Are You Ready for Your Digital Transformation Journey?

Digitalization is driving the 4th Industrial Revolution by transforming businesses and creating value throughout the entire industrial value chain
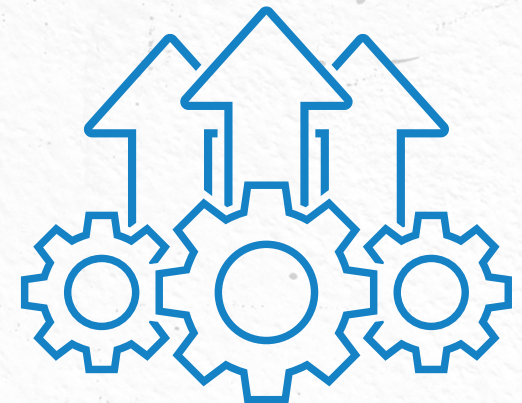
FROST & SULLIVAN VISUAL WHITEPAPER

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CONTENTS

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INTRODUCTION

Frost & Sullivan created this visual whitepaper to educate the industrial landscape on Industry 4.0.

Frost & Sullivan leveraged its 60+ years of market intelligence experience and distinguished reputation in industrial technologies to illustrate and discuss why industrial organizations should seriously consider embarking on a digital transformation journey by providing insightful concepts, facts, and concrete quantitative and qualitative evidence.

We will first set the context by providing a brief historical background, discussing the evolution and disruptions of the industrial and manufacturing realms, and clarifying terminology by elaborating on the digitization, digitalization, digital thread, digital transformation, and digital maturity concepts (which are often incorrectly used interchangeably).

We then dig into the Industry 4.0 era, its promise, current state, level of adoption, implications, and impact on the industrial ecosystem from a technological and business strategy standpoint.

Next, we briefly elaborate on the Industry 4.0 market, how the COVID-19 pandemic acted as a catalyst for digital transformation projects and accelerated Industry 4.0 adoption, and why "XaaSification" has established itself as a critical technology enabler.

We also explore the most critical Industry 4.0 needs and challenges and how PTC can become a unique partner for a thriving digital transformation journey. We present the most relevant Industry 4.0 use cases and how digitally matured companies are successfully approaching them, obtaining real, measurable, and quantifiable benefits and results.
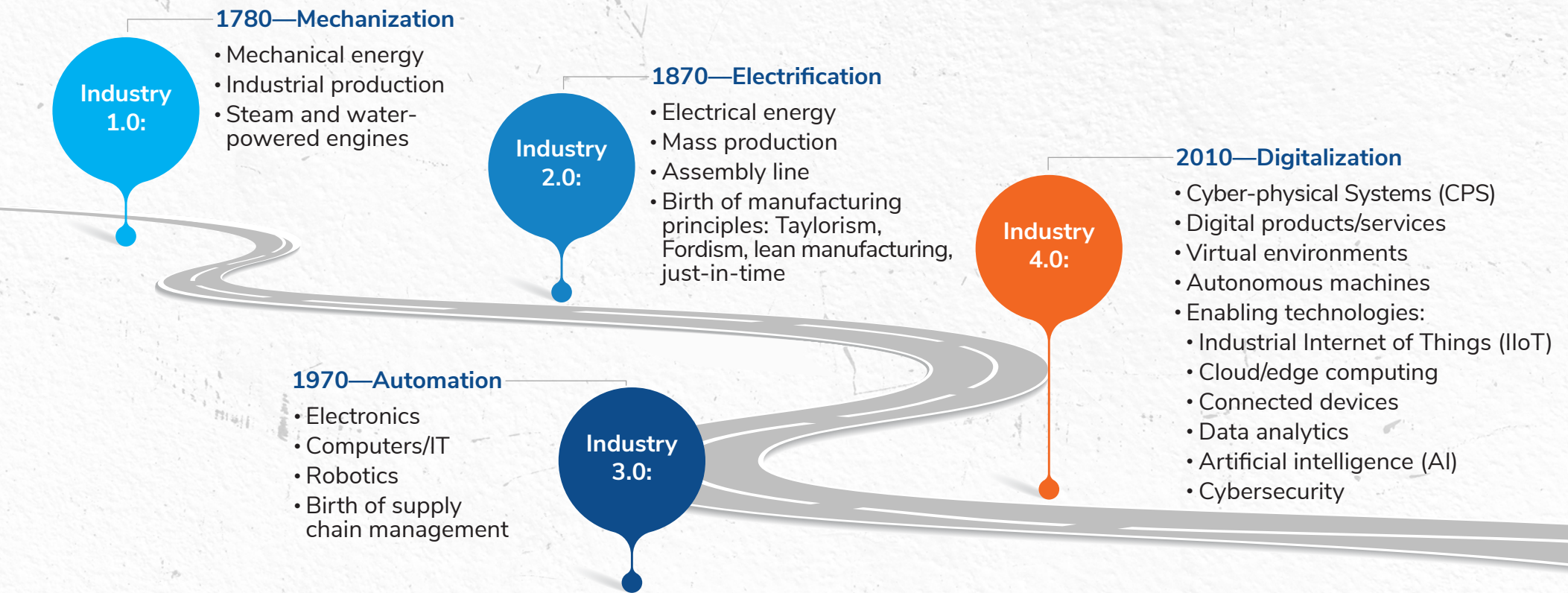
Finally, we will present our analysis of what is next for the industrial landscape evolution.

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Industry X.0 and Digital Transformation: How Did We Get Here?

Industry 4.0: Timeline of Industrial Revolution, 1780–2022

Industry 1.0:

1780—Mechanization
- Mechanical energy
- Industrial production
- Steam and water-powered engines

Industry 2.0:

1870—Electrification
- Electrical energy
- Mass production
- Assembly line
- Birth of manufacturing principles: Taylorism, Fordism, lean manufacturing, just-in-time

Industry 3.0:

1970—Automation
- Electronics
- Computers/IT
- Robotics
- Birth of supply chain management

Industry 4.0:

2010—Digitalization
- Cyber-physical Systems (CPS)
- Digital products/services
- Virtual environments
- Autonomous machines
- Enabling technologies:
  - Industrial Internet of Things (IIoT)
  - Cloud/edge computing
  - Connected devices
  - Data analytics
  - Artificial intelligence (AI)
  - Cybersecurity

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Source: Frost & Sullivan, 2022

From Digitization to Digital Transformation: Reaching Digital Maturity

Digitization: This is the process of converting physical or analog information into a digital representation or format and is the connection between the physical world and computer software. It allows for data process, transfer, and utilization while laying the foundation for digitalization.

- **Digitalization:** This is the act of using digitized data, digital technologies, and digitally enabled strategies to enable, improve, optimize, or automate processes, functions, or operations; transform business models; create new revenue streams; and create new products or services. It turns data into knowledge and actionable insights.

- **Digital Thread:** This is a digitized and automated mechanism for correlating information across business processes, systems, products, equipment, and services through an integrated data flow. It is a real-time record of a product or system value chain and life cycle, from its creation to its end-of-service and removal. Benefits:

  - Product quality
  - Product innovation

Digitization

Digitalization

Digital Transformation

Digital Thread
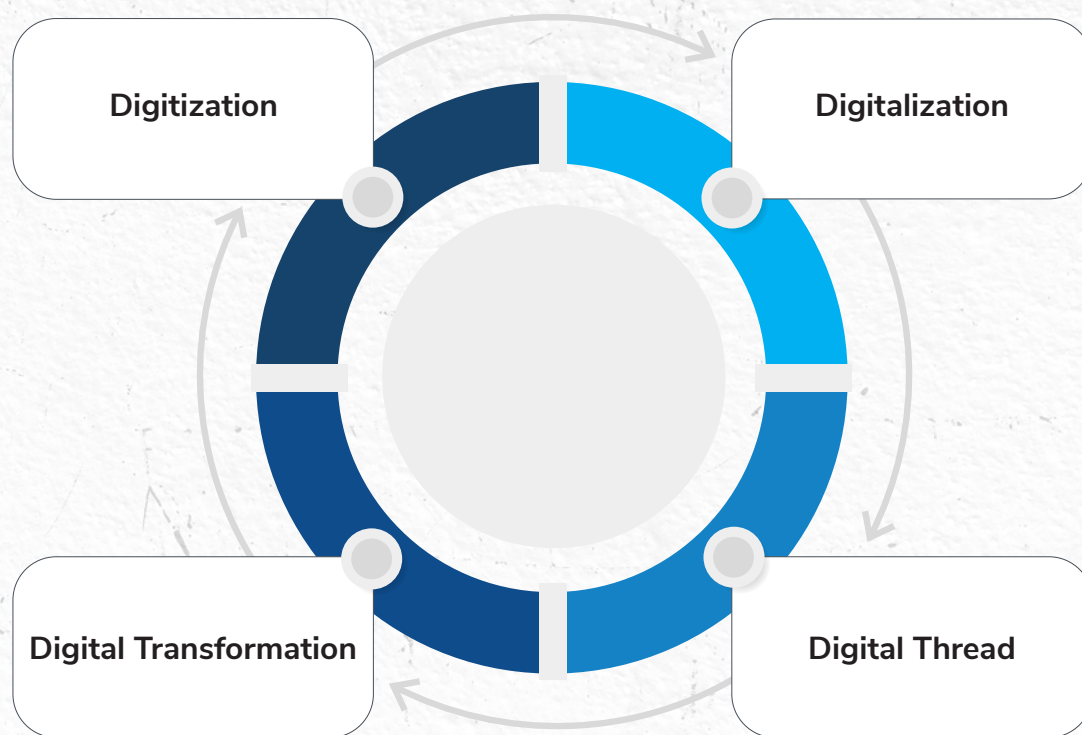
- Engineering efficiency

- Cost reduction (up to 10%)

- Time-to-market

- ESG compliance

- Sustainable manufacturing

- **Digital Transformation:** This is the act of enabling digital businesses through digitalization at an enterprise-wide scale, including people, processes, and technologies. It completely reinvents the way a business is run and empowers it to quickly adapt to new market conditions and customer needs. Pillars:

  - Empower employees, employee-centric

  - Engage customers

  - Optimize operations

  - Transform product and services

- Benefits:

