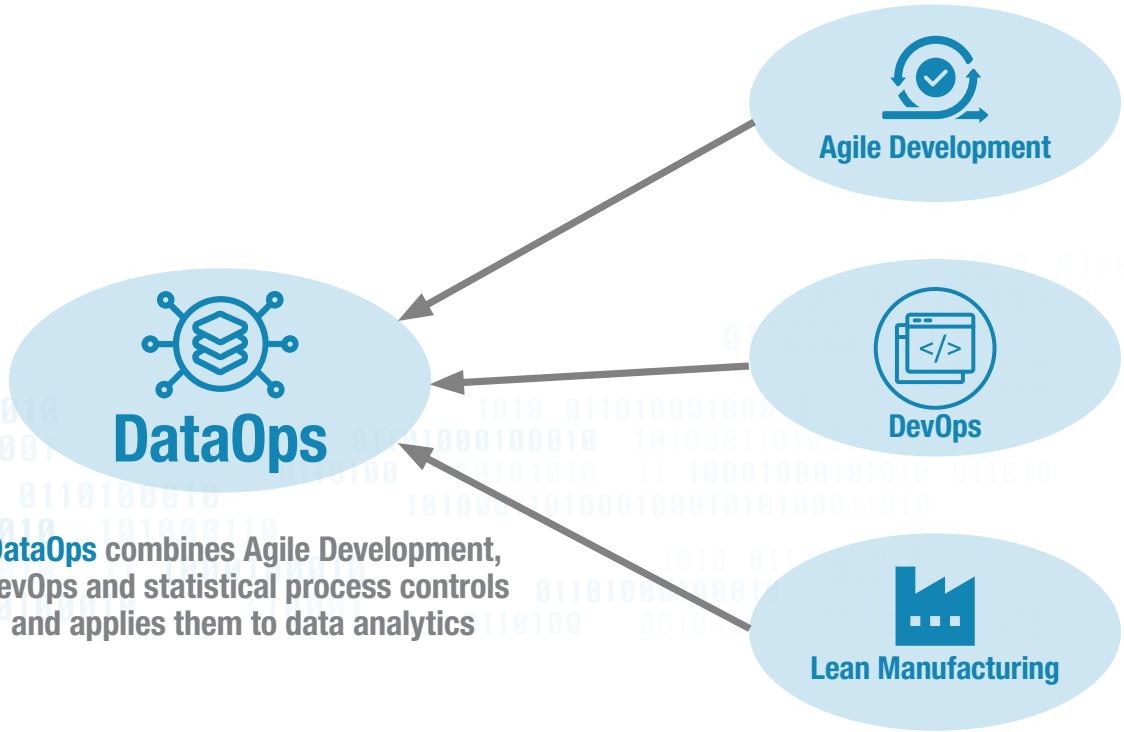
IX Leaders and Improvement *(cont.)*

Analytics Types and Opportunities *(cont.)*

When we try to deliver information to everyone who needs it, we have to start with collecting raw data and making it useful.

The previous two pages showed how analytics (and IX) leaders use a broad range of metrics to target improvement and provide timely access to them. When we try to deliver information to everyone who needs it, we have to start with collecting raw data and making it useful. The data model appears to be a finished product with many systems able to deliver and access data. The reality is somewhat different and is a key to analytics success: If you are serious about analytics, you need to put in place an organization that can support the creation and growth of the enterprise data model.

THE DATA MODEL IS THE CENTER OF ANALYTICS, AND WILL SUPPORT EXPANDING IX AND ANALYTICS PROGRAMS

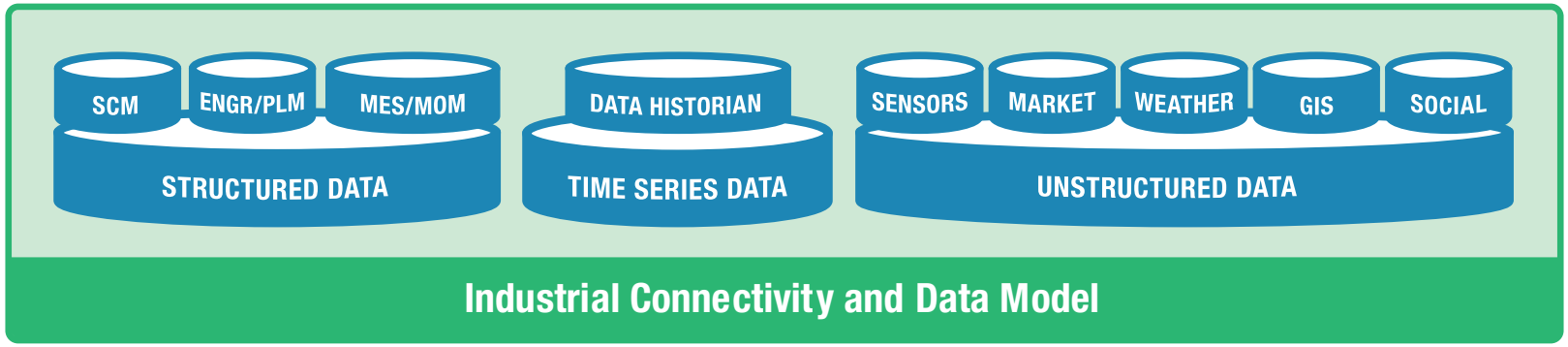


DataOps combines Agile Development, DevOps and statistical process controls and applies them to data analytics

IX Leaders and Improvement *(cont.)*

Analytics Types and Opportunities *(cont.)*

The base architecture will be defined from the major systems that are part of the enterprise transformation and the data these need to share. Although the data model will support the IX program, at the early stages, incremental change can be driven more by the need for specific analytics rather than the larger transformation programs.



