McKinsey & Company

Accelerating the value creation and adoption of Al in manufacturing

CxO document

The Digital Manufacturing Revolution - Harness AI to lead the future

The Revolution is Here: Embrace the Future of Manufacturing

Five technologies are revolutionizing Manufacturing —**IIoT**, machine learning, agentic AI, advanced robotics, and digital twins. Companies that embrace these innovations are achieving unprecedented gains in productivity, sustainability, and resilience. The time to act is now.

The Opportunity: Transform Operations, Drive Impact

Imagine a global network of Al-powered factories, connected by a common data platform, which can optimize operations in real time. Focusing on the 17 use cases that matter — like agentic Al at scale, digital twins and neural network for E2E process optimization — that deliver measurable value and reimagine processes end-to-end.

The Path to Scale: Proven Principles for Success

With a business led, people-centered and AI-powered approach. Together with our technology partners — Microsoft, AWS, SAP, C3.ai, Nvidia and more — we deploy proven playbooks that accelerate time-to-impact and unlock transformative growth.

Why McKinsey: Your Partner in Transformation

With deep expertise and proven cases, McKinsey, Quantum Black and our preferred technology partners helps you move from strategy to scaled transformation. Let's shape the future of manufacturing together.

The future is digital. Start your journey today.

The case – 5 technologies are transforming the way we do operations



Deep dive next

Potential impact











Industrial Internet of Things (IIoT) & Edge Computing

Real-time monitoring of assets, IoT sensors, connected worker solutions, digital worker productivity tools **Machine learning**

Predictive maintenance, supply chain optimization, energy optimization, OEE root cause analysis **Agentic Al**

Production and maintenance GenAl co-pilot, quality automated workflows, autonomous decision-making, and generative design Autonomous & Industrial Robotics

Smart material handling, pickand-place, assembly, and human-robot collaboration (cobots) Advanced Simulation & Digital Twins

Virtual commissioning, process optimization, what-if scenario planning, real-time production mirroring, launch and training

20-30% reduced downtim

Double OEE

20% inventory reduction

2-4× higher indirect labor productivity

3-6X higher direct labor productivity

2-3X faster launch

1 The case – Agentic Al is redefining your teams with the power of human-agent integration...

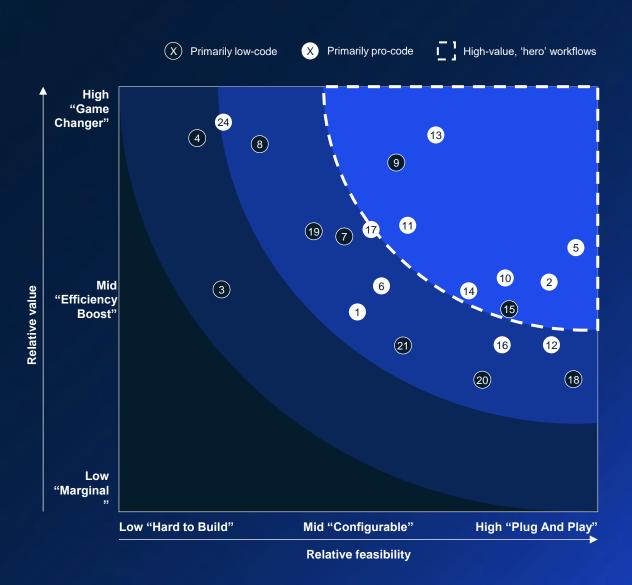


1 The case – ...where it can easily reinvent most workflows of indirect functions

Illustrative example

Operations







(2) The case - Industry leaders are going beyond automated warehouse and AGVs, venturing into testing humanoids

Three levels of humanoid autonomy emerging



REACTIVE



Responds to external stimuli (i.e. sensor input), performing repetitive or hazardous tasks with no decision-making capabilities



