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INDIA INDUSTRY 4.0 ADOPTION

A Case to Mature Manufacturing Digitalization by 2025

February 2022

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Capgemini

Leaders' Note

In 2011, when Germany announced Industrie 4.0, the world was at the cusp of a smartphone revolution, 4G LTE got standardized, and back home, India announced its Manufacturing 2025 goal of 25% addition to the national GDP by 2025. Countries unequivocally supported the clarion call to transform industrial production fundamentally, and digitally.

A decade later, and two years into the pandemic, Industry 4.0 has acquired a mission status! Leaders of Industry 4.0 have revived their national missions at speed. Emerging economies have accelerated digital transformation at unseen speed across their manufacturing sector, specifically MSMEs, led by the urgent need to be a connected, visible, and trusted global value chain partner.

Industry 4.0, the concept of technology-led industrial progress, has evolved – from an enabler of digital transformation to a must-have delivering superior customer experiences and sustainable business models. But how is the world, and India, tracking against its Industry 4.0 plans?

NASSCOM, in collaboration with Capgemini, launched this research study to assess adoption of Industry 4.0 across India's manufacturing sector. In-depth inputs from 55 large and mid-sized discrete and process manufacturers and 25 technology providers reveal very valuable insights.

Industry 4.0 is at an inflection point in Indian manufacturing with an absolute intent and urgency to increase investments in the next 2 years – on scaling up foundational readiness in Cloud, RPA, IoT and Big Data – and in rapidly enhancing capabilities in more advanced and integrated use cases leading to globally connected smart factories. There are challenges and the study proposes recommendations to address them.

Mature digitalized manufacturing will be crucial to the 2025 digital economy goal. We hope you find value in the insights from this study.

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05 Recommendations – Maturing India's Industry 4.0 Adoption by 2025

Executive Summary (1/2)

Industry 4.0 Investments Have Grown ~10X Since 2011; Estimated to Double by 2025 to $200+ Bn

01

- Global manufacturing technology spend has risen 2.4X in the last decade, to $509 Bn today, yet it forms just 1.5% of the global digital economy of $32+ Tn
- Industry 4.0 investments by manufacturing companies, now at $102 Bn, comprise 20% of all manufacturing tech spend
- Fresh CapEx infusion of $100+ Bn by USA, UK, China, Japan, and India will pave the way for accelerated Industry 4.0 growth by 2025
- By 2025, digital technologies are estimated to comprise 40% of all manufacturing tech spend

Global Industry 4.0 Adoption Positively Disrupted by COVID-19 With Emerging Economies Picking Up Pace

02

- Servitization, integrated customer experience and the need for business agility with flexible operations will drive a leap in Industry 4.0 maturity
- Leading economies, such as US, China, and Germany, started early and are now ready to reap the multiplier effect of a strong foundation in Industry 4.0
- Disruptors, such as Japan, Korea, and UK, are building unique propositions, such as Japan's Society 5.0
- Emerging economies, such as India, France and Canada, are taking the collaborative ecosystem development route, along with tax incentives

Industry 4.0 has Evolved as a Set of Interconnected Technologies and Use Cases Spanning Entire Value Chains

03

- Successful Industry 4.0 implementations are an interconnected technology framework to enable customer-oriented production
- Industry 4.0 adoption further enables companies to rethink their silo-ed business and operational KPIs, to exploit synergies with seamless data flow and real-time decisions
- It is critical to start with an enterprise-wide adoption view and break it into smaller projects, rather than integrating multiple PoCs

Executive Summary (2/2)

Indian Manufacturing has Started Pivoting to Digitalization, with $5.5 - $6.5 Bn Spent on Industry 4.0 in FY21

04

- ~50% of the tech spend by Indian manufacturers is on Industry 4.0 technologies, a high proportion, but from a fraction of the sector's total representation
- 50% of the Industry 4.0 spend is on foundational tech – Cloud and IoT. But, 35 – 40% of the companies are at PoC stage and will need rapid PoC-to-production transition
- 75% of the Industry 4.0 spend is by leading discrete manufacturers in Auto, Electricals and Electronics, while Chemicals and Pharma lead in the process manufacturing segment

NASSCOM Survey and Interviews with Cross-Sector Manufacturers Reveals the Shaping Leap in Industry 4.0

05

- India aims to build a $1.1 Tn manufacturing sector; 25% of national GDP by FY26, creating 100 Mn new direct jobs
- Digital transformation projects across the sector have witnessed >25% reduction in timelines, from PoC to adoption to RoI
- In the next 18-24 months, companies plan to ramp up investments in emerging network tech, big data analytics, central and remote-controlled monitoring, and automation
- Strong focus on supplier derisking strategies, coupled with traceability needs, will push for value chain digitalization

Measurable RoI, Consistent Data Policy, Ecosystem Support, and Investments by GoI Will Accelerate Adoption

06

- India's manufacturing clusters or industrial corridor policy will be critical in creating smaller hubs for focused investment and innovation
- MSME incentives through dedicated GoI contracts or industry-led initiatives will transform the 90% base of Indian manufacturing
- Shifting focus from cost to incentives for quality and globally-competitive solutions will boost the innovation mindset in a culturally resistant sector

