EHS 4.0:
THE STRATEGIC IMPERATIVE
FOR ENVIRONMENT, HEALTH AND SAFETY LEADERS

Drive Business Value with Digital Transformation

LNS
research

EHS 4.0: THE STRATEGIC IMPERATIVE FOR ENVIRONMENT, HEALTH AND SAFETY LEADERS

Drive Business Value with Digital Transformation

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Executive Summary

Executive Summary

While the goals of environment, health and safety (EHS) management remain relatively constant, the challenges and opportunities in achieving them have changed dramatically. The digital revolution known as Industry 4.0 is disrupting industries, and transforming business models, processes and performance. This creates new business and operational risks to be managed, and new opportunities to optimize performance.
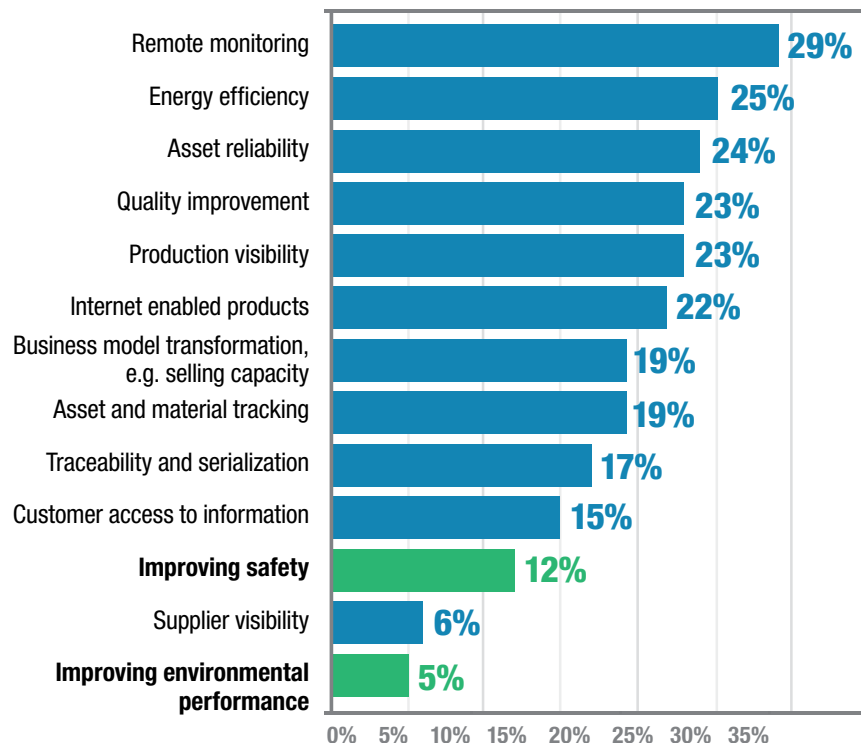
How can EHS leaders survive and thrive in the wake of Digital Transformation? EHS 4.0 is a new framework to overcome the limitations of traditional approaches to EHS management. Technology

innovations based on the Industrial Internet of Things (IIoT) and Big Data analytics (among others) offer breakthrough capabilities to systematically improve safety and environmental performance.
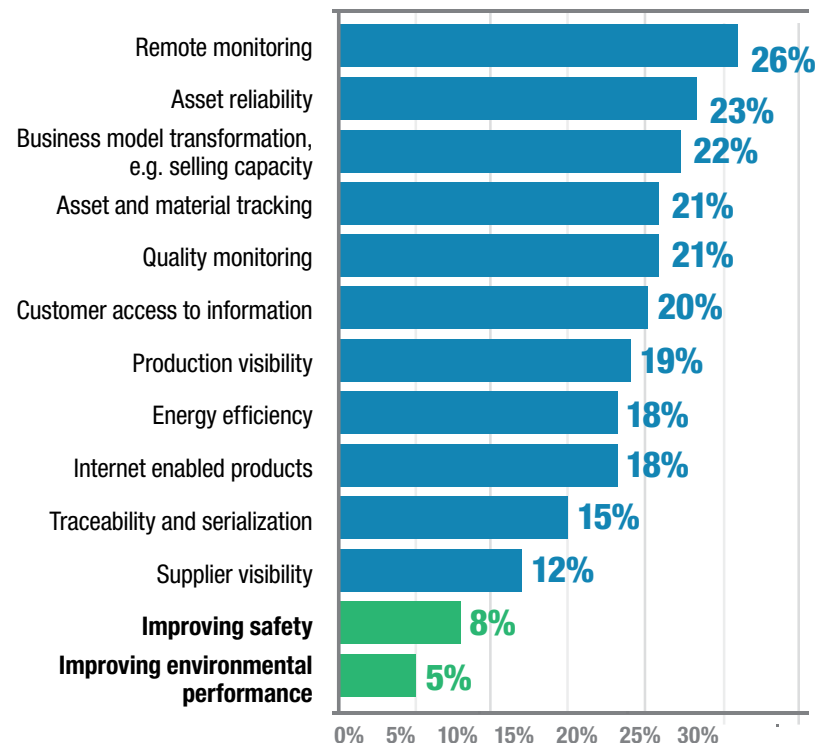
The EHS function has been on the sidelines of the digitalization trend, as industrial operations has led the way. Investments focused on EHS management use cases have been comparatively low.

This research explores the current state of EHS management relative to Digital Transformation, and how EHS leaders can seize the opportunity to leverage modern technology for safety and environmental performance improvement.

What are the top IIoT use cases your company is pursuing today? *(N=252, all respondents)*

Use case	%
Remote monitoring	29%
Energy efficiency	25%
Asset reliability	24%
Quality improvement	23%
Production visibility	23%
Internet enabled products	22%
Business model transformation, e.g. selling capacity	19%
Asset and material tracking	19%
Traceability and serialization	17%
Customer access to information	15%
Improving safety	12%
Supplier visibility	6%
Improving environmental performance	5%

What are the top IIoT use cases your company will start pursuing in the next year? *(N=249, all respondents)*

| Use case	%
Remote monitoring	26%
Asset reliability	23%
Business model transformation, e.g. selling capacity	22%
Asset and material tracking	21%
Quality monitoring	21%
Customer access to information	20%
Production visibility	19%
Energy efficiency	18%
Internet enabled products	18%
Traceability and serialization	15%
Supplier visibility	12%
Improving safety	8%
Improving environmental performance	5%

Research Demographics

Research Demographics

The data presented in this eBook represent the survey responses of over 300 business leaders and professionals who participated in the LNS Research EHS Management survey. In addition, some results from other LNS Research surveys such as Manufacturing Operations Management are included. This helps provide a unique perspective on the role of EHS management in Operational Excellence and the value of EHS integration into core business operations.

The industry demographics of the survey are congruent with the demographics of the industrial landscape. Discrete manufacturing is the largest segment, followed closely by process and batch industries. The research has broad participation across industry verticals, geographic regions, and company sizes.
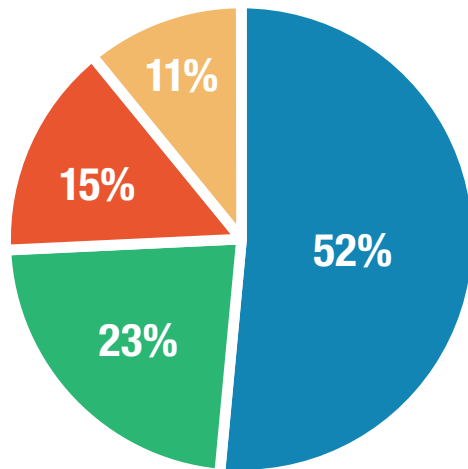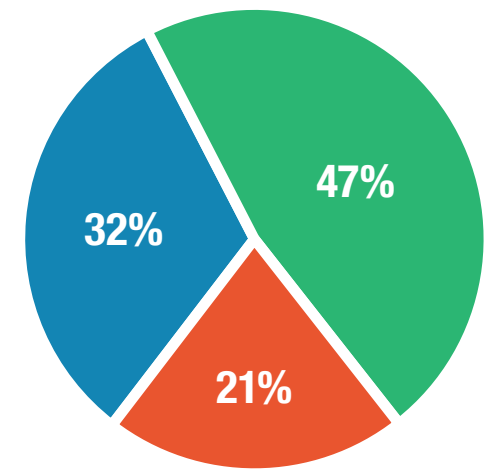
GEOGRAPHY

HQ Location

- ■ North America — 52%
- ■ Europe — 23%
- ■ Asia/Pacific — 15%
- ■ Rest of World — 11%
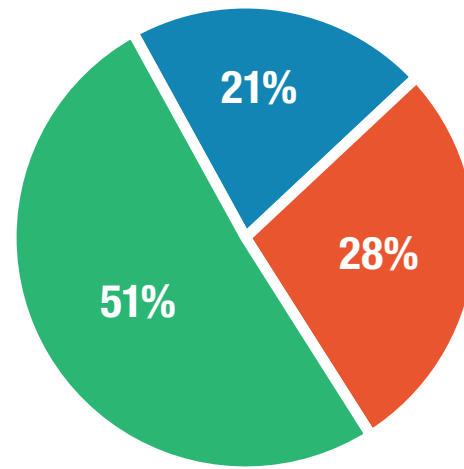
REVENUE

Company Revenue

- ■ Small: Less than $250 Million — 21%
- ■ Medium: $250 Million - $1 Billion — 28%
- ■ Large: More than $1 Billion — 51%

INDUSTRY

- ■ Process Manufacturing — 32%
- ■ Discrete Manufacturing — 47%
- ■ Batch Manufacturing — 21%

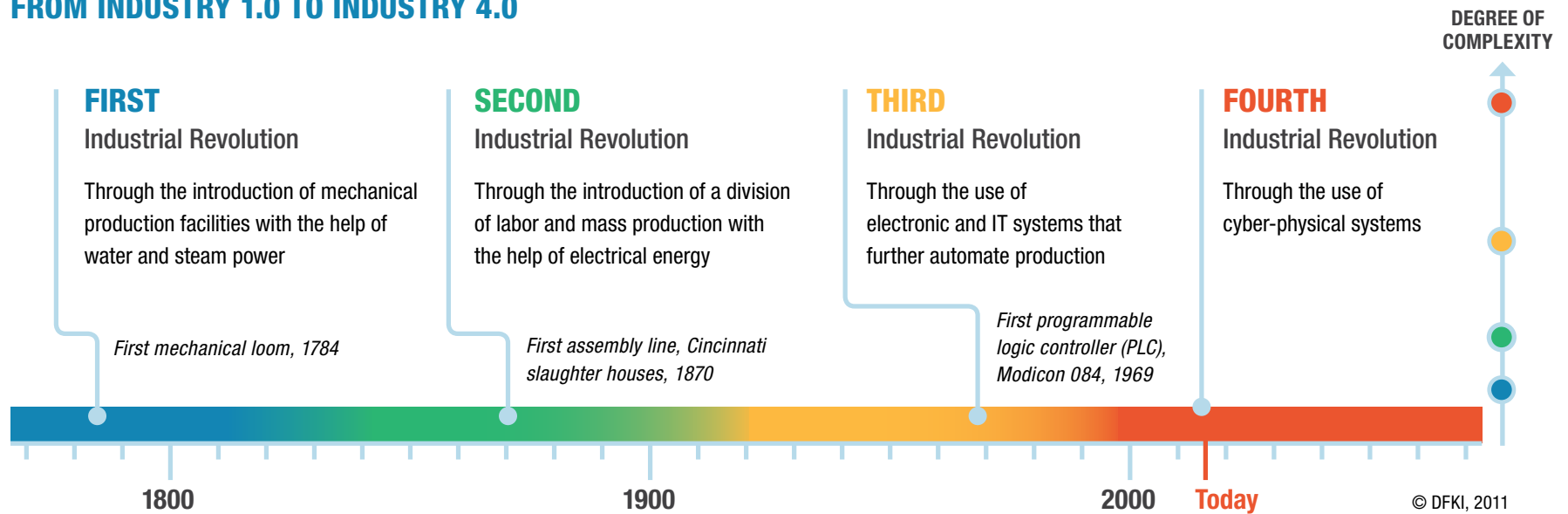# EHS 4.0: Confront the Challenges of Modern EHS Management

Why EHS 4.0?