IX Leaders and Improvement *(cont.)*

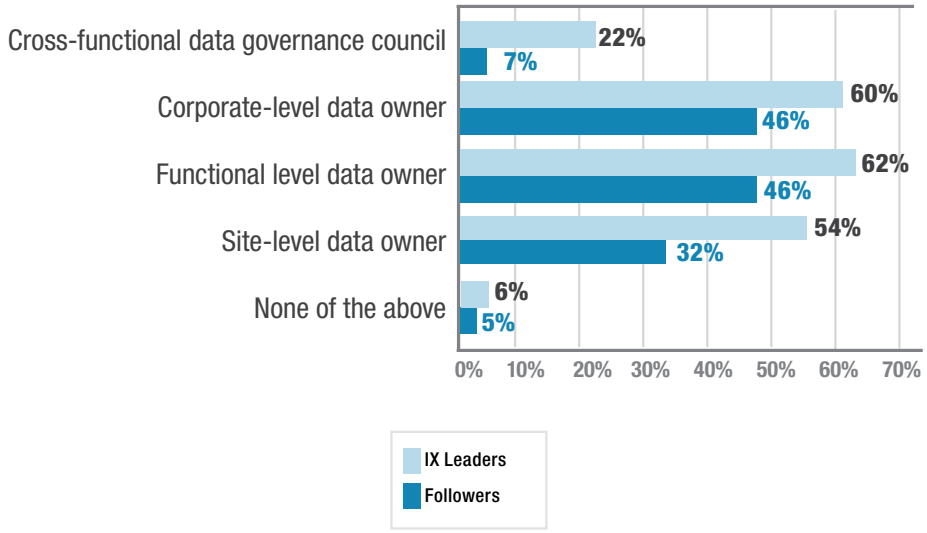
Analytics Types and Opportunities *(cont.)*

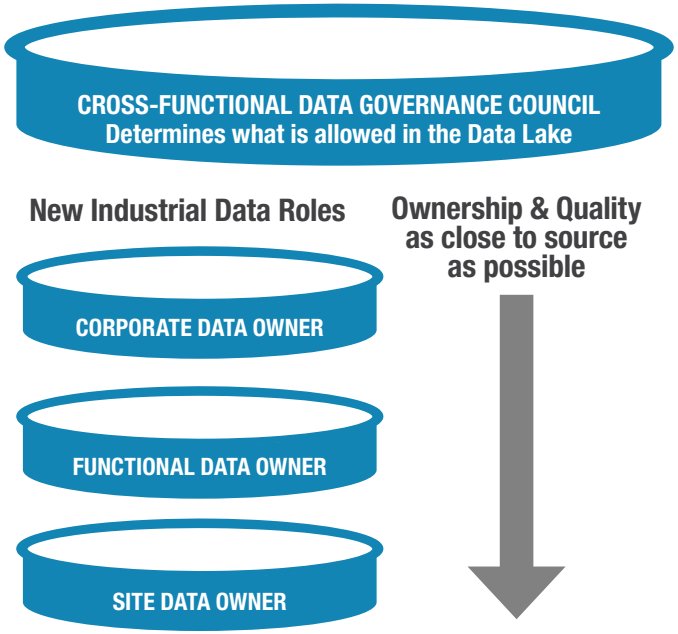
LNS Research is certainly not alone in promoting rigorous data handling in the industrial space. Both MESA, our partner in this research, and the DataOps Manifesto actively works to encourage better data governance. The manifesto lists 18 principles, all of which are key to a successful analytics strategy. Some are obvious but others are great like, "Reduce Heroism," and create sustainable and scalable data analytics teams and processes.

Smart IX leaders create more data-specific roles and they push data ownership and quality responsibilities as close to the source of the data as possible. A couple more of the DataOps principles, "It's a team sport," and, "Value working analytics," directly address the need for the right people to manage global data management.

DATA OPS AND GOVERNANCE

WHICH OF THE FOLLOWING DATA ROLES DOES YOUR ORGANIZATIONAL HAVE?





