SMART CONNECTED ASSETS

Making the Industrial Internet of Things Real

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SMART CONNECTED ASSETS

Making the Industrial Internet of Things Real

TABLE OF CONTENTS

Executive Summary 3

Section 1: Research Demographics 5

Section 2: Operational Excellence: A Key Driver for APM 7

Section 3: Smart Connected Assets & APM: A Pillar of Operational Excellence 11

Section 4: Smart Connected Assets:
The Cornerstone of Smart Connected Operations 16

Section 5: Smart Connected Assets: Getting There Is a Journey 20

Section 6: Recommended Actions 24

Executive Summary

Introduction

For manufacturers today the Industrial Internet of Things (IIoT) is front and center in virtually every business publication and also the central focus of almost every vendor from automation suppliers to enterprise software suppliers' sales and marketing programs. Headlines that shout about the billions of connected devices that are going to radically change business challenge today's business leaders to embrace the IIoT and transform their companies. There is no doubt that the IoT is transforming commerce in several industries; one only needs to look at Uber, Netflix or Airbnb to see examples of whole new business models in the consumer sector. Understanding how to translate that into the manufacturing sector has proven to be the challenge.

To be sure, manufacturers have been connecting manufacturing assets together for a long time. Since the advent of programmable logic controllers (PLCs) and distributed control systems (DCSs) almost 50 years ago, the digital age and machine-to-machine (M2M) communication has permeated the plant floor. This has led to incremental improvements in productivity, quality, and equipment reliability as increased data has led to better insight into manufacturing processes. However, LNS Research believes that manufacturing and allied asset intensive industries like mining, energy, and utilities are on the verge of radical changes brought on by the convergence of information technology (IT) with a host of operational technologies (OT).

Anyone who attends any vendor or industry conference or user group meeting today knows that the story revolves around smart devices, brilliant assets, the smart grid, or dozens of other marketing driven categories of devices using information more effectively. Typically one of the proof points for the value of the IIoT and smart devices has been in Asset Performance Management (APM). From the LNS Research perspective APM is based on the concept that *healthy assets are the foundation of a healthy business*. At the heart of the IIoT and APM is what LNS Research calls Smart Connected Assets, and it is these Smart Connected Assets that will drive the changes in the manufacturing landscape going forward.

SMART CONNECTED ASSETS

Converged Sensors, Instrumentation, Controls, and Assets

REAL TIME → PREDICTIVE → AUTONOMOUS

AWARE OF AND CAN REACT TO:

Design and Configuration

Internal and External Operating Conditions

Past Performance

Predicted Future Failure

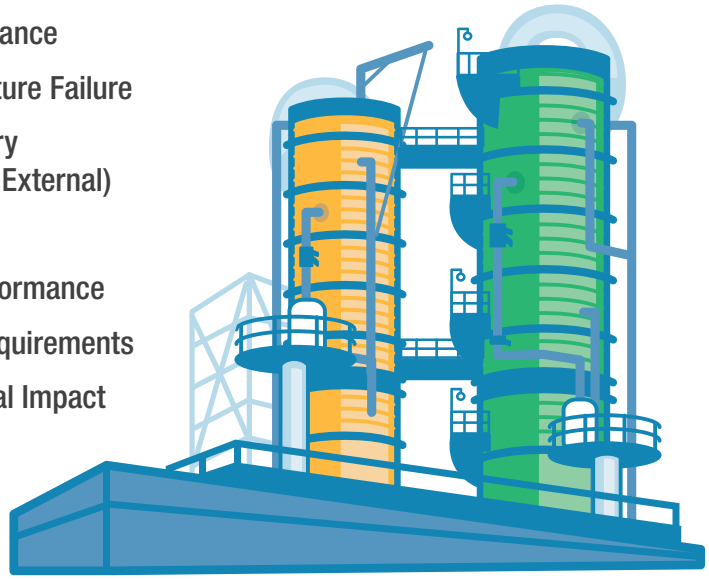
MRO Inventory (Internal and External)

Raw Material

Supplier Performance

Customer Requirements

Environmental Impact



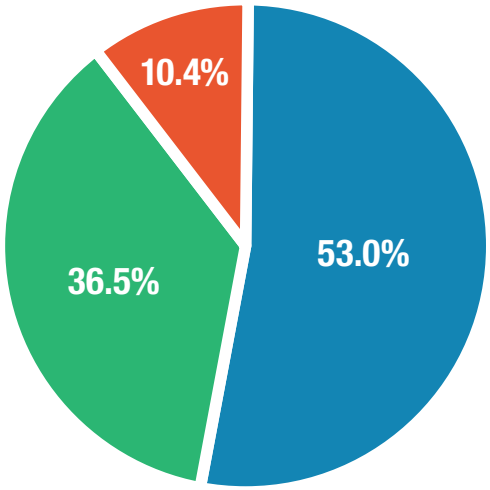
SECTION 1

Research Demographics

Research Demographics

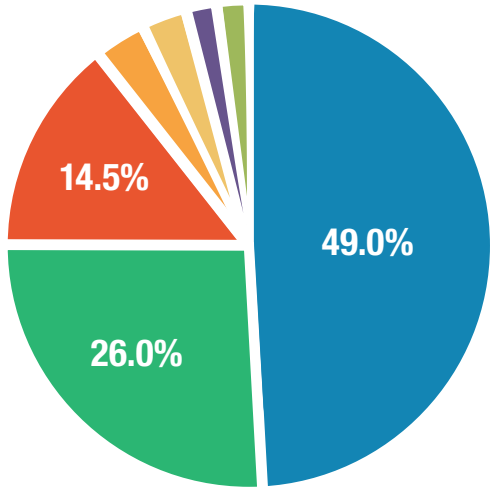
Before getting into Smart Connected Assets, it is important to set the stage for the supporting data used throughout this eBook. Over 250 executives and other senior leaders have completed the 2015 LNS Research Asset Performance Management Survey, coming from a variety of company sizes and geographies across a range of industries. The survey questions drill down into the challenges and opportunities that companies face, strategic objectives and imperatives for pursuing APM, the metrics they use to gauge their APM performance, and their perceptions as to which suppliers are aiding them in their pursuit of Operational Excellence as it relates to APM and their spending plans going forward.

Just under 50% of the respondents are from North America, just over 25% are from Europe, almost 15% from Asia Pacific, and the remainder are from the rest of the world. A wide variety of industries are represented, with Industrial Equipment being the largest group with 13.5% of the respondents and the rest of the industries ranging from just over 10% (Oil & Gas) down to 1% (Semiconductors) of the respondents. As one would expect in asset intensive industries with a focus on APM more than 50% of the respondents were from companies with over $1 Billion in revenue. Medium sized companies represented 10% of the respondents and just over 35% represented small firms with revenues less than $250 Million.