EHS 4.0 is a reference to Industry 4.0, also known as the Fourth Industrial Revolution. The first three were: mechanical production using water and steam power, mass production using electricity, and using electronic and IT systems to automate production.

Industry 4.0 makes use of cyber-physical systems to connect people, machines, and data in new ways. Several critical technology changes including sensor-equipped devices, cloud computing, mobile apps, and Big Data enable the overarching trend of the Industrial Internet of Things (IIoT). Smart connected assets are the manifestation of cyber-physical systems in industrial operations, and will in part optimize operations with predictive/autonomous control in consideration of EHS constraints and opportunities.

EHS 4.0 is not a technology per se but rather is enabled by technology innovations. EHS 4.0 is a framework of capabilities that can help organizations go beyond traditional EHS management to transform how they manage EHS and performance improvement.

EHS 4.0 is not a solution in search of a problem. The increased complexity and rate of change in the business environment gives rise to new risks that companies must manage in the face of ever-growing stakeholder demands and resource constraints. The situation calls for a fresh approach to EHS management, and EHS 4.0 provides the means to harness today's technology to do just that.
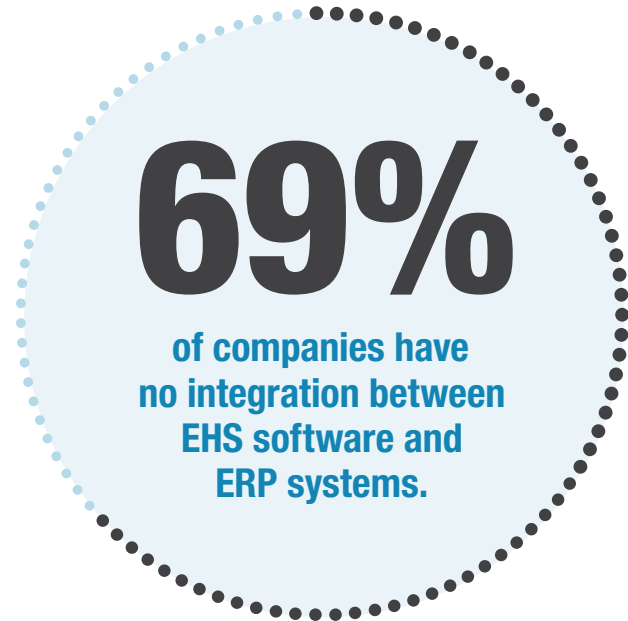
FROM INDUSTRY 1.0 TO INDUSTRY 4.0

DEGREE OF
COMPLEXITY

FIRST
Industrial Revolution

Through the introduction of mechanical production facilities with the help of water and steam power

First mechanical loom, 1784

SECOND
Industrial Revolution

Through the introduction of a division of labor and mass production with the help of electrical energy

First assembly line, Cincinnati slaughter houses, 1870

THIRD
Industrial Revolution

Through the use of electronic and IT systems that further automate production

First programmable logic controller (PLC), Modicon 084, 1969

FOURTH
Industrial Revolution

Through the use of cyber-physical systems

1800   1900   2000   Today   © DFKI, 2011

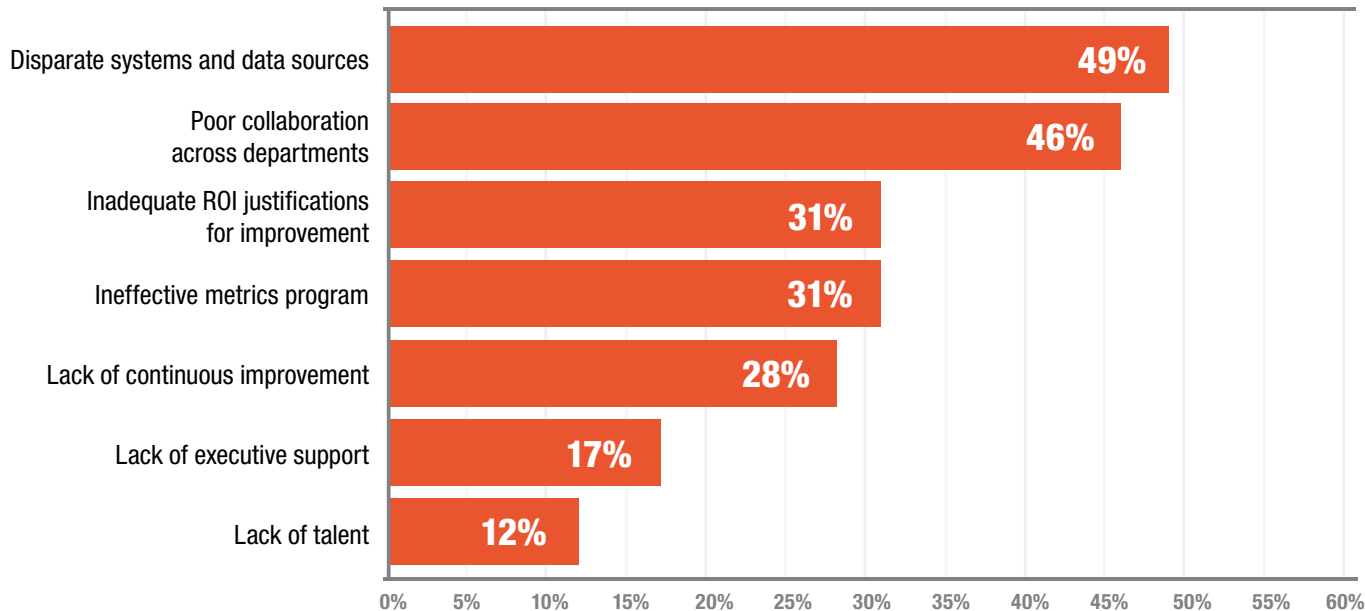# What's Blocking EHS Performance Improvement?

Our surveys of industrial organizations consistently show that the toughest challenges to EHS performance improvement are quite basic: disparate systems and data sources, and lack of cross-functional collaboration. No wonder lack of visibility as reflected by ineffective metrics programs is also near the top.

In essence, a typical organizational malady plagues EHS: silos. Silos of information, systems, and organization hinder EHS performance improvement. Although this is not unique to the EHS function, it does represent a set of thorny, inter-related issues that organizations must deal with to drive continuous improvement.

69%
of companies have
no integration between
EHS software and
ERP systems.

Top challenges to EHS Performance Improvement

Challenge	Percentage
Disparate systems and data sources	49%
Poor collaboration across departments	46%
Inadequate ROI justifications for improvement	31%
Ineffective metrics program	31%
Lack of continuous improvement	28%
Lack of executive support	17%
Lack of talent	12%

0%   5%   10%   15%   20%   25%   30%   35%   40%   45%   50%   55%   60%

Traditional EHS Management Has Limitations

The art and science of EHS management is well-developed, with great advancement in recent decades in the management systems and programs used to manage compliance and risk. Industry-wide performance as reflected in incident rates and fatalities has consistently improved. Yet many organizations get stuck in their EHS and safety journeys, hitting performance plateaus or stalling out.

The challenges to EHS performance improvement previously cited help explain the situation. As business and operating environments change rapidly and become more complex, the problem of "silos" and isolation worsens. Lack of collaboration and process integration shows up in several dimensions: across the core operations value chain, vertically from "shop floor to top floor," and across the extended supply chain.

VALUE CHAIN DISCONNECT VERSUS INTEGRATION

DESIGN   **BUY**   **BUILD**   **SELL**   **DELIVER**   **SERVICE**
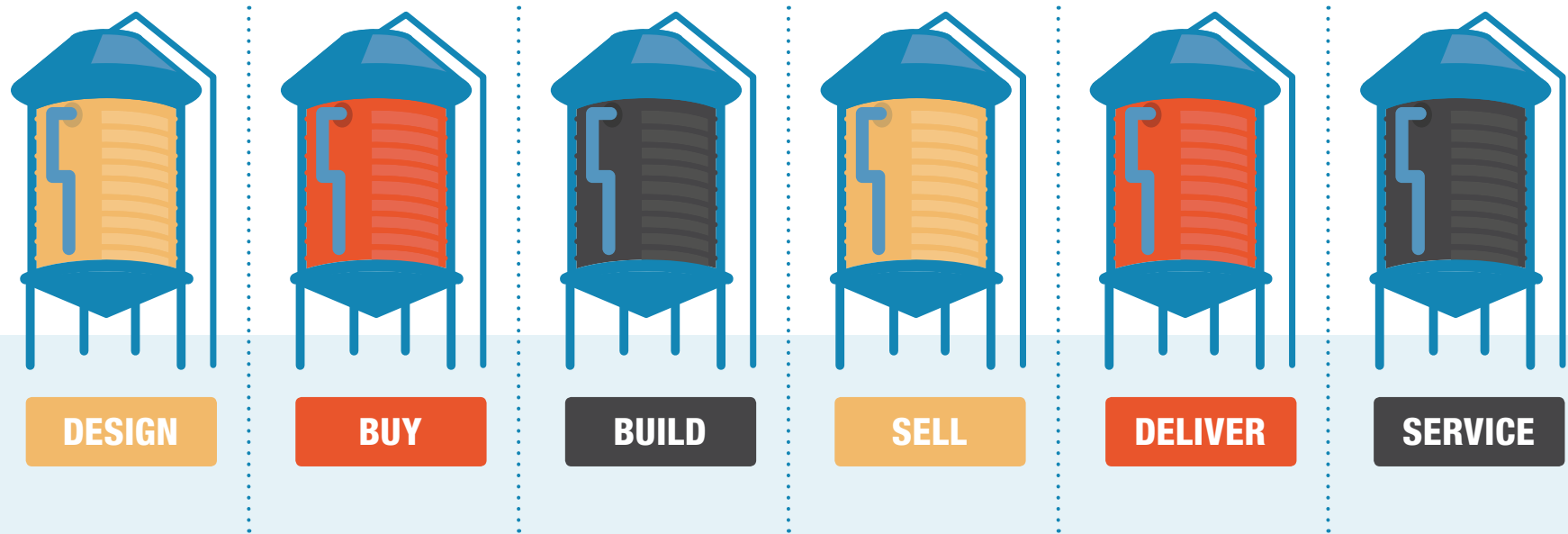
Traditional EHS Management Has Limitations *(Cont.)*

These multi-dimensional disconnects in traditional EHS management cause gaps in the execution of policies, procedures, and processes defined by the management system, which in turn result in incidents and adverse events that drag down performance. Lack of visibility of high-quality data and the actionable insights they enable limit performance improvement. EHS 4.0 provides a vehicle for improving the situation.

