

Connected Worker:

CONNECTING PEOPLE AND SYSTEMS TO TRANSFORM FRONTLINE OPERATIONS



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Section 1

Executive Summary

Executive Summary

In a global business environment characterized by disruption, change, and volatility, the digital transformation of industrial operations is much more than a well-established trend. Industrial Transformation (IX) is the strategic approach manufacturers and other industrial organizations increasingly rely on for competitive differentiation and ultimately sustainable, profitable growth.

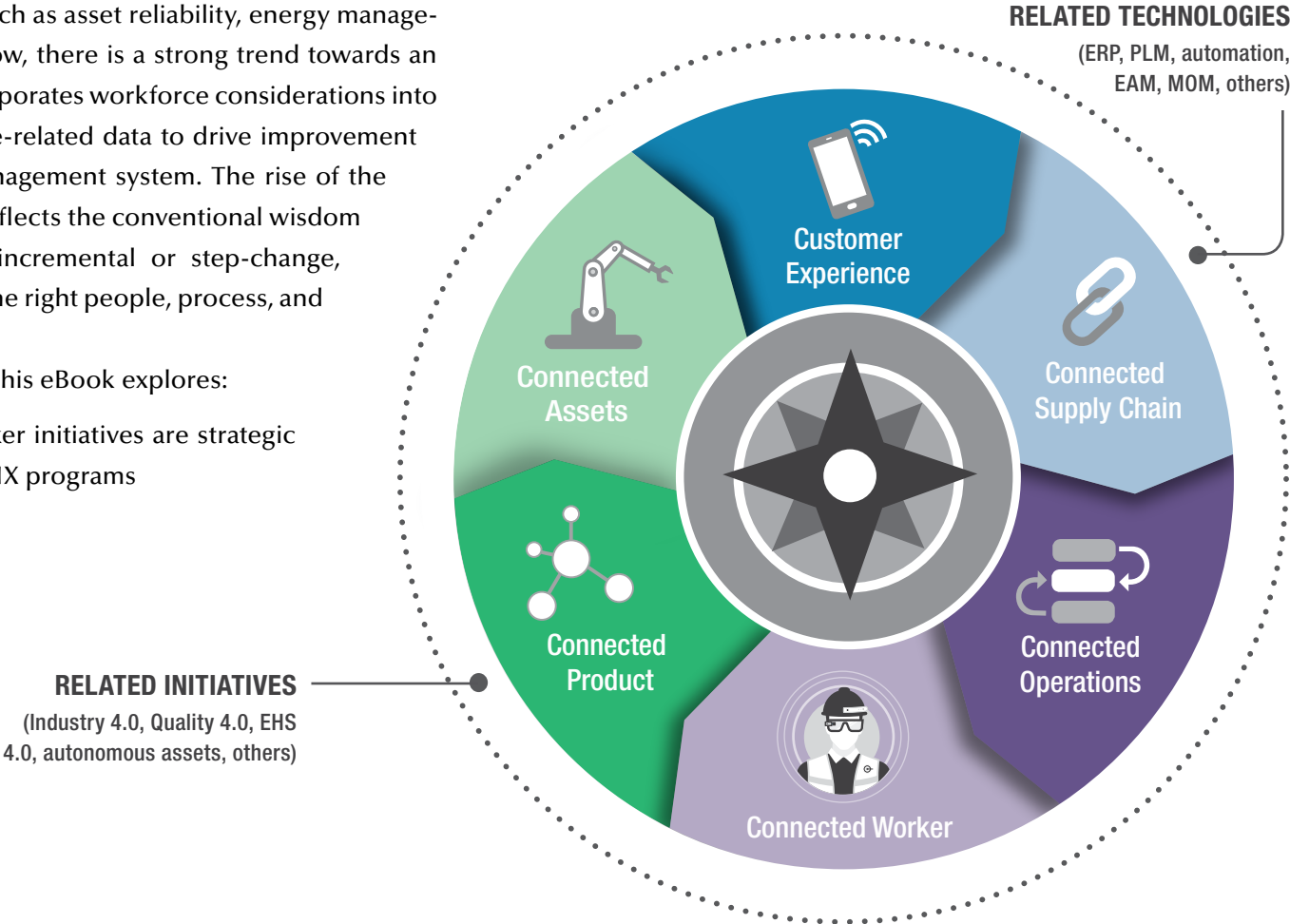
The digital technologies of IX have opened a new frontier: the digitally Connected Worker. Use cases in the initial wave of IX investment focused on using asset-related data and advanced analytics to drive improvement in areas such as asset reliability, energy management, and product quality. Now, there is a strong trend towards an integrated approach that incorporates workforce considerations into IX initiatives and using people-related data to drive improvement in the overall operational management system. The rise of the digitally Connected Worker reflects the conventional wisdom that improvement, whether incremental or step-change, calls for holistic alignment of the right people, process, and technology capabilities.

The research presented in this eBook explores:

- Why Connected Worker initiatives are strategic as well as their role in IX programs

- Frameworks for conceptualizing and formulating Connected Worker solutions
- The selection and implementation of Connected Worker use cases, and evidence of business value
- Actionable recommendations

IX USE CASE NAVIGATOR



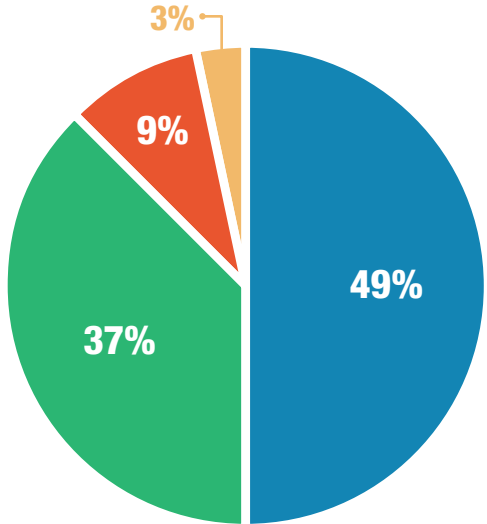
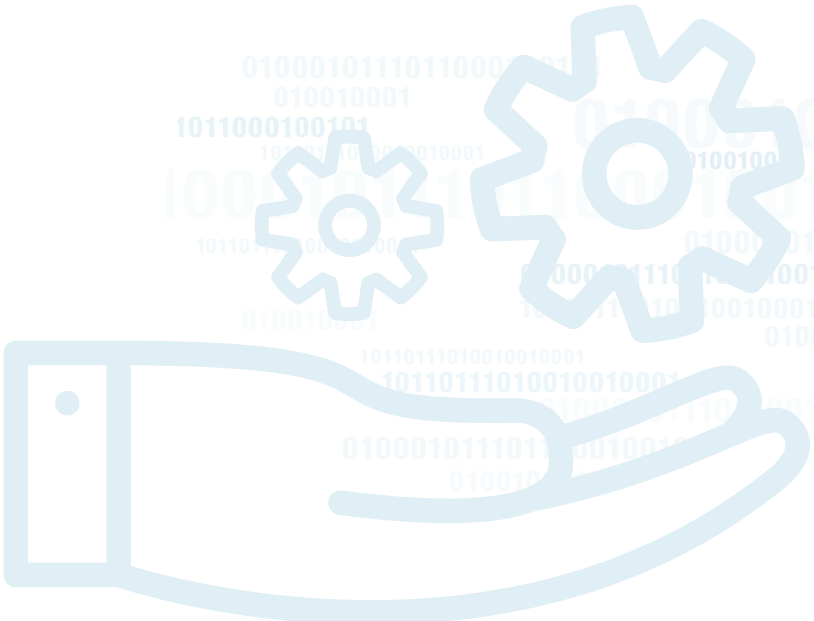