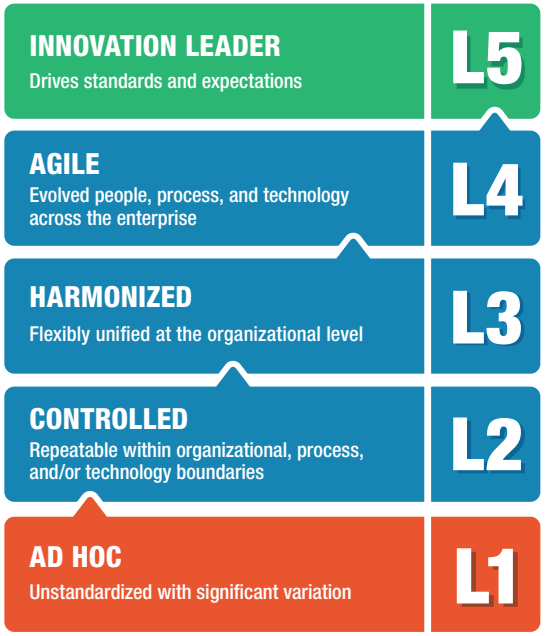
IX Leaders and Improvement *(Cont.)*

Analytics Types and Opportunities *(cont.)*

In order to manage change, a data team must be created that is part of the larger IX team, but with very specific organization. This team will be the data lake and data model owners with absolute authority to manage what goes into the lake and how the model is developed to support new functionality. IX Leaders should join forces with analytics leaders to form the data team and to define its governance model that will:

- Manage what is in the data lake
- Define the overall and expanding data model
- Stipulate the ownership for decision making
  - Separated into different levels
  - Owners are close to the data they understand
  - Analytics and IX data models developed together
- Incorporate quality and security into all aspects of the data system

In summary, to drive analytics that add value to your enterprise, the development of a value chain-wide data model is the first prerequisite.



Section 5

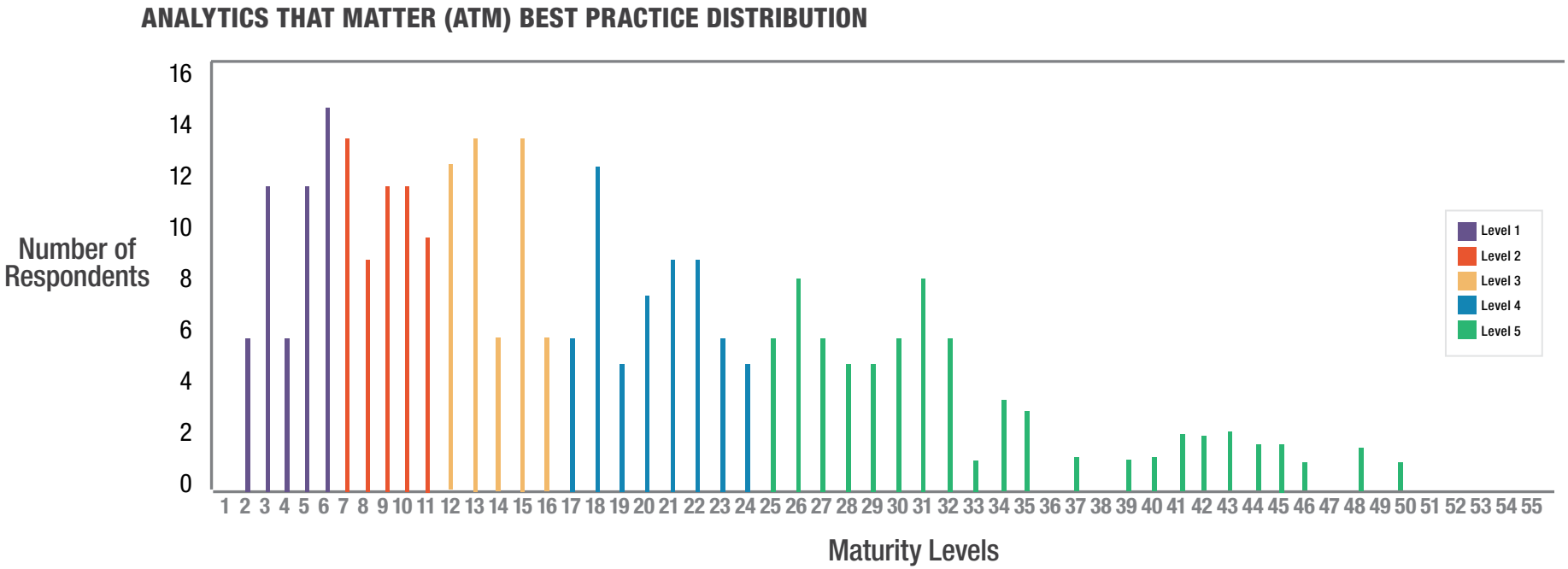
Analytics Maturity
Putting It All Together

Analytics Maturity - Putting It All Together

Having looked at modeling, deployment, leadership, and the use of analytics, a key question arises with many LNS Research clients: How am I doing? Indeed clients ask the same questions of their IX programs, APM, quality, and others. The idea is not to spend months doing a complete consulting engagement to benchmark against dozens of peers and competitors, but rather to take a quick look at how you fit onto a simple maturity scale. The threshold between each level is determined by calculating the responses of approaching 300 manufacturing enterprises and calculating the quintiles. We can see from the small chart below that the thresholds are uneven – getting into the top quintile is quite a challenge for most enterprises.