ONLY
19%
of companies have
real-time visibility
to EHS metrics
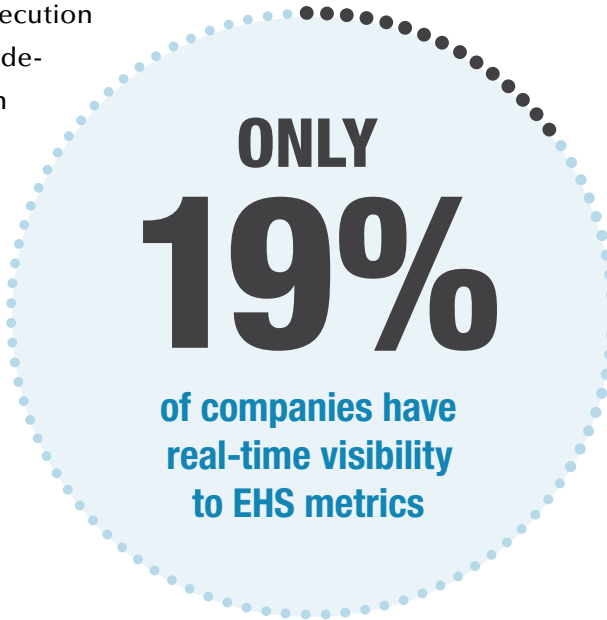
**VERTICAL DISCONNECT
VERSUS INTEGRATION**

EXECUTIVE
MANAGEMENT

OPERATIONS LEADERS

FRONTLINE WORKERS
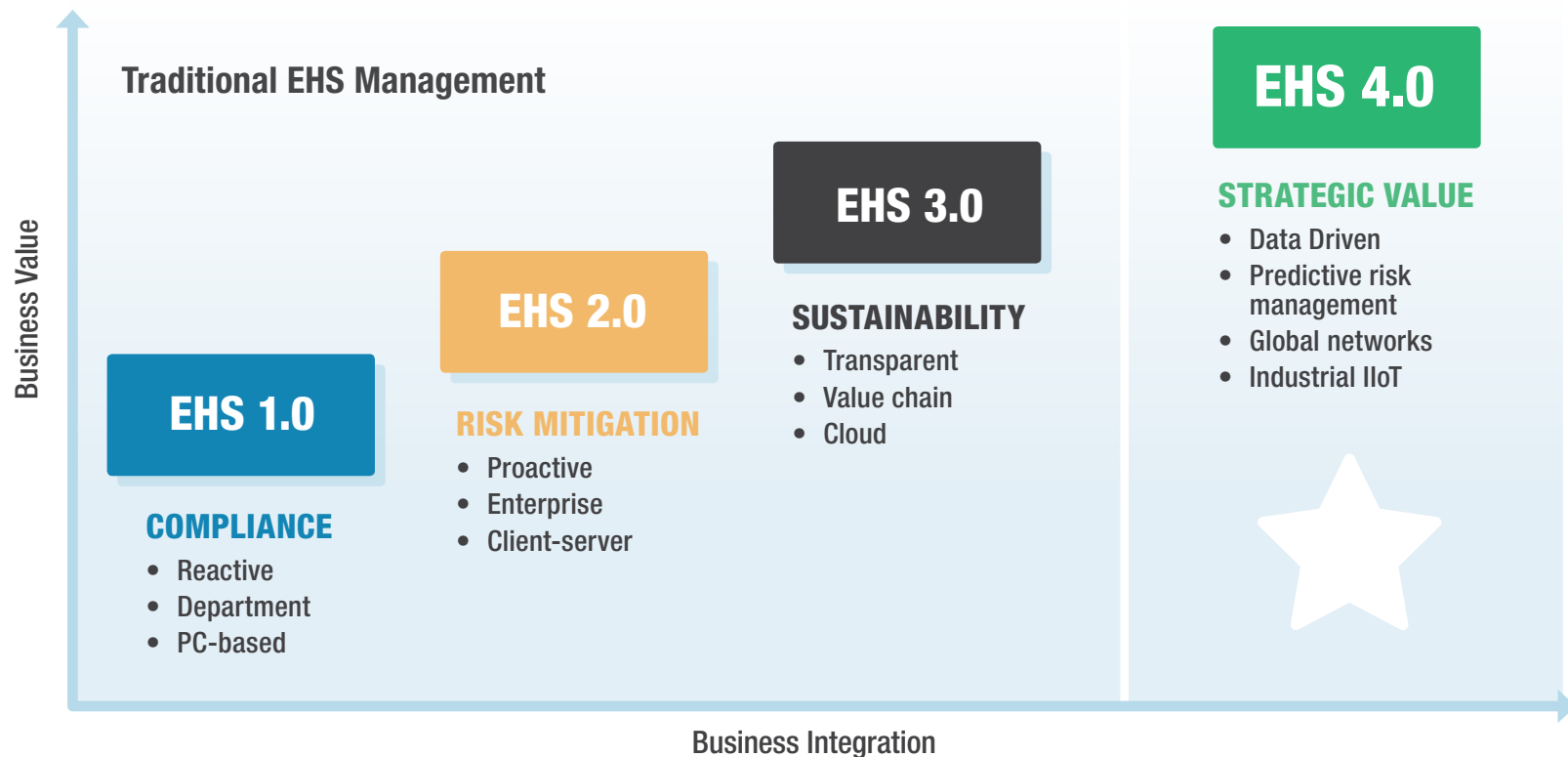
What is EHS 4.0?

An Evolution Toward Business Performance and Strategic Value

Business integration has been the holy grail of EHS management for a long time. Since EHS is among the most pervasive business functions enterprise-wide, the more it can be embedded in day-to-day operations, the better. As companies implement Operational Excellence and other improvement initiatives, there are increased expectations that this business integration will occur and that the EHS function will move from being a cost center to adding value to the enterprise.

EHS 4.0 represents the evolution of the business focus of EHS management in recent decades, from compliance, to risk mitigation, to sustainability, to strategic value. It enables advancement beyond traditional EHS management based on leveraging digital innovations to overcome the entrenched barriers to performance improvement.

Traditional EHS Management

Business Value (vertical axis)

Business Integration (horizontal axis)

EHS 1.0

COMPLIANCE
- Reactive
- Department
- PC-based

EHS 2.0

RISK MITIGATION
- Proactive
- Enterprise
- Client-server

EHS 3.0

SUSTAINABILITY
- Transparent
- Value chain
- Cloud

EHS 4.0

STRATEGIC VALUE
- Data Driven
- Predictive risk management
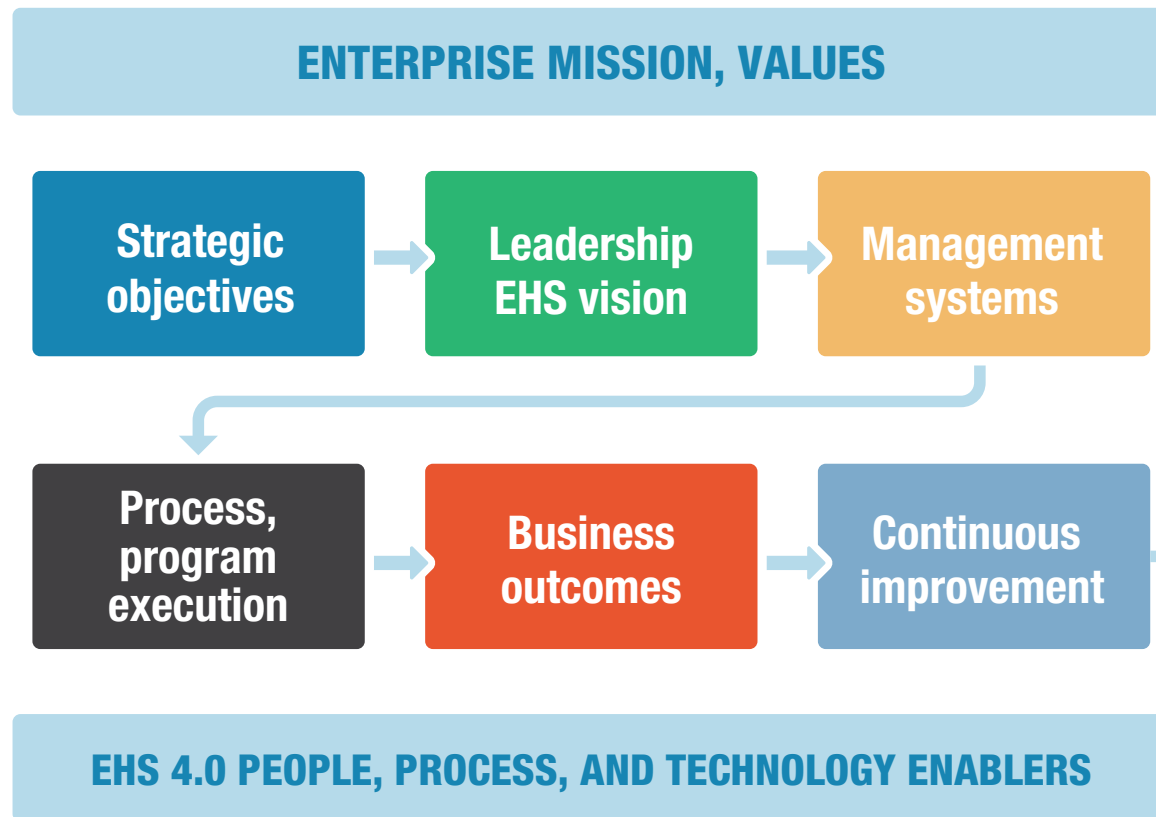- Global networks
- Industrial IIoT

First Comes Business Alignment, Then a Culture of EHS Continuous Improvement

Sustaining EHS continuous improvement and performance requires a supportive organizational culture. The key to a culture of operational and EHS excellence is business alignment, starting with the enterprise mission and core values. Top level management must establish and clearly communicate a vision for EHS management and how it will support the company's strategic objectives.

Management systems provide the framework of policies, procedures, and processes that will enable the EHS vision. Execution occurs through programs, activities, and metrics, and management review closes the continuous improvement loop.

All these elements need to work together, otherwise performance will plateau or decline, which is common even in well-managed companies. EHS 4.0 helps drive integration of EHS management into the business across people, process and technology dimensions. This alignment helps overcome the barriers to performance improvement and operationalize the desired EHS culture.

ENTERPRISE MISSION, VALUES

| Strategic objectives | → | Leadership EHS vision | → | Management systems |

| Process, program execution | → | Business outcomes | → | Continuous improvement |

EHS 4.0 PEOPLE, PROCESS, AND TECHNOLOGY ENABLERS

Digital Technologies: Necessary (But Not Sufficient) for EHS 4.0

Digitalization is the basis for EHS 4.0. It is not only advancing the frontiers of traditional EHS management to enable step-change improvement in existing processes and practices. Digital innovations also enable new entirely new questions to be answered, and problems to be addressed in new ways.

But EHS 4.0 is not just about technology. It's about how new technology can improve EHS and business performance. Digital technologies are merely tools that a company can apply in the context of the overall EHS continuous improvement process. No amount of whiz-bang technology will work in isolation to paper over a defective EHS management system or organizational culture.

Technologies such as Cloud computing and mobile apps working with an IIoT platform can be a game-changer, with a connected, engaged workforce and insights gained from a data-driven approach to EHS management.