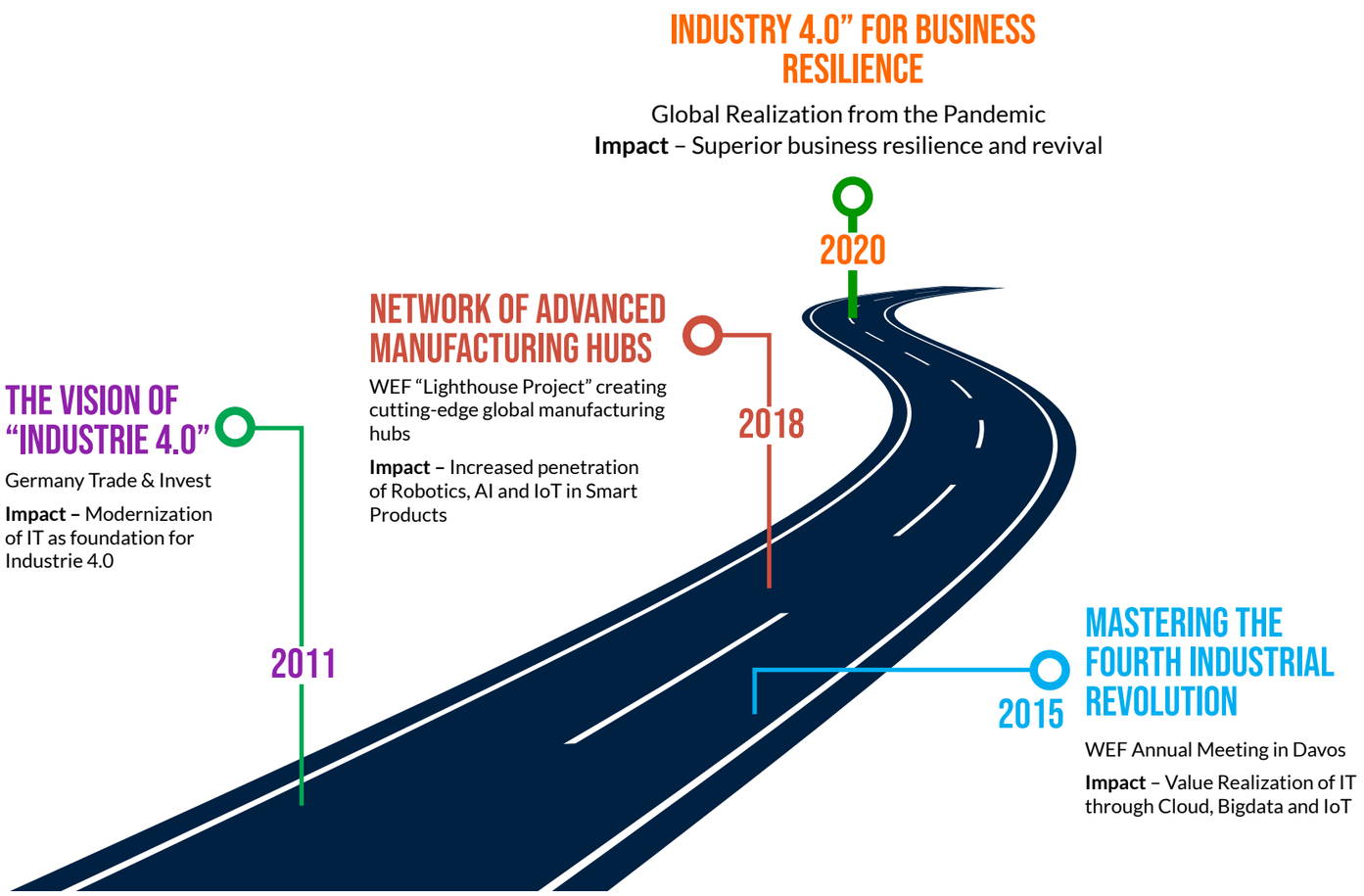
01

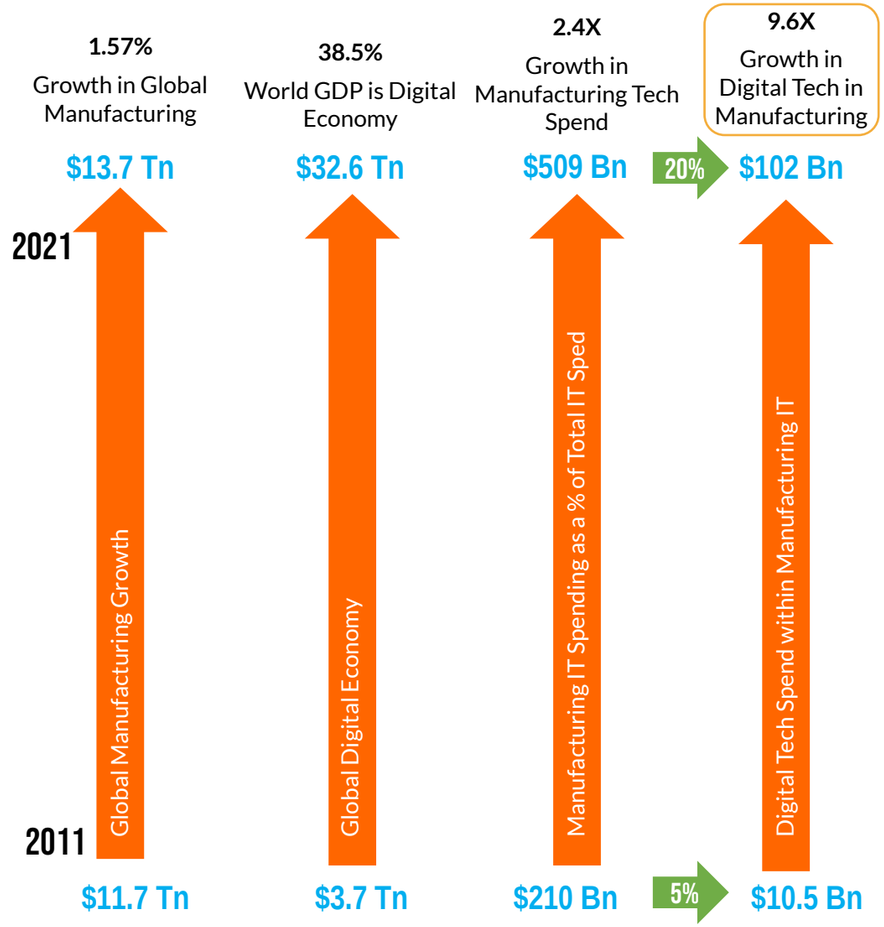
Industry 4.0 – Tracing A Decade-Long Evolution

Technology in manufacturing has evolved from Industry 1.0 – Mass Production for Global Markets – to Industry 4.0 – “Customized” Mass Production using connected, cyber-physical systems

Role	"Mass Production for Global Markets”	“Assembly Line – Focusing on One Task / Person”	Efficient Manufacturing – Reduce Manpower Dependency	“Cyber Physical System – Connected Machines”
	18th Century	19th Century	20th Century	Today
	Industry 1.0 Mechanical production equipment powered by steam and water	**Industry 2.0** Mass prodcution assembly lines requiring labor and electrical energy	**Industry 3.0** Automated production using electronics and IT	**Industry 4.0** Intelligent production incorporated with IoT, cloud technology and big data
Impact	“Humans using machines for mass production”	“Move towards job specialization”	Faster Product to Market profitable manufacturing	“Continuous learning / customized mass production”

Since 2011, Industry 4.0 has witnessed a decade of transition, from comprising 5% of manufacturing IT spend to 20% by 2021, a 9.6X rise driven by smart solutions and business sustainability needs





Sources: World Bank, World Economic Forum, Global Industry Analysts Inc., Gartner, Research Team Analysis

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By 2025, Industry 4.0 will have created a tightly integrated manufacturing and value chain digitalization experience for over two-thirds of the world's manufacturers

US, China, India, Brazil, and the UK are betting big on Industry 4.0 acceleration through 2025, as these nations plan $100+ Bn of new investments, majorly in IoT, AI/ML, IT-OT integration, robotics and human-machine interfaces, and digital twin capabilities.

MATURED TECHNOLOGIES

$50 - $60 Bn @10% CAGR

- Cloud Computing
- Industrial Robots
- Internet of Things
- AI in Manufacturing
- 3D Printing

MATURING – NEXT 5 YEARS

$4 - $5 Bn @30% CAGR

- 4D Printing
- Quantum Computing
- Cyber-Physical Systems
- Advanced Human-Machine Interface (HMI)
- Exoskeleton/Man-Machine

EXPANDING TECHNOLOGIES

$30 - $40 Bn @15% CAGR

- Cybersecurity Technology
- AR/VR in Manufacturing
- Big Data & Analytics
- Mobile Factories
- Wearables & Sensors

NASCENT TECHNOLOGIES

$3 - $4 Bn @25% CAGR

- Digital Twin
- 5G in Manufacturing
- Edge Computing
- Voice Controlled Devices
- Blockchain in Manufacturing

$12.7 Bn Cyber Physical System spend by 2026 @ 10.2% CAGR

$7.6 Bn Human Machine Interface (HMI) spend by 2025 led by China

2.7 Mn industrial robots in factories around the world, growing @ 12% CAGR

$77 Bn spent on industrial IoT in factories with 1.44 Bn data points per plant per day

$16.7 Bn expected spend on AI in Manufacturing by 2026 led by China and Japan

56% of manufacturing companies plan to test 5G sometime in 2021

$3 Bn spent on digital twins with a 58% y-o-y growth led by auto and transportation

Sources: IIoT World, International Federation of Robotics, Report Linker, The Manufacturing Institute, Research Team Analysis

In this journey, the ambit of Industry 4.0 has itself evolved from transforming a production facility to digitalizing the industry value chain, to now revolutionizing customer experience with smart products

Smart Industry: Industry 4.0 is Transforming Operations, Supply Chains, and Customer Solutions

SMART SUPPLY CHAIN

Visible Supply Chains

- Traceability of suppliers and material
- Predictability of events and potential disruptions

SMART SOURCING

- **Smart Contracts** – Digital contracts and SLAs through the supply chain
- **Smart Procurement** – Procurement integration with SCM and CRM; AI-based supplier risk management; responsible sourcing for ESG compliance

SMART SOURCING

- **Smart Logistics** – Movement tracing and ML-based real-time route and mode optimization
- **Smart Warehousing** – Autonomous warehouses with robotics and HMI; AI-based inventory, returns, and, reverse logistics management

SMART OPERATIONS

Location-Agnostic Command and Control

- Multisite integration with central control towers
- Flexible decentralization strategy

SMART FACTORY (SINGLE/MULTISITE)

- **Smart Machines** – Legacy retrofitting; embedded software and self-optimizing machines; self-organizing and correcting machines; digital twins for remote monitoring
- **Smart Process Line** – Process automation to self-optimzing process lines; intelligent robotics – cobots and HMI; data integration across MES, SCM, CRM, and procurement
- **Smart Services** – Virtual machining; AR/VR-based remote servicing; predicitve condition monitoring and maintenance
- **Smart Resourcing** – **Self-adjusting HMI and robotic integration; AR/VR based operator assist; remote monitoring**

SMART SOLUTIONS

Intuitive products and flexible service models

- CPS-equipped cnnected products that enhance usability experience
- New data-driven business models

SMART PRODUCTS

- **CPS Equipped** – Products equipped with embedded IoT sensors, self-learning and self-optimizing capabilities using AI at the Edge, connectivity tech for M2M communication, and autonomous operations

SMART SERVICES

- **Servitization of Product Lines** – Data from smart products drives bespoke, predictive customer services
- **New Data-Driven Business Models** – M2M data led predictive analytics and advisory services aimed at innovative employee and customer experience