Analytics maturity is spit into three main categories: people, process, and technology, and each of these, in turn, is split into three characteristics. We can plot your maturity against the individual level in each category so you can easily see your strengths and areas for improvement. This output, and that from other maturity assessments, is invaluable in planning and tracking IX transformation programs.

The ATM survey proves an excellent starting point for analyzing analytics maturity in manufacturing companies. The key assistance that this simple model can do is to compare adoption rates of specific capabilities in relation to your peers who are at the same level.



Analytics Maturity - Putting It All Together *(Cont.)*

In the chart below, we see there is little benefit in comparing a company at Level 2 with those at levels 4 or 5; we know the gap is cavernous. However, we can see in our Company A example, that there are plenty of capabilities that need to be addressed to compete with peers.

As we continue to do with the 2020 Analytics That Matter survey, LNS Research tries to renew its surveys approximately every two years. By doing this, we get a side benefit that the input data for the maturity quintiles is renewed and so the thresholds of maturity, we hope, go up. Indeed, we have seen most metrics improving in our biennial surveys. Companies can then recalibrate their position in those surveys that they have used. Standing still will inevitably mean that a company has become less mature and relative to its peers, hence, likely less competitive.

MATURITY CAPABILITIES: COMPARISON TO COMPANY A

Maturity Capabilities	LEVEL 1	LEVEL 2	LEVEL 3	COMPANY A	LEVEL 4	LEVEL 5
Adopted EQMS	22%	35%	33%	X	24%	42%
Plan to hire specialists in industrial analytics	41%	45%	31%	☑	29%	38%
Effective management of production across a specific line of business and associated plants	29%	35%	33%	X	27%	31%
Effective management of safety and risks	32%	45%	33%	X	29%	21%

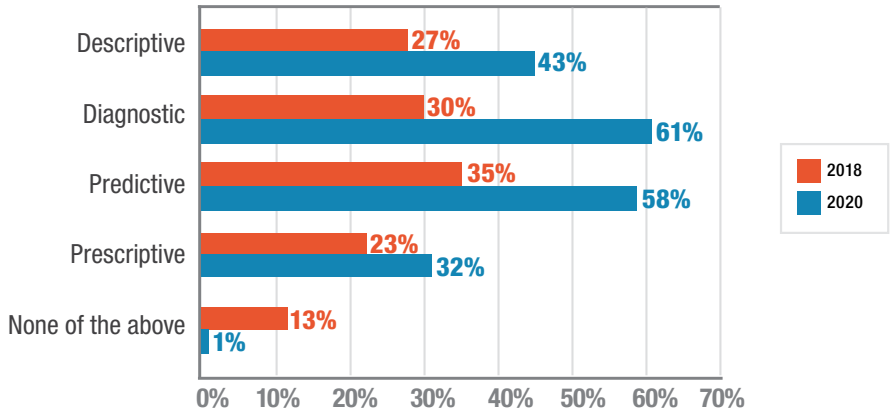
Analytics Maturity - Putting It All Together *(Cont.)*

Benefiting from Analytics – Predictive to Prescriptive

The usage of different types of analytics from descriptive to prognostic is a well-understood way of categorizing the capability of a particular analytic algorithm rather than the technology it uses. Theoretically, a diagnostic analytic could use advanced Artificial Intelligence (AI) techniques or first principal physics; thankfully that is not usually the case, and more complex analytics use more sophisticated algorithms.

Two years ago, LNS Research studied the use of the four main types of analytics and, surprisingly, we saw a clear pattern in usage from simple descriptive to predictive analytics update that was fairly similar; our expectation was that the drop off in usage would be after diagnostic, that descriptive and diagnostic would be widespread and predictive and prescriptive much less deployed.

WHICH LEVELS OF INDUSTRIAL ANALYTICS SOPHISTICATION DO YOU USE IN YOUR ENTERPRISE?



As we can see in the chart, this was not the case, and when we compare against the 2020 results, we see the same pattern. The continuation of this trend is very encouraging for everyone who is considering moving to ever more sophisticated analytics.

Things have really changed in the last two years – the adoption levels for predictive and diagnostic analytics have both approximately doubled in the past two years and now a majority of respondents for both have these capabilities. Manufacturers have clearly done a lot of work implementing analytics - yet, we have not seen a commensurate increase in analytics success – a much smaller portion of companies, just 23%, are analytics leaders. Addressing this imbalance should be a key target of executives in industrial companies.

Prescriptive analytics is a different beast than the previous three for the fundamental reason that it acts on the system. Predictive analytics just tell us what is likely to happen. Indeed, prognostic analytics is an estimate of outcomes, including when they will happen, based on a number of predictors or other analytic inputs. Only prescriptive does something and so it is essential that your analytics gain trust before wide deployment is likely. These barriers to uptake are clearly shown in the numbers: the increase in uptake of prescriptive analytics is just 9%.

There are common examples of prescriptive analytics, such as real-time optimization in process control. This is based on well-proven first principle mathematical models that are understood by the process engineers who use them. Therein lies built-in trust! Problem solved for this one complex but mature application; of course Real Time Optimization (RTO) was around long before analytics was even thought of in manufacturing, so some will claim that this is not really prescriptive analytics, but it does demonstrate the main issue, trust, very well.