INDUSTRIAL INTERNET OF THINGS PLATFORM by LNS Research describes the connectivity, network styles, analytics, and applications frameworks to support smart connected operations and smart connected assets; within and across a plant, facility or production network in a manufacturing or other industrial operations setting.
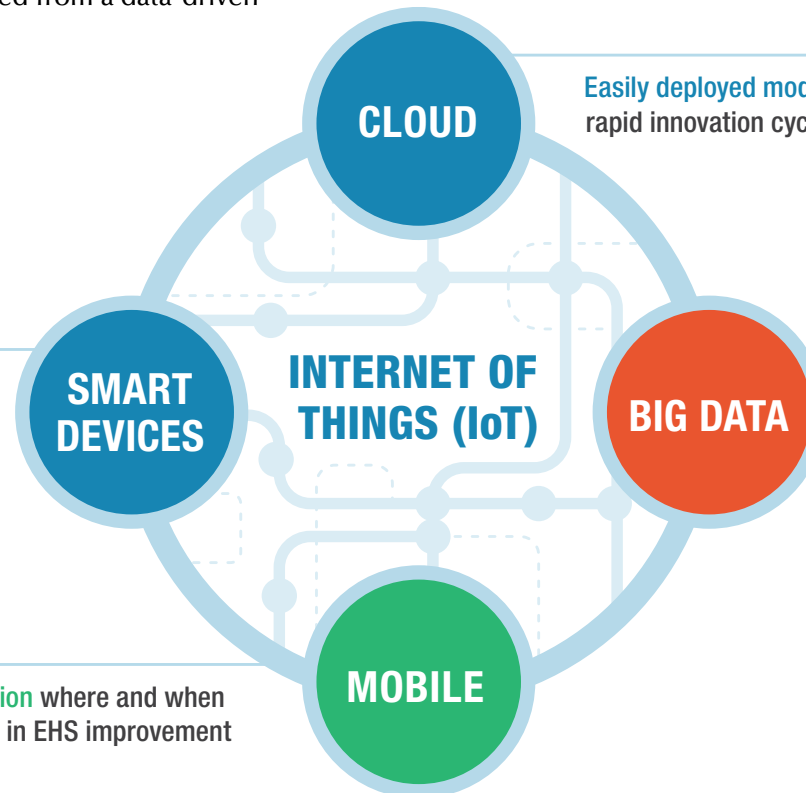
Click to learn more about the
Industrial Internet of Things Platform

EHS PERFORMANCE IMPROVEMENT

CLOUD

Easily deployed modular EHS applications with rapid innovation cycles and powerful analytics

INTERNET OF THINGS (IoT)

SMART DEVICES

Smart connected devices to learn from and respond to worker and workplace conditions in real time

BIG DATA

Collect and analyze large volumes of operational and EHS data to predictively reduce risk

MOBILE

Capture and deliver information where and when needed to engage employees in EHS improvement

Dimensions of EHS 4.0

EHS 4.0 certainly includes the digitalization of EHS management. More important is the impact of that digitalization on EHS technology, processes and people, and ultimately performance.
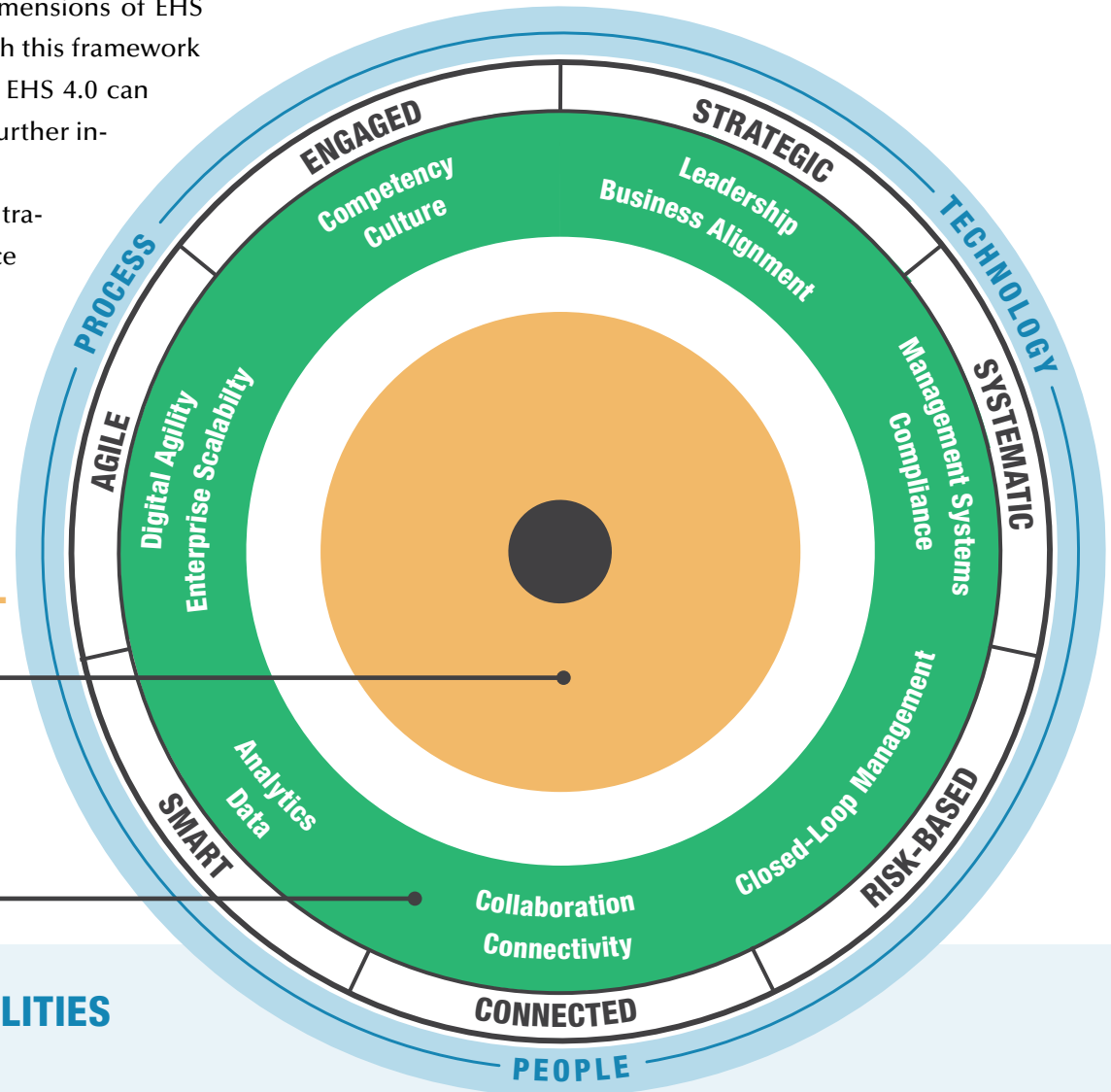
LNS Research has identified seven essential dimensions of EHS 4.0 which can be used to inform, plan, and act. With this framework and research, EHS business leaders pinpoint how EHS 4.0 can transform existing capabilities and initiatives, and further integrate EHS into business strategy and operations.

The framework also provides a perspective on traditional EHS management. EHS 4.0 doesn't replace traditional EHS approaches and methods, but rather builds and improves on them. Industrial and commercial organizations can benefit by using the framework to interpret their current state and identify what changes are needed to move to the desired future state.

As we explore the seven dimensions of EHS 4.0, we will focus on how digitalization enabled by technology innovations impact EHS processes, people, and performance.

EHS 4.0 DIMENSIONS AND CAPABILITIES

TRADITIONAL EHS

EHS 4.0

ENGAGED
STRATEGIC
TECHNOLOGY
SYSTEMATIC
RISK-BASED
CONNECTED
PEOPLE
SMART
AGILE
PROCESS

Competency
Culture

Leadership
Business Alignment

Management Systems
Compliance

Closed-Loop Management

Collaboration
Connectivity

Analytics
Data

Digital Agility
Enterprise Scalability

Understanding the Dimensions of EHS 4.0

Strategic

Like it or not, EHS management is not a core value chain function. That distinction is left to those areas of the business that directly produce value for customers, such as R&D, manufacturing, and supply chain. The job of business functions like EHS, quality, and human resources is to support the enterprise in meeting strategic objectives.

With a historical emphasis on compliance and cost-reduction, enterprise executives and EHS leaders themselves challenge the EHS business function to shed the cost-center label so that the organization can view it as a source of strategic value. EHS leaders have made real progress in recent years by shifting the business focus of EHS management from reactive compliance to proactive risk management.

Much remains to be done to elevate EHS management and improve awareness of it as a source of strategic value, but the potential benefits of doing so are significant. Those companies that are innovation leaders are much more likely to view EHS as strategic than less mature organizations. They consider EHS to be a top corporate priority and align EHS objectives with Operational Excellence initiatives.
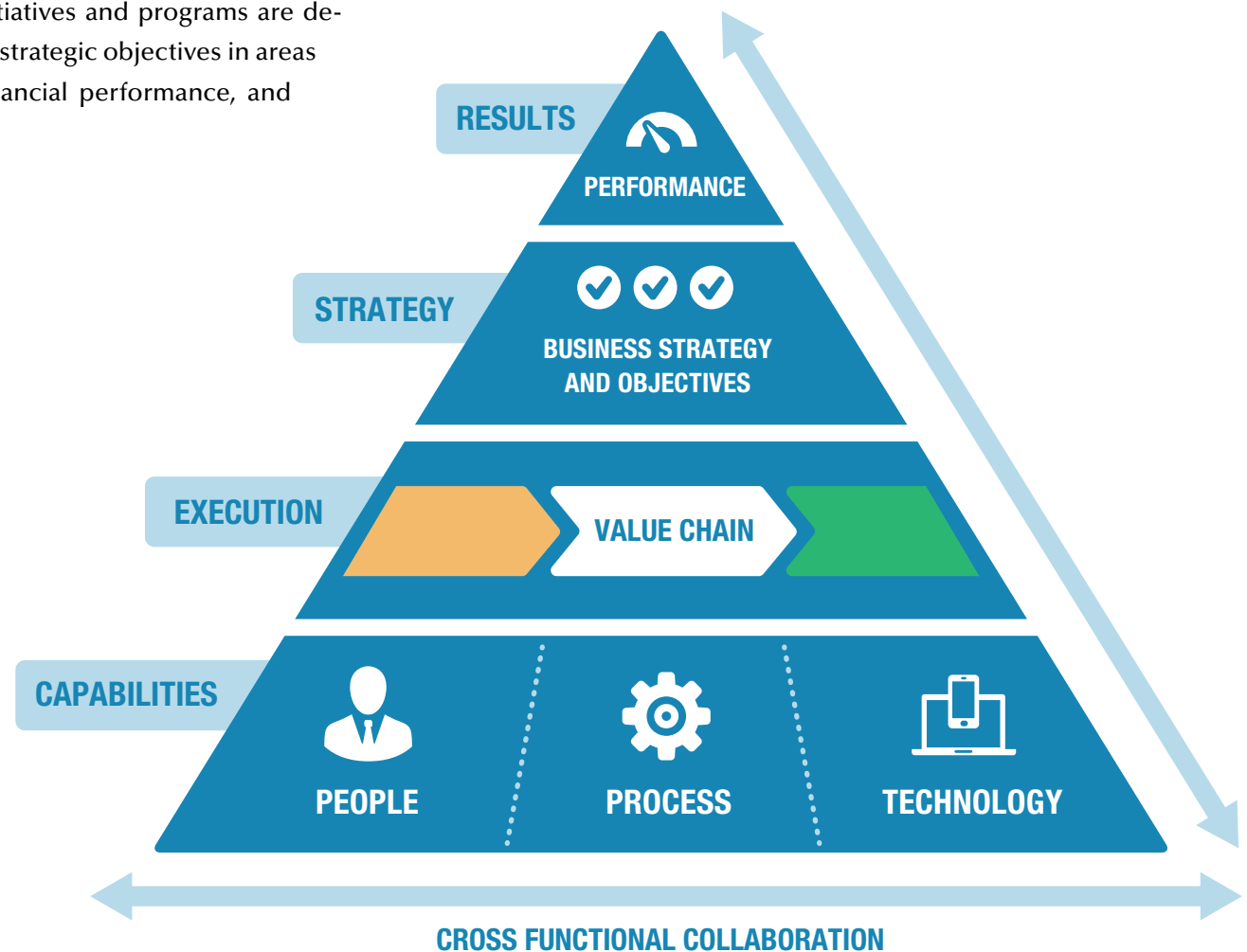
BEST PRACTICE	ADOPTION BY INNOVATION LEADERS	ADOPTION BY ALL COMPANIES
EHS is a top corporate priority	78%	30%
EHS objectives are aligned with Operational Excellence initiatives	93%	32%