Section 2

Research Demographics

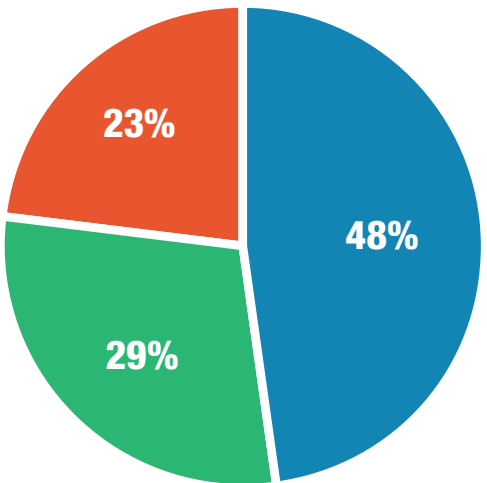
Research Demographics

The main source of the research data presented in this eBook is a global survey executed by LNS Research in 2019 on the topic of “Industrial Transformation Technology and Use Cases.” We obtained valid survey responses from 275 executives, management, and operations personnel in industrial organizations. The respondent pool was well-diversified by geographic region, industry, and company size. The survey gathered data on the status of Industrial Transformation programs including strategic initiatives, deployment of enabling digital technologies, and use case implementation.



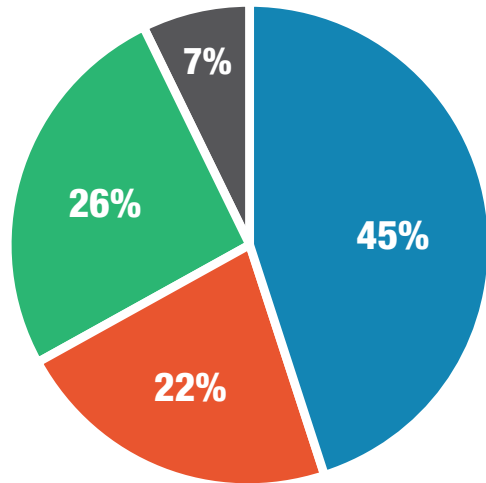
GEOGRAPHY

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



INDUSTRY

- Discrete Manufacturing
- Batch Manufacturing
- Process Manufacturing



COMPANY SIZE

- <\$500 Million
- \$500 Million - \$1 Billion
- \$1 Billion - \$10 Billion
- >\$10 Billion



Section 3

Current State of Connected Worker Initiatives

Industrial Transformation (IX)

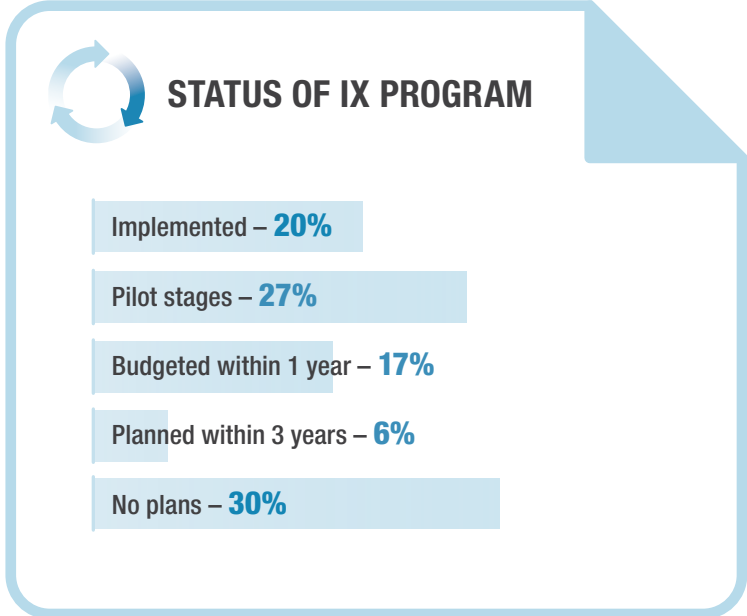
The digital transformation of industrial operations is much more than a well-established trend. IX is the strategic approach manufacturers and other industrial organizations increasingly rely on to enable competitive differentiation, and ultimately sustainable, profitable growth.

LNS Research defines IX as the orchestrated application of digital technologies to enable step-change performance improvement. Our research shows that nearly half of industrial organizations are already well underway with implementing or piloting a wide range of IX initiatives to digitally connect their operations.

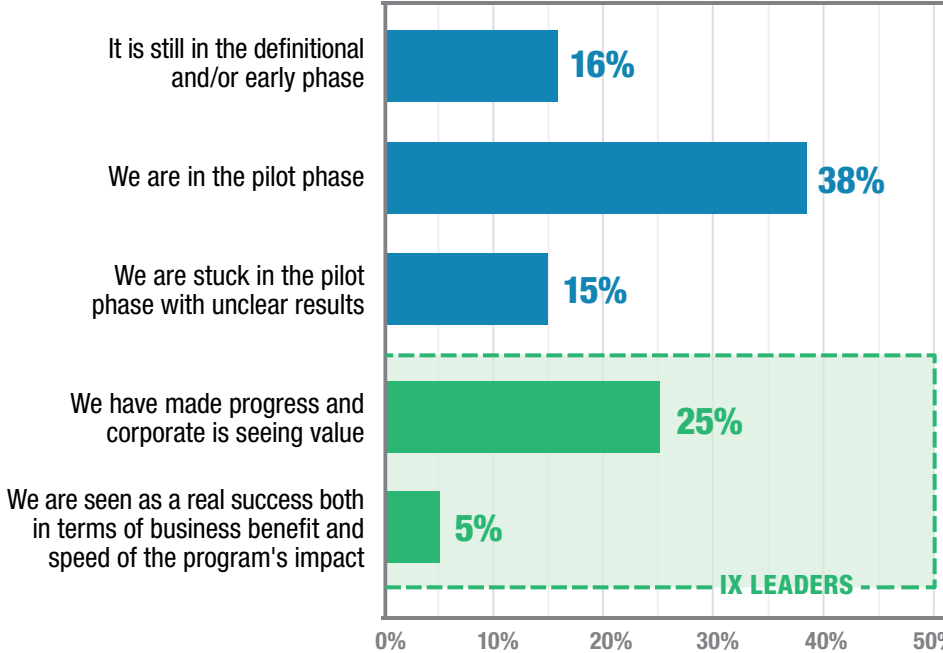
However, not all is going smoothly. Despite significant levels of IX investment, there is considerable disparity in organizational achievement of business value and targeted results. Our research has