COLOR BY COMPANY REVENUE

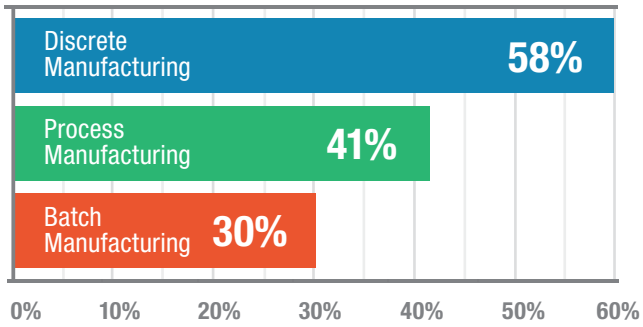
- Small: $0 - $250MM
- Medium: $250MM - $1BB
- Large: $1BB+



COLOR BY HQ LOCATION

- North America
- Europe
- Asia / Pacific
- South America
- Middle East
- Africa
- Australia/New Zealand

Industry



SECTION 2

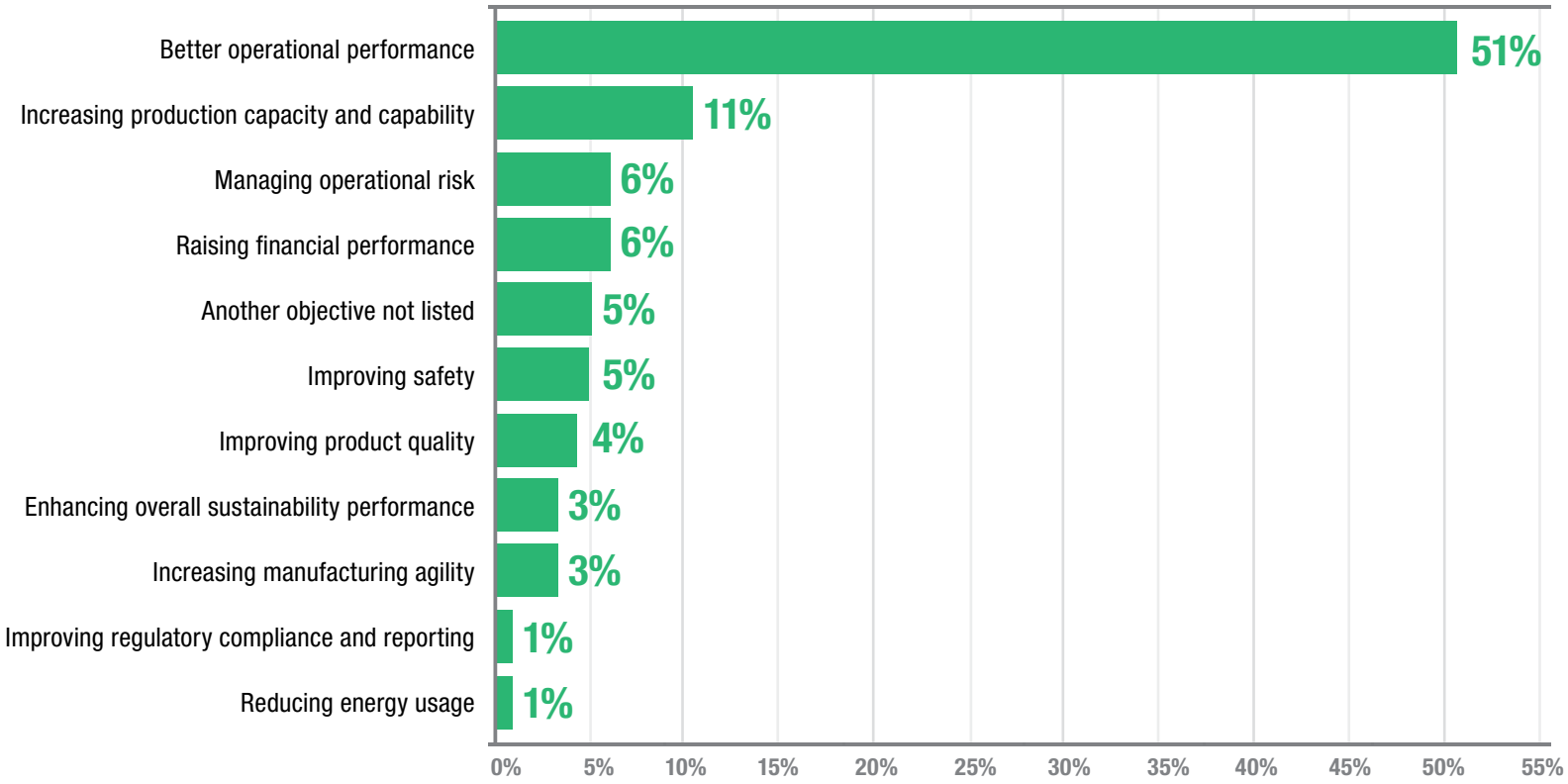
Operational Excellence: A Key Driver for APM

Industry Drivers

The number one strategic objective for respondents to the LNS Research APM survey for improving APM performance is "better operational performance," with more than 50% of all respondents ranking it as their number one objective, and over 80% ranking it as a top three driver. As the number one response it exceeded all the other reasons combined and the second place driver, "increasing production capacity and capability" almost five-fold. For those that did choose another objective improving operational performance was still the number one "second choice," with 19% of the respondents selecting it, and for those that chose it as the third most important objective it came in second to managing operational risk (12%) with 11% of respondents.

When looking at asset intensive industries like Oil & Gas, Mining, and Utilities the results were essentially the same as industry as a whole with "managing operational risk" a distant second place, with only 15% of the respondents identifying it as their primary driver.

What is the number one strategic objective for improving asset performance in your organization?

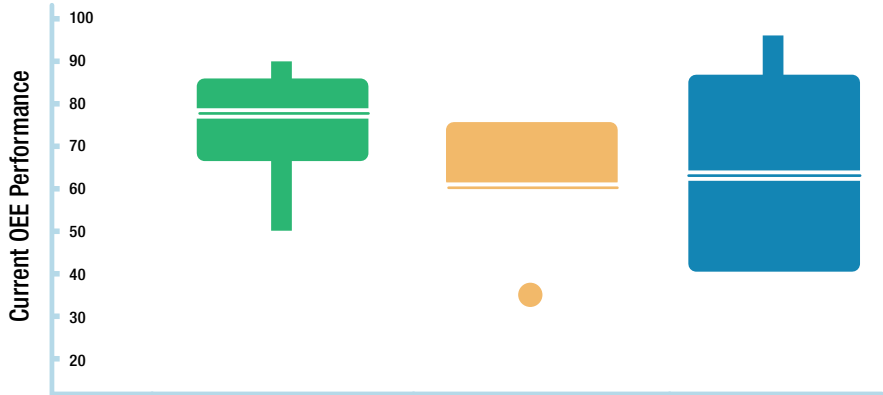


Industry Drivers *(cont.)*

Companies that did not rank "better operational performance" as the number one objective were typically performing better, at least from an Overall Equipment Effectiveness (OEE) perspective, than those that ranked it as their primary driver. While OEE can sometimes be misleading in that it is best used as an internal measure of performance improvement rather than an industry benchmark, it remains a metric that manufacturing management uses to gauge performance. This is not surprising since companies that already have achieved a higher level of operational performance are more likely to focus on other areas of improvement such as managing operational risk or increasing production capacity and capability.