Strategic *(Cont.)*

In order for EHS management to add strategic value, it must involve executive leadership for sponsorship of initiatives and investments. EHS 4.0 brings the opportunity to further elevate the value of EHS management to a strategic level based on these elements:

- **Leadership** – a clear vision for EHS management is established by top level executives, with rigorous communication and visible demonstration

- **Business alignment** – EHS initiatives and programs are designed to support enterprise strategic objectives in areas such as market position, financial performance, and operational excellence

EHS 4.0 is data-driven, providing the ability to capture and analyze much larger amounts and varieties of EHS and operational data. This helps EHS leaders better understand EHS performance, and its impact on the business, in a more accurate and timely manner. For example, a fact-based discussion about the impact of a behavioral safety program on asset downtime is likely to get more attention from the COO than a discussion about incident rates.
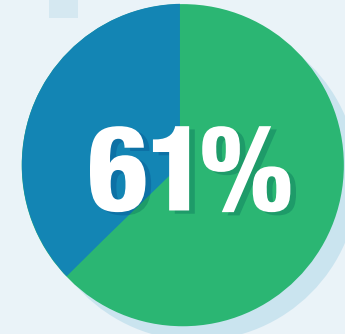

RESULTS

PERFORMANCE

STRATEGY

BUSINESS STRATEGY
AND OBJECTIVES

EXECUTION

VALUE CHAIN

CAPABILITIES

PEOPLE   PROCESS   TECHNOLOGY

CROSS FUNCTIONAL COLLABORATION

Strategic *(Cont.)*

Executive sponsorship requires sound business justification. Even in organizations that hold safety and EHS performance as core values, there will be competition for executive attention and resources. EHS 4.0 enables greater visibility to EHS performance and provides relevant information and fact-based insights to help establish business value.
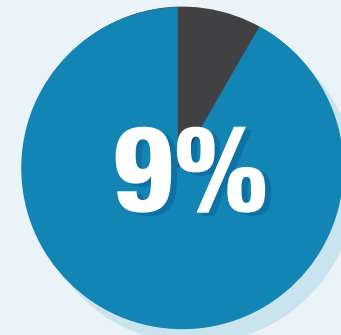
EHS 4.0 also helps senior executives become more engaged in safety and environmental performance day in and day out. Real-time dashboards showing safety performance enterprise-wide with the ability to drill down to the plant level command more attention than a monthly report. It also gives executives more frequent opportunities to learn, communicate, and act on EHS matters. The net effect is that business leaders rely more on facts and business results, and less on platitudes in promoting their EHS vision for the organization.

EHS4.0

TRADITIONAL EHS

CONNECTED

EXECUTIVE

Objective Alignment

Executive Ownership

EHS KPI

CROSS-FUNCTIONAL

DEPARTMENTAL

EHS OBJECTIVES ALIGN WITH OPERATIONAL EXCELLENCE INITIATIVES

61%

EHS IS
a top corporate priority

9%

EHS IS NOT
a top corporate priority

Systematic

Management systems based on consensus standards have long been put to good use in managing EHS performance. ISO 14001 (environmental management) and OHSAS 18001 (occupational health and safety management) are widely deployed in companies worldwide as frameworks to drive continuous improvement. Although implementing a management system is straightforward, ongoing execution is not.

The challenges of effective implementation are evident by numerous incidents that harm people, production, and the environment. Another symptom is the inability to consistently meet compliance obligations, exposing companies to regulatory sanctions, impairing relationships with business partners, and damaging the corporate reputation.

As noted before, the number one challenge to EHS performance improvement is disparate systems and data sources. Only 33% of industrial companies report having implemented dedicated EHS software, which is an indication of a lack of process standardization and automation. Without adequate information technology support to operationalize the management system, continuous improvement stalls.

COMPANIES LACK EHS SOFTWARE
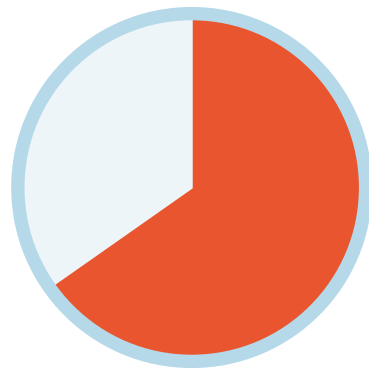
67%
NOT IMPLEMENTED

33%
IMPLEMENTED

49%
of companies cite FRAGMENTED DATA SOURCES AND SYSTEMS as a top challenge in achieving EHS objectives.

Systematic *(Cont.)*

EHS 4.0 enables these key elements for systematic performance improvement and execution:

- **Management systems –** realizing management systems in daily business operations with consistent execution, learning, and continuous improvement

- **Compliance –** ability to capture, track and meet compliance obligations from all sources including legal, customer, business partner, and other stakeholder requirements

With EHS 4.0, we enter a new era of executing management systems based on process standardization and harmonization, and advanced analytics. Cloud-based software platforms for EHS management provide the foundation for enterprise-grade data management, workflow, reporting and analytics.

The benefits go far beyond efficiency gains. Greater visibility and a wider span of control enhance organizational learning. The improved ability to share and deploy lessons learned across the enterprise enables a more proactive, preventive risk management posture.

Compliance assurance is table stakes for maintaining a license to operate. This requirement applies whether compliance obligations are legal requirements, internal standards, or imposed by stakeholders. With EHS 4.0, organizations can better manage the increasingly complex compliance burden. For example, Cloud-based automated regulatory content updates and applicability determinations reduce effort and improve compliance. Smart connected devices can alert to compliance deviations such as permit exceedances, and Big Data analytics can help pinpoint root causes and suggest preventive actions.
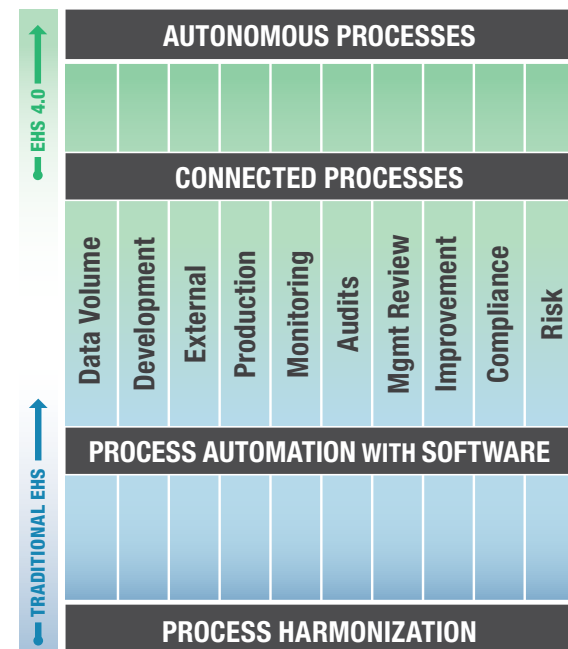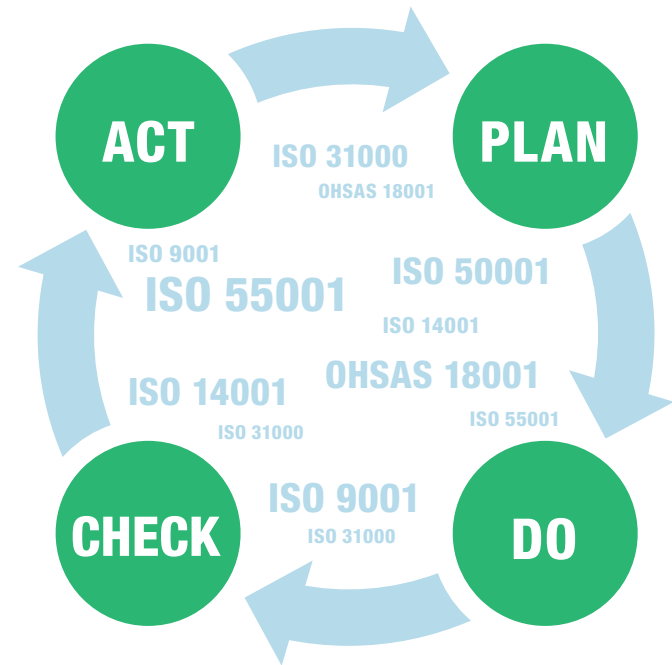
Risk-Based

The notion of a risk-based approach to safety and EHS management isn't new. What's changed is the scope and nature of the EHS risk management process, and how it relates to overall enterprise risk management, sustainable operations, and profitable growth. This calls for a robust risk process appropriate for each organization's risk profile.

For a single-site manufacturer, a simple paper-based job safety analysis process may be adequate. On the other hand, a large global organization operating in a high-risk industry likely needs a robust risk management process, backed by rigorous quantitative risk assessment methods. Regardless of the specific risk assessment methodologies used, companies need a well-defined closed-loop risk management process in line with the ISO 31000 risk management standard.

But there is a gap between the business requirements for effective risk management and reality in the field. Despite increased awareness of operational risk and the consequences of under-managing it, most organizations still don't have a formal risk management framework in place, let alone visibility to risks across global operations and extended supply chains. Innovation leaders are much more likely to have systematic risk management process in place.

ONLY
5%
of companies have
companies have a mature
Operational Risk
Management program

BEST PRACTICE	ADOPTION BY INNOVATION LEADERS	ADOPTION BY ALL COMPANIES
Identify risk factors across operations	93%	45%
Prioritize risk factors across operations	85%	35%
Quantify risk factors across operations	80%	33%
Track mitigation of risk factors across operations	88%	27%
Visualize risk factors across operations	70%	26%

Risk-Based *(Cont.)*

EHS 4.0 helps organizations effectively implement a risk-based approach to managing safety and environmental business risks with these capabilities:

- **Closed-loop risk management –** a proactive and systematic process to identify hazards, for risk analysis, implementing control measures, and monitoring effectiveness

Risks in industrial operations surface from three main sources: events, such as incidents; changes to processes, equipment, organization, and other operational parameters; and proactive performance management activities such as inspections and audits.

New technologies help organizations better identify and manage these risks in dynamic and complex operating environments. For example, mobile applications help engage more employees in real-time hazard identification, inspections including control effectiveness, and task management at the work interface.

The powerful combination of IIoT data and analytics enables new levels of risk management effectiveness. Automated data collection from sensor-equipped smart assets coupled with advanced analytics can help identify

patterns and trends that lead to adverse events. This is useful for preventive actions, to monitor the effectiveness of controls in real-time, and even initiate autonomous corrective actions. Machine learning and artificial intelligence can mine data for key learnings to apply enterprise-wide to mitigate risk and prevent adverse events.