categorized companies based on where they are in their IX journey: “Leaders” (the top 30% experiencing real success), early-stage “Followers” (54%), and those that are “Stuck” in pilot stages (15%).

Much of the first wave of IX investment was directed at process performance improvement based on asset and equipment-related data and insights, with asset reliability as a prime example. Our research shows that industrial organizations are shifting to a more holistic view of Connected Operations that digitally integrates frontline workers into the overall operational management system – the Connected Worker.



The Top 30% of Companies are Succeeding as IX Leaders



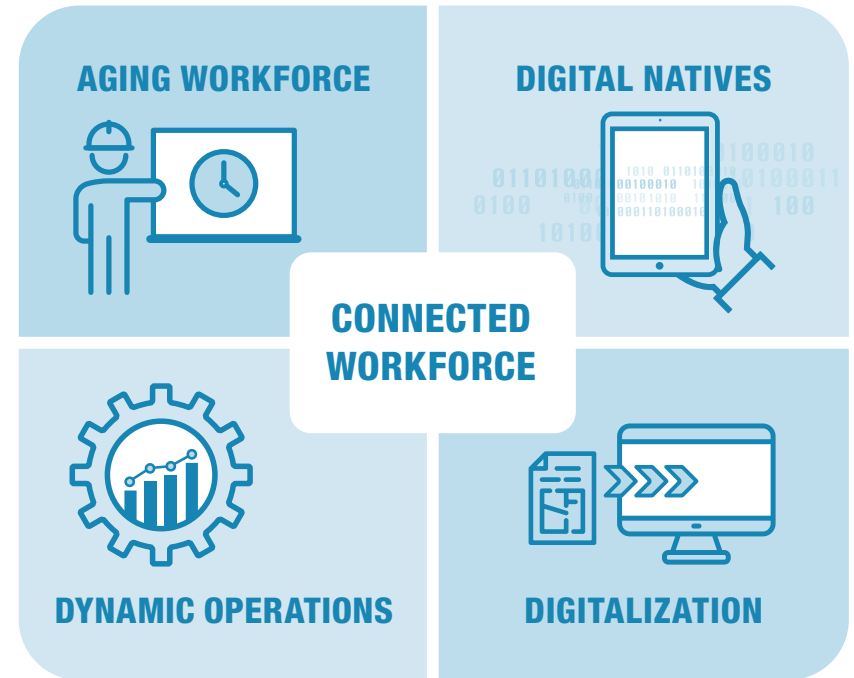
Demographic and Technology Shifts Driving Change

Much of the strategic emphasis on Connected Worker initiatives is driven by several interrelated trends that impact the industrial workforce. This “perfect storm” demands a response from every industrial organization.

- The U.S. Bureau of Labor Statistics estimates a shortage of more than two million manufacturing workers by 2025, with more than 10,000 baby boomers retiring daily. This impacts manufacturers as valuable skills, experience, and institutional knowledge are lost.
- The widespread implementation of IX programs introduces a wide array of new digital technologies to enable the factory of the future, such as IIoT, automation systems, advanced analytics, and many others. These dynamics change the competencies needed to effectively deploy digital technologies and provide the operational agility required to respond to a dynamic production environment.
- The next generation of employees entering the workforce and advancing through the ranks are digital natives with an entirely new set of perceptions and expectations regarding technology and attitudes about work in general.

To be competitive industrial organizations must address the resulting skills gap with a strategic approach that recognizes both the risks and opportunities presented by these workforce trends. This includes rethinking how the frontline workforce is managed and the role of Connected Worker digital technologies in meeting unprecedented challenges in hiring, training, and retaining a workforce with the requisite competencies and agility.

Trends Driving Connected Worker Initiatives



WORKFORCE CHALLENGES

- Recruit, train and retain people to address skills gap
- Enable organizational learning and knowledge transfer
- Engage and empower frontline workforce
- Drive productivity, safety and quality improvements

Expanding Role of Connected Worker Initiatives in IX

To what extent are the generational and technological trends discussed in the previous section having an impact on IX investments and activities? Our research shows that Connected Worker initiatives have become equally or more common as other IX strategic initiatives such as Connected Operations, Assets, and Products. This finding is in keeping with the notion that IX is fundamentally business transformation enabled by technology, requiring an approach that factors people, process, and change management considerations into the equation.

Within this broad pattern, we see some interesting differences in adoption among industry sectors. Discrete manufacturers are further along than the process industries in implementation of Connected Worker technologies (38% vs. 19%). We think this is likely due to the stronger match within discrete industries of proven Connected Worker technologies such as augmented reality and smart wearables for a wider range of use cases across the value chain--including production, maintenance, and field service. Global discrete manufacturers tend to have larger networks of operations

and more complex products and production processes than process industries. This makes the discrete sector more conducive to quick wins from digitally connecting people within and across operations. However, we see the process industries catching up quickly, with 50% of process organizations already piloting Connected Worker technologies.