PARTIAL



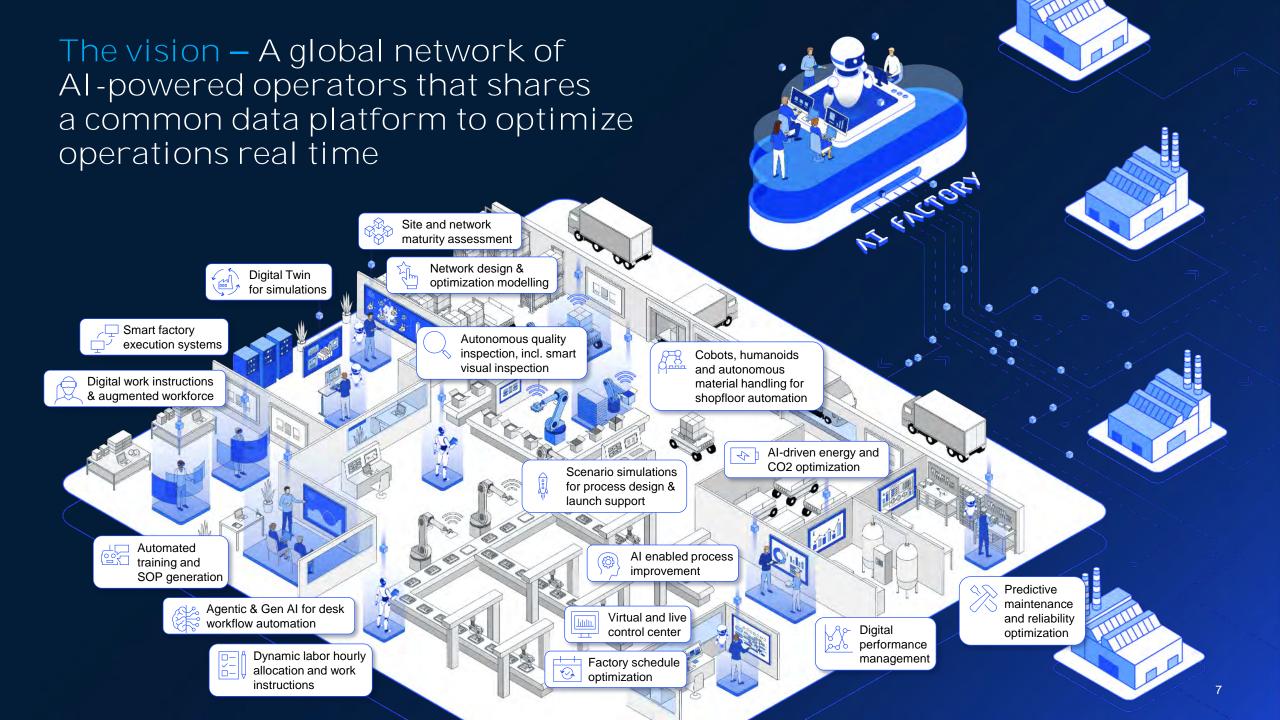
Adapts to specific applications using machine learning with limited decision-making, largely applied to address labor shortages



FULI



Operates independently, performing complex tasks across fields, learning from experience, and interacting seamlessly with humans



The use cases that matter – 17 use cases that will make the difference and should be your focus