CLOSED-LOOP RISK MANAGEMENT PROCESS
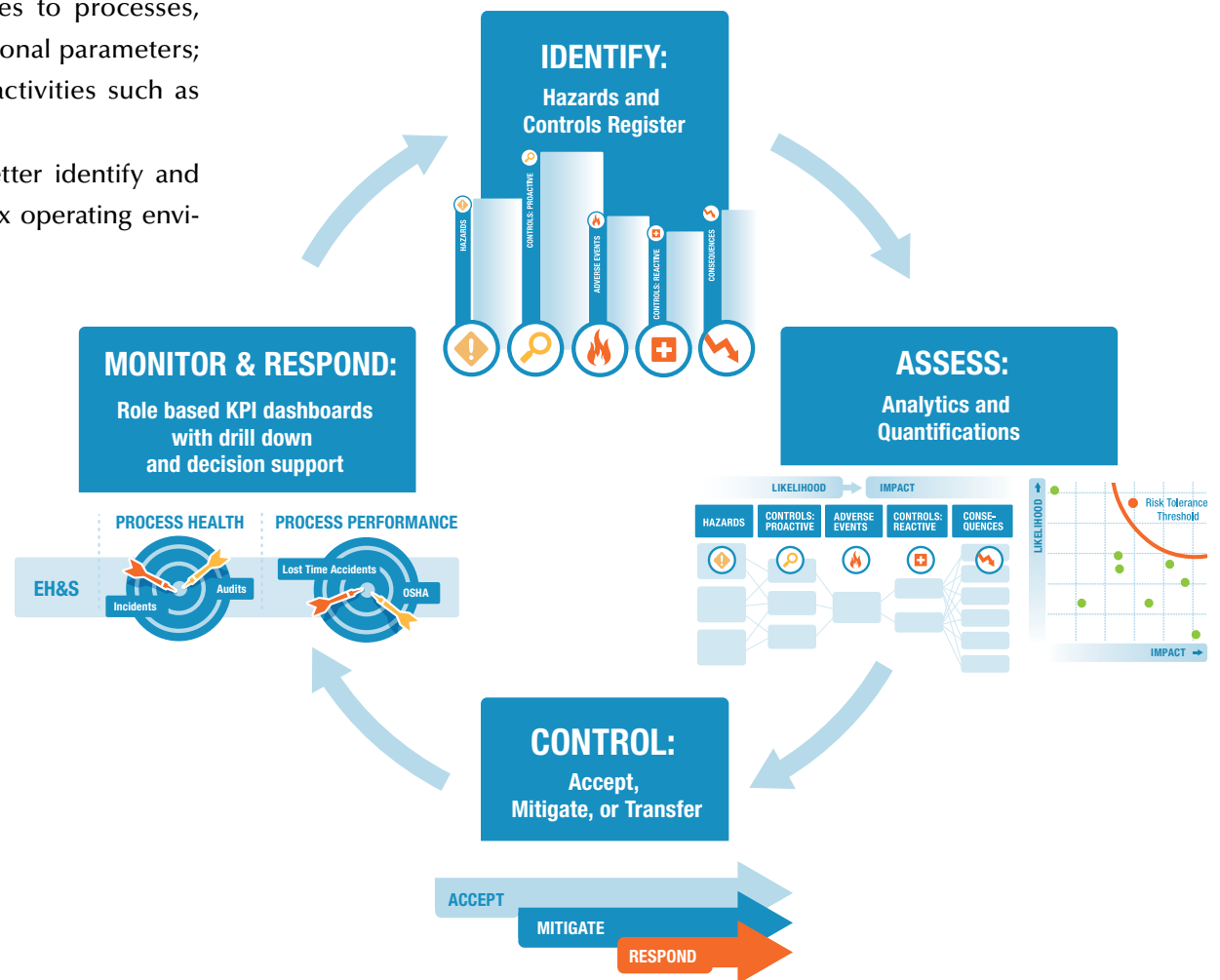
Connected

EHS requirements and activities occur in and impact business operations across the entire value chain. Perhaps no business function has as many touchpoints with other business activities as EHS. Given the pervasiveness of EHS, it's no wonder that achieving effective business and functional integration has been a long sought-after goal of EHS and operations business leaders looking to reduce cost and risk.

Although industrial companies have made much progress, there's still a long way to go. Operational Excellence initiatives such as Lean and Six Sigma have provided a means to integrate EHS further into daily operations. Still, our research data consistently shows that a lack of cross-functional collaboration is one of the main barriers to EHS performance improvement, cited by 46% of respondents.

The lack of business integration manifests itself in disconnected processes, missed handoffs between functions, and lack of visibility to information needed for decision-making. The disconnects occur in two dimensions:

Horizontal silos – Silos of information, processes, and organization exist across the value chain. This disconnect causes a lack of collaboration and disconnects between various groups and departments such as EHS, quality, operations, asset management, human resources, supply chain and so forth. EHS performance is sub-optimized.

Vertical barriers – Key EHS representatives and stakeholders fall into a hierarchy of three categories, each with different EHS information needs: frontline workers and safety engineers, operations and EHS leaders, and executive management. Information must flow smoothly from "shop floor to top floor" to meet each stakeholder's and representative's requirements, yet barriers exist that prevent this exchange.

Information
MUST FLOW SMOOTHLY from

SHOP FLOOR TO TOP FLOOR

to meet each stakeholder's requirements, yet barriers exist that prevent this exchange.

46% OF COMPANIES

say LACK OF CROSS FUNCTIONAL COLLABORATION is a top challenge to EHS performance improvement.
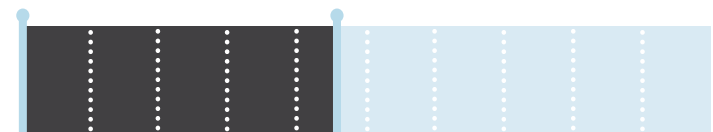
Connected *(Cont.)*

The two key elements of EHS 4.0 that help break down silos and open new frontiers of process integration and information flow are:
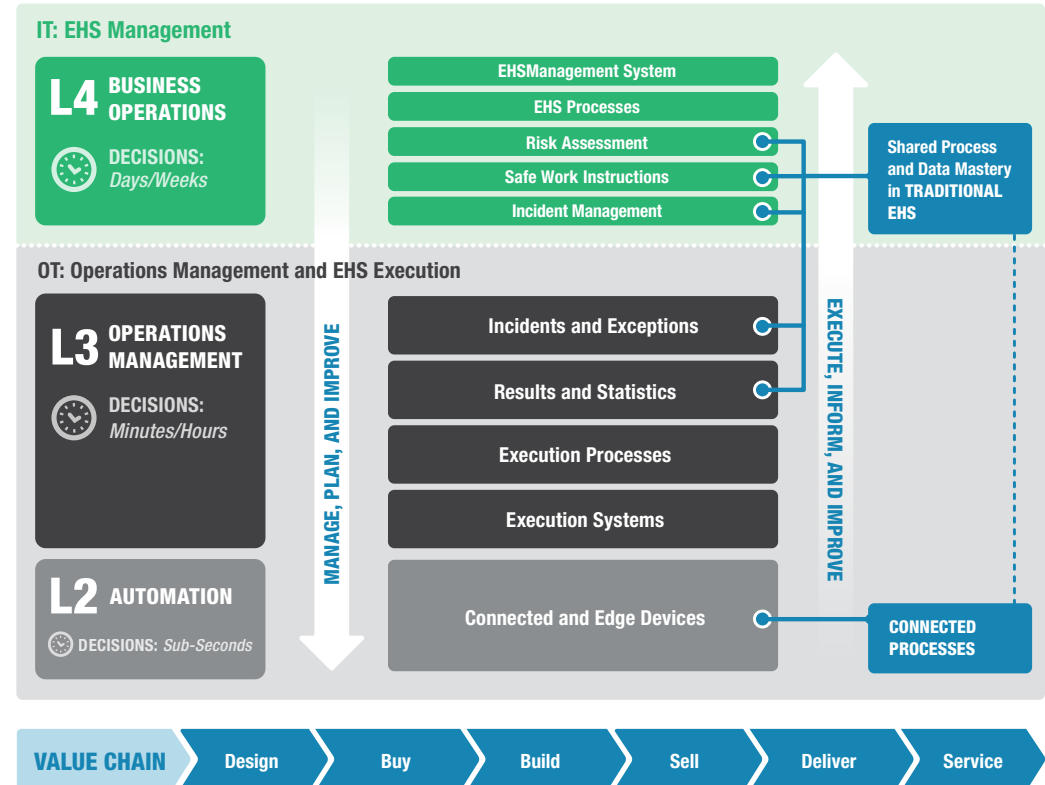
- **Collaboration** – business and functional integration of EHS into daily operations, enabling cross-functional collaboration, end-to-end process integration, and information flow across the value chain
- **Connectivity** – unrestricted, bi-directional flow of decision-support information between and among people and equipment on the plant floor, operations leaders, and the executive suite

Connectivity enhances communication, which in turn enhances collaboration. EHS 4.0 is a basis to establish a common language to improve the accuracy of operational risk management based on actual safety performance.

Digital innovations of EHS 4.0 have a major impact on how organizations can more effectively connect and integrate EHS management into the fabric of the business. The low hanging fruit for improving collaboration is cloud-based enterprise EHS management software. With "one source of truth" for EHS information supported by automated workflows, the EHS function is better equipped to interact with and add value to other areas of the business such as research and development (R&D), procurement, operations, maintenance, supply chain, quality, etc. Modern EHS software also offers more options for integrating with other enterprise business systems, such as human resources, asset management, and supply chain.

Removing the barriers to vertical information flow is greatly facilitated by the IIoT and the trend of information technology/operational technology (IT/OT) convergence. Sensor-equipped smart assets and devices on the plant floor generate large volumes of operational data at the machine and process level. Traditionally, this data was locked up in process control systems. Now IIoT platforms make the data available for sophisticated analysis along with EHS data. The availability of data and advanced analytics provides a

IT/OT CONVERGENCE EXPLAINED WITH ISA-95

IT: EHS Management

L4 BUSINESS OPERATIONS

🕐 DECISIONS: *Days/Weeks*

| EHSManagement System |
| EHS Processes |
| Risk Assessment |
| Safe Work Instructions |
| Incident Management |

Shared Process and Data Mastery in TRADITIONAL EHS

OT: Operations Management and EHS Execution

L3 OPERATIONS MANAGEMENT

🕐 DECISIONS: *Minutes/Hours*

- Incidents and Exceptions
- Results and Statistics
- Execution Processes
- Execution Systems