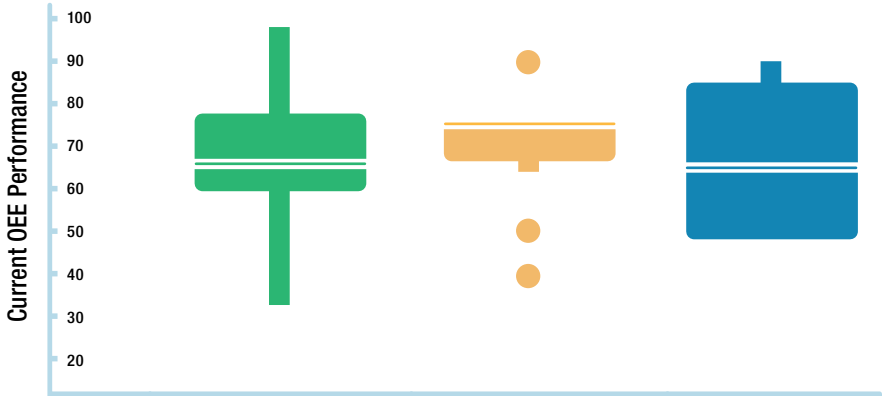
If the results from the survey serve as a leading indicator companies that focus on improving Operational Excellence can expect approximately a 10 point increase in OEE.

WHAT IS THE **SECOND** MOST IMPORTANT STRATEGIC OBJECTIVE?



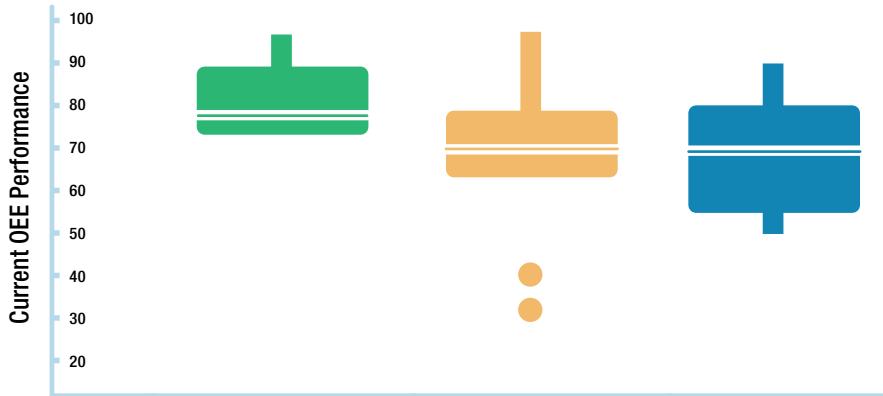
	Better operational performance	Increasing production capacity & capabilities	Managing operational risk
Count	73	64	90
Median	78	60	62

WHAT IS THE **NUMBER ONE** STRATEGIC OBJECTIVE?



	Better operational performance	Increasing production capacity & capabilities	Managing operational risk
Count	301	80	53
Median	66	75	65

WHAT IS THE **THIRD** MOST IMPORTANT STRATEGIC OBJECTIVE?



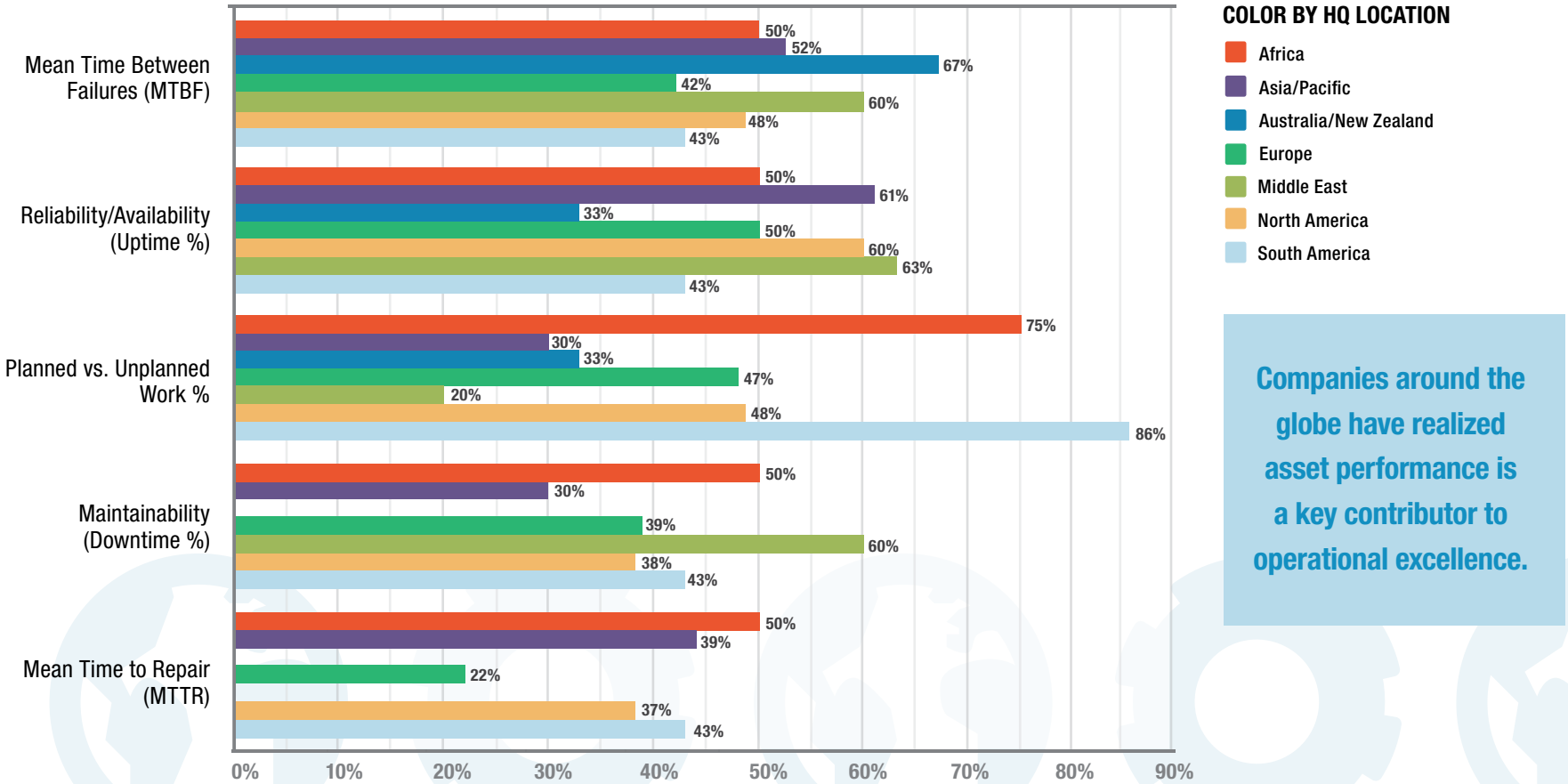
	Better operational performance	Increasing production capacity & capabilities	Managing operational risk
Count	84	107	58
Median	78	70	69.5

Asset Performance and Operational Excellence

While OEE may be the Key Performance Indicator (KPI) many manufacturers use to get a feel for their Operational Excellence, when it comes to the day-to-day metrics they use to manage APM there is variation. The most common metric is Mean Time Between Failure (MTBF), which dominates across all regions except Africa, where mining is a key industry and "planned versus unplanned" work percentage was the primary indicator. Reliability or availability measured as uptime percentage came in a consistent second.

It is clear that companies around the globe have realized that asset performance is a key contributor to achieving Operational Excellence.

Which APM metrics does your organization measure?



Companies around the globe have realized asset performance is a key contributor to operational excellence.