Business needs			Potential impact	IIoT & Edge Computing	Machine learning	Agentic Al	Autonomous & Industrial Robotics	Advanced Simulation & Digital Twins
Optimized network & strategy	Site and network i	Site and network maturity assessment						$\overline{\mathbf{V}}$
o. a.ogy	Network design &	optimization modelling	5-10% conversion cost reduction					✓
Rapid & flawless launch and ramp-up	Scenario simulation support	ons for process design & launch	50% launch time acceleration				✓	$\overline{\hspace{1cm}}$
Efficient and built-in- quality manufacturing	Dynamic labor hor instructions	urly allocation and work	15-30% productivity improvements	V	✓			$\overline{\hspace{1cm}}$
	Digital performance	ce management	30% OEE increase	V	$\overline{\mathbf{Q}}$			
	Factory schedule	optimization	50% increased schedule adherence		$\overline{\mathbf{V}}$			
	Agentic and Gen	Al for desk workflow automation	25% reduction in team productivity					
	Cobots, humanoic handling for shopf	ds and autonomous material floor automation	80% labor productivity increase					
	Digital Twin for pro	ocess simulations	15% productivity uplift					$\overline{\mathbf{V}}$
	Al-driven process analysis	optimization and root cause	50% throughput increase					
	Live virtual control	l center	10% cycle time reduction	V				
	Autonomous quali inspection	ity inspection, incl. smart visual	40% scrap reduction from quality issues	V			\overline{V}	
	Smart factory exec	cution systems	+30% uplift in machine utilization	V				
Resource-efficient operations	Predictive mainter	nance and reliability optimization	30% downtime reduction	V				
	Al-driven energy a	and CO2 optimization	40% energy and carbon savings		V			
Rapid workforce reskilling	Digital work instru	ctions & augmented workforce	20% labor productivity uplift					
	Automated trainin	g and SOP generation	80% productivity uplift	V				8

The proof – World Economic Forum (WEF) Lighthouse network demonstrates how AI and digital transforms manufacturing and achieve high impact

189

WEF Lighthouses within the global network

Implemented digital technologies at scale, driving significant advancements in productivity, sustainability, and operational resilience



Impact achieved

+100%

factory output

+8470

lead time reduction

+90%

shortened changeover times



Key principles – lessons learned from 100+ Digital & Al Transformations

Business and people led; Al powered

Al has significant impact potential and is a key requirement to stay competitive; focus on business impact where every initiative should create immediate value, it will trigger profound changes in ways of working, require organizational adjustments, and cause new talent needs

Scaling in Domains is what matters

PoVs are not enough; capturing impact at scale requires an overarching masterplan, a sound industrialization approach, and a spillover logic to avoid pilot purgatory

Focus on people is a priority

To ensure sustained impact from Digital & AI, potential readiness gaps and fears of employees need to be addressed to enable long-term solution adoption

Partnering is key to success

Instead of developing solutions end-to-end in-house, organizations need to partner to adopt and keep pace with rapid technological advancements

Digital needs a strong backbone in Data and IT

While efforts can be started in existing environments, full value capture requires a scalable and shared IT infrastructure

Faster results by applying a proven playbook

Having a clear ecosystem of products, trusted tech partnerships, and the right experience reduces complexity and speeds up execution

Client cases - Organizations across industries are already realizing value from digitalization and beginning to do this at scale









Description

- Helped leading copper mining player confirm opportunity from advanced analytics
- Developed and scaled custom AI solution to increase productivity
- Avoided investing in new facility

- Implemented GenAl maintenance co-pilot
- Accelerates troubleshooting, root cause problem analysis and information retrieval
- Reduced overall impact of breakdowns
- Achieved WEF Lighthouse status through digital transformation
- Digitally connected value chain E2E from suppliers to consumers
- Predictive modelling of product reordering needs at individual customer level

- Identified and prioritized use cases and built Lighthouse deployment approach
- Developed proof of concept and implemented advanced scheduling using digital twin with live data feed and optimizer

Impact from Digital

15-20%

Increase in production across all sites

\$1.5B+

CAPEX avoidance

2,000+

Employees introduced to Agile ways of working

~3 P.P.