  - Data-driven enterprise

  - Increasing profits

  - Enhanced customer experience

  - Increased innovation

  - Improved agility
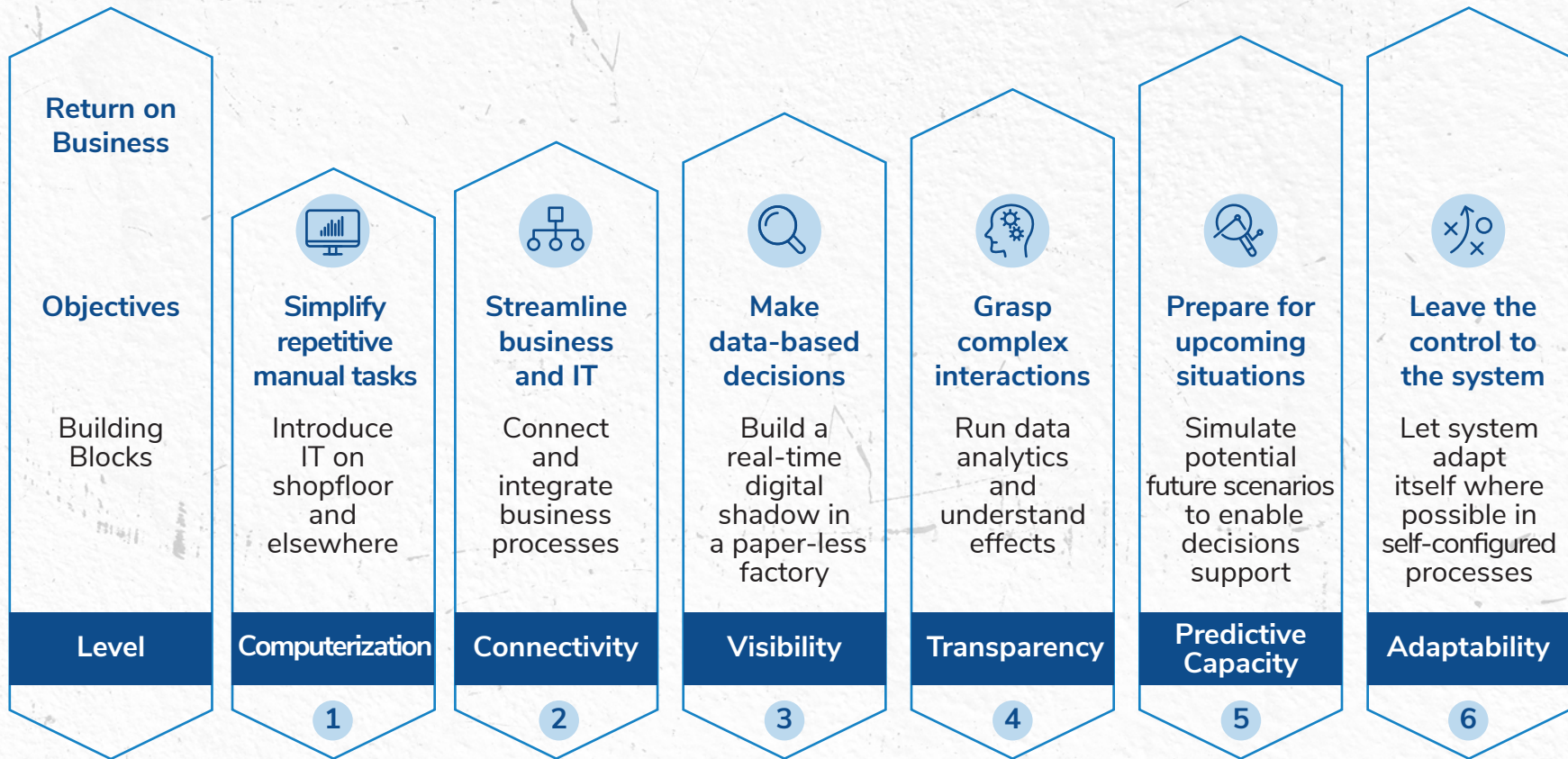
  - Better competitiveness

Digital Maturity:

A measure of an organization's ability to rapidly respond to the developments and shifting trends of digital technology, creating real value through digital strategies.

In 2017, Germany's National Academy of Science and Engineering (acatech) released the Industrie 4.0 Maturity Index (updated in 2020) as a way of determining a manufacturing company's current digital transformation stage and then assessing their business processes from a technological, organizational, and cultural standpoint.

Return on Business						
Objectives	**Simplify repetitive manual tasks**	**Streamline business and IT**	**Make data-based decisions**	**Grasp complex interactions**	**Prepare for upcoming situations**	**Leave the control to the system**
Building Blocks	Introduce IT on shopfloor and elsewhere	Connect and integrate business processes	Build a real-time digital shadow in a paper-less factory	Run data analytics and understand effects	Simulate potential future scenarios to enable decisions support	Let system adapt itself where possible in self-configured processes
Level	**Computerization**	**Connectivity**	**Visibility**	**Transparency**	**Predictive Capacity**	**Adaptability**
	1	2	3	4	5	6

Maturity stages of the acatech Industrie 4.0 Maturity Index

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Birth and Rise of Industry 4.0

Industry 4.0, also known as I4.0 or the fourth industrial revolution, is a term coined by the Verein Deutscher Ingenieure (VDI, Association of German Engineers) in April 2011 and refers to using digital technologies in the industrial and manufacturing realms to achieve digital transformation. Although the rise of electronics, computers, and robotics has resulted in the automation of manufacturing processes since the late 1960s (Industry 3.0, I3.0, or the third industrial revolution), it was the advent of breakthrough digital technologies in the early 2010s that disrupted the industrial landscape and (except for during 2020 and the COVID-19 pandemic) increased productivity and net output year after year to unprecedented levels.

Moreover, the widespread adoption of digital technologies since the COVID-19 pandemic has primarily been responsible for the 13.0% increase in global industrial production and the 28.2% increase in global manufacturing output between 2020 and 2021.
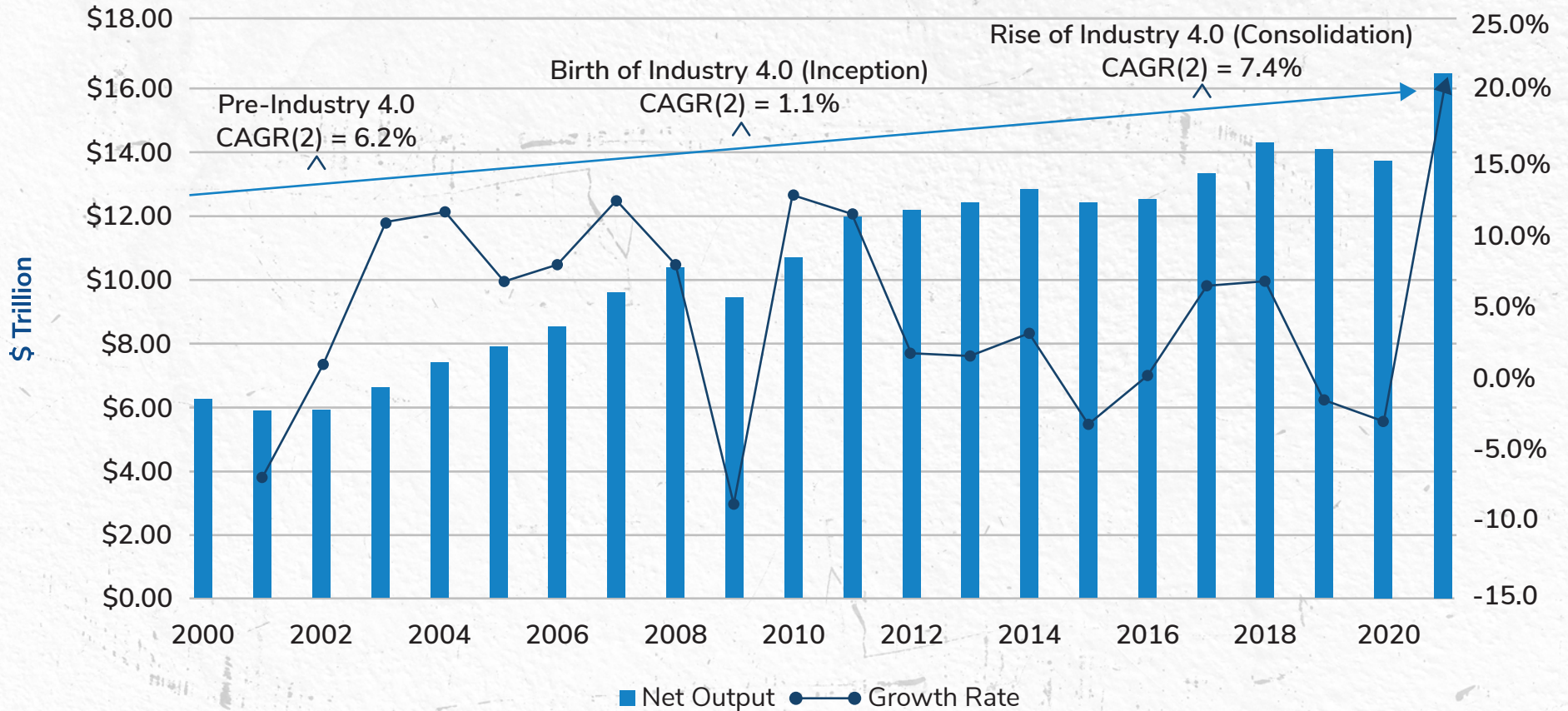
Industrial Production, Global, 2010-2021[1]
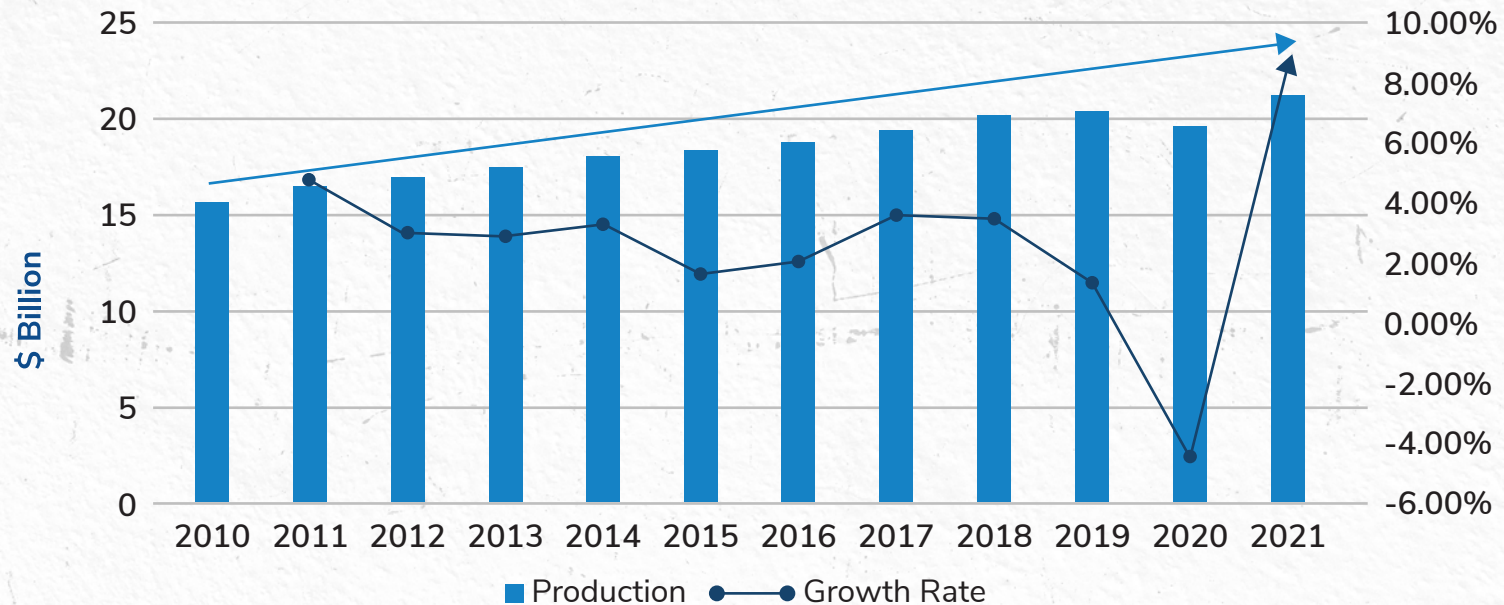
Notes:
(1) World Bank member countries, seasonally adjusted figures
(2) CAGR: Compound Average Growth Rate

Sources: Statista, World Bank

Manufacturing Net Output, Global, 2000-2021[1]

Pre-Industry 4.0
CAGR(2) = 6.2%

Birth of Industry 4.0 (Inception)
CAGR(2) = 1.1%

Rise of Industry 4.0 (Consolidation)
CAGR(2) = 7.4%

■ Net Output ●— Growth Rate

Notes:
(1) World Bank member countries, national accounts data, seasonally adjusted figures
(2) CAGR: Compound Average Growth Rate
(3) Manufacturing refers to industries belonging to United Nations' International Standard Industrial Classification (ISIC) divisions 15-37.