Analytics Maturity - Putting It All Together *(Cont.)*

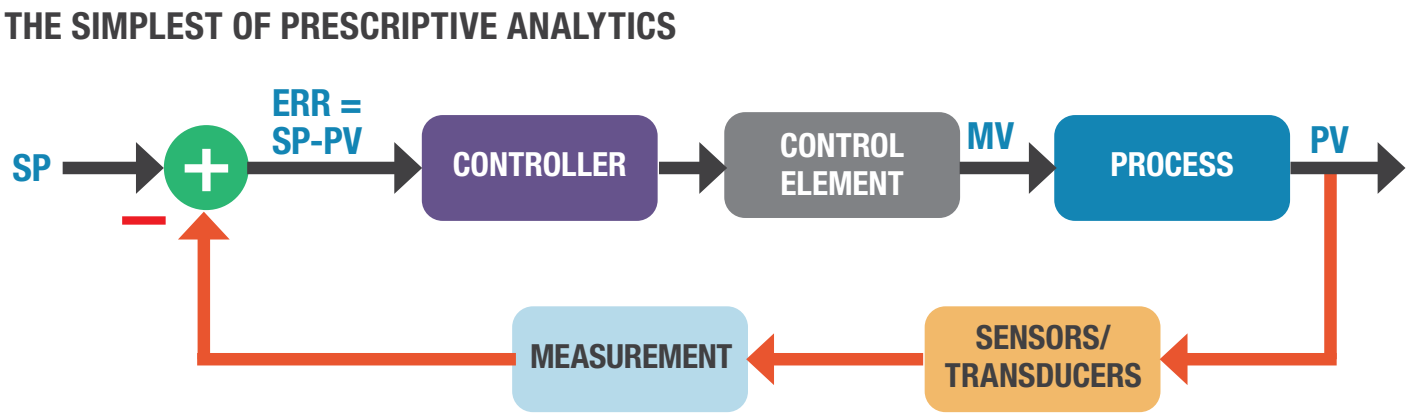
Use Analytics Maturity to Drive Trust and Prescriptive Analytics

The expansion of the analytics market is inevitable. We see a constant increase in the number of specialist companies that can deliver new insights for a wide variety of manufacturing industries. This expansion will offer new opportunities to advance the benefits of analytics. The data model we talked about earlier and an understanding of maturity, both from an analytics and a maturity viewpoint, will enable us to move to new horizons of prescriptive analytics where the software takes over some decision processes, and the IT, OT, and data experts trust the output.

Bringing the experts together and demonstrating the capabilities of the operational architecture will put us in a position to demonstrate to traditional plant management the benefits of control 4.0, driven by new technologies such as machine learning.

There is one more consideration for the importance of transforming analytics; disruption in your industry, after COVID-19, will bring benefits to those that can make leaps forward – truly game changing can bring huge benefits; aim high, not just at incremental change of 20-30%.

COVID-19 is going to change manufacturing in many ways; one example is social distancing. Can you think of prescriptive actions your plant can take to improve productivity while maintaining social distancing? Something to consider.



Analytics Maturity - Putting It All Together *(Cont.)*

More People

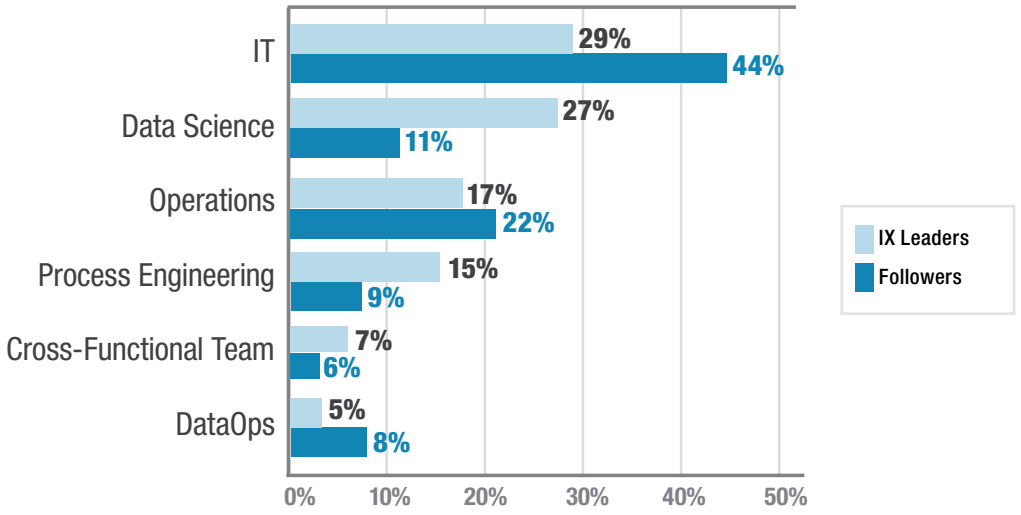
Although not a main theme of this report, the concept of information and operational technology, IT/OT, convergence is never far away when talking Industrial Transformation (IX). The success of IT/OT convergence is a leading indicator for IX - good cooperation between the two groups is a prerequisite to successful IX.