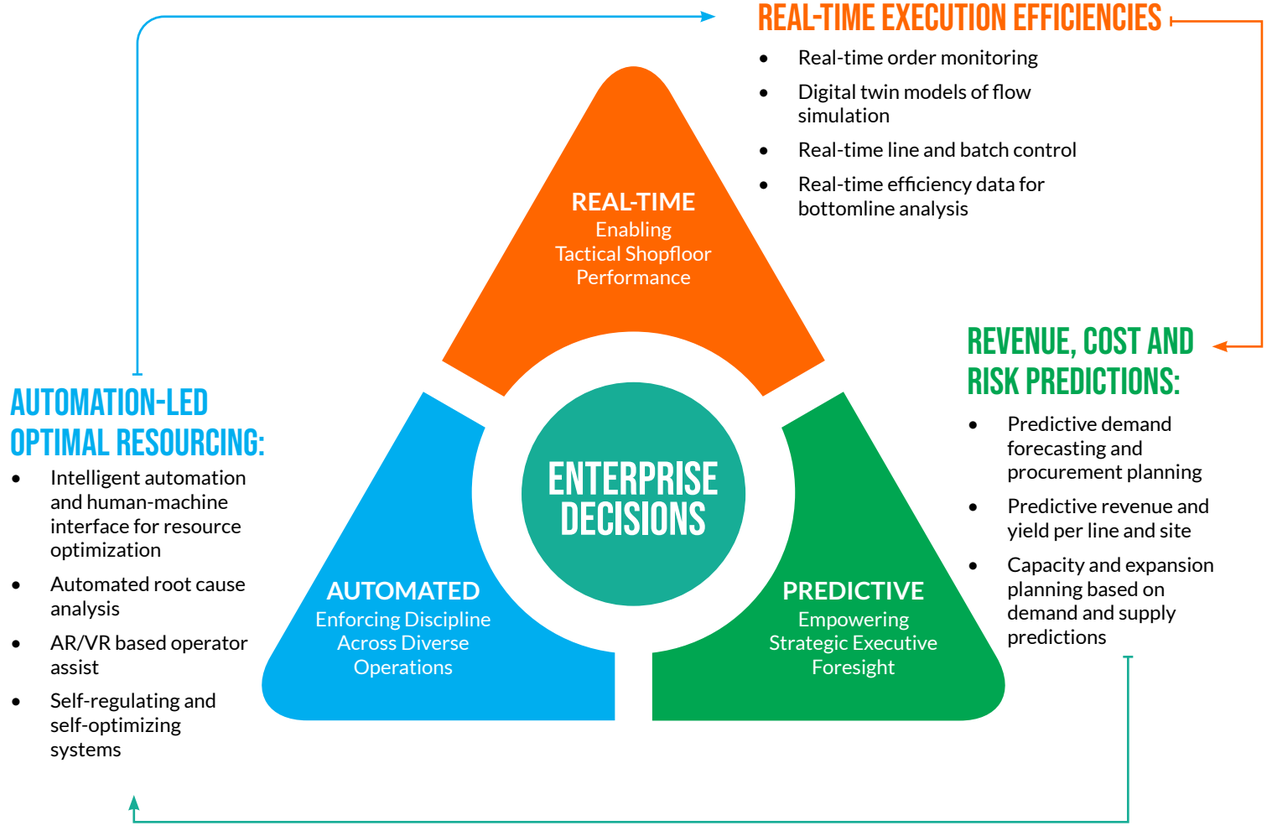
Source: Research Team Analysis

In effect, Industry 4.0 has led to seamless integration of data and insights flow pan-organization, resulting in agile and contextualized planning and execution from the shopfloor to the boardroom

TRADITIONAL DECISION FLOW WITH DATA IVORY TOWERS

Source: Research Team Analysis

INDUSTRY 4.0 DECISION FLOW – REAL-TIME, PREDICTIVE, AUTOMATED, AND CONNECTED



Industry 4.0 has led to a redefinition of organizational success with more integrated and cross-functional KPIs and discrete tracking of technology investment RoI across the value chain

TRADITIONAL BUSINESS KPIS

Manufacturing Intensity (% of Revenue)	Return on Invested Capital (RoIC)	Return on Assets (RoA)	Lost Demand
Manufacturing Cost Per Unit	Gross/ Operating Margin	Inventory Turns	Cash-to-Cash Cycle Time

TRADITIONAL FLOOR SHOP KPIS

Manufacturing Cycle Time	OEE	Throughput Rate/ Rework	Plant Uptime	Safety Incidence Rate
Asset utilization	ROA	Mean time between failure (MTBF)	Equipment/ Line Productivity	Scrap Rate

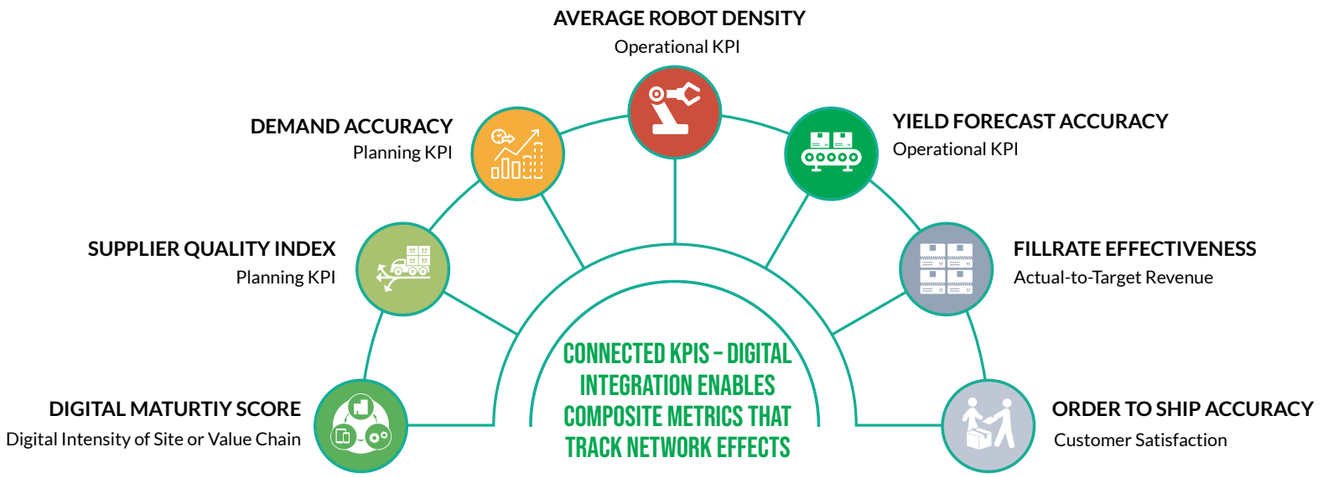
+

INDUSTRY 4.0 BUSINESS PERFORMANCE KPIs

Manufacturing Intensity	Manufacturing Intensity	RoI/ RoIC	New TAM Conversion
Manufacturing Cost Per Unit	Marginal Cost per New Unit	Cost per Line Switch	% Digital Transaction Success

PLANNING, OPERATIONS, AND CUSTOMER SATISFACTION KPIS GET INTEGRATED INTO "CONNECTED KPIS"

Illustrative list of redefined KPIs



Sources: World Economic Forum's Global Lighthouse Network, Datapine, Research Team Analysis

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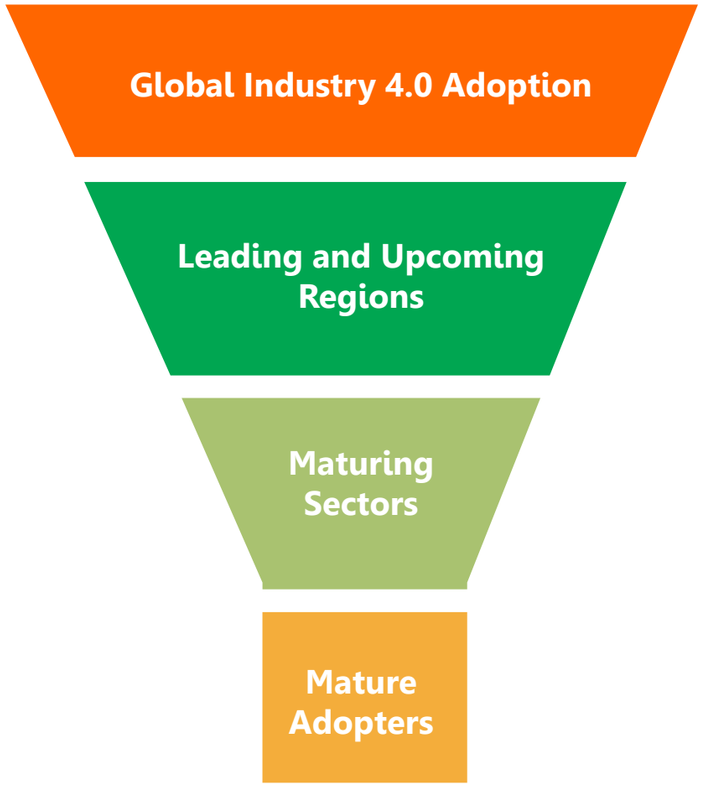
Global Industry 4.0 Evolution and Adoption Trends