The global manufacturing net output (value added) has witnessed a 7.4% CAGR since the consolidation of Industry 4.0 (2017 onwards)—the highest level since 2000.

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Sources: World Bank

The emergence and widespread adoption of technologies (such as the Internet of Things (IoT), AI, additive manufacturing, cloud computing, edge computing, digital twins, Big Data analytics, digital ind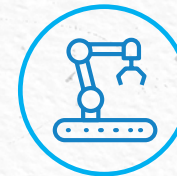ustrial platforms, augmented/virtual/mixed reality (AR/VR/MR), industrial cybersecurity, IIoT connectivity, smart sensing, and advanced robotics) and enablers (such as IT/OT convergence and open automation standards) have blurred the boundaries between the physical and the digital/virtual world. This has created new industrial paradigms, such as smart manufacturing and smart factories.

Different Technologies

| Internet of Things (IoT) | AI | Additive Manufacturing | Cloud Computing | Edge Computing | Digital Twins | Big Data Analytics |

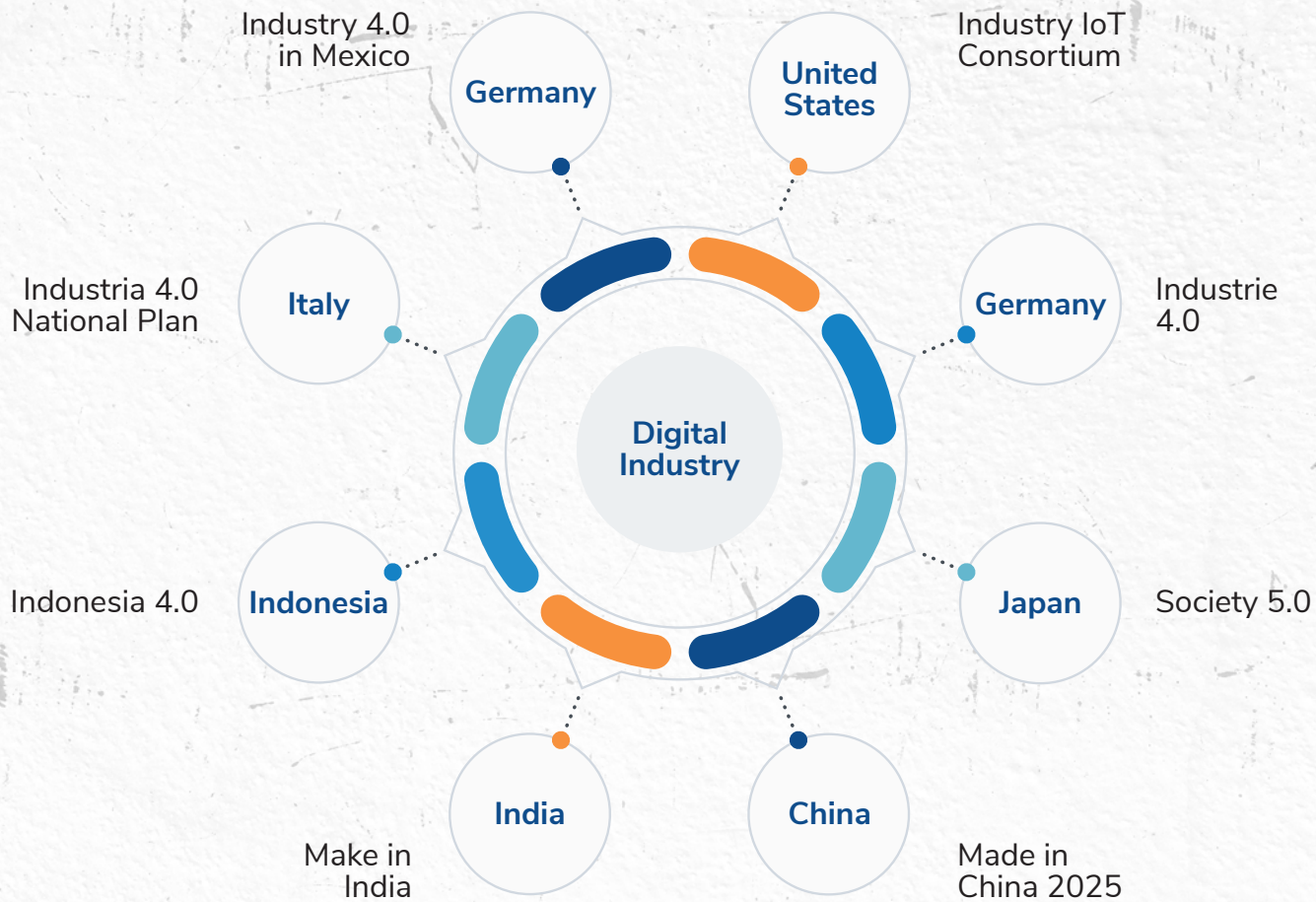| Digital Industrial Platforms | Augmented/ Virtual/Mixed Reality (AR/VR/MR) | Industrial Cybersecurity | IIoT Connectivity | Smart Sensing | Advanced Robotics |

Enablers

| IT/OT Convergence | Open Automation Standards |

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Industry 4.0's massive societal impact led leading manufacturing countries (e.g., the United States, China, Japan, Germany, India, and Italy) to launch strategic government initiatives and programs that will enable digital transformation across diverse industries and act as a core factor for sustainable economic growth and development.

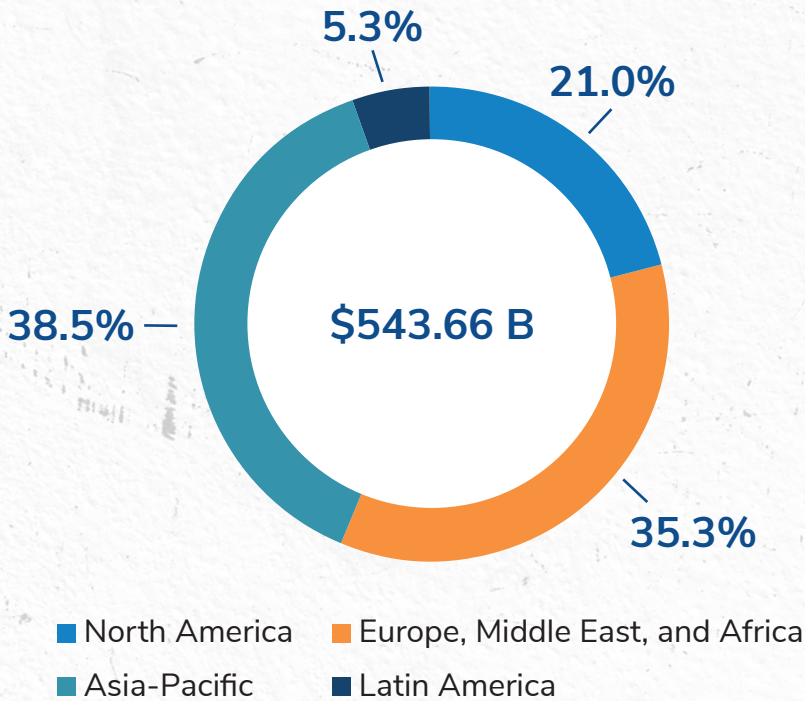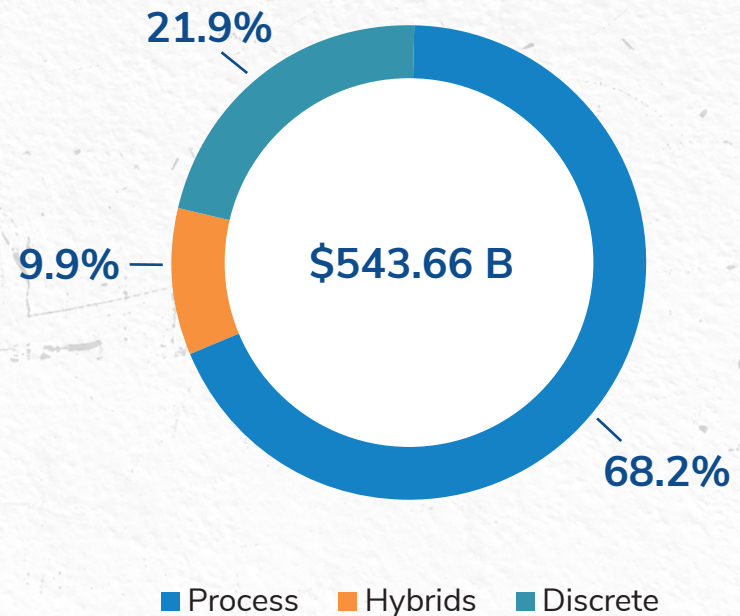Industry 4.0 in Mexico — Germany
Industry IoT Consortium — United States
Industria 4.0 National Plan — Italy
Industrie 4.0 — Germany
Indonesia 4.0 — Indonesia
Society 5.0 — Japan
Make in India — India
Made in China 2025 — China

Digital Industry

The Industry 4.0 Market at a Glance

$457.54 B	CAGR 9.0% →	$543.66 B
2022 Global Total Addressable Market for Industry 4.0		2025 Global Total Addressable Market for Industry 4.0

Total Addressable Market for Industry 4.0 by Region, Global, 2025

5.3%
21.0%
38.5%
$543.66 B
35.3%

- North America
- Europe, Middle East, and Africa
- Asia-Pacific
- Latin America

Total Addressable Market for Industry 4.0 by Industry, Global, 2025

21.9%
9.9%
$543.66 B
68.2%

- Process
- Hybrids
- Discrete

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Market Definition

The Industry 4.0 market includes digital solutions (hardware, software, and life cycle services) that drive business innovation and operational transformation across the industrial, energy, and manufacturing markets. These solutions can focus on a specific value chain function or span the end-to-end industry value chain, including design, simulation, sourcing and supply chains, operations and manufacturing, customer experiences, and life cycle services.

Market Drivers
Key Drivers for Industry 4.0 Adoption

Sustainability

Because they produce actionable insights through data analysis, Industry 4.0 technologies make more efficient and cleaner business operations possible and focus on CO2 footprint reduction, energy-efficient technology use, and waste reduction.

Tech-savvy Workforce

Knowledge and expertise in fields such as communication protocols, data management, advanced analytics, and application programming are a must-have for any industrial organization going through a digital journey. The modern, digital-native technical workforce is increasingly mastering these domains and fulfilling industries' demands.