When we look at analytics, we can see a similar pattern emerging; data scientists (DS) and data engineers (DE) need to not just coexist, but to cooperate from data lake to sensor. DS/DE convergence can bring fundamental change to how companies derive value from information, sharing industry and manufacturing knowledge with data manipulation and dissemination. Just starting these conversations will fundamentally change how we run our businesses and enable IX.

In order for IX and analytics programs to be successful, the first prerequisite is leadership. We introduced the concept of IX Leaders and Analytics Leaders earlier – we cannot over-estimate their importance and how the right corporate culture can enable the step changes needed to make IX and advanced analytics a reality.

When we see how IX Leaders handle organization, it is no surprise that the CDO or CIO is responsible for handling the data model and, overwhelmingly, the CIO leads the analytics program. These leaders often have decades of experience in delivering data value to the enterprise, including to operations who are the customer. There are typically few operations leaders with long expertise in data management and, of course, ensuring the IX team is properly staffed leads us back to the whole convergence story – IT/OT and DS/DE.

WHICH ORGANIZATION HAS THE PRIMARY ROLE IN DEFINING & MANAGING YOUR COMMON DATA MODEL?



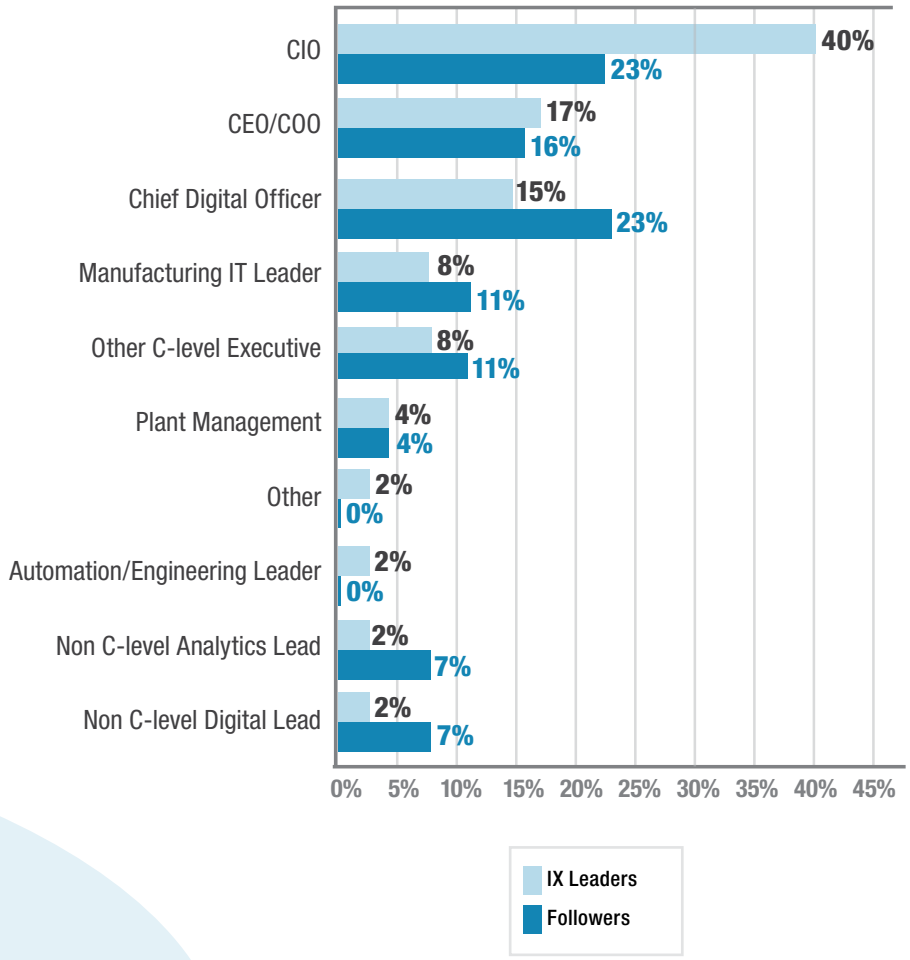
Analytics Maturity - Putting It All Together *(Cont.)*

More People *(cont.)*

While it is good to see splitting up roles, the organizations being put in place are not yet mature and do not address all the data needs. This is why analytics programs are not delivering...lack of a data model and the wrong people leading the data model.

The next page asks about hyped technologies. When we consider that AI is at the top of the feared technologies, and much of the growth in diagnostic and predictive analytics has been based on AI, we can see a potential gap between those delivering the technology and those that have to use and trust it. Last, and definitely not least, there isn't commensurate growth in prescriptive and prognostic analytics - so people (and systems) still can't take direct action to improve manufacturing.

WHO IS RESPONSIBLE FOR YOUR ANALYTICS PROGRAMS?



IX Leaders differentiates leadership roles between data and analytics. IT LEADS THE ANALYTICS PROGRAM, BUT DATA SCIENCE LEADS THE DATA MODEL.

Operations and OT is the customer.