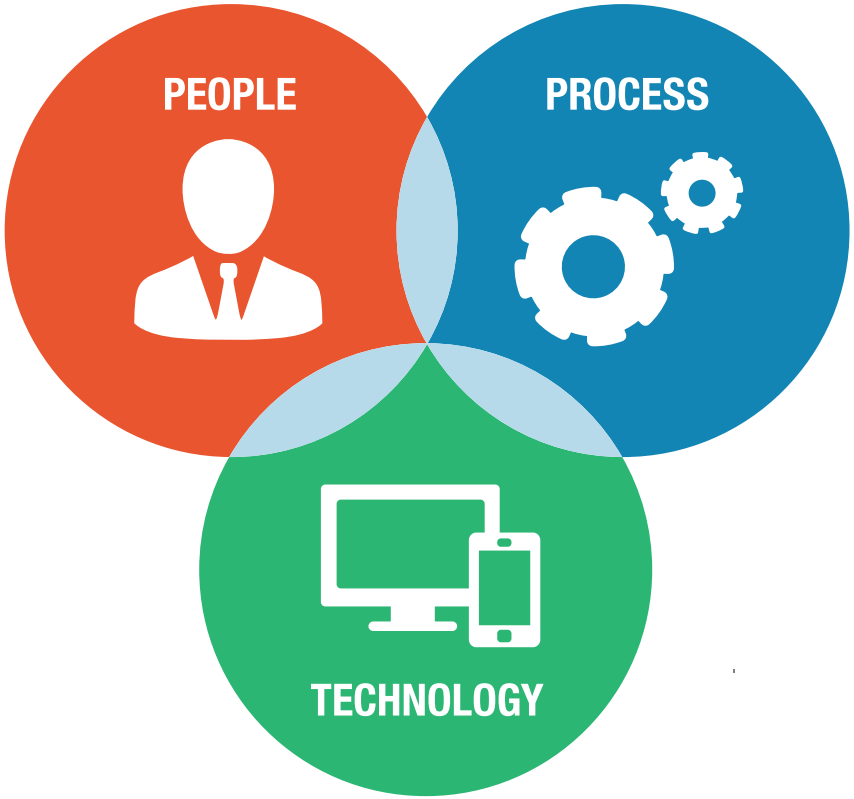
SECTION 3

Smart Connected Assets & APM: A Pillar of Operational Excellence

Operational Excellence: Key Elements

Since Operational Excellence is a driving factor for so many companies both overall and as an imperative for their APM investments it is important to understand how LNS Research views Operational Excellence. LNS Research has always focused on the intersection of people, processes, and technology. Any one element without the other is fundamentally flawed. No matter how exceptional a particular technology may be, if the process that leverages that technology is incorrect then it only enables poor performance on a faster and bigger scale than if the process were manual. Likewise no matter how efficient and well designed a process is, if people fail to follow and adopt it, the organization will not achieve the benefits it seeks.

One of the outcomes that Smart Connected Assets will ultimately deliver will be autonomous asset operations. This does not negate the importance of people in this triad below, however. In fact, it makes people all the more important as they shift their roles from labor to intellectual value adding positions. People ultimately become the process managers ensuring that Smart Connected Assets are tasked with the proper objectives and follow the proper processes to achieve them.



Operational Excellence: Pillars

If people, processes, and technology are the platform that supports Operational Excellence in a business then the pillars that support that platform derive from the core activities that business must encompass to delivers it goods or services. For almost all manufacturers and asset intensive service providers like Utilities, Mining, and Oil & Gas companies these are:

- Asset Performance
- Operations
- Energy
- Environment, Health & Safety
- Quality

For some manufacturers, particularly in consumer-focused industries, new product development and introduction (NPDI) and supply chain management (SCM) may be additional practice areas that are fundamental to business success. Regardless of whether an organization has five, six, or even seven pillars the key is understanding that these pillars support the people-process-technology platform in a multi-dimensional way.

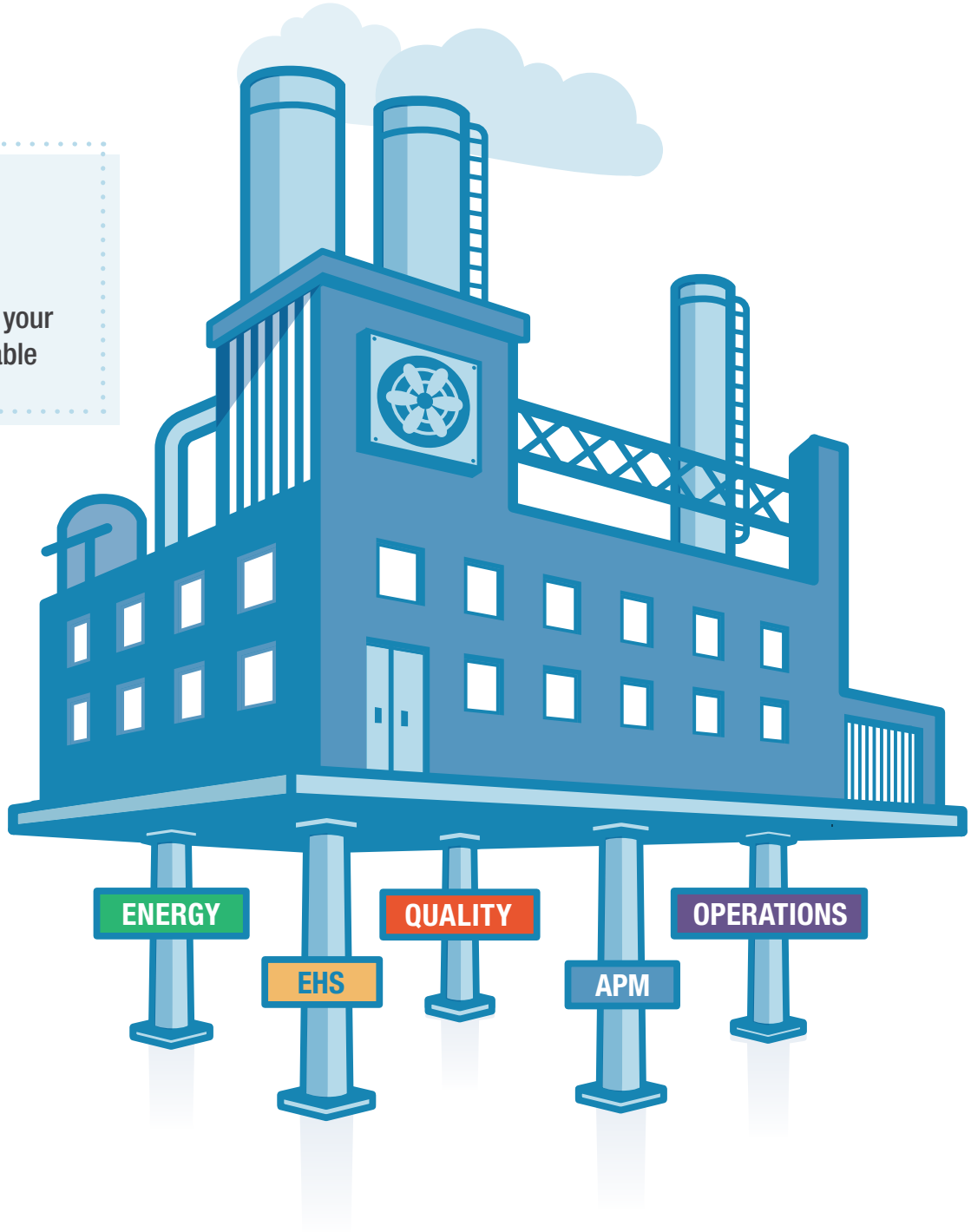
Operational Excellence: Pillars *(cont.)*