Plateauing Industry 4.0 adoption since 2017, coupled with COVID-19 led delays and disruption through 2020-21, have pushed for more sustainable and resilient targets for 2025

Industry 4.0 Pre-Pandemic Trends

- 20% — Global manufacturing technology spend attributable to Industry 4.0 technologies
- 36% — North America, Germany, and South Korea report between 30-40% of companies at maturity
- 38% — Automotive, followed by Electronics, manufacturers show advanced Industry 4.0 adoption, highest across all sectors
- 30% — <30% Global manufacturers report extensive adoption of Industry 4.0 technologies



Industry 4.0 Outlook Through 2025

- 40% — Global manufacturing technology spend to be on account of Industry 4.0 technologies
- 40% — Asia-Pacific, led by China, is estimated to deliver fastest Industry 4.0 adoption, nearing 40% of global
- 35-40% — Telecom, Pharmaceuticals, Electricals, and Energy & Utilities will advance rapidly using 5G technology
- 70% — More than two-thirds of global manufacturers will report extensive Industry 4.0 deployments

Servitization, integrated customer and employee experience, greater operational flexibility and agility, and the pursuit for smart products will drive Industry 4.0 in the next decade

SERVITIZATION

Emergence of managed Industry 4.0, machines-as-a-service, and manufacturing-as-a-service

Telecom companies will offer 5G-based “Smart Factory as a Service” in partnership with expert production automation and digital services companies

OMNICHANNEL CX

Convergence of production systems – MES, SCADA – with strategic planning ERP, SCM, CRM will enable a complete customer view

Manufacturers are integrating customer experience led planning and design thinking into operational planning

SMART SOLUTIONS

Smart products and smart services will leverage massive M2M data to enhance and innovate existing solutions

Smart services, on top of smart products, will be the leading market-side differentiator in Industry 4.0, combining the power of predictive with innovative services

EMPOWERING EX

Accelerated push for automated lines with intuitive human-machine interfaces

2.7 million industrial robots could be deployed, increasingly by Asian manufacturers, on semi-autonomous lines (using cobots), or fully-autonomous ones

FLEXIBLE OPERATIONS

Multi-shoring grows, as a China+ strategy; more so, as a strategic plan to hedge risks to viable and sustainable supply

EU countries are reshoring using robotics and automation, while Telcos and Pharma are shifting production to talent-rich Asia

BUSINESS AGILITY

Global trade volume shrunk by 13-32%, driven by over-reliance on China controling 28% of global manfacturing exports

Industry 4.0 solutions can offer anywhere between 15 – 30% improvements in supply chain latency and reporting, resulting in predictive corrective response

Source: World Economic Forum's Global Lighthouse Network, International Federation of Robotics, Research Team Analysis

Globally, consumers of Industry 4.0 can be segmented into leading, disrupting, and emerging economies, although the shift-up across segments is uniquely paced and likely to stay dynamic

	Leaders of Industry 4.0			Disruptors of Industry 4.0			Emerging Consumers of Industry 4.0		
% of Global Manufacturing Share	16.5%	4.9%	28%	7.4%	3.6%	1.6%	1.8%	1.1%	2.5%
Manufacturing-to-National GDP (%) Manufacturing output ($ Tn)	10.80% $2.3 Tn	17.80% $0.7 Tn	26.20% $3.9 Tn	20.00% $1 Tn	27.2% $0.5 Tn	8.4% 0.23 Tn	9.3% 0.24 Tn	9.5%	16.9% $0.34 Tn
Manufacturing Tech Spend ($ Bn) % of Mfg output	$90.4 Bn ~4%	$27.1 Bn ~4%	$154 Bn 4%	$40.5 Bn 4%	$19.6 Bn ~4%	$9.1 Bn 4%	$9.7 Bn ~4%	$5.4 Bn	$11.7 Bn ~3.4%
Industry 4.0 Journey - Year	2011	2011	2015	2016	2014	2013	2013	2017	2018
Industrial Digitalization Ranking	#7	#3	#5	#6	#1	#4	#8	#9	#20
Readiness for the Future of Production	#1	#6	#25	#16	#4	#3	#12	#7	#30

Industry 4.0 leaders launched national-scale initiatives fueled by massive local sourcing of advanced manufacturing tech, focused global partnerships, and common national objectives

Industry 4.0 Initiatives of Leading Economies, Illustrative List

United States

- **2011** – Advanced Manufacturing Partnership; $500 Mn invested
- **2014** – Advanced Manufacturing Partnership (AMP) 2.0 – Industrial Internet Consortium*
- **2018** – National Strategic Plan for Advanced Manufacturing
- **2020** – 3 pathways for creating centers for Manufacturing Innovation; $45 Bn planned#

*Founding companies – GE, Intel, IBM

Investment in IoT by US manufacturers by 2022

Vision 2030
$1.2 Tn Infrastructure Bill to boost Industry 4.0

German

- **2011** – Industrie 4.0 developed by BMBF; $500 Mn invested
- **2013** – "Platform Industrie 4.0" created by 3 private associations
- **2014** – Horizon 2020: EU's Framework Programme for Digital Tech Research & Innovation
- **2018-2020** – Collaborations: "Industrial Internet Consortium" with USA, "Alliance Industrie du Futur" with France, "Robot Revolution Initiative" with Japan

2020: 300 active players from 159 organisations in "Platform Industrie 4.0"

Vision 2025
Additional GVA of up to EUR 425 Bn forecasted

China

- **2014** – The Made in China 2025 plan by 150 scientists and scholars
- **2016** – Smart Manufacturing Development Plan
- **2018** – Internet Plus: Industrial integration with the internet
- **2020** – Industrial Digitalization: Local production + cost focus + lower product defects

Investment – $2.9 Bn Advanced Manufacturing Fund and $20.2 Bn National Integrated Circuit Fund (subsidies, low interest loans, tax breaks etc.)
Targets – 40 national (and additional regional) innovation centers, 70% local market share of total domestic technology suppliers, 50% reduction in Product defects

Vision 2025-45
10-year plans to make China world's leader in manufacturing

High | Medium | Low — High, Medium and Low are defined as degrees of implementation based on manufacturing intensity, global manufacturing share and Industry 4.0 strategies

Source: CIAFactbook, World Bank, World Economic Forum, BloombergNEF's (BNEF) 2020 National Industrial Digitalization Ranking, ScienceDirect, ResearchGate, Euromonitor, Research Team Analysis

Industry 4.0 disruptors created focused initiatives jointly led by academia and research institutions of the industry, with healthy societal and SME participation

Industry 4.0 Initiatives of Disrupting Economies, Illustrative List

Japan

- **2016** – Society 5.0 enacted by Govt. of Japan; $1.44 Bn in AI investments
- **2017** – "Investment for the Future Strategy 2017" & AI Tech Strategy
- **2018** – Growth Strategy Council with govt., industry, academia
- **2019** – Linked Society 5.0 and the SDGs at the G20 Summit "Society 5.0 for SDGs"

*Founding companies – GE, Intel, IBM

$87 Bn in robotics and $6 Bn in IoT market in 2019

Vision 2025
Fully connected, digital execution of services for people

South Korea

- **2014** – Manufacturing Industry Innovation 3.0 introduced; Private Sector's Smart Factory Standard Research Council
- **2017** – 10,000 smart factories across public and private sector
- **2020** – IT Legislation, SME Incentives – $414.4 Mn in R&D, legislation for IT in SMEs

Govt funding with 25% productivity improvement & 27% defect reduction

30,000 Smart Factories by 2025; 4,500 SME Smart Factories

Vision 2025
Skilling 40,000 workers in fully autonomous manufacturing

United Kingdom

- **2011** – "High Value Manufacturing Catapult" Established
- **2013** – "Future of Manufacturing" presented by UK Govt & Digital Catapult Established
- **2015** – 7 institutes & Advanced Manufacturing Research Centre (AMRC) joins Digital Catapult
- **2020** – "5G Factory of the Future" consortium of industry+academia

£486 Mn R&D Investment
5,897 Industrial partners
3,322 SME partners

Vision 2050
Achieving $3+ Bn of financial impact

High | Medium | Low — High, Medium and Low are defined as degrees of implementation based on manufacturing intensity, global manufacturing share and Industry 4.0 strategies

Source: CIAFactbook, World Bank, World Economic Forum, BloombergNEF's (BNEF) 2020 National Industrial Digitalization Ranking, ScienceDirect, ResearchGate, Euromonitor, Research Team Analysis

Emerging economies of importance in Industry 4.0 adoption have lately focused on building industry and academia partnerships to innovate and take advantage of government incentives