Strategic Initiatives Implemented in IX Program

	CURRENTLY IMPLEMENTED	PILOT STAGES	BUDGETED - 1 YEAR	PLANNED - 3 YEARS	NO PLANS
Connected Worker	34%	33%	12%	8%	13%
Connected Operations	34%	33%	21%	5%	6%
Connected Assets	25%	31%	20%	10%	13%
Connected Products	28%	31%	22%	9%	10%

The Key Role of Connected Worker Use Cases

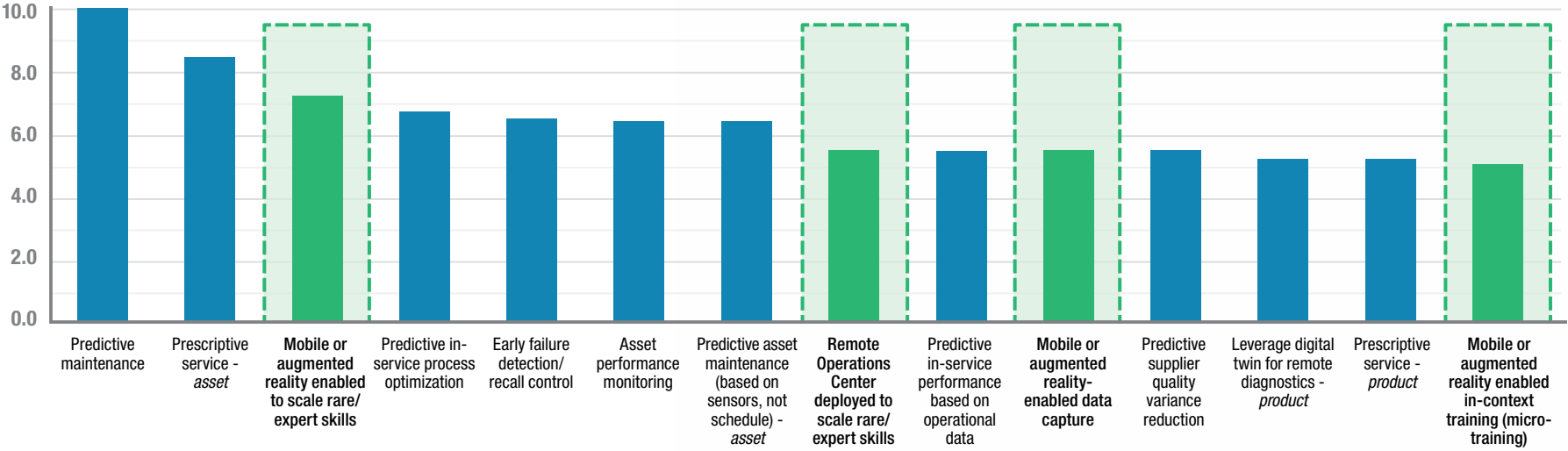
Industrial organizations clearly recognize the potential business value to be gained from IX investments aimed at Connected Worker projects. Nearly a third of the highest impact IX use cases as reported by survey respondents fall squarely into the Connected Worker category; many others are closely related.

Consistent with our previous research, asset- and equipment-focused IX use cases dominate the top impact list. These include asset performance monitoring, predictive maintenance, and prescriptive service. Our latest research indicates much greater recognition of the opportunity to leverage the collective synergy of digital technologies, distributed work settings, and specialized skills. Such Connected Worker scenarios may include the creation of remote operations centers to access and scale rare or expert skills, as well as use of mobile and augmented reality technologies to capture data, obtain digital work instructions, and receive in-context training, among others.



Highest Impact IX Use Cases

 CONNECTED WORKER USE CASES





Section 4

Emergence of the Digitally Connected Worker

Evolution of Workforce Connectivity and Engagement

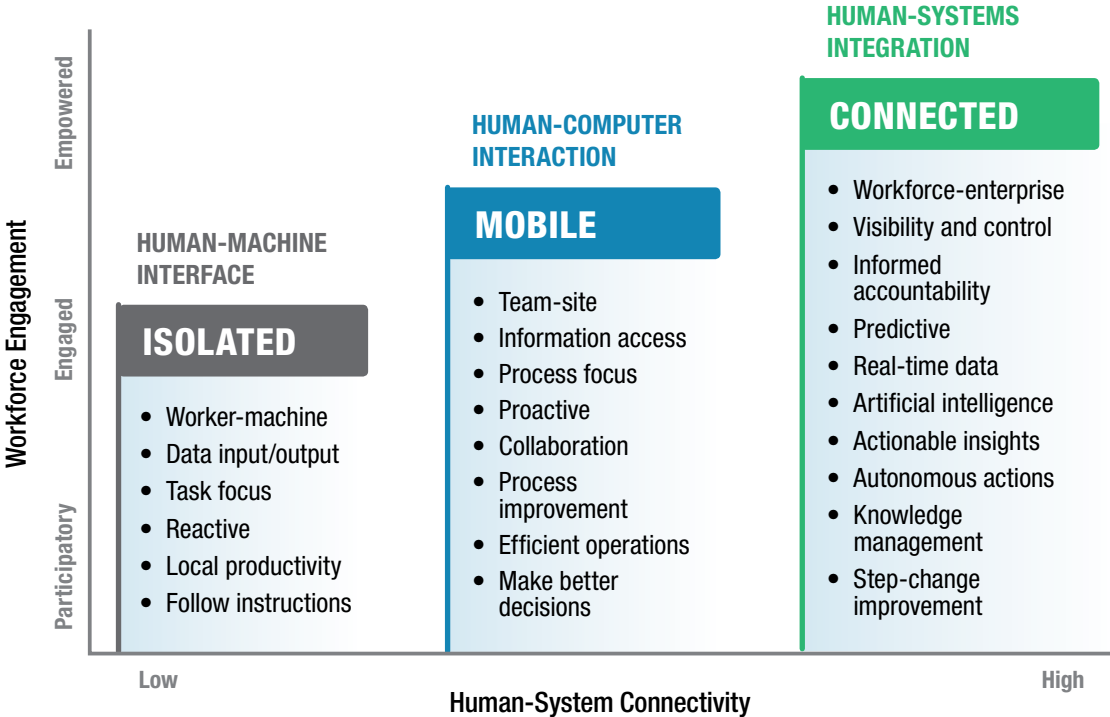
The three industrial revolutions leading up to today’s IX era are well known: The birth of mechanical production in the late 18th century, mass production in the late 19th century, and automation and computerization in the mid-20th century. With each successive wave of technology-enabled advancement came major changes in how work was performed in frontline operations.

The basis for much of this change is the degree of connectivity between frontline workers and their work environment, and ultimately how the workforce interacts within the organization’s overall operational management system. As automation took hold, Human-Machine Interface (HMI) technology enabled digital interaction of workers with machines and equipment, with local incremental productivity improvements.

The subsequent broad and deep computerization of industrial operations extended the degree of workforce connectivity with enterprise and site IT and OT systems, including mobile applications. With these developments in Human-Computer Interaction, the frontline workforce could more readily access information when and where needed and collaborate better within teams and across the enterprise. This connectivity enabled a shift from focus on performing the task at hand more efficiently to having more visibility and control needed to improve performance at a higher organizational level.

Now with the digital technologies of IX, work on the frontlines is being revolutionized once again with deeper connectivity between the workforce and overall industrial operations. Connected Worker technologies enable greater integration between people and systems across operations, extending capabilities to wherever work is performed. The greatest opportunity comes from use of IIoT technologies to capture a wealth of human-workplace interaction data, and application of advanced analytics including artificial intelligence (AI) to glean actionable insights for operational performance improvement enterprise-wide.