Improvement in OEE

500

Breakdown reduction

10%

OEE increase

30%

cost reduction associated with process automation

5-10%

Production rate improvement

10+

Factories targeted for scaling

Client cases – Organizations across industries are already realizing value from digitalization and beginning to do this at scale



Automotive



Chemicals



Consumer electronics



Life Science

Description

 Implemented five lighthouse use cases across the endto-end customer value chain of a truck manufacturer

- Lead data & analytics transformation
- Supported makeover into a 'Know-How' company incl. roadmap, value assurance office, design of target architecture, target operating model
- Digital transformation focused on improving financial and operational KPIs
- Implemented agile digital use case development, CoE's, and a scalable upskilling program leveraging digital learning
- Launched a transformation for top 6 sites to identify 90+ lean and digital initiatives
- "Low/no-code approach" was applied to deploy 6 prioritized use cases to improve OEE, yield, labor productivity and quality outcomes

Impact from Digital

~35%

Time savings when editing SpecBooks in R&D

20%

Efficiency uplift for admin tasks in Sales

€600M+

Value identified (revenue increase, cost reduction, and intangibles such as increased resilience, shorter time to market, higher customer satisfaction)

~35%

Direct labor productivity

300+

Frontline leaders, IT and middle management trained through holistic capability building program

2

Centers of Excellence (CoE) built

~\$1M

Annual saving through increased volumes

~15%

Uptime increase within 6 weeks

500

OEE improvement through digital guides



Design your factory of the future



Business process reimagination

End-to-end core process redesign in Launch & Ramp-up, Manufacturing, Quality, Maintenance, Utilities and Energy

Value driven roadmap

Value-based prioritization of use cases per core process | High ROI network-wide deployment roadmap | Finance & senior leaders' endorsement





Data & IT/OT Infrastructure

Core system deployment |
Network-level cloud integration |
Smart sensors | Longterm
architecture and minimum
requirement road map definition

Scalable applications

Appstore and reusable applications | Partnership with technology leaders

Drive scale and adoption



Operating model

Tech CoE | User engagement | Performance management | Governance | Value assurance

Reskilling people at scale

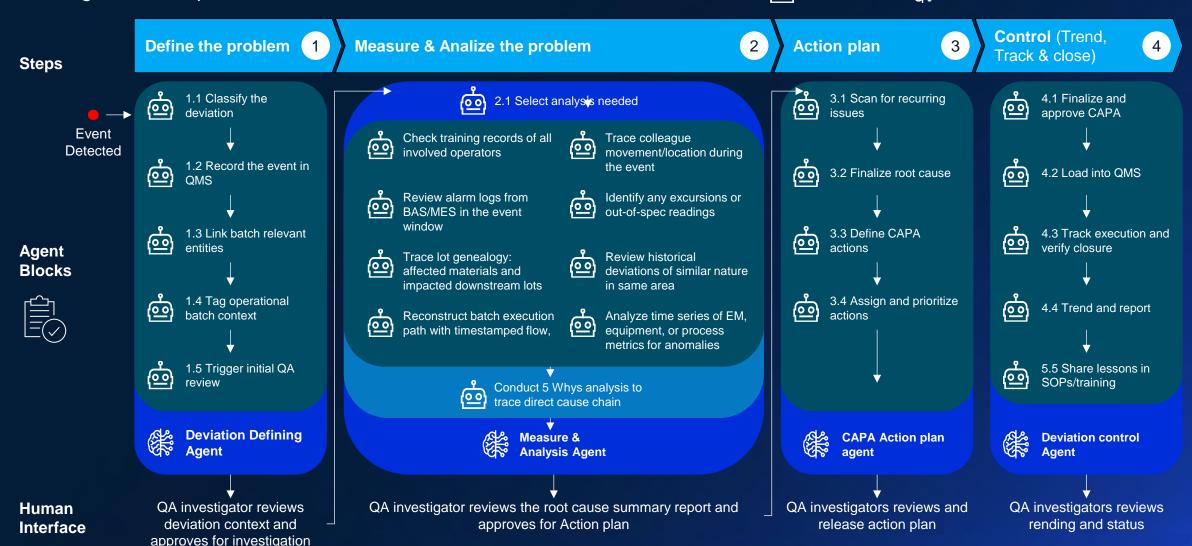
Organization-wide reskilling | Al academy | New factory capability | Adoption