Industry 4.0 Initiatives of Disrupting Economies, Illustrative List

France

2013
New Industrial France Initiative (Alliance pour l'Industrie du Fu)
$25 Mn invested

2015
Supplemented with "Alliance for the Industry of the Future"
€2 Bn to focus on modernization of France's production tools

2016
Industry of the Future program – Subsidies, repayable loans & tax incentives (€2.5 Bn)
Industry of the Future loans for SMEs

2017-2020
"La French Fab" created as industrial ecosystem in 2017 and "France Relance framework" in 2020
3% of global IoT spending in 2019
47 "Key Technologies 2020" for France

Vision 2030
Extensive focus on role of Industry 4.0 in defense systems

Canada

2017
NRC's Advanced Manufacturing program for industry+academia; "Innovation Superclusters"
$950 Mn invested

2018 – 2020
Collaborative R&D – $17.4 Mn; 11 academic institutions, not-for-profit & SMEs
$1 Tn manufacturing sales goal, $540 Bn manufacturing exports

Vision 2030
Doubling output and exports for a $6+ Tn value add

India

2011
National Manufacturing Policy (NMP) promulgated with 25% share of manufacturing

2018
SAMARTH Udyog launched; Siemens India launched First Digital Factory
Smart Advanced Manufacturing and Rapid Transformation Hub

2020
International Collaborations: India-Israel, Indo-German & Plugin Alliance
Plugin Alliance: Entrepreneurship (SINE)-IIT Bombay+Large Firms+SMEs

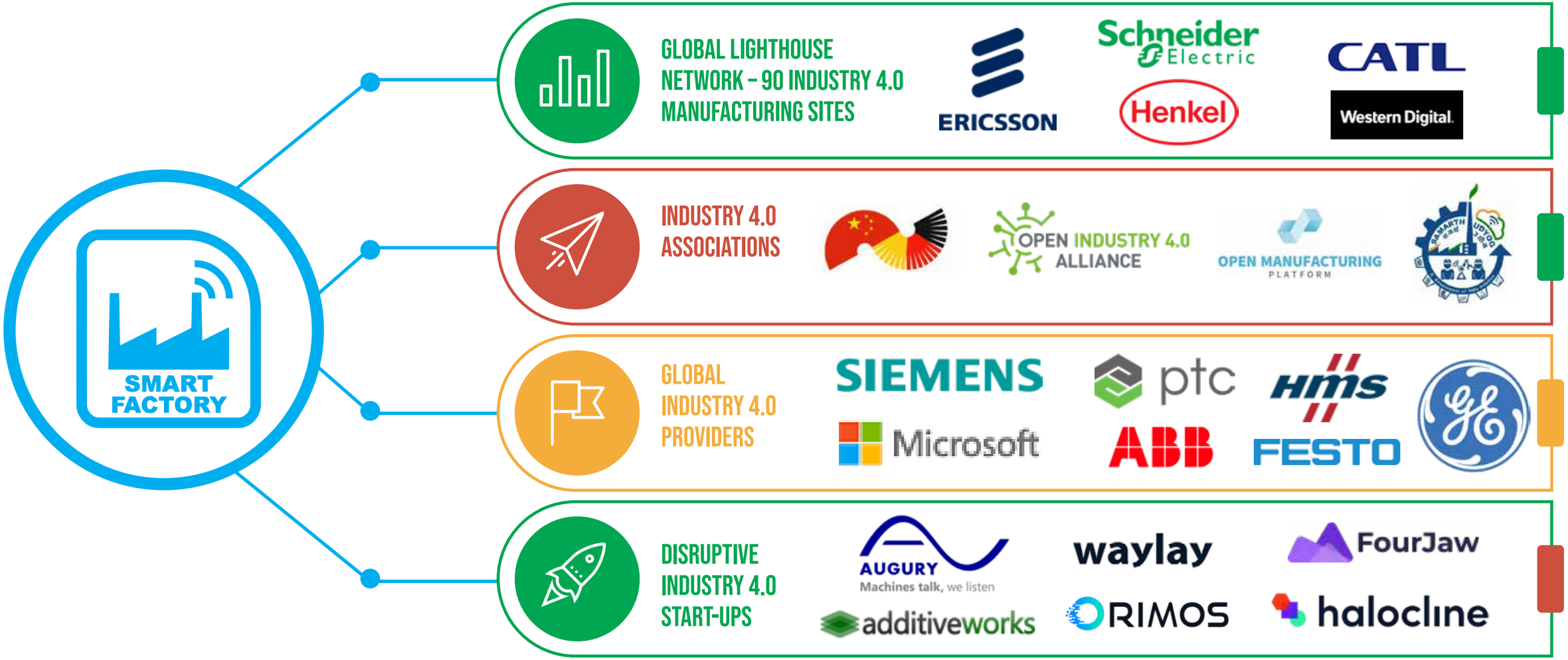
Vision 2025
Manufacturing to contribute 25% of $5 Tn GDP

High | Medium | Low

High, Medium and Low are defined as degrees of implementation based on manufacturing intensity, global manufacturing share and Industry 4.0 strategies

Source: CIAFactbook, World Bank, World Economic Forum, BloombergNEF's (BNEF) 2020 National Industrial Digitalization Ranking, ScienceDirect, ResearchGate, Euromonitor, Research Team Analysis

COVID-19 has further demonstrated that fast-tracking the leap from point solutions to complete digitalization is possible with convergence of global adopters, providers and best practices



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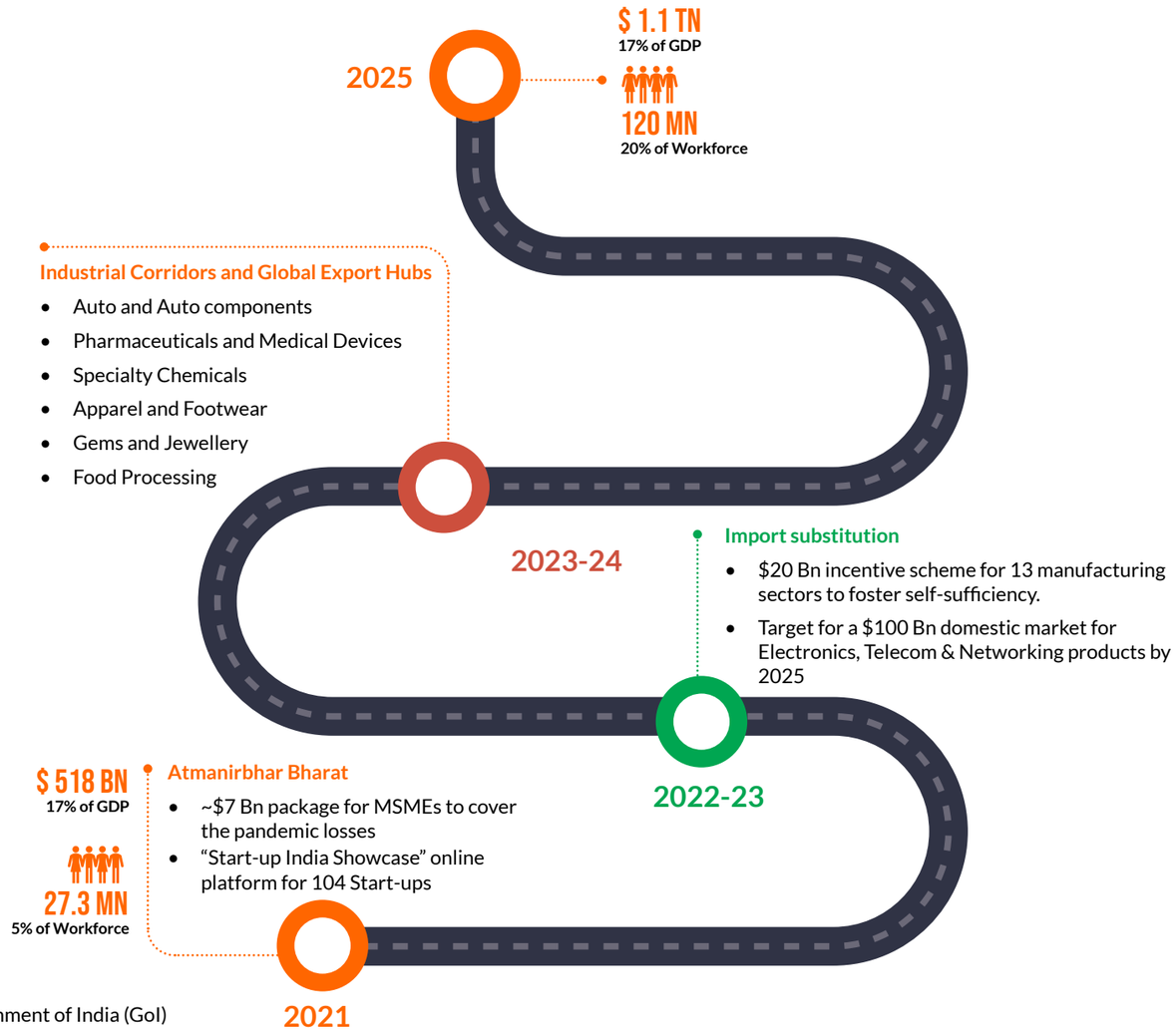
India Industry 4.0 Adoption