Evolution of Frontline Connectivity and Workforce Engagement

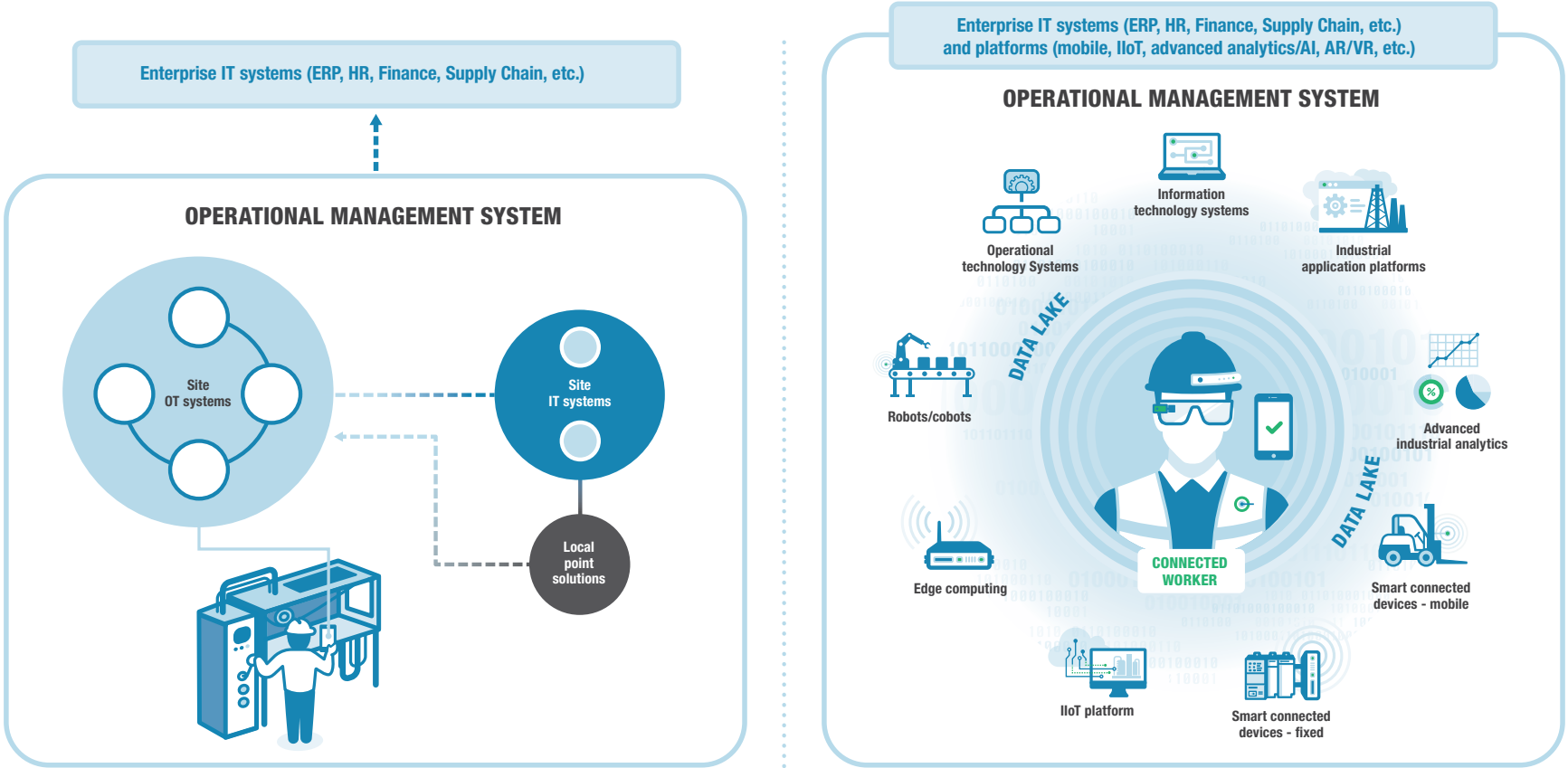


The Connected Worker in the Operational Management System

The core value chain operations of an industrial organization can be viewed as an operational system with many sub-systems--a system of systems. The system elements function together to use inputs (materials, resources, etc.) and produce outputs (products and services). From a broader perspective, this system operates within an ecosystem that incorporates customers, suppliers, business partners, and other stakeholders.

IX is focused on the systematic use of technology to optimize the whole operational management system by increasing connectivity among the system elements, in turn optimizing how they work together to produce desired outputs and outcomes. Frontline workers have

always been at the heart of industrial operations: operating machinery, maintaining equipment, troubleshooting and fixing production problems, repairing products in the field, etc. The Connected Worker concept is best viewed as extending the critical role people play in frontline operations from limited interaction with elements of the operational management system to a high degree of interconnectivity. It is this enhanced connectivity with the whole operational management system that enables frontline workers to be empowered with accurate information and knowledge, enabling visibility, informed decision-making, and operational agility.



Connected Worker Solutions: From Simple to Complex

There is no standard definition of what a Connected Worker solution is; a wide range of digital technologies can be called into play to enable Connected Worker use cases. The key criterion is that application of the technology increases the degree of connectivity between the worker and one or more elements of the operational management system to facilitate the multi-directional flow of data, information, actionable insights, and autonomous actions.