Cultural shift and scaling

Narrative | Role modeling | Incentives | Al culture

1 Reimagining processes – We will reinvent processes end-to end embedding technology into the core

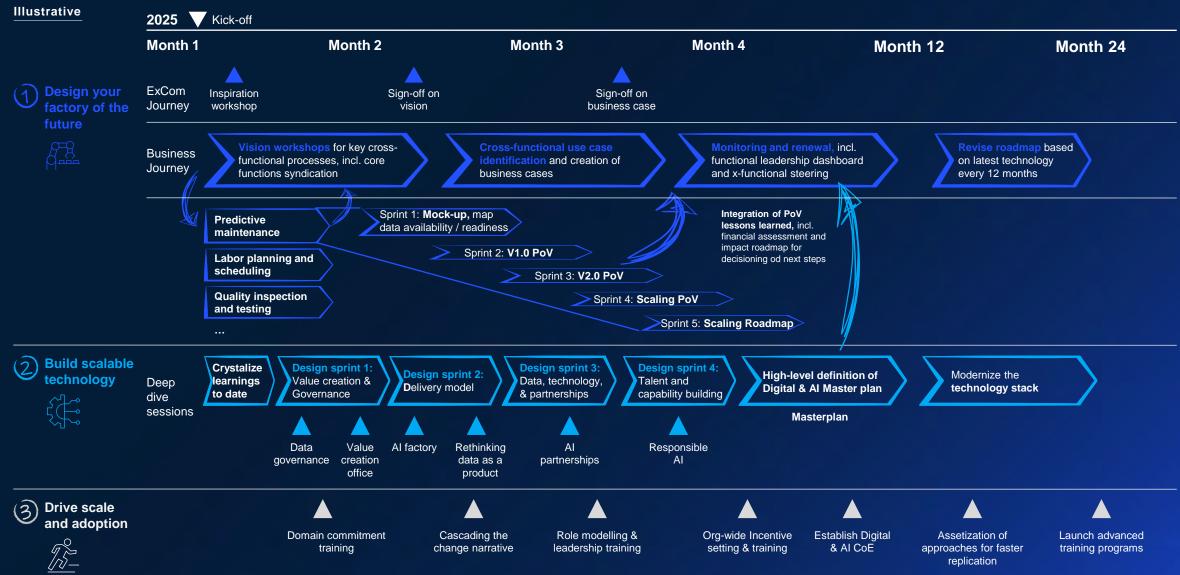
Investigation example



Agent group → Agent Flow/Sequence

oo Individual Agent

1 Value driven roadmap – An integrated roadmap aiming at delivering value, building the fundamentals and driving adoption