Aided by GoI* policies and private sector investments, Indian manufacturing is witnessing a push to adopt digital technologies to achieve the target of 25% contribution to GDP by FY26

Levers to Boost Industry 4.0 Adoption in India

1. **National Infrastructure Pipeline (NIP)** – $1.9 Tn 2025 plan to develop world-class infrastructure through PPP, via 9000+ projects
2. **$1 Tn Digital Economy** – $500+ Bn additional GDP contribution target for manufacturing based on the adoption of digital technologies across sectors and supply chains
3. **Ease of Doing Business**- Target to be in the top 50 of the World Bank's Ease of Doing Business index (up from 130 in 2016 to 63 in 2020) will be achieved with value chain adoption of technology for transparent and seamless trade
4. **Production Linked Incentive Scheme (PLI)** – Announced in May 2020, PLI aims to reorient India's production towards local production, self-reliance, and lower imports by way of revenue-linked incentives
5. **Smart Advanced Manufacturing and Rapid Transformation Hub (Samarth Udyog Bharat 4.0)** – Multi-ministry and GoI initiatives with the launch of five Common Engineering Facility Centers (CEFC) to promote the development of Industry 4.0 technologies across sectors.
6. **Labour Reforms**- Government initiated legislation to consolidate 29 discrete laws under four codes covering wages; occupational safety, health and working conditions; industrial relations; and social security



Sources: IBEF, RBI, SAMARTH Udyog, MeitY, Ministry of Labour and Employment, World Bank, Research Team Analysis | *Government of India (GoI)

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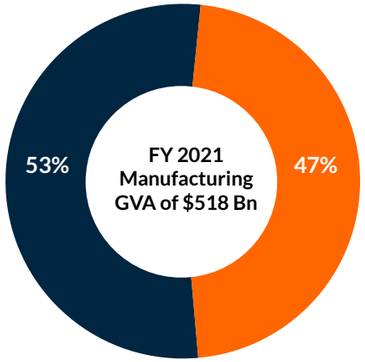
Major Indian manufacturing sectors have collectively invested ~$12 Bn in technology, and have attracted nearly ~$11 Bn worth of FDI to enhance operational efficiencies and global competitiveness

Discrete Manufacturing: Output and Investments

Sector	Output 2021 (E)	Output 2025(E)	FDI* (FY 2021)	Tech Spend Annualized	RoIC* (FY 2019)
Automotive	$118 Bn	$300 Bn	$4 Bn	$4.7 Bn	13.7%
Electrical/ Equipment	$48 Bn	$72 Bn	NA	$0.9 Bn	7.7%
Electronics	$23.5 Bn	$152 Bn	NA	$0.2 Bn	12%
Textile	$75 Bn	$190 Bn	$0.3 Bn	$1.1 Bn	5.2%



Process Manufacturing: Output and Investments

Sector	Output 2021 (E)	Output 2025(E)	FDI* (FY 2021)	Tech Spend Annualized	RoIC* (FY 2019)
Drugs/ Pharma	$60 Bn	$150 Bn	$2.5 Bn	$2.4 Bn	16%
Chemical	$100 Bn	$304 Bn	$3.3 Bn	$1 Bn	13.4%
Food Processing	$40 Bn	$470 Bn	$0.4 Bn	$0.8 Bn	8.4%
Cement	$32 Bn	$190 Bn	$0.6 Bn	$0.6 Bn	17%

India's Industry 4.0 Market – $5.5-$6.5 Bn of the manufacturing technology spend is on IoT platforms, Cloud, Cybersecurity, Data Analytics , AI/ML, and AR/VR

Sources: IBEF, InvestIndia, Indian Electrical & Electronics Manufacturers' Association, AEPCIIndia, Care Ratings, Research Team Analysis | *FDI – Foreign Direct Investment, RoIC – Return on Invested Capital

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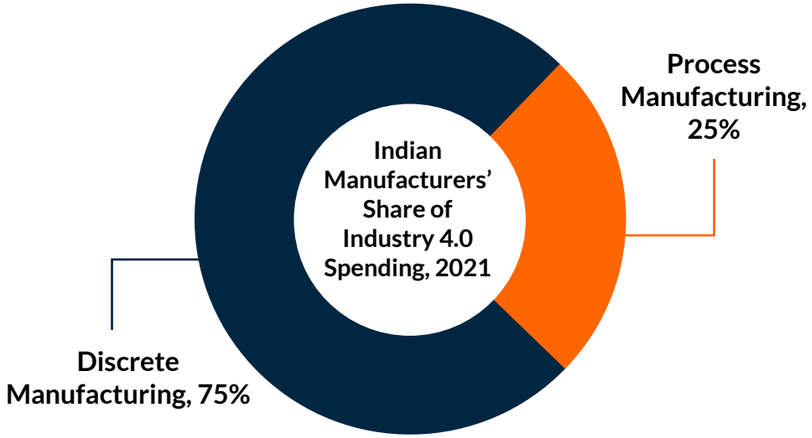
Discrete manufacturers, led by Auto, Electricals and Electronics sectors, are the incumbents in Industry 4.0 spending, while process manufacturers are investing more in process automation

Discrete Manufacturing – $4.8 Bn

- Indian Automakers stepped up investments in Cloud and digital systems, shedding legacy IT infrastructure
- Electronic component manufacturers in India have invested heavily in Connected Technologies like 5G & IIoT, boosted by initiatives of NASSCOM CoE-IoT and central and state governments' VARCoE
- From retrofitting legacy machines on process lines with IoT devices, to entirely autonomous process lines monitored remotely via digital thread – the discrete segment is capitalizing on M2M data to manage end-to-end operations



Process Manufacturing – $1.6 Bn

- Indian pharmaceutical companies are taking a technology-first approach, prioritizing Cloud-based modernization with preference for "pay-per-use" models
- 50% of the sector spends greater than 6% of its annual revenue on technology spend and is in early or intermediate stages of Industry 4.0 adoption
- Other process industries, like Chemicals, are at early stages of Industry 4.0 deployment, with greater focus on Cloud, and plans to speed up automation

Data and Analytics	Connectivity Tech	Intelligent Automation	Advanced DigiTech

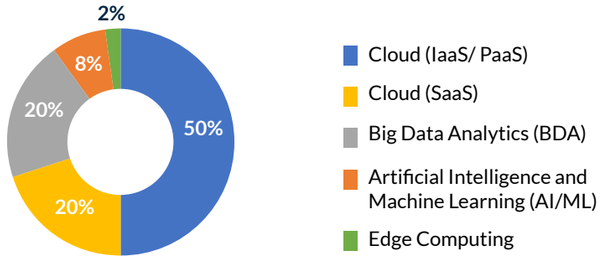
Source: Research Team Analysis

Most Industry 4.0 investments are currently in Cloud, IoT, Big Data Analytics, Connectivity Tech, and RPA, while a few manufacturers are experimenting with single/multi-site dark factory platforms

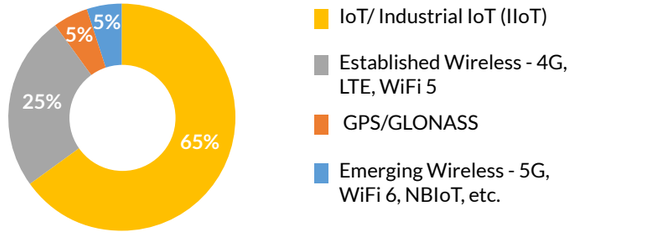
India Manufacturing Industry 4.0 Spend Distribution by Technologies