Competitiveness

The environment is highly competitive due to the intensely fragmented market and participant diversity, which results in the increased availability and adoption of numerous Industry 4.0 offerings.

Government Initiatives, Technical Bodies

Market growth drivers include government incentives and funds for Industry 4.0 technology adoption as an industrial enabler for sustainability (Industrie 4.0, Made in China 2025, Make in India), the establishment of legal regulatory frameworks, the emergence of technology-related consortiums (the Industrial IoT Consortium, the Digital Twin Consortium), alliances (Open Industry 4.0 Alliance, Open Manufacturing Platform), and groups (such as the FDT Group) working to establish technical standards.

Innovative Business Models

The industrial manufacturing space has successfully embraced and adopted the value-based and outcome-driven XaaSification and servitization business models. These include software-as-a-service (SaaS), platform-as-a-service (PaaS), equipment-as-a-service (EaaS) subscription models. They allow:
- More predictable and sustainable new revenue streams
- Faster growth and rapid Return on Investment (RoI) – as every new customer increases revenue at a minimal increment in cost)
- Enhanced customer satisfaction

End users pay only for what they consume.
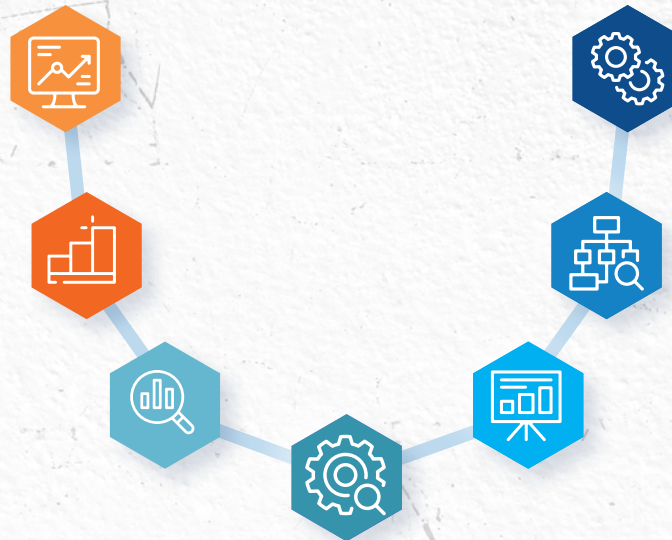
Market Restraints

Legacy Systems
Factory assets that are more than two decades old are rarely compatible to digitization.

Industry Expertise
A lack of in-depth industry knowledge among third-party Industry 4.0 vendors hinders rapid scaling of the digitization ladder.

Capital Expenditure
Manufacturing companies are reluctant to spend on digitization without a proof-of-concept.

Multiple Vendor and Protocol Variety
Multiple protocols and third-party IIoT vendor inclusion are making supply chains even more complex and more vulnerable to risk.

Profitability from Data Analytics
Under-utilization of installed sensors is a major manufacturing sector obstacle.

Macroeconomic Context
Economic slowdown, recession, the Russo-Ukrainian conflict, chip shortages, and inflation rates not seen in decades are hindering technology investments.

Supply Chain Disruption
Current market supply and demand dynamics present a challenge for manufacturers. High consumer demand, increased material and freight costs, and sluggish deliveries are all causing system-wide complications for purchasing executives.

Post COVID-19 Pandemic Implications

The COVID-19 pandemic crisis has catalyzed the digital transformation of the industrial and manufacturing landscape. It has brought business leaders and industry executives into a new reality shaped by an uncertain landscape. The need for versatility, resilience, agility, intelligence, creativity, and quick decisions has never been so critical, and the following post-COVID-19 pandemic implications dominate the market:

TRENDS

▶ Increased demand for new digital business strategies
▶ Accelerated adoption of Industry 4.0-related technologies

CHALLENGES

▶ New levels of operational excellence due to labor shortages, adverse macroeconomic conditions (inflation, supply chain disruption), and the rise of sustainability and net-zero initiatives

GROWTH OPPORTUNITIES | CALL TO ACTION

▶ M&As and Strategic Partnerships ⟶ To gain market share and expand digital product portfolios

▶ Sustainability and Net-zero Initiatives ⟶ To reduce CO_2 footprint and energy consumption, achieving "greener" businesses

▶ Asset Performance Management ⟶ To reduce operating costs, operating risks, and increase productivity

▶ Digitalization of Industry Knowledge ⟶ To capture retiring aging workforce knowledge and expertise
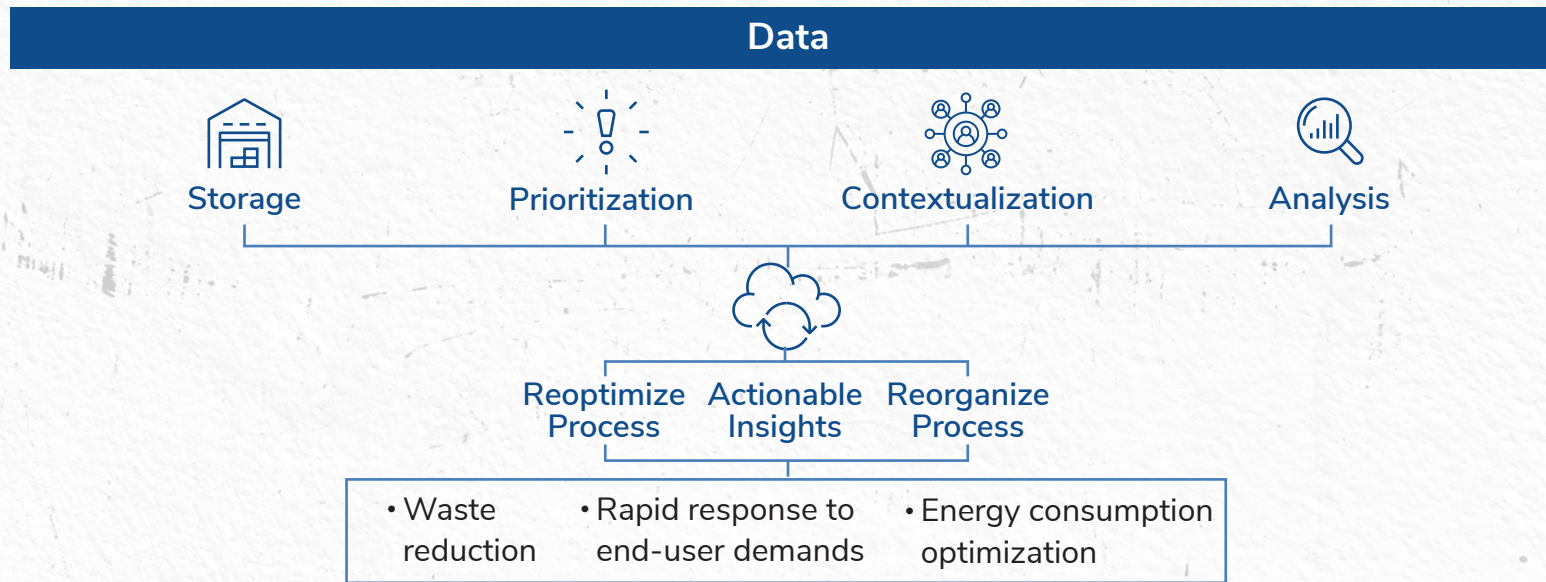
Sources: Frost & Sullivan

Why Industries Should Embrace Digital Transformation

Digital transformation has become a requirement for surviving in today's industrial world. While formerly a typical mid-term objective, challenging market conditions have made technology investment and digitalization a top priority among all industries.

Now a decade since the inception of Industry 4.0, Frost & Sullivan sees that the use of technology has entered the mainstream. Despite differences in digital maturity, pragmatists and conservatives (the majority of end users) are embracing digital transformation at the same pace as innovators (technology enthusiasts) and early adopters (visionaries). Those who remain skeptical or show considerable resistance to embracing digital transformation are suffering consequences, such as not staying competitive or (in many cases) being forced to abandon the market.

Industry 4.0 has turned data into the most valuable, transformational, and strategic asset, the "golden thread." Leveraging that data to create knowledge and actionable insights to optimize enterprise-wide businesses and operations will determine the success of industrial organizations.

Data

Storage   Prioritization   Contextualization   Analysis

Reoptimize Process   Actionable Insights   Reorganize Process

- Waste reduction
- Rapid response to end-user demands
- Energy consumption optimization

Companies and organizations that have embraced the digital transformation journey are now experiencing numerous benefits, such as:

- Increased production efficiencies (up to 30%):
  - Reduced emissions (up to 25%) and waste (up to 20%)
  - Improved energy efficiency (up to 40% consumption reduction)
  - Improved safety and work conditions (60% to 90% of routine, labor-intensive tasks can be automated via AI)
- Reduced operational costs (up to 25%)
  - Flexible and decentralized production
  - Integrated value chain through the digital thread
- Improved capital utilization
  - Reduced downtime
  - Reduced inventory rate
- Improved quality
  - Mass customization
- New business models and revenue streams
  - Service-based, subscription-based revenue models ⟶ e.g., SaaSification, where a software-as-a-service (SaaS) model has become the most successful and widely adopted business model and revenue stream for digital industrial companies
- Benefits:
  - Lower total cost of ownership (TCO)
  - Security and scalability
  - Improved user experience
  - Availability and mobility
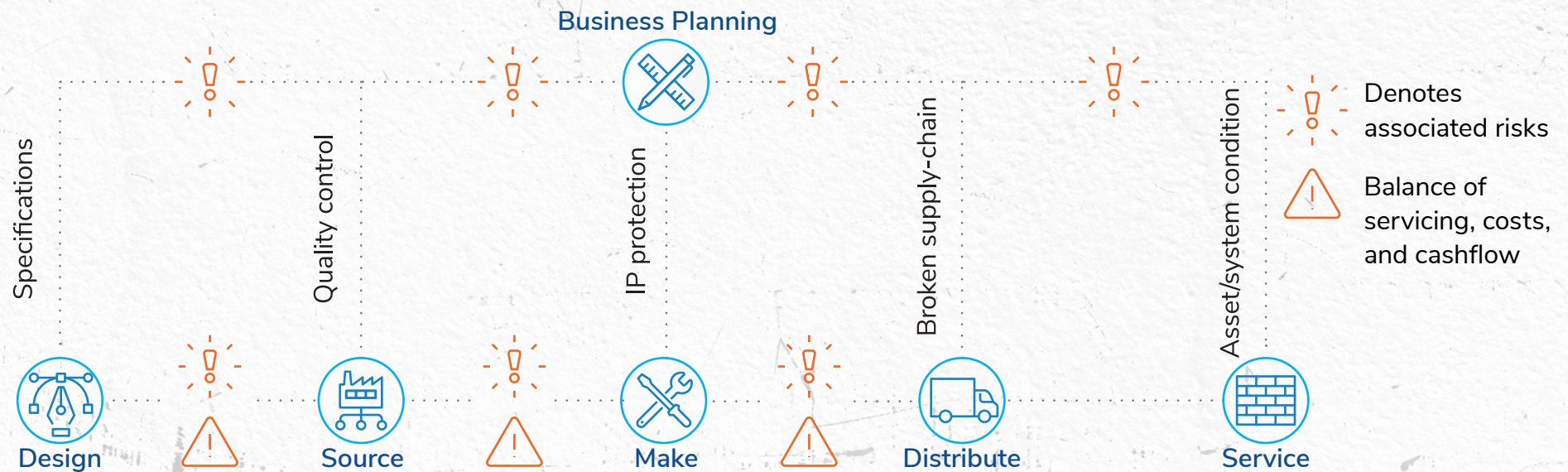- Pay-per-use models
- Outcome-based models