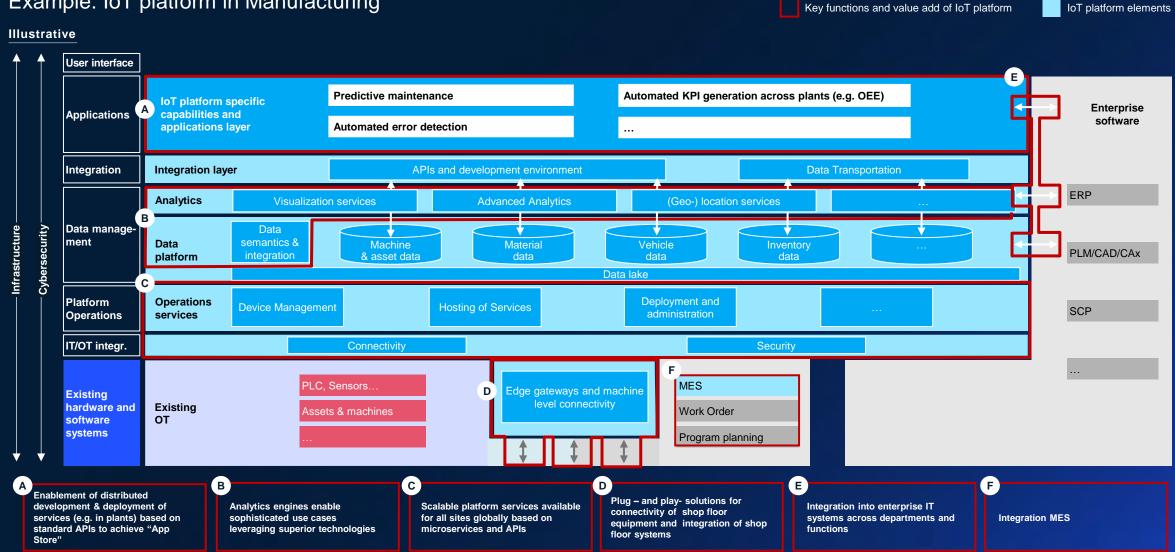
PoV: Proof of Value

2 Appstore – Our library of Applications enables fast scaling of impact to your network



2 Technology architecture – You will need to adapt your technology architecture to scale use cases

Example: IoT platform in Manufacturing



2 Technology partner - You will need to partner with leaders to leverage the latest advancements in technology

Not exhaustive

Deep dive next

Partner layer

Purpose

Potential Partnerships

Hyperscalers and data platforms

Provide industry agnostic data platforms, software and Al environment

Hyperscalers





aws

Google



Manuf. partners









Automation partners



Digital

visualization

partners

TULIP

System Integrators

Industrialize the data applications in the client environment

OT SI

HITACHI



RA



Infosys*

IT SI

♠ cognizant









Business transformation & Value assurance

Re-invent client processes and secure impact delivery and adaptation

> McKinsey & Company





Build by McKinsey 2a | Solution landscape – We bring a comprehensive view of the best solutions in the market to add to your Appstore for each prioritized use case



3 Al Center of Excellence – The Al Factory is a key enabler to centrally design, develop and effectively scale Al use cases

[Roles can be internal or external



Product Managers

Defines product vision per use case and prioritizes features driving user value



Data Scientists

Design and deploy models to enable use cases



Data Engineers

Design data infrastructure and information flows, manage data architecture



IT/OT Integration Engineers

Oversee integration with PLCs, SCADA, MES, working with control systems and IoT engineers



Manufacturing Domain Experts

Act as translators between shopfloor and technical team, and validate solutions in the real world

Not exhaustive

Al Factory: how to enable digital transformations through a dedicated Center of Excellence



Ensure core capabilities and resources are established to build the foundations and scale use cases



Maintain AppStore portfolio and introduce a robust gatekeeping process for introduction of new use cases



Ensures digital transformation stays on track by monitoring progress, tracking impact, driving adoption, managing risks and driving accountability







3 | Value assurance – "Quarterly Value Releases" create a steady cadence of impact realization over the longer-term

From...

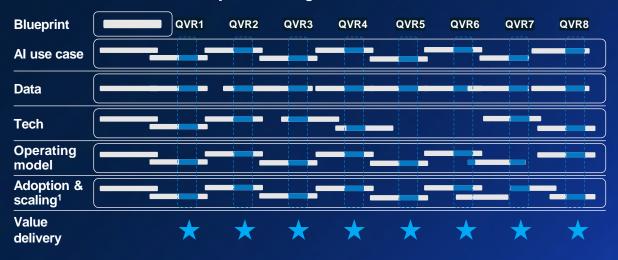
- Broad transformation efforts with vague business impact
- Parallel program of "horizontal" foundational efforts
- Minimal linkages between horizontals
- Value delivery mostly at the end of each horizontal
- Focused on 3 of the 6 "building blocks"
- No explicit link to business/scientific flows & impact



"We will have an industry-leading data lake in 3 years"

...To

- Targeted transformation support with specific link to business or scientific value
- Programme links all horizontals via "QVRs"
- View on interdependencies and acceleration opportunities
- Value delivered every 3-6 months through each QVR
- Each QVR touches all 6 building blocks
- Link from QVR to impact through scientific/business flows