In $ Bn and %, 2021

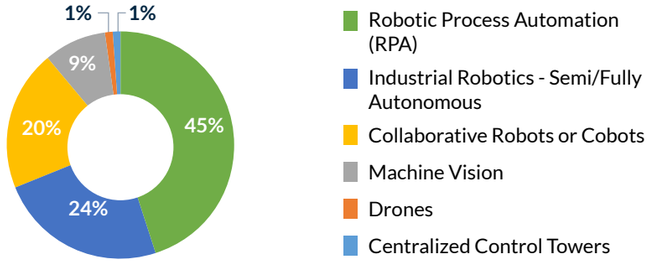
Data and Analytics, $3.1



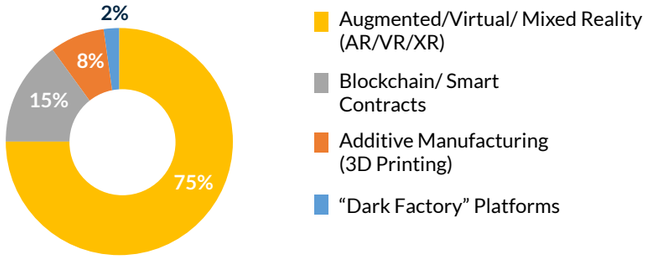
Connectivity Tech, $1.9



Intelligent Automation, $1.0



Advanced DigiTech, $0.4



Top 10 Technologies

By Spend in $ Bn, 2021

1	Cloud	2.17
2	IoT/IIoT	1.24
3	BDA	0.62
4	Existing Wireless	0.48
5	RPA	0.45
6	AR/VR	0.3
7	AI/ML	0.25
8	Industrial Robotics	0.24
9	Cobots	0.2
10	Machine Vision	0.1

50% of the current Industry 4.0 spend is in Cloud and IoT/IIoT, indicating early stages in establishing Industry 4.0 foundation

Source: Research Team Analysis

Connected and mature value chains invest in digitalization across the supply chain, compared with value chains that have just established or are still emerging, highlighting the network advantage

Manufacturing Value Chain Maturity

Mature Value Chains

Value chains have advanced tech deployment and healthy global supply ecosystems

Established Value Chains

Value chains are established yet lack technological sophistication; potential for industry 4.0 disruption is high

Emerging Value Chains

Critical stages of the value chains do not exist in India. Sunrise sectors should build digital-native value chains

Industry 4.0 Adoption Trends Across Manufacturing MSMEs

Supply Chain	20%
Floor Shop	60%
Warehousing	15%
Customer	05%

Automotive

Supply Chain	30%
Floor Shop	50%
Warehousing	15%
Customer	05%

Drugs/ Pharma

Supply Chain	20%
Floor Shop	70%
Warehousing	10%
Customer	0%

Chemical

Supply Chain	20%
Floor Shop	55%
Warehousing	25%

Food Processing

Supply Chain	30%
Floor Shop	45%
Warehousing	25%

Textile

Supply Chain	30%
Floor Shop	50%
Warehousing	20%

Aerospace/Defense

Supply Chain	15%
Floor Shop	65%
Warehousing	20%

Electronics/ Semiconductor

Supply Chain	20%
Floor Shop	50%
Warehousing	30%

Electrical/ Equipment

Supply Chain	20%
Floor Shop	70%
Warehousing	10%

Cement

Source: Research Team Analysis | In Emerging value chains, Industry 4.0 investment at a stage reflects the spend by companies with visibility of that stage, however, does not suggest maturity in any way

India's 90% manufacturing companies are MSMEs* that account for 33% of manufacturing GVA and 45-50% of exports, but they lag in tech adoption due to scale, financing, and leadership challenges

Manufacturing Sectors Dominated by MSMEs

Industry 4.0 Adoption Across Manufacturing MSMEs – Tech Challenges, Yet Growing Adoption

MSME Technology Adoption Challenges

- Awareness and know-how of the diverse and continuously evolving digital solutions space
- CapEx for greenfield tech investments
- Sustained commitment to scale technology PoCs
- Adequate and experienced services providers of a scale relevant to the MSME segment

Important Industry 4.0 Merits for MSMEs

- Multiple Cloud and SaaS-based service models for MSMEs to reduce non-core tech investments and CapEx
- Improvements in quality of products and services with the help of Industry 4.0 technologies, such as lowered cost of quality inspections using computer vision
- Business risk mitigation with predictive analytics – predictive sourcing risks and equipment maintenance

MSME Industry 4.0 Adoption During COVID-19

1. A leading gear manufacturer of India automated machine data digitalization using IoT devices on nearly 50% of their machines
2. A specialty chemicals company adopted IoT based connected sensors and real-time data capture to enable operations licensors to remotely resume and monitor line operations from outside India
3. A leading healthcare chain in India fully digitized home care solutions combining AI-based customer segmentation with focused healthcare delivery through telehealth solutions and an integrated eCommerce site for healthcare services

Source: Research Team Analysis | *MSMEs are medium, small and micro enterprises in India as per definition by the Ministry of MSME

NASSCOM's State of Industry 4.0 analysis spanned 55 in-depth interviews and survey inputs covering the top 5-6 manufacturing sectors in India, and 25 in-depth supply-side interviews

NASSCOM partnered with UnearthInsight to develop the primary research strategy, rollout, and analysis of inputs that covered key manufacturing sectors (large and mid-sized companies included), major solution providers, and startups.

Participants' Profile – Manufacturing Companies

- Technology Heads CIOs, Head of IT
- Operations Heads COO, Head of Operations
- Heads of Digital Transformation/ Innovation
- Head of Manufacturing/ Facility Head

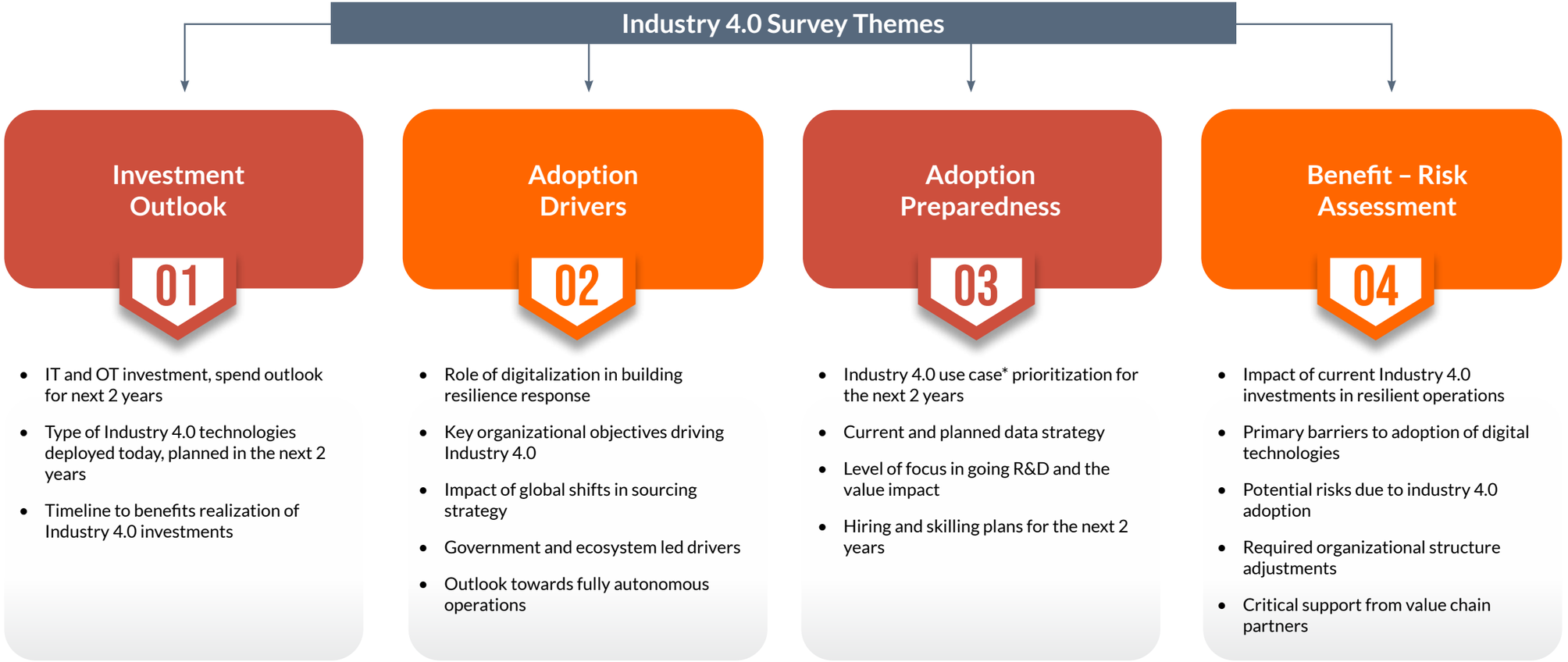
Participants' Profile – Technology Solution Providers

- Technology Heads CIOs, Head of IT
- Functional Heads Manufacturing verticals
- Product Heads Head of Product Engg.
- Start-up CEOs Founders
- Account Directors Head of Solutions

Surveyed and Interviewed Enterprise Segments

- Automotive OEM and Parts
- Electronics & Equipment
- Chemical, Cement & Food Processing
- Pharmaceuticals
- IIoT Platform Providers
- Intelligent Automation Providers
- Implementation Partners (IT Services)