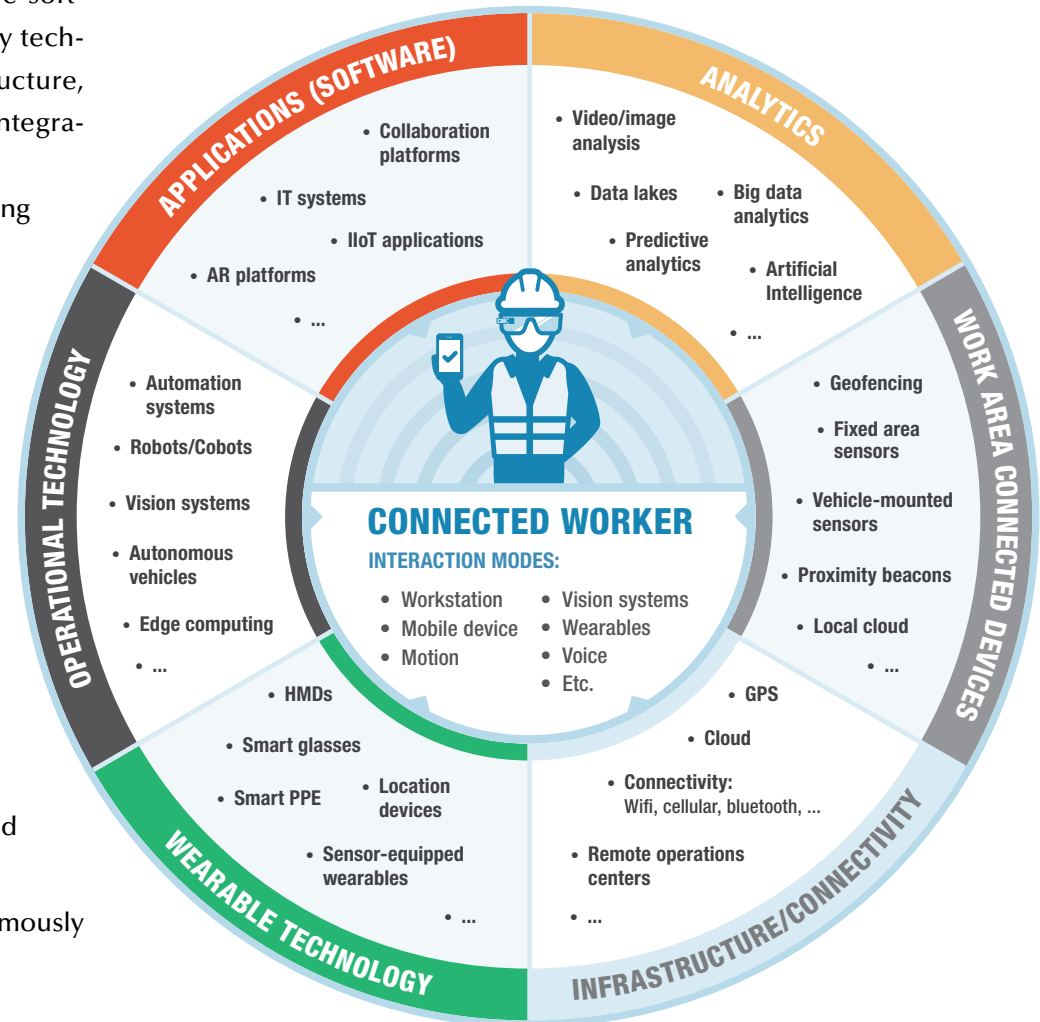
In most cases Connected Worker solutions will combine software and hardware, along with implementation services. Key technology categories include Applications, Analytics, Infrastructure, Wearable technology, Work area connected devices, and integration with OT systems.

Solutions can range from simple to more complex depending on the problem to be solved. Some examples are:

- **DATA INPUT:** Reporting a safety incident at a kiosk on plant floor
- **INFORMATION ACCESS:** Maintenance work orders available on mobile device on mobile devices
- **IN-CONTEXT INFORMATION:** Use of an augmented reality software platform for in-context training via head-mounted display
- **PREDICTIVE:** Use of an IIoT platform to collect Big Data on worker-machine interactions and apply predictive analytics to identify impending safety risks
- **PRESCRIPTIVE:** AI-enabled prescriptive maintenance to predict asset failure and provide outcome-focused maintenance recommendations
- **AUTONOMOUS:** Human-robot collision avoidance autonomously triggered by body-worn sensors

Each of these solutions will require a variety of solution components, some of which may already be in place at the site or enterprise level. Consideration of how the Connected Worker solution will work with the existing Operational Architecture is key.

Connected Worker Solution Components





Section 5

Scope, Use Cases, and Evidence of Value

Broad Scope and Impact Across the Value Chain

LNS Research defines the Connected Worker scope to potentially include all frontline workers involved in production of goods or delivery of services whether they are working in the plant, at a remote facility, or at a customer site. IX initiatives optimize end-to-end processes by holistic implementation of people, process, and technology capabilities. Connected Worker opportunities exist across these “digital threads” encompassing core value chain functions such as operations, maintenance, and field service, as well as support functions such as EHS and Quality. Similarly, the range of Connected Worker use case opportunities spans the entire operational management system, with the potential to drive diverse benefits by fundamentally changing how workers interact with and engage in the work environment.

Connected Worker: Operations-Wide Scope and Benefits



VALUE CHAIN FUNCTIONS

- Operations
- Maintenance
- Engineering
- Supply Chain
- Service
- Support (EHS, Quality)
- ...



USE CASES

- Training/micro-training
- Remote expert access
- Maintenance execution
- Safe work procedures
- Agile work instructions
- Complex assembly
- Quality inspection
- Picking
- Field service
- ...



TARGETED BENEFITS

- Reduce risk
- Improve safety performance
- Assure compliance
- Improved product quality
- Workforce agility
- Competency management
- Knowledge management
- On-time delivery
- Customer retention
- ...