Value Chain and the Digital Thread

Although manufacturing and operations occupy a central stage in the Industry 4.0 era, the application of digital technologies and adoption of digital transformation is limited to manufacturing. It extends to enterprise-wide business operations and the entire product value chain. In fact, Industry 4.0 is changing the value chain paradigm:

Current Value Chain, 2023 – Linear, Disjointed, and Reactive

Business Planning

Specifications · Quality control · IP protection · Broken supply-chain · Asset/system condition

Denotes associated risks

Balance of servicing, costs, and cashflow

Design · Source · Make · Distribute · Service

Data silos, reactive schedule control, poor customer centricity

Follows product, process or people

Conflicting KPIs

Unmanageable lead times

Surplus inventory

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Source: Microsoft Supply Chain Paper; Frost & Sullivan

Future Value Chain, 2030 – Circular, Integrated, and Predictive

Upgrades

Design

Maintenance and Reliability

CX Platform

Engineering

Operations

Manufacturing

Responsive customer-centric value chain

Follows data

Digital tech enabled

Optimized operations

E2E view of the lifecycle

Source: Microsoft Supply Chain Paper; Frost & Sullivan

The Digital Thread

Services

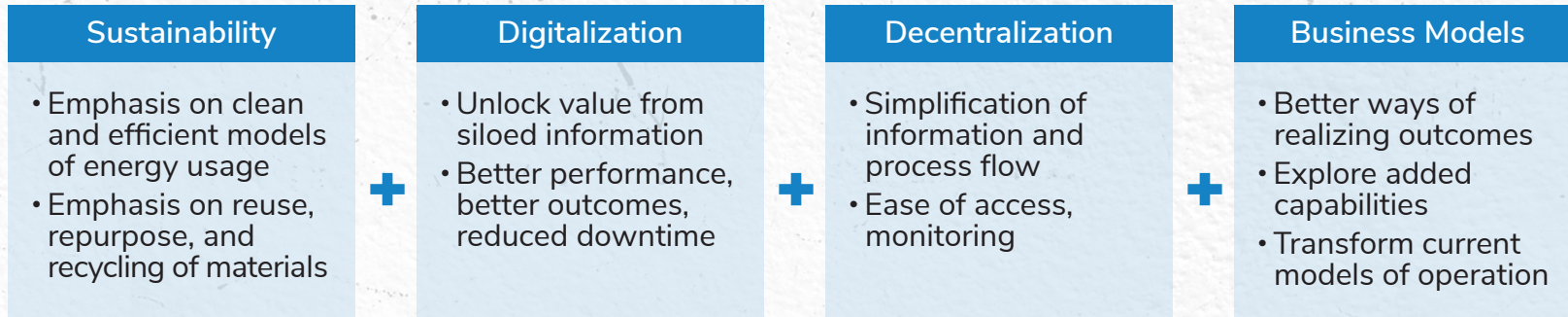Engineering
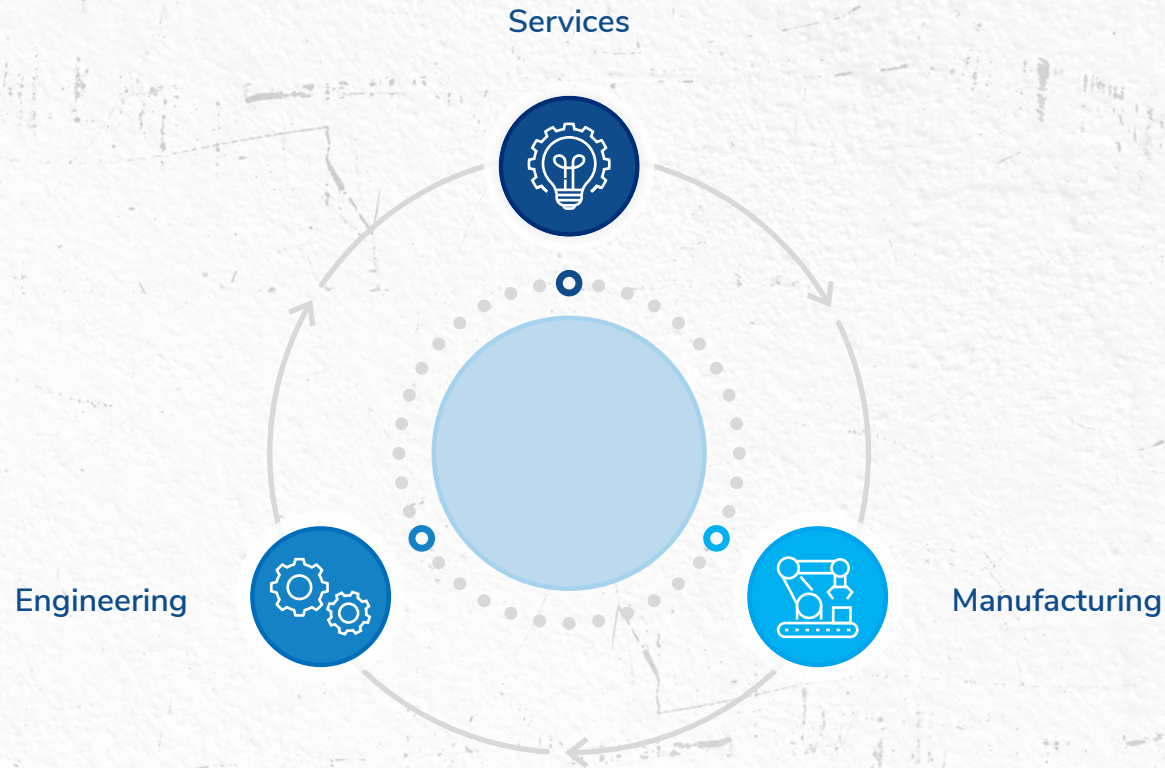
Manufacturing

Digital technologies are revolutionizing every aspect of the product value chain, including design, simulation, sourcing, and supply chains; operations and manufacturing; customer experiences; and life cycle services. They can also create a closed loop between the physical and digital worlds to transform the way products are engineered, manufactured, and serviced, thereby enabling the digital thread.

The Digital Thread

In the Industry 4.0 era, sustainability, digitalization, decentralization, and business models are the four underlying factors to focus on and invest in for a complete enterprise-wide industrial transformation. Key benefits are:

Sustainability		Digitalization		Decentralization		Business Models
• Emphasis on clean and efficient models of energy usage • Emphasis on reuse, repurpose, and recycling of materials	**+**	• Unlock value from siloed information • Better performance, better outcomes, reduced downtime	**+**	• Simplification of information and process flow • Ease of access, monitoring	**+**	• Better ways of realizing outcomes • Explore added capabilities • Transform current models of operation

Decarbonization

4IR and 5IR

Edge Computing

XaaS (Anything-as-a-Service)

Energy Efficiency

Cloud and Cybersecurity

Blockchain

Data-as-a-Service

Circular Economy

AR/VR

Ops Decentralization

Shared Economy

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Source: Frost & Sullivan

How to Plan and Execute an Enterprise-wide

Industry 4.0 and digital transformation are more than just a technology transformation; they are all about redefining an organization's strategy and cultural mindset, empowering employees to embrace change, and utilizing technology to accelerate the value creation for clients and stakeholders.

A transformation strategy is based on three pillars, also known as the PPT Framework: People, Processes, and Technologies.

- People will need to be upskilled and reskilled to perform their jobs better and experience a behavioral shift.

- Processes should be streamlined, simplified, and optimized.

- Technology by itself will not accomplish much without the people and processes around to support it, and as such, technology should not lead the transformation. The transformation should guide technology adoption and implementation.

Technologies

People   Processes

Source: Frost & Sullivan
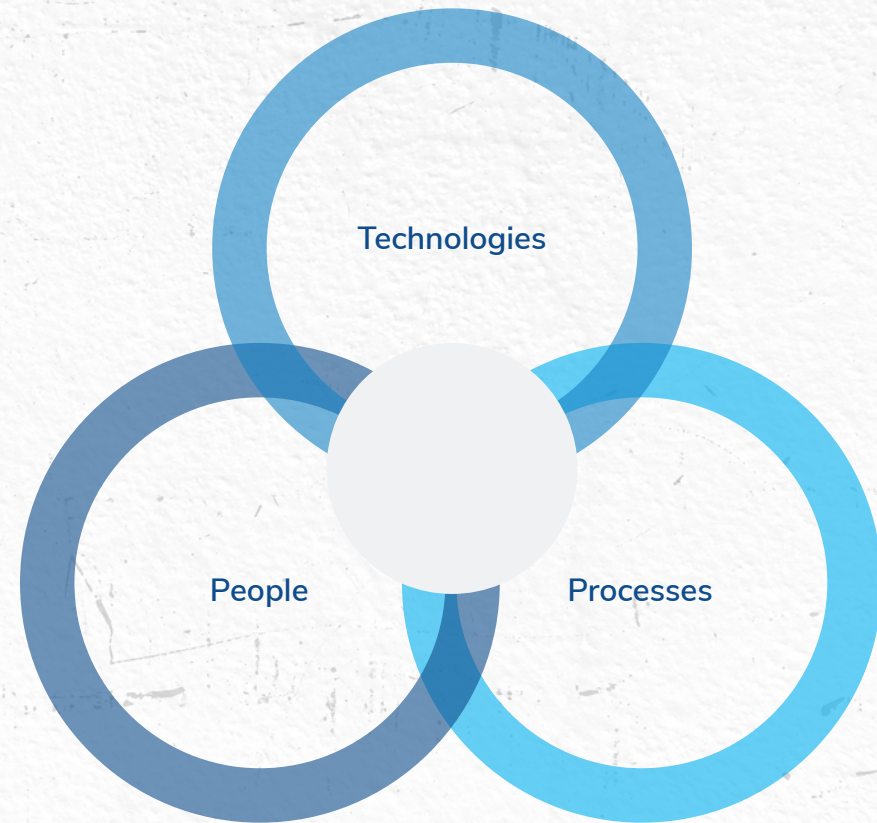
How to Plan and Execute an Enterprise-wide

These three components must be balanced and coordinated for a successful enterprise-wide transformation. They must also be supported by a corporate change management program that is driven by a governance model, a top-down/bottom-up buy-in approach, and a focus on the following workforce dynamics:

Leadership

Timing

Employee Experience

Augmented Workforce

Engagement Culture

Enhanced Collaboration

Innovation and Creativity

Lifelong Learning

Talent Retention

Winning Strategy—Frost & Sullivan's 6 Principles for a Successful Digital Transformation

1 Think of business objectives, then follow with technology implementation

2 Wrap and extend legacy investments, do not rip and replace

3 Create the best, most compelling, and most differentiated customer experiences; shift from Proof of Concept (PoC) to Proof of Value (PoV)