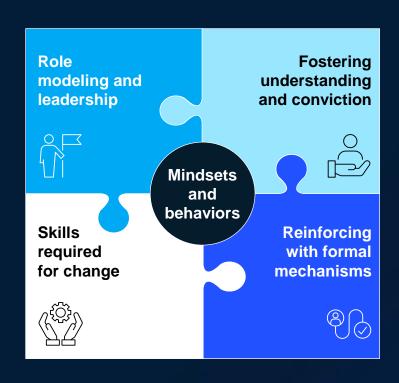


"We will have an MVP in the hands of users in 90 days"

Exact design and sequence of QVRs is anchored in business timelines and needs for value creation

1. Including change management

3 Drive scale and adoption – Initiatives to support AI adoption should cover a full set of levers to change mindsets and behaviors

































Our proven approach – 5 steps to go from business strategy to at scale network transformation



McKinsey

McKinsey & Company Operations Bring best-in-class processes and expertise in manufacturing.

Design vision and aspiration for Factory and network of the future

leveraging digital and Al

Conduct Use case rapid design Hackathon

Assess

Assess process maturity and size opportunity. incl. IT/OT architecture and digital capabilities

Build value-driven roadmap and business cases signed-off by ExCo

Make vs buy and solution landscape assessment

Build quick prototypes on top of tech partner infra. to bring 1-2 use cases to life

Architect

Design future state process leveraging AU & Digital

Design CoE and deployment model

Design upskilling & change mgt plan

Act

Build lighthouse site and / or End-to-end process reinvention

Build innovative applications using proprietary tools or on top of partnership platform

Accomplish

Replicate lighthouses

Ensure value of Core system and Al transformations

Drive at-scale adoption and change in ways of running factories

Technology partners



Bring Art of the possible to life through live demos, success stories in inspiration sessions

Provide underlying platforms and starter templates for quick application prototyping

Assist on advanced technical components of PoVs (e.g. integrations, custom widgets)

Assess feasibility of roadmap (data, tech.)

Design future state technology architecture

Prepare technology stack for deploying priority use cases

Deliver a productionready use case to prove value & determine the stack required to scale

Rapidly scale the use cases across all domains and sites

Add new use cases as determined in the roadmap

Continue to upgrade the technology stack as needed

Upgrade the client's technical environment to meet requirements for full scalability and sustainability of solutions

Provide capacity and expertise to maintain tech and support client teams

Our qualifications – Why McKinsey is best suited to support you in your Digital & Al Transformation

Not exhaustive



We bring extensive experience of leading Digital & Al Transformations in manufacturing

Proven track record of delivering impact through Digital & Al transformations for industry leaders, with +100 technology transformation engagements completed in the past year

Leading truck Developed scalable (Gen)Al backbone across all OUs

Mining Deployed Al technology to

Mining Deployed AI technology to industry leader increase productivity by 15%+

Global food company

Implemented GenAl maintenance co-pilot

Tier 1 auto player Developed digital twin to drive a 10% productivity uplift



Our Quantum Black team bring extensive experience and expertise on data, Al & Tech

QuantumBlack Labs is our dedicated CoE working to accelerate Al deployments. QB Labs translates cutting-edge technology and innovation to practical applications, accelerating impact for our clients

40+

offices worldwide

1200+

technologists specializing in AI

3

remote delivery hubs (Budapest, Bengaluru, Ho Chi Minh) enabling





We bring established assets to fast track the build of use cases

Robust ecosystem of proprietary assets ready to be deployed for high priority use cases within Manufacturing and beyond, which can be customized to your specific needs in a quick, efficient way

iDIAGNOSE

DPS

POBOS

ESO suite



ThroughputX

Value Maximizer



We partner with technology leaders to bring the best of the world

Established ecosystem of **strategic partnerships** with technology alliances, academic institutions, and industry collaborators















Infosys



How to get started - A few ways to kick-start your digital journey