OPERATIONAL EXCELLENCE SUPPORT

I Fall short on any pillar and your OpEx platform becomes tippy

II Fall short on two or more pillars and your OpEx platform becomes totally unstable

People – Process – Technology
Operational Excellence Platform

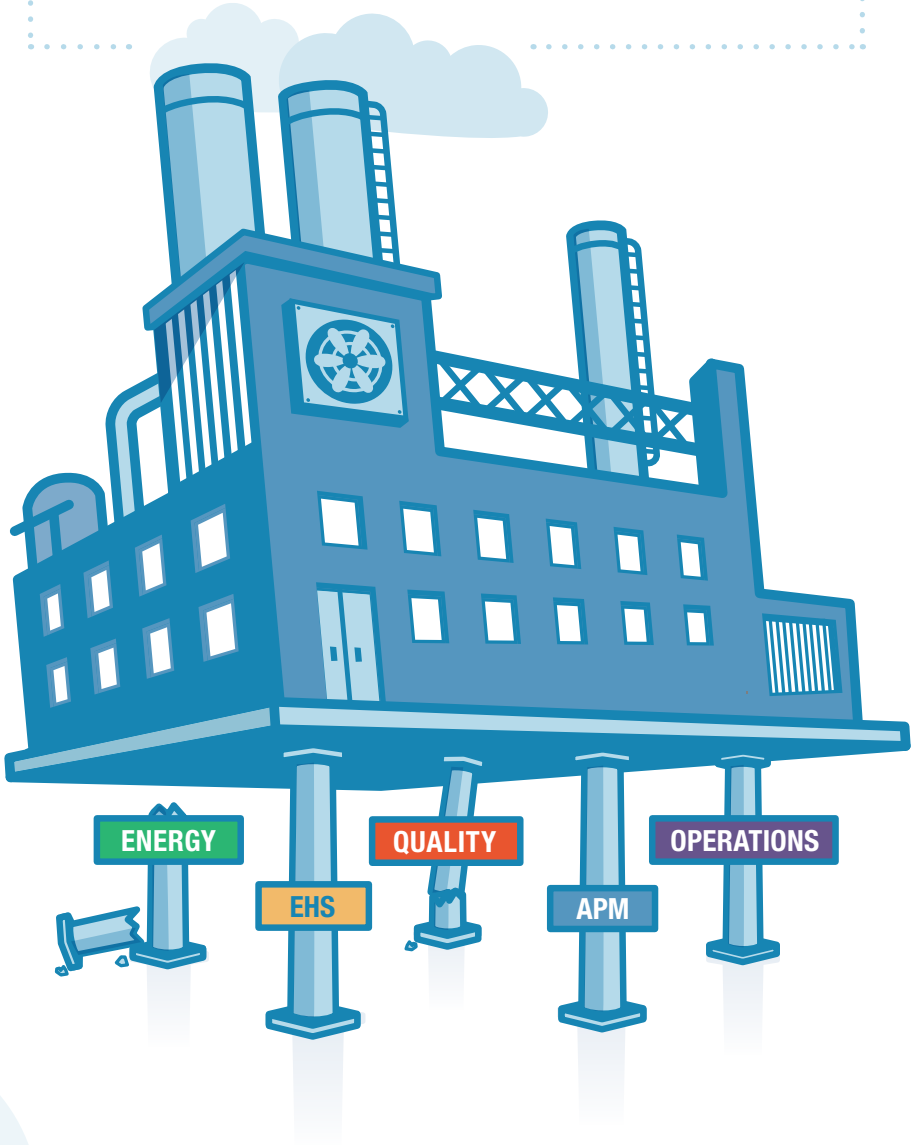


Operational Excellence: APM Centric Perspective

Since Operational Excellence is multi-dimensional it is critical that the underlying support for it be balanced. If any pillar fails in its support for Operational Excellence the entire business is threatened. If two or more pillars fall short a catastrophic result will ensue and the business will fail.

When asset performance is the underperforming pillar it puts the enterprise at a great risk. Any time a piece of production equipment fails it can not only impact productivity, but safety and quality as well. Since OEE is the product of availability, productivity, and quality it should be clear that any time equipment is not fulfilling its primary function due to maintenance issues that it has a drastic negative impact on OEE. This is why so many companies have focused on APM as a way to drive Operational Excellence.

Since asset performance is central to productivity, quality, and safety in manufacturing, Operational Excellence is simply not achievable without a robust approach to APM.



People – Process – Technology
Operational Excellence Platform

SECTION 4

Smart Connected Assets: The Cornerstone of Smart Connected Operations

Architecting Smart Connected Assets

The true value of IIoT is in creating new manufacturing models. LNS Research believes that as these new approaches to manufacturing evolve the concept of a Smart Connected Enterprise will emerge. Whether it is new greenfield construction or the retrofitting of existing plants and assets, integration across the entire application stack is going to be central in the shift from a hierarchal model to one that is more peer-to-peer oriented.

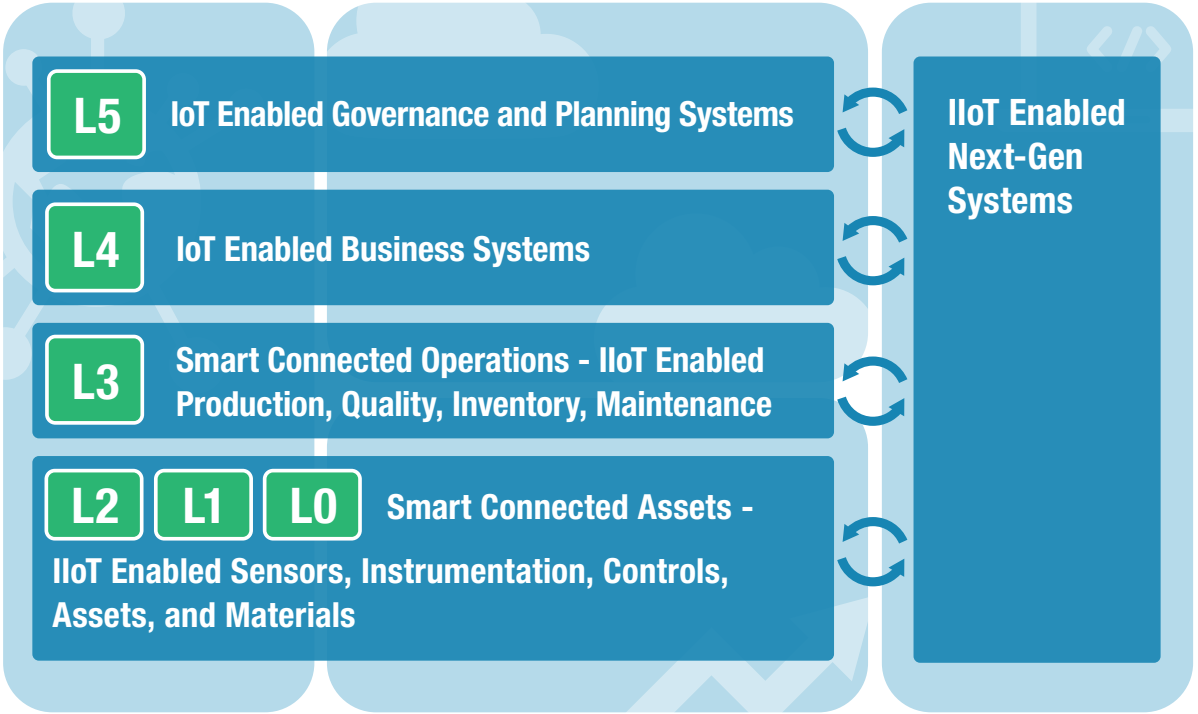
Shop floor to top floor integration has proven over the past 30+ years to be largely an intractable problem due to the very hierarchical systems in place today; the IIoT Platform will change this in two ways.