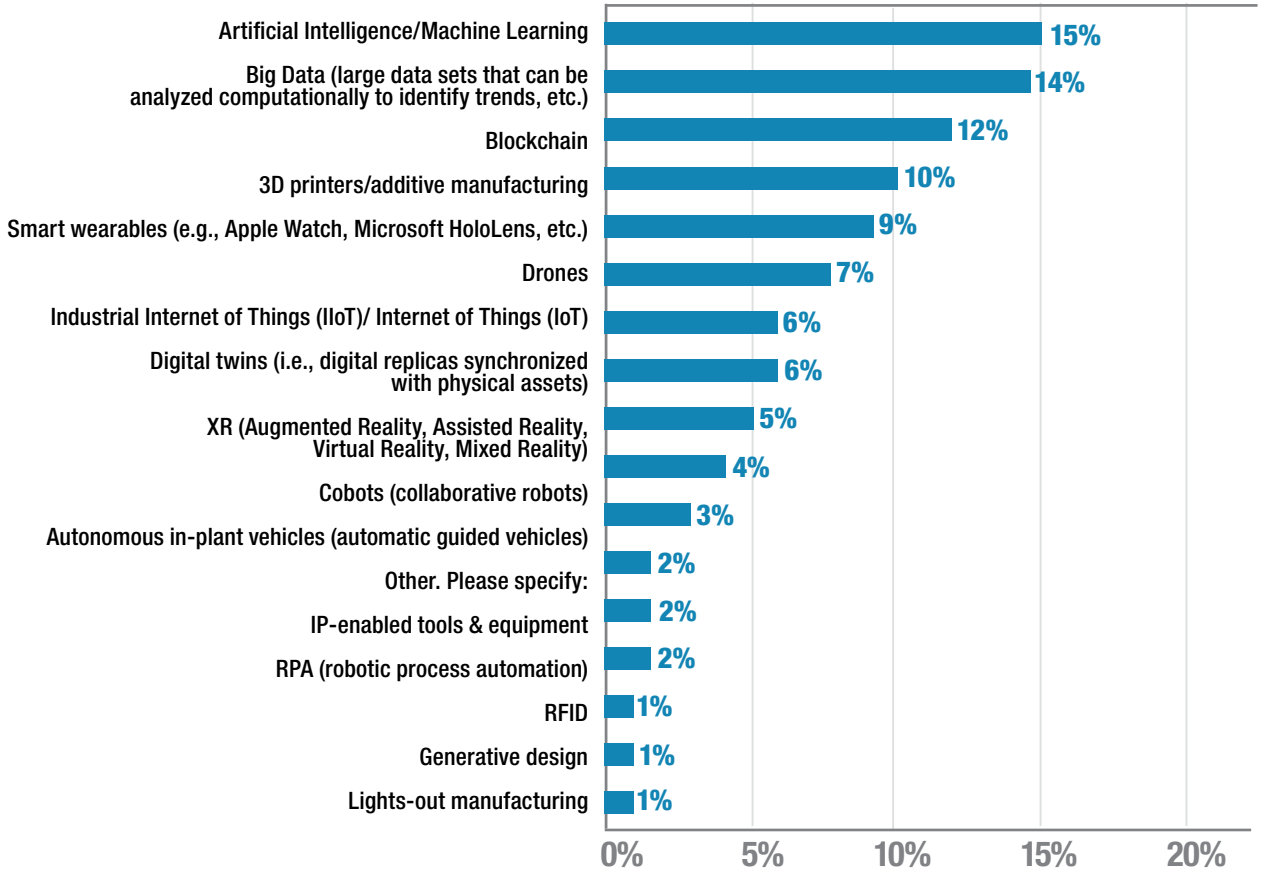
Analytics Maturity - Putting It All Together *(Cont.)*

What is Scary?

Here is one last bit of data from our survey – what is scary? We asked our survey respondents which upcoming technologies were they likely to use in the next three years." A quarter already use machine learning. So, we asked, "What do you think is the single most over-hyped technology or innovation in the manufacturing industry?"

The top four made up half the respondents, and what was at the top? AI/Machine learning followed by big data analytics does not need to be all hype, but it does need AI/ML and big data sets (with small letters).

WHAT DO YOU THINK IS THE SINGLE MOST OVER-HYPED TECHNOLOGY OR INNOVATION IN THE MANUFACTURING INDUSTRY?



Section 6

Recommendations and Resources

Recommendations

Analytics are the heart of any Industrial Transformation (IX) program; without data, duly cleansed and calculated, it is hard even to start such a program. We recommend to undertake the short maturity assessment to identify strengths and weaknesses. This will help focus on people, process, or technology when starting out.