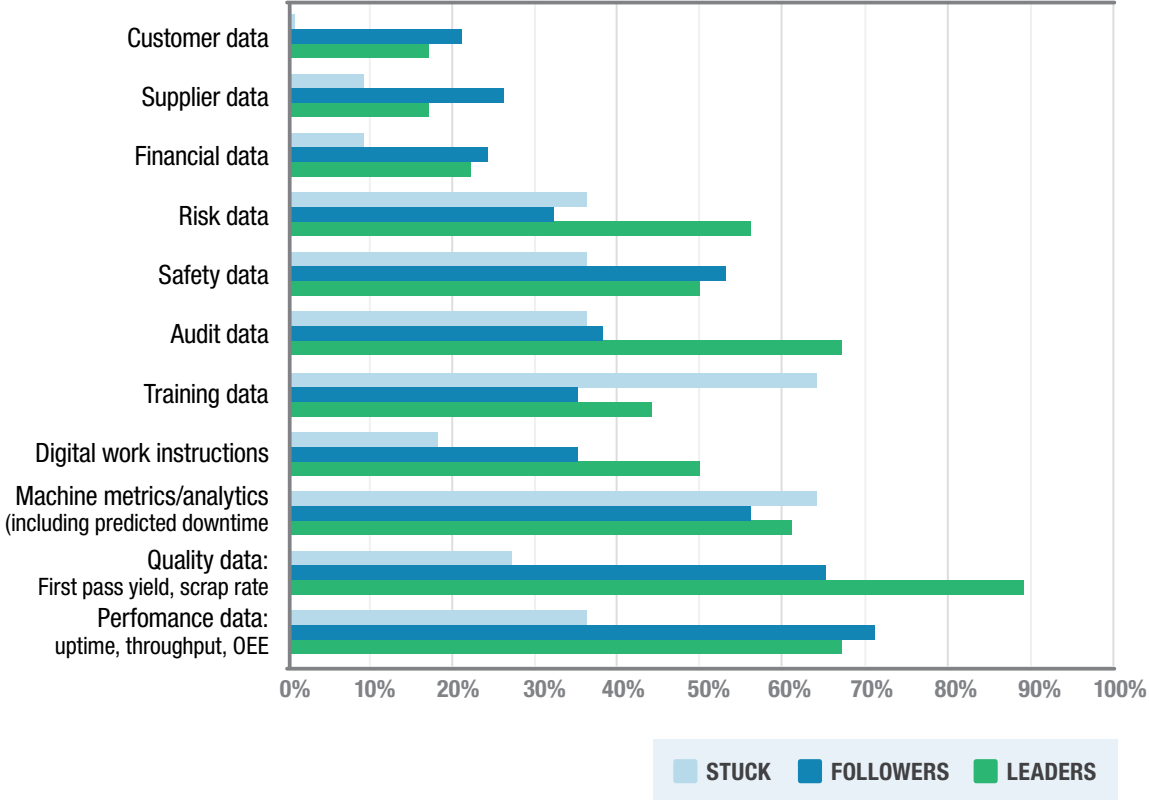
Empower Frontline Workers with Data

IX Leaders provide more operational data and information on the frontlines than IX Followers. This “democratization of data” empowers production, maintenance, and other frontline workers to make better, faster decisions and be more proactive in identifying and acting on improvement opportunities. This pattern of broader availability holds true for a wide range of data types. In this regard, the gap between IX Leaders and Followers is particularly notable for the following types of data:

- Digital work instructions
- Performance (OEE, uptime, etc.)
- Machinery metrics
- Quality
- Risk
- Safety
- Audit
- Training

Deeper analysis of our survey data shows that IX Followers tend to not include enough data sources in their systems to maximize value, and do not trust machine operators and plant floor personnel, reserving data and analytics for managers and above. Conversely, IX Leaders are more likely to empower frontline workers with data and decision-making authority, which helps to reduce bottlenecks to improve safety, quality, and throughput. Connected Worker technologies can play a pivotal role in advancing this opportunity.

Data Types Available to Production Personnel



High Potential Use Cases Address Critical Workforce Challenges

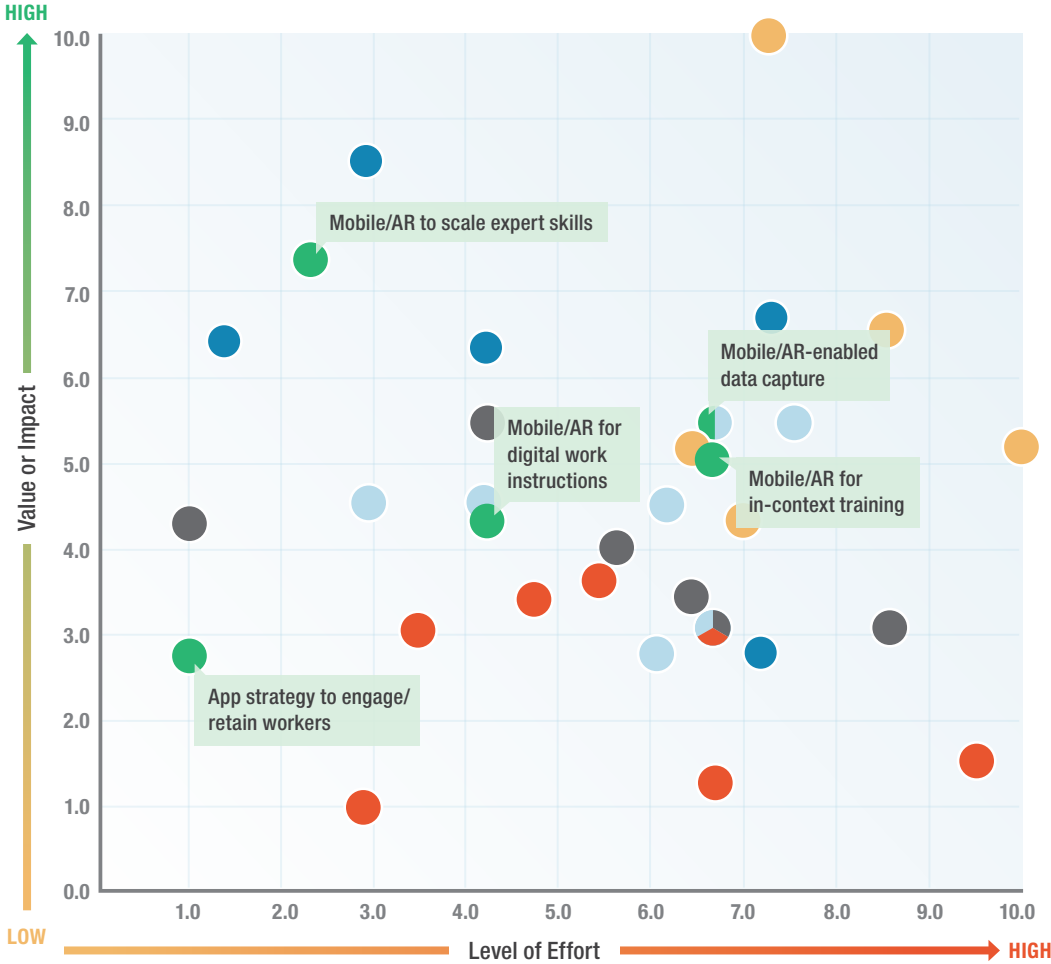
Selecting the right problems to solve is key to the success of IX initiatives. Many organizations struggle to identify which use cases to focus on and at what point along the IX journey. Our research assessed IX use cases based on expected impact on operational performance and resources needed to implement. Along with Connected Asset and Operations use cases, Connected Worker use cases feature prominently as having high favorable risk-reward ratios.

Not surprisingly, the Connected Worker use cases with the highest potential help address the critical workforce demographic and skill gap challenges faced in all industrial sectors:

- Use of mobile/augmented reality technology to scale rare/expert skills
- Implementing an application strategy to improve worker engagement/retention
- Use of mobile/augmented reality for in-context training (micro-training)

The approach used to select Connected Worker use cases for implementation will vary by organization and depend on the status and capabilities of the IX initiative overall. Many organizations have met with success by initially focusing on relatively low effort, quick win projects that solve a well-defined, important business problem. Candidate use cases should be quantitatively assessed by their impact, resources required, and cultural readiness.