First, the traditional architecture will begin to converge and flatten as solution providers port or re-write existing applications to run on top of IIoT platforms. Moving forward, it is likely that there will be vendors talking much more about IoT enabled Manufacturing Operations Management (MOM), Manufacturing Execution Systems (MES), sensors, instrumentation, controls, assets, and materials. This IoT enablement is what will trigger the emergence of "Smart Connected" Assets and Operations.

Second, the creation of IoT enabled next-generation systems will enable true shop floor to top floor integration and mashup applications by eliminating the dependency of unbroken integration between traditional systems and allowing for the flow of data to and from anywhere in ways that make sense given limitations of legacy systems and the use cases for new business models.

The combination of IIoT enabled legacy systems and IIoT enabled next-generation systems built with Smart Connected Assets is the foundation for enabling the Smart Connected Enterprise.

SMART CONNECTED ENTERPRISE



Smart Connected Assets: Capabilities

The Smart Connected Operations concept is a future looking vision that describes what the factory or production line of the future will look like. It will involve IIoT enabled MOM applications integrated with IIoT enabled Smart Connected Assets and IoT enabled business systems. It is an integral part of creating the Smart Connected Enterprise and is often where companies have breaks in the strands of the Digital Thread.

Smart Connected Operations are aware of internal and external operating conditions, systems, and events as well as the traditional operations disciplines of quality, inventory, maintenance, and quality. As more and more systems, devices, sensors, assets, and people are connected, more and more data will be collected that is both structured and unstructured, enabling new analytical techniques to provide previously undiscoverable results.

Over time, Smart Connected Operations will allow manufacturing organizations to move from providing just real-time data, to providing real-time data in context of operations with predictive analytics embedded, to eventually a true autonomous production environment where production equipment can make decisions independent of human intervention in the context of real business conditions and objectives.

SMART CONNECTED OPERATIONS

Integrated Assets, Operations, and Business Systems

REAL TIME → PREDICTIVE → AUTONOMOUS

AWARE OF AND CAN REACT TO:

Plant, Asset and Product Design or Configuration 5, 8

Inventory levels and flow 1, 3, 4, 8, 12 | **Quality performance** 4, 9

Asset performance 5 | **Internal and External Operating Conditions**

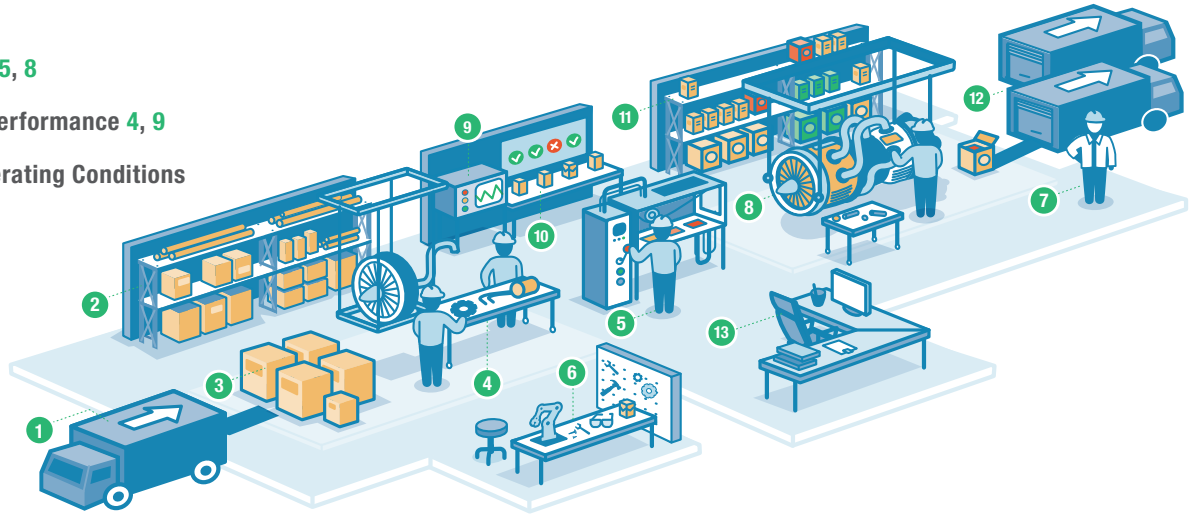
Supplier Performance 1

Customer Demands and Requirements 12

Environmental Impact

Mobile enabled employees with collaboration and optimal decision making 7, 13

Closed loop business process 13



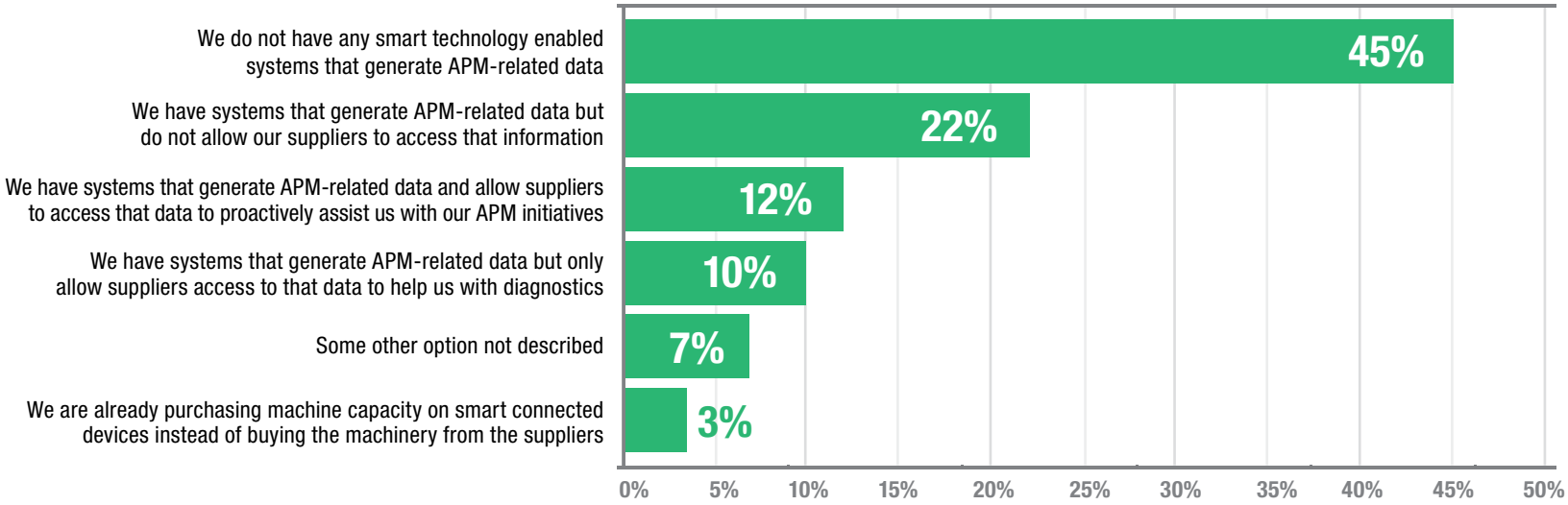
Smart Connected Assets: Attitudes

While the concepts of Smart Connected Operations and Assets are very real from an enabling technology perspective very few companies have begun to make the transition in the way they leverage the technology. Just under one half (46%) of survey respondents indicated they do not have any smart connected assets that generate APM related data today. Only 3% of the respondents have actually transformed their operations by buying capacity instead of capital, which is what noted speaker and Harvard Business Review author Michael Porter sees as the future of manufacturing.