MANAGE, PLAN, AND IMPROVE

EXECUTE, INFORM, AND IMPROVE

L2 AUTOMATION

🕐 DECISIONS: *Sub-Seconds*

- Connected and Edge Devices

CONNECTED PROCESSES

VALUE CHAIN | Design | Buy | Build | Sell | Deliver | Service
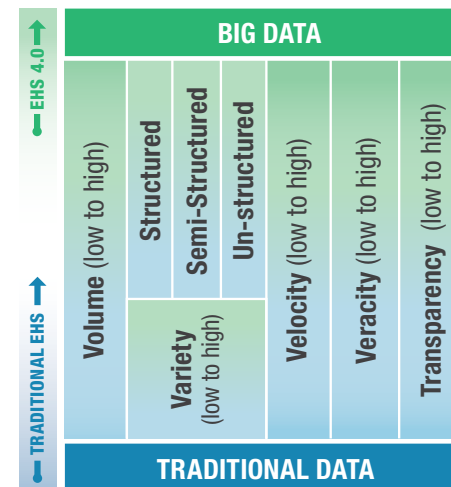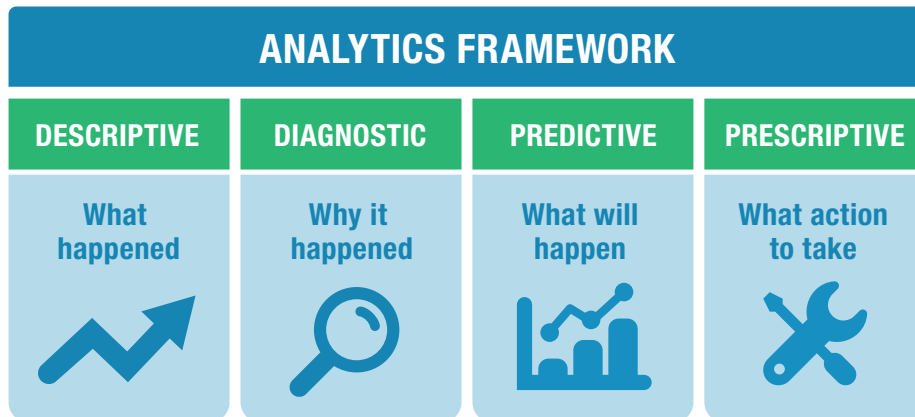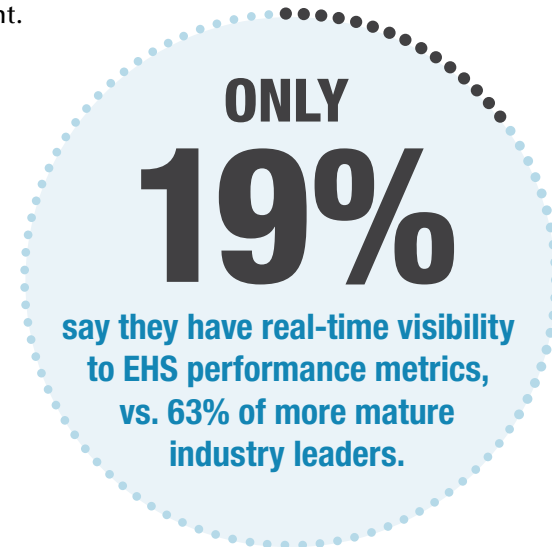
Smart

much clearer picture of EHS performance in the context of operational performance, improving visibility and control of compliance and risk management at all levels.

EHS management has a long history of being data intensive, involving collection of lots of data (e.g., from emissions and exposure monitoring), calculations, and reporting. Key EHS activities such as incident management, inspections and audits, action management, and permit and task management all generate and use data for reporting and decision support.

Traditionally, EHS data management has focused on collecting and using transactional data to fulfill compliance and reporting requirements. The real value of data comes from analytics that expose the insights contained therein. However, the EHS function has barely scratched the surface of tapping into the full potential of data-driven decision-making as evidenced by the fact that only 19% of all companies say they have real-time visibility to EHS performance metrics, versus 63% of more mature industry leaders.

Early analytics capabilities have evolved from descriptive (what happened) to diagnostic (why it happened). The analysis of safety incident data to identify and analyze causal factors is an example of

these basic analytics methods that tend to look backward at what went wrong. Although useful, these methods by nature tend to be reactive. On the other hand, predictive and prescriptive analytics help staff anticipate what will happen next, and determine what actions they should take accordingly. Advanced analytics in combination with Big Data from the IIoT hold great promise for proactive EHS risk management.

ONLY
19%
say they have real-time visibility to EHS performance metrics, vs. 63% of more mature industry leaders.

ANALYTICS FRAMEWORK

DESCRIPTIVE	DIAGNOSTIC	PREDICTIVE	PRESCRIPTIVE
What happened	Why it happened	What will happen	What action to take

BIG DATA

EHS 4.0

Volume (low to high) | Structured | Semi-Structured | Un-structured | Velocity (low to high) | Veracity (low to high) | Transparency (low to high)

Variety (low to high)

TRADITIONAL EHS

TRADITIONAL DATA

Smart *(Cont.)*

Smart EHS management depends on the availability of a sufficient volume of the right data, and the application of advanced analytics technology to extract insights. The key EHS 4.0 elements to achieve this are:

- **Data** – capturing and maintaining data and Big Data with sufficient variety, velocity, volume, and accuracy to enable data-driven decision-making

- **Analytics** – using analytics tools to convert data into actionable insights, including predictive and prescriptive analytics

Predictive analytics is the use of advanced analytics technologies to develop, refine, and apply algorithms to find patterns and trends that can help predict future events. Predictive analytics is an essential tool to shift from analyzing what went wrong in the past to predictive risk management to prevent injuries, accidents and other adverse events.

Gaining actionable insights from predictive analytics requires a substantial amount of historical data. The data could be traditional transactional data from business IT systems such as safety and incident information, employee human resources data (work history, tenure, etc.), maintenance activities, training records, production data and much more. Most companies have an abundance of this sort of traditional business data to support predictive analytics efforts. Data sources could also include high volume Big Data captured by sensors such as operating conditions, emissions rates, and lighting, or weather conditions captured on an IIoT platform.

By identifying previously unknown correlations between various factors, predictive analytics can be used to identify leading indicators to manage EHS more proactively. Machine Learning takes predictive analytics even further by automating analysis with artificial intelligence to refine the predictive model and generate prescribed responses, perhaps even autonomous actions.

MACHINE LEARNING
ANALYTICS

+

BIG DATA

=
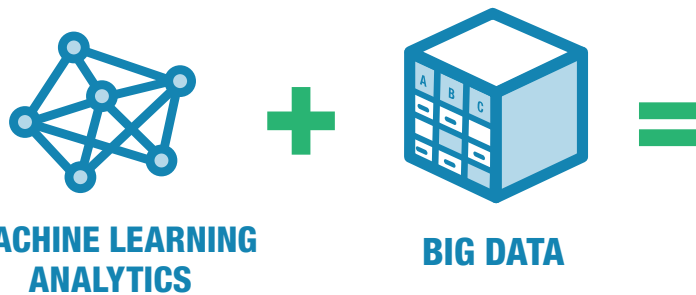
NEW
ANSWERS
to
NEW QUESTIONS

EXAMPLE: Discover previously unknown relationships between certain employee demographics, operating conditions, and environmental factors, and identify leading indicators.

MACHINE LEARNING
ANALYTICS

+

DATA

=

OLD
ANSWERS
to
NEW QUESTIONS

EXAMPLE: Predict incidents based on analysis of machine sensor data on the use of safety systems.
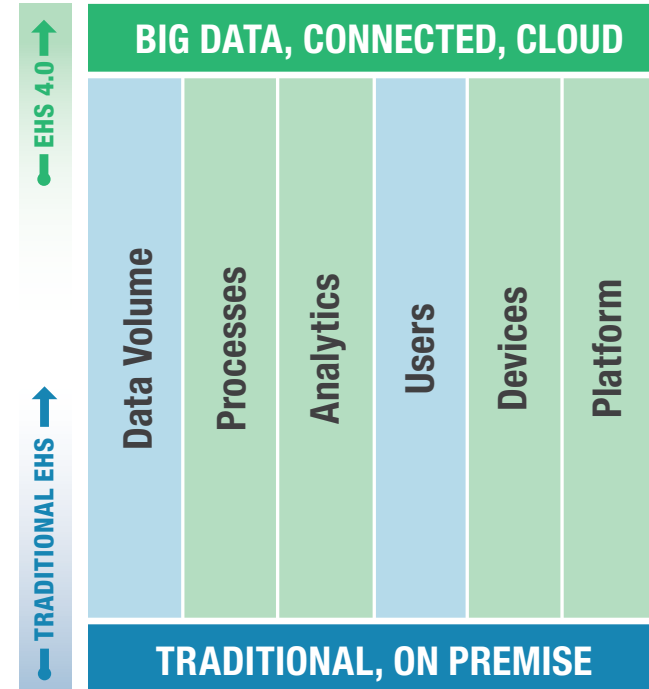
Agile

Business agility helps organizations manage the risk associated with the primary by-product of Industry 4.0: relentless change. The EHS business function is heavily impacted by change in the form of dynamic compliance obligations, increased stakeholder demands, and change-induced risk exposure.

Adapting to changes in the internal and external business environment is difficult. The first hurdle is to be proactive in identifying changes and assessing the potential risks before implementing change. Some changes are obvious and major, such as a merger of companies, which has major implications for the combined risk profiles and EHS cultures of the two organizations. Such situations require a strategic risk and change management approach. At the other end of the spectrum, a myriad of significant changes occurs in the course of daily business and operations.

Adapting to change requires seeing it coming, and getting on top of things before new risks arise. But the processes and systems in place to identify and manage change and the resulting risk are woefully inadequate in many organizations.

Agile EHS management is characterized by the ability to successfully adapt to internal and external change. Key EHS 4.0 elements needed for agility are:

- **Enterprise scalability** – the ability to provide the right information and functionality at the right time, with flexible support of data volume, users, devices, and analytics enterprise-wide

- **Digital agility** – create new applications and deploy them in different ways; mash-up apps, Cloud computing, configurability, fast innovation and much more

Agile *(Cont.)*

Without global scalability, EHS management is much less effective due to limited ability to harmonize processes, best practices, competencies, and lessons learned corporate-wide. In EHS 4.0, Cloud computing is an important contributor to scalability. Organizations can acquire software-as-a-service (SaaS), easily adding capabilities and users, data, analytics, and devices without the need to acquire, install, and manage the software on premise. This flexibility to scale up and down with organizational changes and quickly innovate is key to business agility.

Digital agility enables organizations to adapt more easily to change by leveraging technology innovations for application development. Apps are the mechanisms through which companies execute processes, collect and expose data, visualize analytics, and enable collaboration. Traditional EHS apps from software vendors are commonly web-based. EHS 4.0 leverages digital innovations to enhance traditional apps in several ways:

- **Mobility** – many commercial EHS software apps have been optimized for mobile devices, providing greater accessibility, participation, adoption, and efficiency; companies can develop their own mobile apps
- **Configurability** – the new generation of Cloud-based EHS software platforms offer flexibility to tailor out-of-the box applications to improve user experience, extend data models, and easily build new applications that are stable through new release cycles
- **Mash-ups** – mash-up apps integrate complementary content from two or more sources; EHS 4.0 accelerates insight from applications and data across the value chain, e.g., Big Data from sensor-equipped assets, external weather information, and maintenance history data to predict risk
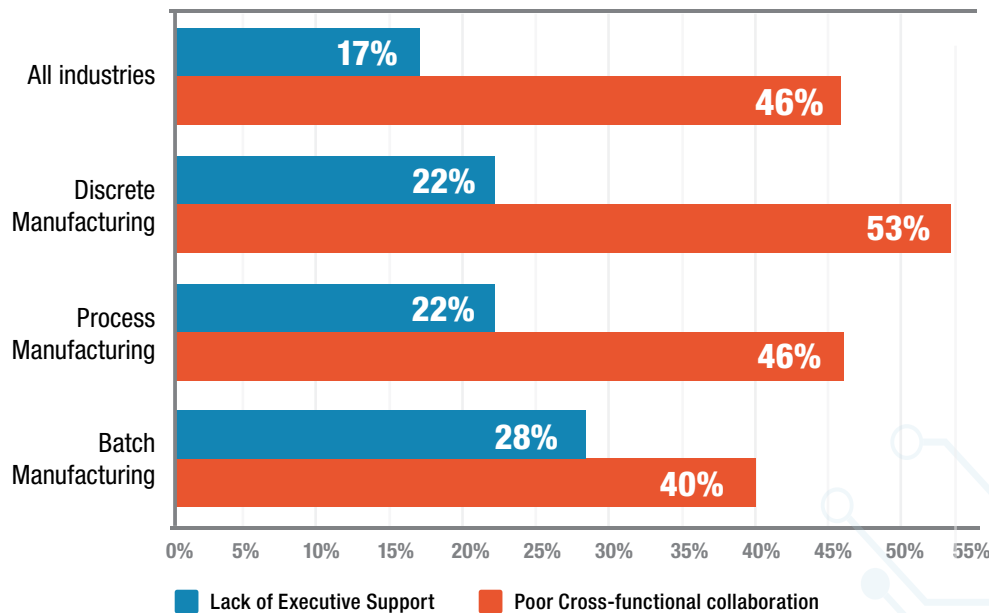