4 Align ⟶ Implement ⟶ Scale ⟶ Optimize

5 Use predictive intelligence

6 Monetize benefits and improvements ⟶ RoI
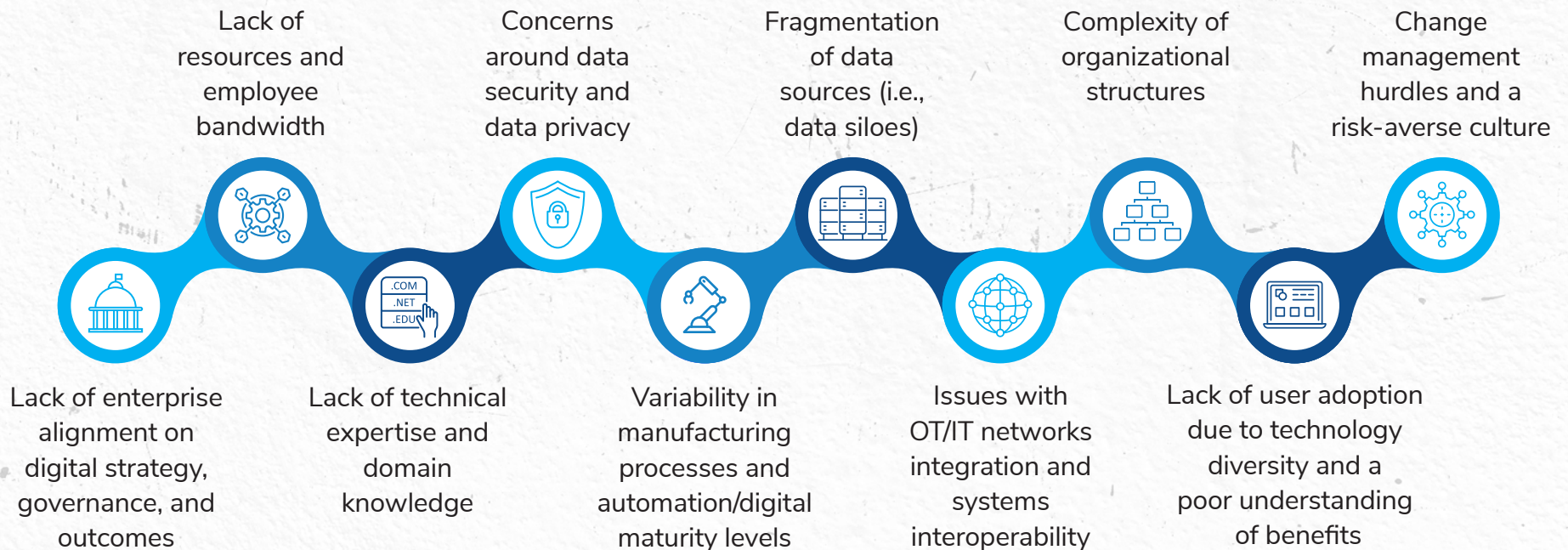
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How to Overcome Digital Transformation

The golden premise of any Industry 4.0 project is: think big, begin now, start small, build momentum, prove value quickly, and scale fast. However, this simple statement hides two complex challenges that nearly 65% of industrial companies face when embarking on a digital transformation project: pilot purgatory, or the failure to straightforwardly scale pilot projects (such as PoCs), and scale purgatory, or the failure to capitalize on pilots and promptly capture the desired impact at scale. A few scale purgatory challenges include poor alignment with financial outcomes, difficulty scaling use cases, a lack of awareness and alignment across the organization, and poor change management.

Frost & Sullivan estimates say that although 80% (and growing) of industrial companies have invested in implementing an enterprise-wide digital strategy, nearly 65% have failed to accomplish real, significant Industry 4.0 business value.

Several technological-related and organizational-related pitfalls combine to industrial companies falling into either pilot or scale purgatory, such as:
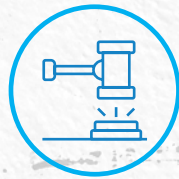
Lack of resources and employee bandwidth

Concerns around data security and data privacy

Fragmentation of data sources (i.e., data siloes)

Complexity of organizational structures

Change management hurdles and a risk-averse culture

Lack of enterprise alignment on digital strategy, governance, and outcomes

Lack of technical expertise and domain knowledge

Variability in manufacturing processes and automation/digital maturity levels

Issues with OT/IT networks integration and systems interoperability

Lack of user adoption due to technology diversity and a poor understanding of benefits

A value-led Industry 4.0 project implementation will allow an industrial organization to:

| Overcome the pilot and scale purgatory | Add a layer of strategy | Lay the governance groundwork | Define where to use limited resources for the best return | Achieve a rapid Return on Investment (RoI) | Get the most significant actionable insights from data | Create a data-driven organization |

An optimal Industry 4.0 value-led proposition should be centered on a strategy that focuses on and removes manufacturing process constraints that create bottlenecks and waste:

Industry 4.0 Value-led Proposition

Plan — **Prove** — **Scale**
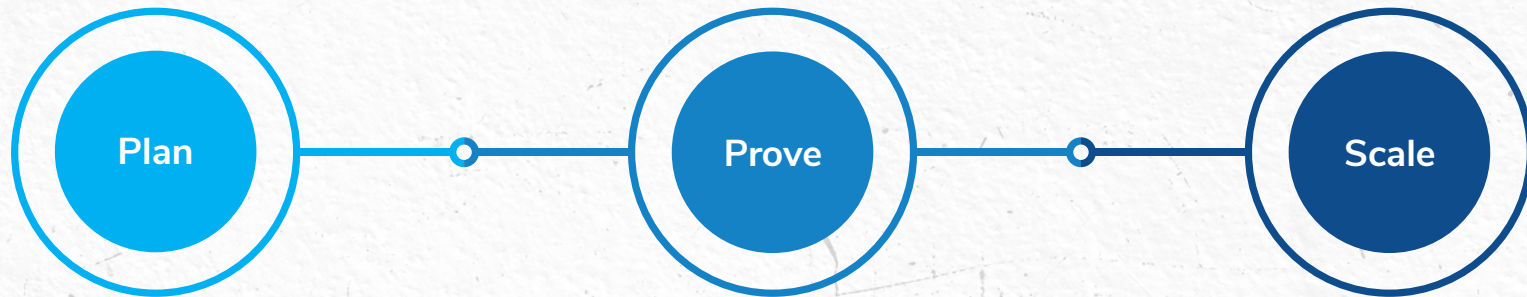
Plan
- Identify Business Value
- Assess Business Value
- Develop Roadmap

Prove
- Digital Technology
- Capture Value (PoV)
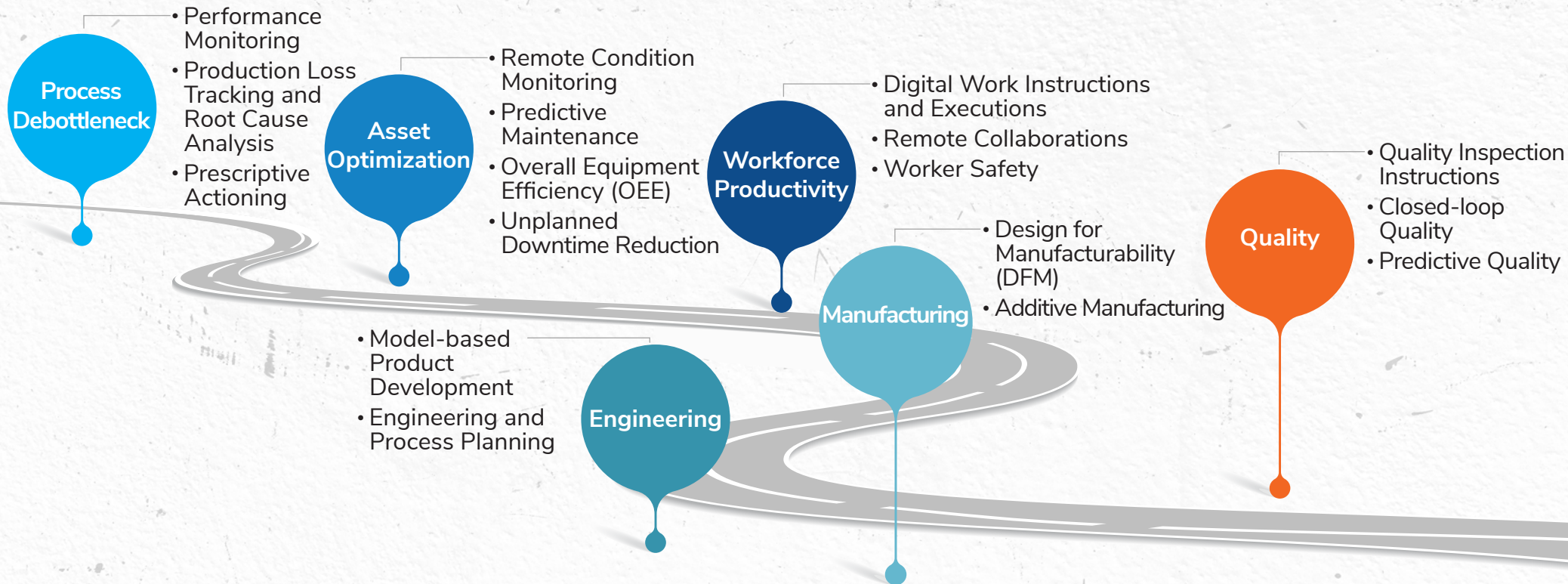- Debottleneck
- Speed

Scale
- Expand Value
- Iterate
- Impact

The focus on a tactical, technology-led implementation rather than a strategic, value-led implementation leveraged by a business case with clear financial impact is the main reason companies fall into purgatory.

How Are Industrial Companies Benefiting from a Digital Transformation Journey?

Frost & Sullivan estimates that nearly half of industrial companies worldwide are experiencing some measurable benefit from turning data into actionable insights and fully realizing business outcomes, depending on the company's digital maturity level. The industrial application of digital technologies has led to a plethora of use cases that enable factory transformation and directly impact revenues, operational excellence, production efficiency, operating costs, productivity, worker conditions, quality, service optimization, and customer satisfaction.

Process Debottleneck
- Performance Monitoring
- Production Loss Tracking and Root Cause Analysis
- Prescriptive Actioning

Asset Optimization
- Remote Condition Monitoring
- Predictive Maintenance
- Overall Equipment Efficiency (OEE)
- Unplanned Downtime Reduction

Workforce Productivity
- Digital Work Instructions and Executions
- Remote Collaborations
- Worker Safety

Quality
- Quality Inspection Instructions
- Closed-loop Quality
- Predictive Quality

Manufacturing
- Design for Manufacturability (DFM)
- Additive Manufacturing

Engineering
- Model-based Product Development
- Engineering and Process Planning

Companies can use numerous methods and use cases to start their factory transformation journey. According to Frost & Sullivan research, implementing a debottlenecking process in production constraint areas will have the greatest impact in the shortest amount of time.