Despite the disappointment one might find in these extremes the good news is that some progress has been made as companies are beginning to make the transition to Smart Connected Assets and beginning to leverage the wealth of information available with the IIoT and through leveraging Big Data and Predictive Analytics.

Twenty two percent of users have smart assets but are only using the data internally to help themselves improve their performance. An equal number are sharing that data with their suppliers so they can assist them in one form or another. Twelve percent allow suppliers access to the data for proactive assistance while the remaining 10% allow it only for diagnostic assistance.

Which statement best describes your attitudes towards APM services provided by the vendors of the smart connected devices in your facility?



"Smart connected products will give rise to the next era of IT-driven productivity growth at a time when the impact of earlier waves of IT has largely played itself out."

–Michael Porter/James E. Heppelmann, *Harvard Business Review*, November 2014

SECTION 5

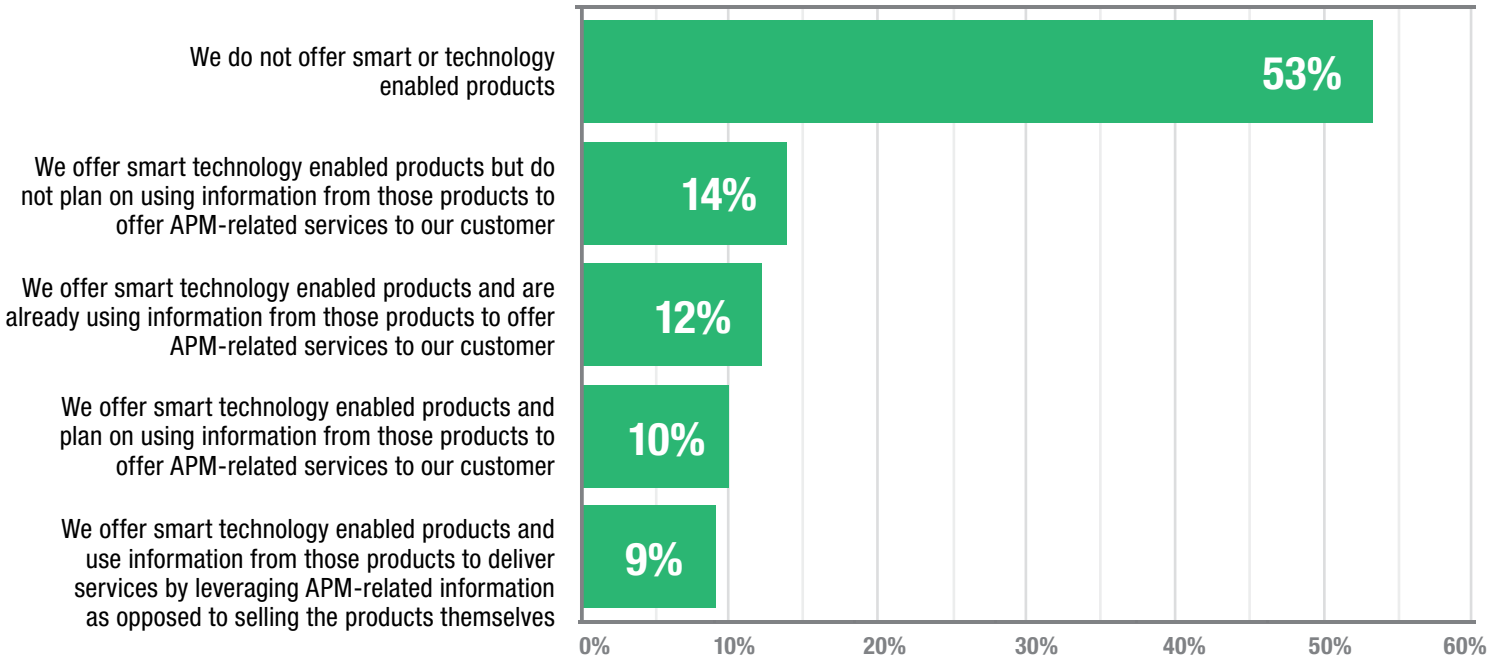
Smart Connected Assets: Getting There Is a Journey

Smart Connected Assets: Current and Future Adoption

Today just under one half of the Original Equipment Manufacturers (OEMs) that responded to the APM survey indicated they are leveraging the power of Smart Connected Assets in their own products. Using standard definitions of market adoption rates the implication is that the IIoT is real and already becoming a market transforming force. Over time it is expected that the number of OEMS that have not leveraged the value of Smart Connected Assets will drop, from 53% today, to far below 50% by the end of 2016.

The 47% of OEMs that do have smart devices are almost evenly split as to how they are leveraging the information those devices provide. LNS Research expects the predominant model to be a mix of using the information to provide value-added services as well as enabling the transformation from selling equipment or capital to selling services (e.g. selling the holes instead of selling drills and bits).

If you are an OEM that manufacturers equipment for sale to other entities (either consumers or other businesses) which statement below best describes your use of smart connected technology in those products?