IX Use Case Impact/Effort Index



STRATEGIC INITIATIVES

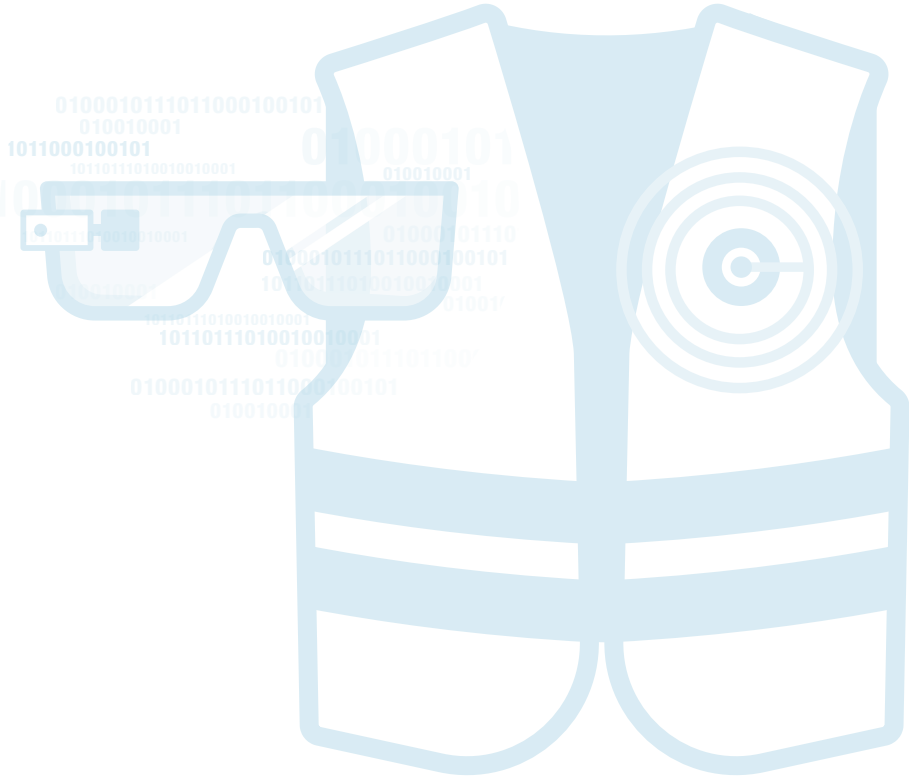
- Connected Assets
- Connected Operations
- Connected Supply Chain
- Connected Product
- Connected Worker
- Customer Experience

Evidence of Value: IX Leaders Exploit Connected Worker Solutions

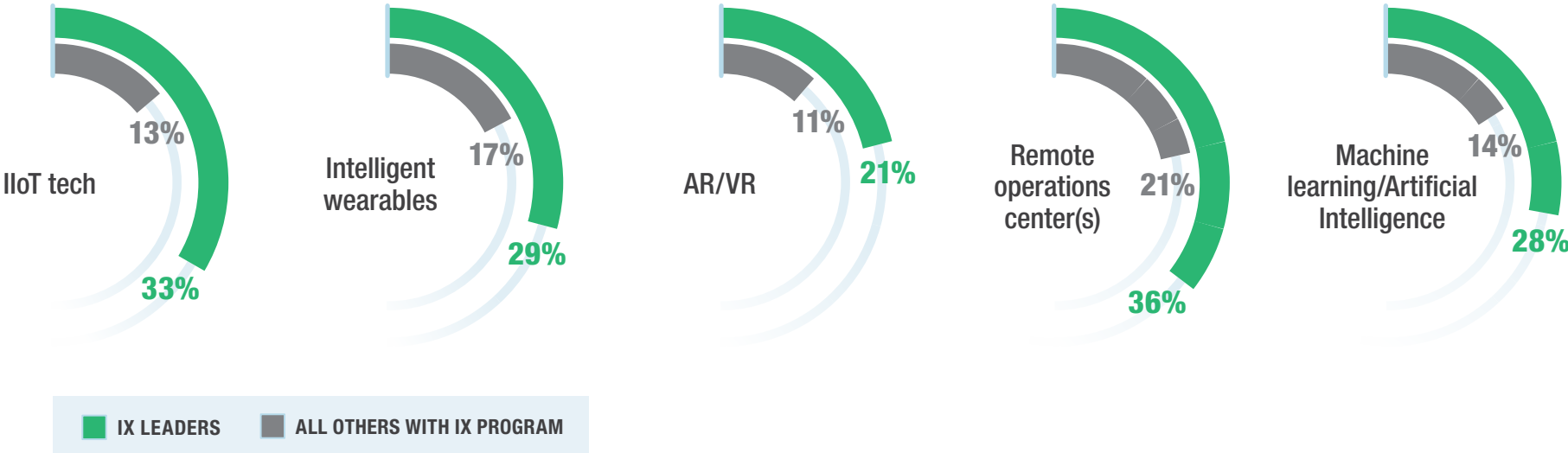
Our research shows that organizations that are IX Leaders are more likely to implement a variety of Connected Worker technologies than IX Followers:

- Augmented Reality/Virtual Reality – 90% more likely
- Intelligent wearables – 70% more likely
- Remote operations centers – 71% more likely
- IIoT technologies – 154% more likely
- Machine Learning/Artificial Intelligence – 100% more likely

This indicates that there is an attractive opportunity for industrial organizations to be proactive in incorporating Connected Worker solutions into their IX programs, with significant potential value to be gained.



Connected Worker Technology Adoption





Section 6

Actionable Recommendations and Resources

Recommendations

Connected Worker initiatives are gaining traction in industrial organizations and are increasingly recognized as an integral component of Industrial Transformation programs. While the potential is high, our research has revealed some common pitfalls. Here are five actionable recommendations to help start or accelerate your Connected Worker initiative.

SELECT USE CASES FOR INVESTMENT BASED ON EXPECTED BUSINESS OUTCOMES. While LNS encourages exploration, our digital readiness research shows that industrial organizations should be careful to start with a clear focus on process improvement and desired business outcomes, rather than technology evaluation/testing per se.

USE A STRUCTURED APPROACH TO SELECT CANDIDATE CONNECTED WORKER USE CASES. LNS has found it useful to assess use cases based in expected impact and benefits relative to the resources required to implement. Many companies have met with success by starting with low risk projects and showing some value rather than going for the home run.

DO NOT UNDERESTIMATE THE IMPORTANCE OF CULTURAL READINESS. Technology-enabled transformation projects are fundamentally change initiatives. Success requires intentional organizational change management to get up and running as well as focused efforts to sustain the project and deliver results over time.

FOCUS CONNECTED WORKER INITIATIVES ON, “WHAT’S IN IT FOR ME?”

Connected Worker projects directly affect individuals in their day-to-day work. This goes beyond practical concerns of how the technology will physically impact how the work is done, and into softer areas such as privacy and fear of micromanagement. Pilot project success depends on getting buy-in upfront from the individuals and groups impacted.

HARNESS THE POWER OF ADVANCED ANALYTICS INCLUDING AI. The greatest strategic value of the Connected Worker opportunity comes from applying AI and other advanced analytics tools to IIoT-generated Big Data on human-workplace interactions to glean actionable insights. This may or may not be part of phase one, but should be given priority in the Connected Worker roadmap.



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 →](#)

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