The next action to make analytics that matter is to build a team whose leader has the respect and trust in the organization to be able to manage the first big hurdle, a data model and suitable data governance. That person may report to, or indeed be, the leader of IX but must have the confidence of IT, OT, and all other data contributors. The following key steps are highly recommended:

- Define and implement a data governance strategy – ensure those that need access to data have it. Those that own data are given the tools to manage it. Initially, it is easy to be overzealous with rules and potentially worry key data partners who want access to low-level raw data directly through the tools they always use. Creating data governance transforms your organization; it doesn't simply focus it on additional tools.
- Agilely build an initial data model, either internally or based on a commercial industrial Internet of things (IIoT) package, that will support analytics programs and ensure data quality. Agree upon what will initially be covered both from a data viewpoint but also architecturally – you need to have cloud and plant access from the outset, but it does not necessarily have to support all future data from the outset.
- Implement some start-up analytics that will demonstrate the value to people and culture, not just a technology demonstrator. Involve leaders who manage at all levels from sensor to enterprise. Work with them on building trust and demonstrating the value, specifically of prescriptive analytics, the real value of the future. Overall, increase both prescriptive and prognostic analytics to promote a data-centric and learning-based organization.
- Address real scenarios that will help improve analytics maturity. For example, address analytics that will help leaders improve their performance and better support their teams. Avoid getting stuck in data silos, but rather use your industrial data model to gather important insights and effectively deliver them to more decision-makers. Implement analytics that will help to develop the data model, the governance model, and trust in analytics.

Define analytics that go beyond the single plant, and even the enterprise. Demonstrate analytics across the supply chain that shows the benefits to your clients and suppliers. There an is unlimited opportunity to share data and analytics applications across the value chain.

Finally, a goal for analytics leaders is to drive opportunities for prescriptive analytics. Build trust among users of less sophisticated analytics so that they can grow with the benefits. Using new technologies, such as machine learning and Artificial Intelligence (AI), along with a trusting workforce, will enable new levels of direct control and returns that cannot be imagined with current technologies.

Industrial Transformation Resource Guide

Companies use digital technology to drive transformation across the value chain. Use these resources to learn how to align the people, processes, and technologies required to achieve Operational Excellence in your organization.

INDUSTRIAL TRANSFORMATION

BLOG | Understanding Industrial Transformation: Definition and Framework for Success

View Blog →

RESEARCH | Industrial Transformation: Architecture and Analytics Just the Beginning

View Research →

RESEARCH | Industrial Control Systems and Edge Computing: Enabling an Operational Architecture for Applications and Analytics

View Research →

INDUSTRIAL ANALYTICS

RESEARCH | Build a Flexible Industrial Analytics Strategy for Today and Tomorrow: Why Business Leaders Should Adopt a Use Case Approach

View Research →

BLOG | How the Right Operational Architecture Powers the Analytics That Matter

View Blog →

RESEARCH | Analytics Really Do Matter: Driving Digital Transformation and the Smart Manufacturing Enterprise

View Research →

FACTORY OF THE FUTURE

RESEARCH | Improving Continuous Improvement: Reinvent Lean Today with Digital Technology

View Research →

RESEARCH | Forging the Digital Twin in Discrete Manufacturing: A Vision for Unity in the Virtual and Real Worlds

View Research →

RESEARCH | MOM and PLM in the IIoT Age: A Cross-Discipline Approach to Digital Transformation

View Research →

APM 4.0

Solution Selection Guide | Asset Performance Management (Platform Vendors), 2018 Edition

View Solution Selection Guide →

RESEARCH | APM 4.0: Prescription for Better Profitability in Operations

View Research →

RESEARCH | The Road to Digital Transformation Success: A Methodology to Modernize Operational Excellence

View Research →

Industrial Transformation Resource Guide *(Cont.)*

QUALITY, COMPLIANCE

RESEARCH | Quality 4.0 Impact and Strategy Handbook
View Blog →

RESEARCH | Driving Operational Performance with Digital Innovation: Connecting Risk, Quality and Safety for Superior Results
View Research →

RESEARCH | Roadmap to Supplier Status: Think Risk Performance, Not Compliance
View Research →

ENVIRONMENT, HEALTH AND SAFETY

WEBCAST | EHS 4.0: Using Technology to Reach New Levels of Safety and Environmental Performance
Watch Webcast →

RESEARCH | Unify EHS and Quality: Capture Synergies and Turn Policy into Action
View Research →

RESEARCH | The Connected Worker: Mobilize and Empower People to Reduce Risk and Improve Safety
View Research →

INDUSTRY FOCUS

AUTOMOTIVE RESEARCH | IATF 16949-2016: A Pivotal Opportunity in Automotive Quality Management
View Research →

AUTOMOTIVE AND A&D RESEARCH | Manufacturing Performance: Automotive and A&D Gaining Momentum with Analytics
View Research →

LIFE SCIENCES RESEARCH | Digitalized Quality in Life Sciences: Roadmap to Sustainable Growth and Speeding Profitable, High-Quality Products to Market
View Research →

LIFE SCIENCE RESEARCH | Quality 4.0 in Pharmaceutical: Use Cases and Advantage in a Digitally Maturing Market
View Research →

METALS AND MINING RESEARCH | Data for Balanced Scorecard: Driving Profits in Mining, Metals, and Materials Industries
View Research →

POWER GENERATION RESEARCH | Driving Better Decision Making with Big Data: A Roadmap for Digital Transformation in the Power Generation Industry
View Research →

ANALYTICS THAT MATTER IN 2020

A New World

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