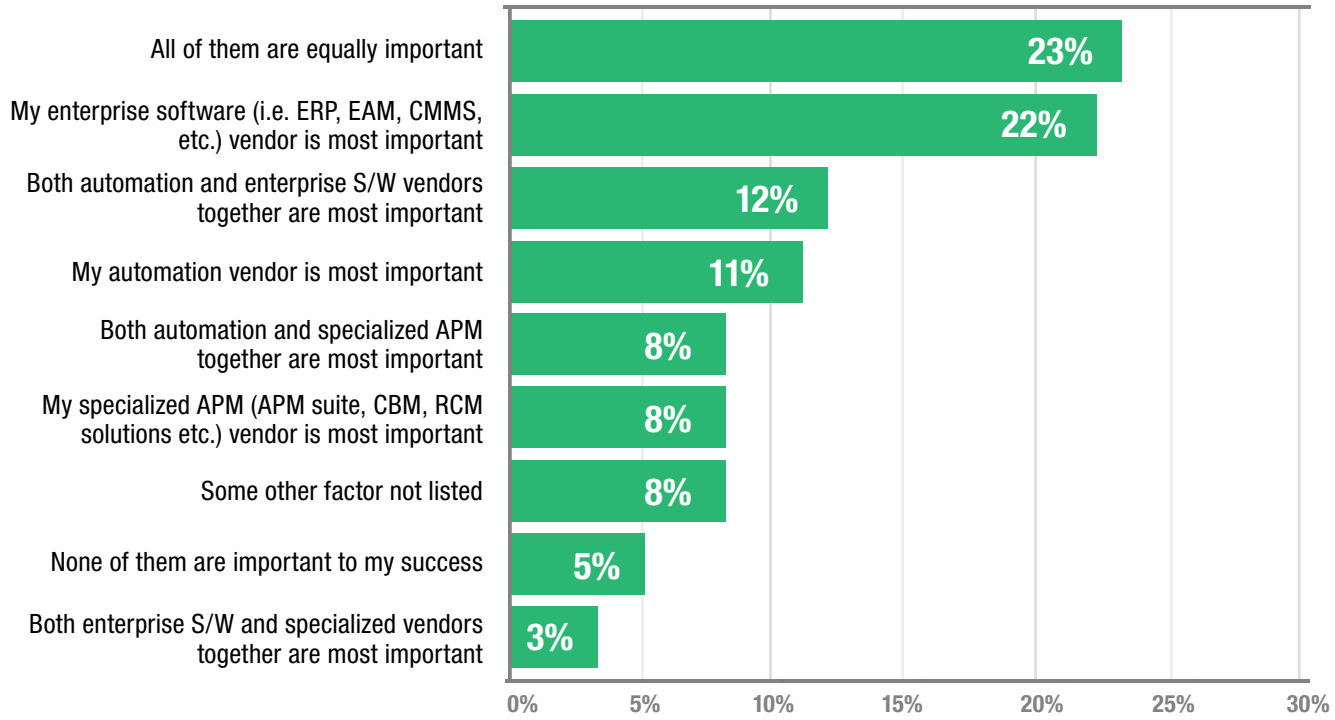


Smart Connected Assets: Current and Future Adoption *(cont.)*

Companies are recognizing that no single supplier can provide all of the value when it comes to Smart Connected Assets, with 46% indicating some combination of vendors is the path to APM success. Twenty-three percent of respondents indicated that a combination of enterprise, specialized APM, and automation vendors are equally important and another 23% indicated a pairing of two of the vendor types was important.

Where a single vendor was deemed most important it was the enterprise software suppliers that took the second position with 22%. This is not surprising since all of the major enterprise suppliers have expanded their portfolios to include predictive analytic capabilities for preventive and predictive maintenance (PM/PdM).

Which description best describes how you view the providers of APM solutions as contributors to your success?



Smart Connected Assets: Current and Future Adoption *(cont.)*

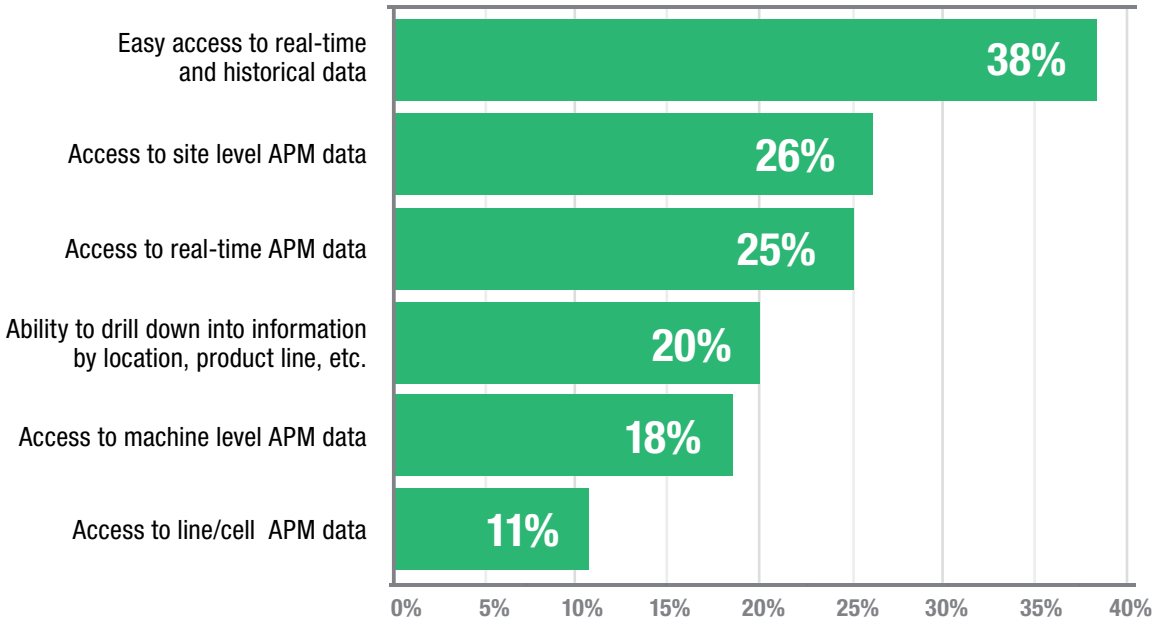
The key to utilizing the data that Smart Connected Assets provide is access to that data to make informed decisions. The good news here is that over one-third of respondents (38%) today have easy access to both real-time and historical data and another 25% currently have access to real-time data.

Even more promising is that 20% of the survey respondents indicated an ability to drill down into the data location, product line, or other subdivision. It is clear that this access to APM data, whether at the site, line or cell, or even down to the machine level, is going to enable the transition from just having connected assets to having Smart Connected Assets.

At a recent analyst event Juha Pankakoski, Chief Digital Officer & CIO of KONECRANES, a Finnish crane manufacturing company with 600 locations worldwide and over 12,000 employees, made the following observation that captures the essence of the value of Smart Connected Assets:

"But at its best, Industrial Internet is not about making old equipment more efficient…but instead solving old challenges differently…with new approaches…that allow customers to innovate solutions for new challenges."

How would you describe your organization's visibility into APM data in terms of granularity?



SECTION 6

Recommended Actions

Summary and Recommended Actions

Smart Connected Assets will transform manufacturing. Some changes will be incremental and impact businesses in small ways while others will be disruptive and potentially change the entire nature of the industry segments in which they exist. The IIoT, Big Data, and Predictive Analytics will impact the way manufacturers and asset intensive industries like Mining, Oil & Gas and Utilities pursue Operational Excellence. Asset Performance Management will become a core competency thanks to Smart Connected Assets, although to date few companies have made the transition.

Going forward the momentum of the IIoT will allow enterprises to gain more insight from their assets, better manage operational risk, and improve their overall effectiveness. While early adopters are few the data suggests that those that are already beginning to adopt the Smart Connected Asset approach are seeing better performance than those that have yet to make the move.

Positioning a business to take advantage of the emergence of Smart Connected Assets involves taking the following steps:

- Abandon reactive maintenance and establish APM as a core competency. Companies that have adopted an APM approach to maintenance show better OEE than those that have not made the shift. Operational risk management comes naturally with an advanced APM program.

- Invest in the IIoT and the analytic tools to use that additional data. As equipment is replaced and technology refreshed, IIoT enabled devices should start to infiltrate the asset base. If the underlying support for connectivity and analytic tools is present to leverage that data, an organization will be in a far better position to benefit from Smart Connected Assets.

- Recognize that Smart Connected Assets will break down the hierarchical structures and systems in the enterprise. The entire spectrum of suppliers can contribute to success when it comes to deriving benefits from Smart Connected Assets. The people-process-technology triumvirate is the basis of Operational Excellence and hierarchical structures and systems will inhibit the ability to get the most from Smart Connected Assets.

- Metrics will still matter and people will still be needed even as Smart Connected Assets evolve to facilitate autonomous activities. While the ultimate end-point for Smart Connected Assets is autonomous behavior it will be a long time in coming. As businesses deploy Smart Connected Assets KPIs and metrics will still be important in understanding progress toward that goal.

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