Case Studies

The following four case studies highlight concrete evidence of an Industry 4.0 value-led proposition and a successful digital strategy implementation:

Case Study #1: Successful Digital Transformation Strategy at Enterprise Scale

- Company: Eaton
- Plan: Drive a complete Industry 4.0 transformation across 9 sites worldwide consisting of a strong digital foundation, ready-to-use applications, and enterprise program governance
- Solution: Digital Performance Management (DPM), Asset Monitoring and Utilization (AMU), Connected Work Cells (CWC)
- Prove: First 3 sites live in 9 months
- Scale: All 9 sites live in 12 months
- Impact: 10-15% improved OEE; 12% reduced unscheduled maintenance; 15% reduced manual efforts

Case Study #2: Achieving Plant-wide Operational Excellence

- Company: Bharat Forge (Kalyani Group)
- Plan: Streamline manufacturing operations and improve efficiency at scale
- Solution: PTC ThingWorx and PTC Kepware
- Prove: One forging and machining line
- Scale: All forging and machining lines
- Impact: 15% improved OEE; reduced operational costs and improved efficiency; established an "Industry 4.0 Center of Excellence" for continuous innovation and improvement

Case Study #3: Improving Visibility with Critical Bottleneck Identification

- Company: Evyap
- Plan: Reduce scrap levels, improve safety, and improve quality through digitalization
- Solution: PTC ThingWorx and PTC Kepware Server
- Prove: One diaper production line
- Scale: All 50 production lines
- Impact: Reduced scrap by 23% (about 2 million diapers or $250,000 saved, resulting in positive RoI in less than two years); saved 1,500 hours by digitalizing all paper forms; 60% improved safety incident rate

Case Study #4: Factory Asset Optimization and Workforce Empowerment

- Company: Rockwell Automation
- Plan: Standardization across operations
- Solution: FactoryTalk Innovation Suite powered by PTC
- Prove: One facility
- Scale: Six global facilities
- Impact:
  - Intelligent asset optimization (use case): 33% increased labor efficiency, 70% increased output, 50% reduced training time, 8% increased productivity, 51% reduced paste-related defects
  - Digital workforce productivity (use case): 75% reduced line starved-condition downtime; 13% increased labor efficiency, 30% reduced training time
  - Enterprise operational intelligence (use case): 80% reduced recall rate

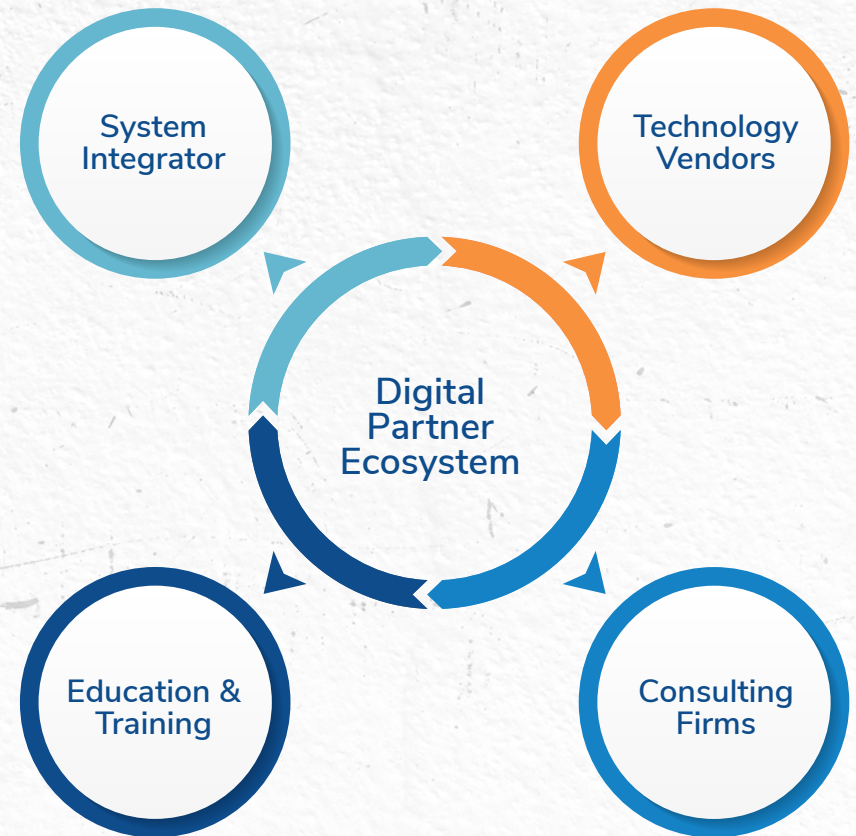Sources: Frost & Sullivan
PTC website (**www.ptc.com**)

Choosing the Right Partner Ecosystem for Your Industry 4.0 Journey

The advent of the digital revolution in the industrial and manufacturing landscape has led some companies to embark on their digital transformation journey with a do-it-yourself (DIY) approach instead of partnering with digitally native organizations. This often leads to overreach and a failure to implement a digital strategy and digital technologies. This DIY approach has well-known drawbacks, such as:

- Building applications from scratch
- Higher TCO due to hidden testing and maintenance costs and a lack of agile software development processes
- Platform and application sprawl
- Poor security and scalability capabilities
- Greater time-to-value

These drawbacks can be easily avoided with a proper digital partner ecosystem where technology vendors play a key role. Nobody knows your process better than you and has the industrial domain knowledge required to optimize your production. Focus on diagnosing your production network, identifying the constraint areas, performing a root cause analysis of bottlenecks, identifying the proper digital use case, and quantifying the value. Let your digital partners help you achieve that value in a speedy and impactful way.

System Integrator

Technology Vendors

Digital Partner Ecosystem

Education & Training

Consulting Firms

FROST & SULLIVAN

Sources: Frost & Sullivan

What to Look For in a Technology Vendor

Industrial companies need a leading extensible, future-proofed edge-to-cloud digital platform technology stack that provides and delivers:

Rapid time-to-value

A full portfolio of pre-built, industrial use case applications aligned to the top use case

Deployment flexibility, scalability, and security

Easy-to-use domain expertise

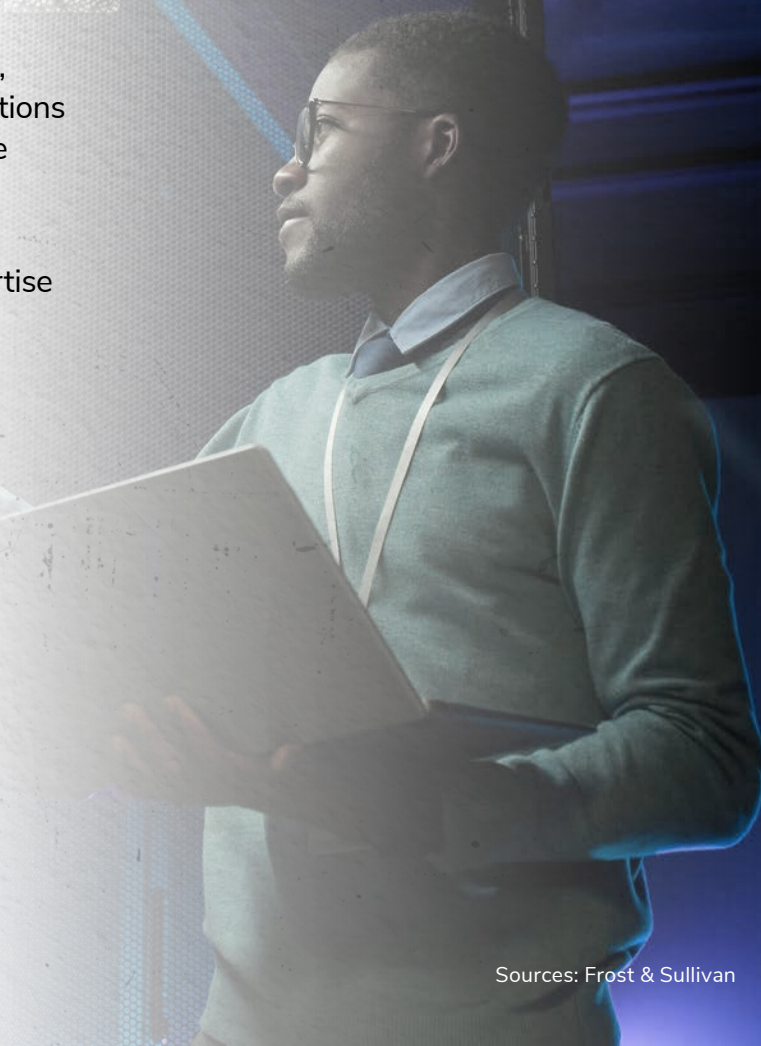Advanced data management and industrial analytics capabilities

SaaS offerings

An ability to wrap and extend to existing systems and assets

Global scale

An easy connection to all types of industrial machines, devices, and assets

FROST & SULLIVAN

Sources: Frost & Sullivan

How PTC Helps Industries Drive Their Industry 4.0 Journey

PTC has a long-standing leading industrial software solution tradition and established itself as one of the most reputable, innovative companies in the Industry 4.0 market by demonstrating a relentless focus on maintaining overall customer experience leadership.

PTC's ThingWorx IIoT platform, built by a team with deep manufacturing domain expertise, is widely recognized as a market leader, particularly for its connectivity, analytics, data modeling, application enablement, and visualization capabilities. The latest addition to the ThingWorx portfolio, Digital Performance Management (DPM) leverages PTC's premise of connecting and integrating the physical and digital worlds to enable real-time, priority-driven, closed-loop manufacturing problem solving by identifying, actioning, and validating the top improvement opportunities with a direct link to financial impact.
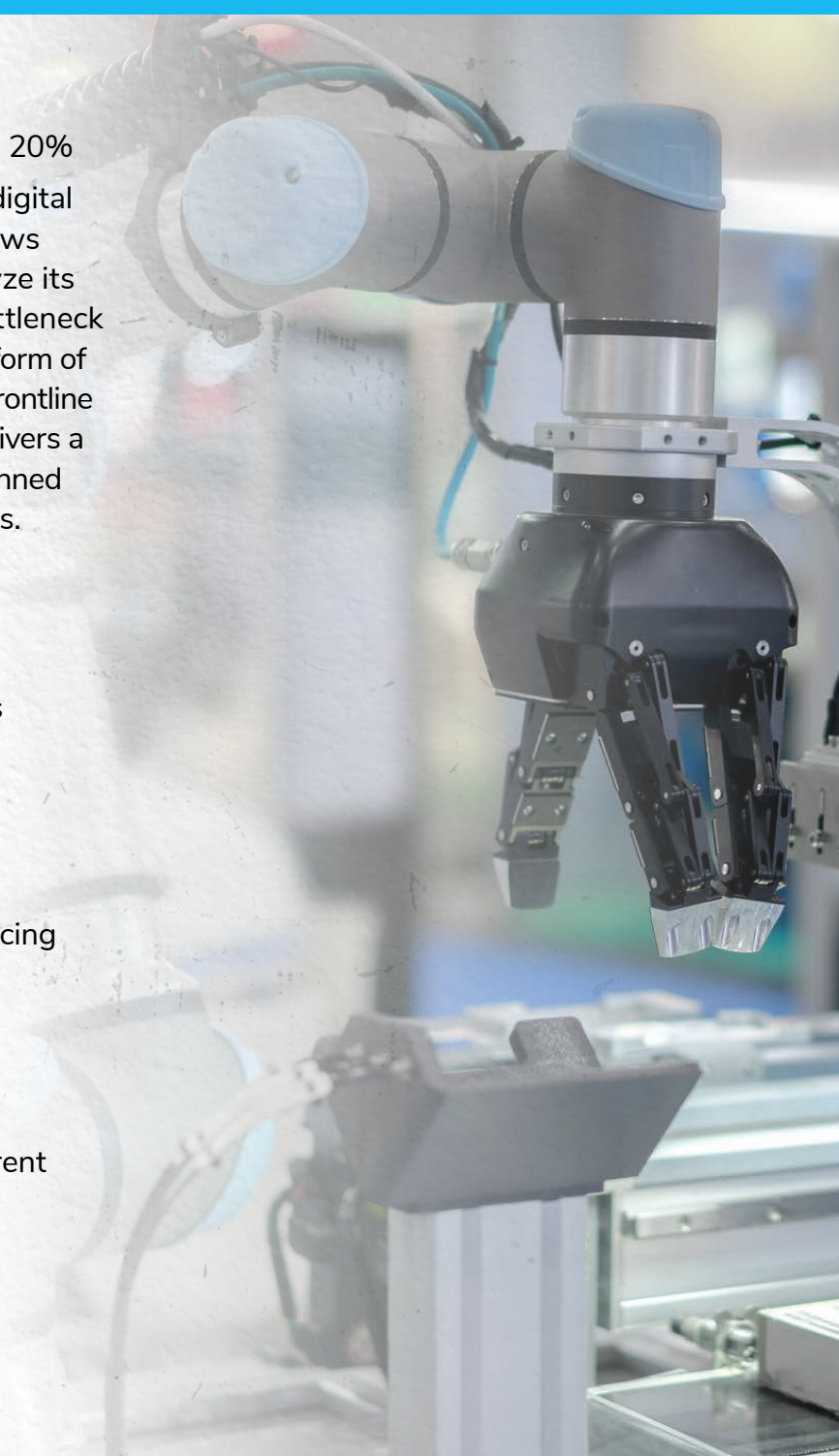
PTC is uniquely positioned to deliver the best experience for a value-centric, self-guided digital transformation journey, thus becoming the preferred digital partner as:

- PTC delivers an unmatched value proposition characterized by an enterprise top-down, prescriptive approach and a value-centric customer engagement strategy.

- PTC offers best-in-class, out-of-the-box enterprise technology and a market-leading pre-built applications portfolio that is deployed on top of its ThingWorx IIoT platform, such as:
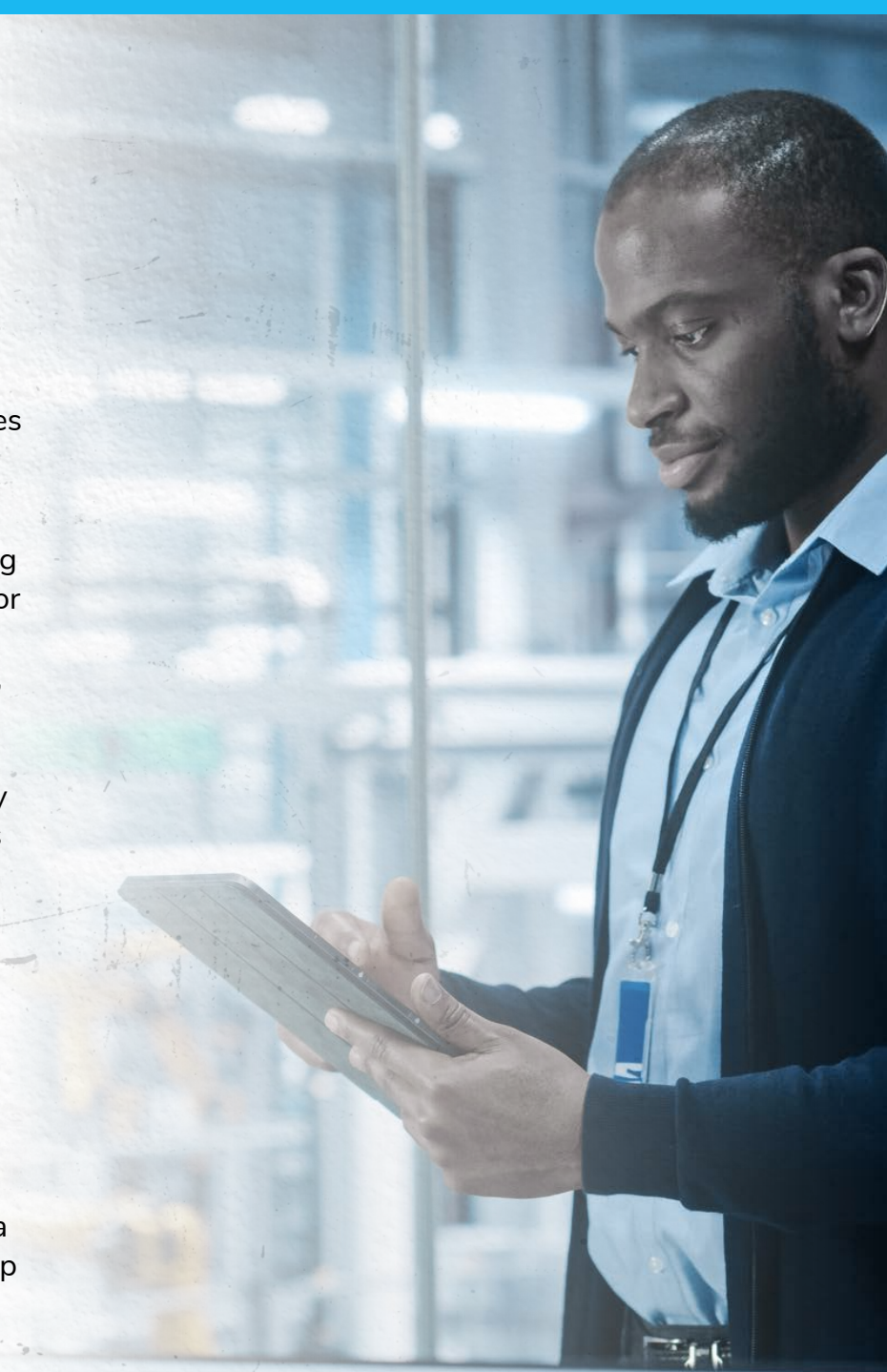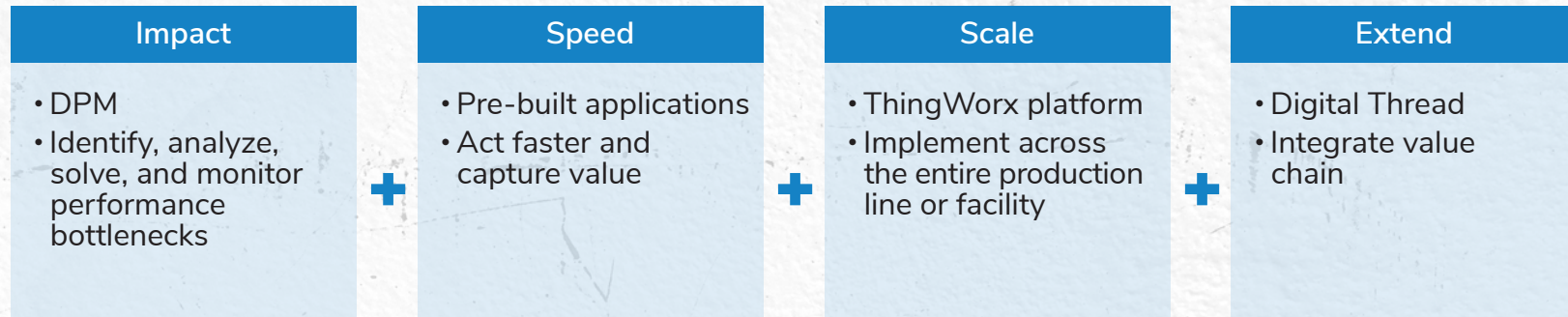
- Process debottlenecking leads to overall efficiency improvement by 5 to 20%
  - ThingWorx DPM, PTC's keystone solution, sits at the center of the digital transformation journey with its enterprise-level capabilities as it allows companies to identify the production performance bottleneck, analyze its root cause, determine the appropriate technology use-case to debottleneck the problem, then improve, confirm, iterate, and scale. This is all in the form of a closed-loop operational performance improvement model that links frontline operational data to the bottom-line financial impact. In the end, this delivers a 5 to 20% initial increase in productivity by reducing planned and unplanned downtime, changeover time, speed losses, small stops, and scrap losses.
- Asset optimization leads to downtime reduction:
  - Asset Monitoring and Utilization
  - Predictive Maintenance
- Workforce productivity leads to operator efficiency improvement, thus reducing changeover time:
  - Connected Work Cell
  - Augmented Work and Training Instructions
  - Augmented Remote Assistance
- Quality improvement leads to defects and rework reduction, thus reducing cost of quality:
  - Quality Inspection Instructions
  - Predictive Quality
  - In-line Quality Control
- Digital thread leads to speed to industrialization, thus avoiding concurrent engineering and eliminating errors:
  - Design for Manufacturability
  - Manufacturing Planning
  - Engineering Change Management

PTC's Industry 4.0 Value-led Proposition

Impact		Speed		Scale		Extend
• DPM • Identify, analyze, solve, and monitor performance bottlenecks	**+**	• Pre-built applications • Act faster and capture value	**+**	• ThingWorx platform • Implement across the entire production line or facility	**+**	• Digital Thread • Integrate value chain

This guided, composable, priority-driven, value-led proposition quickly generates impactful quantifiable benefits:

- Impact:
  - 5-20 % maximum efficiency improvement (increase revenue)
  - 5-10% benefit in process industries
  - 5-15% benefit in batch industries
  - 5-20% benefit in discrete industries
  - 5% hour reduction (decrease of operating expenses)
  - 5% more changeovers
- Speed: 90-day PoV
- Scale: Up to 20 sites in 24 months
- Extend: 20% time-to-market reduction

Learn more about PTC's Industry 4.0 solutions at www.ptc.com/digital-transformation-strategies

The Last Word

Although each industrial revolution started with a true disruption and a paradigm change in production processes, Industry 4.0's complexity and capabilities have had an unprecedented impact on manufacturing. The massive amounts of generated data, the rise of digital technologies, and the introduction of applied sciences in manufacturing have combined to elevate operational excellence, efficiency, and productivity to unprecedented heights.

The industrial value chain is progressively switching from a linear, disjointed, reactive model to a circular, fully integrated, predictive, technology-adaptive, sustainable, and customer-centric scheme, enabling the digital thread across the enterprise-wide business. This is perhaps Industry 4.0's greatest impact.

The three building blocks of a successful digital strategy implementation are plan value, prove value, and scale value. This value-led approach ensures optimal business outcomes and financial impact for Industry 4.0 initiatives.

The solid foundation of Industry 4.0 technologies, as well as more customer-centric approaches, are leading to the creation of Industry 5.0 themes. The fifth industrial revolution should not be seen as a continuum of Industry 4.0, but instead as a parallel evolution that will take Industry 4.0 execution one step further. The focus of Industry 5.0 will go beyond building products and delivering services. It will extend to refreshed experiences, hyper-customization, full human-machine cooperation (where human intelligence will be in harmony with cognitive computing), self-aware technologies, and interactive products that will shake customers out of the status quo.

In order to be competitive and survive in this market, it is imperative for industrial companies to embark on a digital transformation journey with the right digital partner.

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