MASHUP
APPLICATION
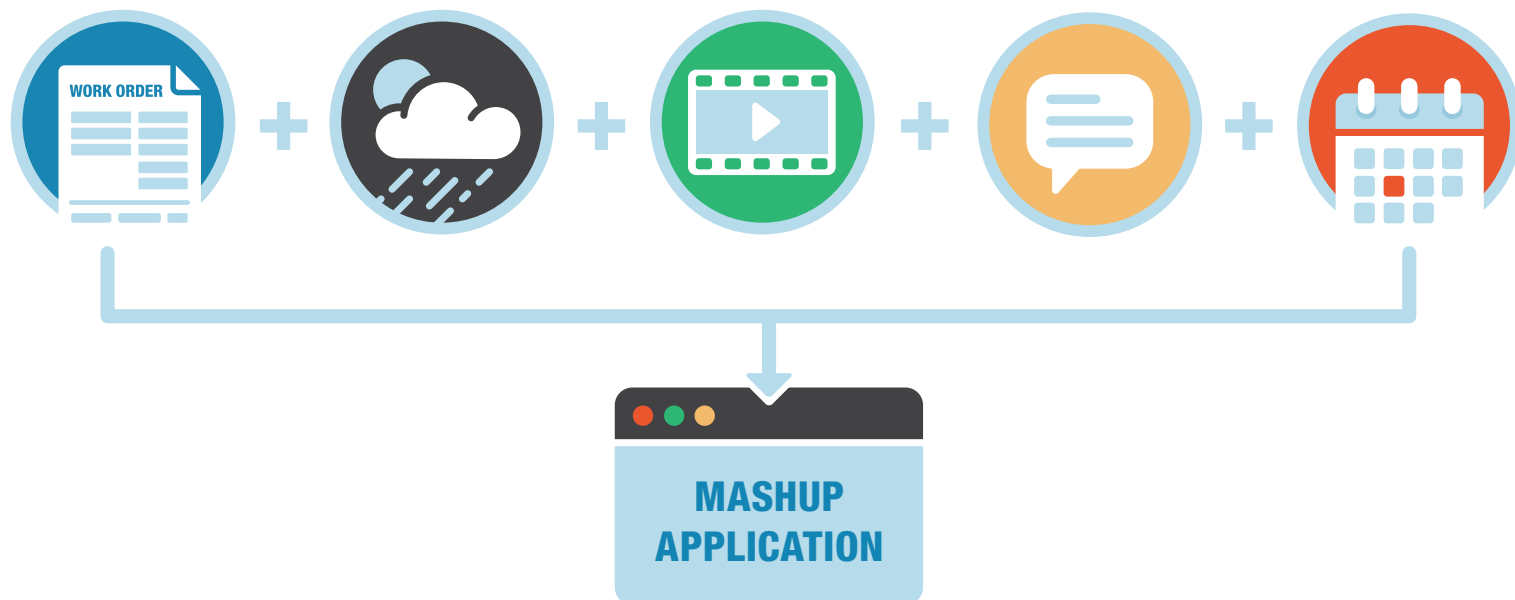
Engaged

Organizational success is based on having the right combination of capabilities in place and aligned to achieve the strategic objectives of the enterprise, with the necessary resources allocated to execute. Necessary capabilities span people and organization, management systems and processes, and technology enablers.

Effective strategic alignment and execution manifest themselves through organizational culture. Organizational culture reflects the shared assumptions and beliefs that guide day-to-day decision-making and behavior in the workplace, and ultimately determine business performance. This notion of culture applies directly to operational and EHS performance.

Organizational characteristics such as effective executive leadership, teamwork, and employee engagement set an enterprise up for success. But in many organizations, these are in short supply and continue to hold back EHS and operational performance improvement.

Key Challenges to EHS Performance Improvement

Horizontal bar chart. Legend: Lack of Executive Support (blue), Poor Cross-functional collaboration (orange).

- All industries: 17%, 46%
- Discrete Manufacturing: 22%, 53%
- Process Manufacturing: 22%, 46%
- Batch Manufacturing: 28%, 40%

Engaged *(Cont.)*

Engaged EHS management is based on a motivated workforce collaborating to achieve the organization's vision and goals for EHS and operational performance. Requisite EHS 4.0 capabilities are:

- **Competency –** cross-workforce management of individuals' ability to complete tasks effectively, and scaling specialized knowledge to meet organizational goals

- **Culture –** instilling and sustaining an organizational culture that effectively implements the executive EHS vision and the policies, processes, and procedures of in-place management systems

Competencies are abilities, knowledge, and skills that impact the success of employees and organizations. They are the basis for an engaged and productive workforce. Beyond traditional learning management systems, EHS 4.0 offers many opportunities to optimize competency management: using social media to share experience; developing new expertise through insights from Machine Learning; virtual reality to improve training delivery; and deploying connected worker strategies to sense worker actions, ensuring compliance and safety.

EHS 4.0 helps realize and sustain the desired organizational culture through better connectivity, visibility, insights, and collaboration. As EHS processes and outcomes become more visible, there is greater opportunity for broad engagement in EHS performance improvement. Mobile apps, analytics dashboards, and other digital innovations can help democratize EHS management, driving ownership beyond the EHS "department" into and throughout the organization.

Path Forward
and Recommendations

EHS Lagging on the Digital Technology Adoption Curve

The technology adoption curve made popular by Geoffrey Moore in his 2006 book "Crossing the Chasm" is a useful way for EHS business leaders to get oriented on the Digital Transformation roadmap. The curve describes the stages a market typically goes through in adopting a new technology.

Core business operations have led the Digital Transformation wave in most industrial companies, with use cases such as asset reliability, production efficiency, and product quality. When it comes to digitalization the overall market has passed through the early adopter phase and into the early majority phase.

By comparison, EHS has been mostly a bystander in the Industry 4.0 movement. EHS has been a significant, if unintended beneficiary of investments to date. For example, improvements in asset reliability help reduce equipment-related injuries, process safety incidents, and environmental emissions management. Now the role of the "digital worker" becomes much more prominent. Connected worker scenarios such as situational awareness, exposure monitoring, and ergonomics will become common, along with asset-oriented environmental, energy, and process safety use cases.

This circumstance represents an excellent opportunity for EHS business leaders. Many organizations have already launched some Digital Transformation initiatives, and have processes and resources in place to do more. In many cases, the digital ground has been plowed and is ready for planting. In this opportunity-rich environment, it's a good time for EHvS to be proactive and make the business case for investment. The alternative is to stand by as change occurs without you, and competitors outpace.

TECHNOLOGY ADOPTION CURVE

2.5%
Innovators

13.5%
Early Adopters

34%
Early Majority

34%
Late Majority

16%
Laggards
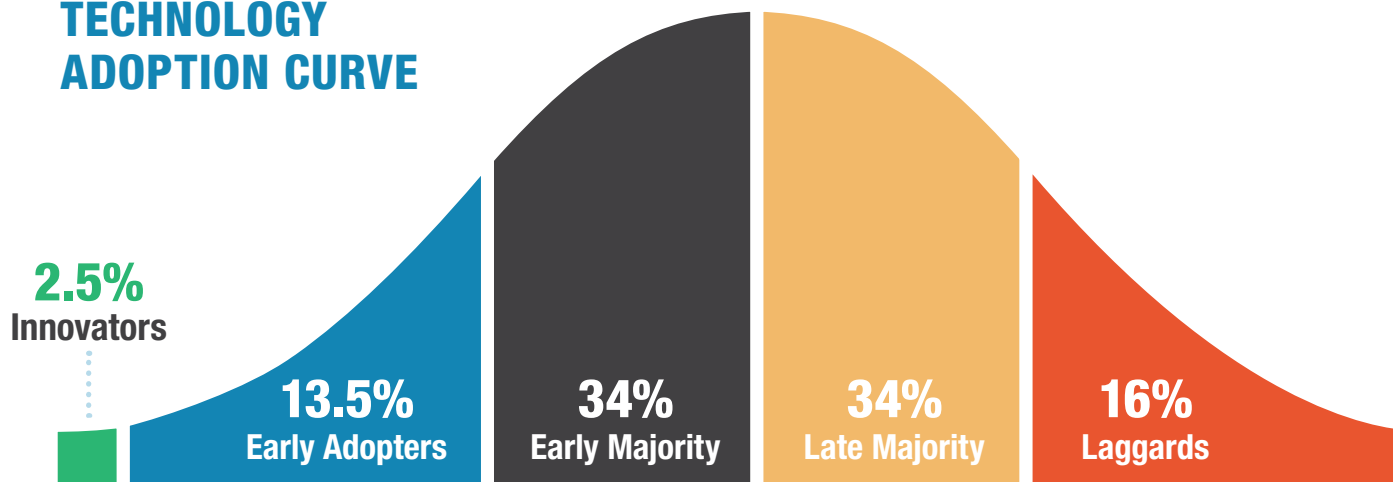
Moore, Geoffrey A. *Crossing the chasm: marketing and selling disruptive products to mainstream customers. New York, NY: HarperBusiness, an imprint of HarperCollinsPublishers, 2014.*

Recommendations

Take steps to get the EHS function fully engaged in your organization's Digital Transformation initiatives:

1. **Adopt systems thinking.** EHS management systems are designed to integrate a wide range of capabilities and processes to achieve performance objectives and drive improvement. Achieving this with traditional EHS management technologies is difficult. EHS 4.0 supports a true inter-connected systems approach across people, process, and technology.

2. **Find opportunities across the value chain.** Digital Transformation requires an end-to-end process approach. Avoid "departmental tunnel vision" and look for opportunities to break down silos and embed EHS across core value chain operations and supporting business functions. This approach will deliver more value and gain stakeholder buy-in.

3. **Recognize and manage security risks.** Digital Transformation is about change, and change creates risk. Key issues that require attention include cyber-security, and data and personal privacy. Get help from IT, and address issues in the project plan in accordance with your organization's policies.

4. **View EHS 4.0 Digital Transformation as organizational change.** Although the application of innovative technology is foundational to EHS 4.0, this is not merely an IT project; instead it is a business transformation initiative. Success will depend on how the initiative works with and supports organizational culture, and how change management is incorporated.

5. **Get started now.** Chances are your organization is already deep into Digital Transformation. If the EHS business function isn't already involved, it probably will be soon. It's far better to engage now in a proactive fashion than to wait for a negative event. Making the move to EHS 4.0 is an opportunity to engage with the Chief Digital Officer as a business leader who is likely striving to help the organization achieve strategic objectives.

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QUICK REFERENCE
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