The Industry 4.0 survey combined four major themes to conduct a preliminary adoption maturity assessment and generate aggregate and sector-specific insights



*The survey identified four major Industry 4.0 use cases:

1. Connected Work - Use of IIoT tech to replace scheduled operations with real-time decision-making
2. Precision Work - Use of automation and robotics on the job floor or in high-risk tasks
3. Intelligent Work - Applications of analytics and AI to real-time data to build predictive and prescriptive strategies
4. Visible Supply Chains - Adoption of IoT/AI/Blockchain and other digital solutions for end-to-end track and trace of material movement

Industry 4.0 is at an inflection point in Indian manufacturing with the intent and urgency to increase investments in the next 2 years, and a rapid shift from PoC hopping to outcome-based deployment

Investment Outlook

1. Big Bet on New IT and OT Investments in Next 2 Years
2. Traditional Tech Upgrade to Reduce Significantly
3. Cloud Adoption Goes Mainstream, Enterprise-Wide
4. Shopfloors Deploy Big Data Analytics, RPA, and IoT
5. Robotics, Cognitive Automation, AI/ ML, Dark Factory at PoC Level
6. End-to-End Supply Chain Digitalization is Fledgling

Adoption Drivers

1. Industry 4.0 Essential to Driving 2025 India Manufacturing Goals
2. Urgent Focus on Digital Skills Hiring and Trainings
3. Packaged Solutions with System Integration Capabilities Sought
4. Long-Term Investments, Supplier Derisking Critical in Long Run
5. Big Capex in Greenfield Smart Factories in Next 2 Years
6. Industrial Corridor Policy, PLI, and GST to Boost Industry 4.0

Adoption Preparedness

1. 50%+ Reinitiated R&D, made MVPs, PoC-to-Production Plan
2. Connected Work Priorities – M2M Data Mgmt, Remote Monitoring
3. Precision Work Priorities – Central Control, Predictive Maintenance
4. Intelligent Work Priorities – Automation, Self-Optimizing Lines
5. Visible SC Priorities – IoT-equipped Logistics, Global Track-n-Trace
6. 67%+ Will Prioritize Integrated Use Cases and Will Train IT on OT

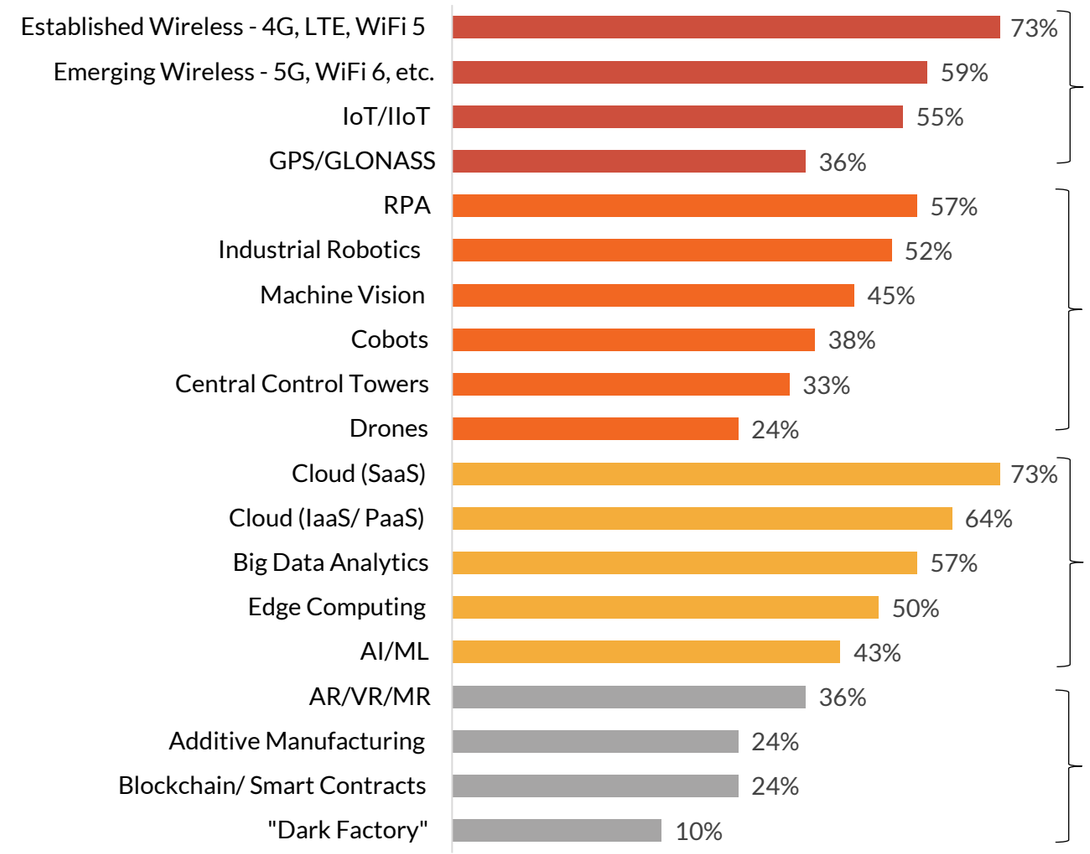
Benefit – Risk Assessment

1. Companies Report 60%+ Market Share Rise in 2 Years of Industry 4.0
2. Automation, Remote Maintenance Helped Lower Pandemic Downside
3. Inability to Prove RoI and High Provider Cost Key Barriers
4. Changing Regulations, Operational Disruptions are Biggest Risks
5. Value Chain Adoption of Technology Critical for Industry 4.0
6. Industry 4.0 Needs a Mindset Change; Cultural Resistance High

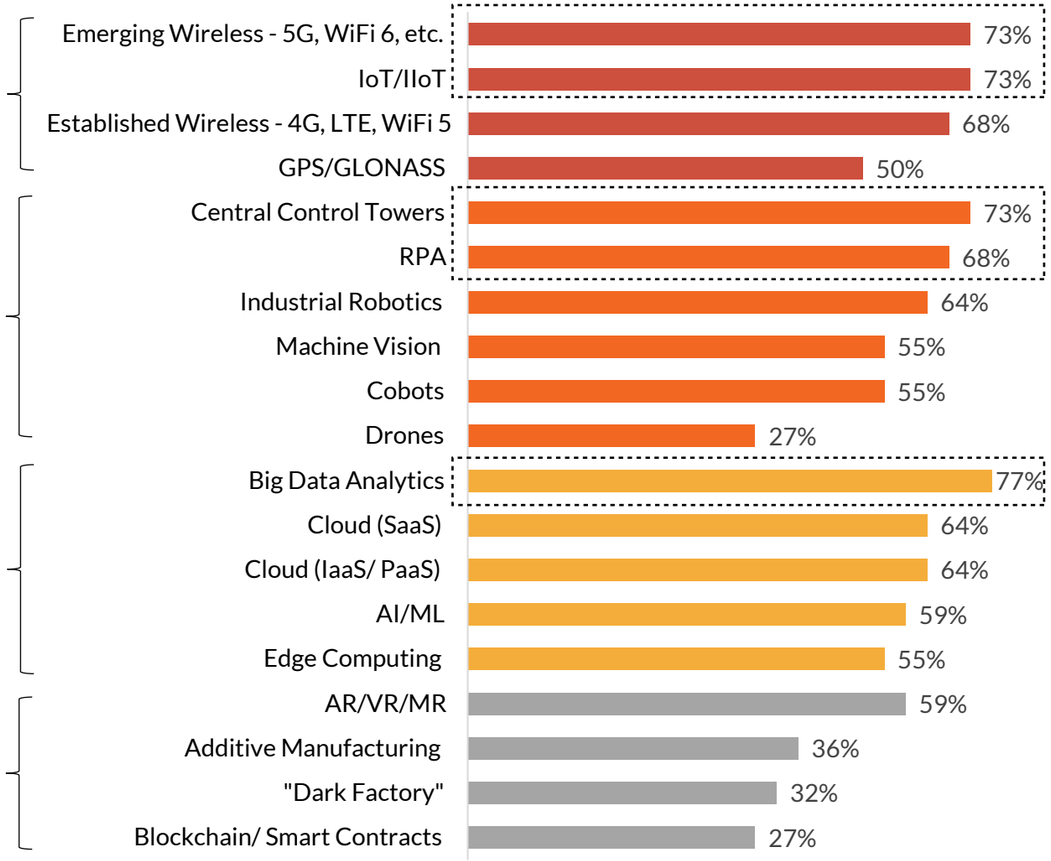
Source: Research Team Analysis

Emerging connectivity tech, big data analytics, centralized and remote-controlled monitoring, and process automation will invite priority investments during the next 18-24 months

Current Production-Grade Industry 4.0 Technology Investments

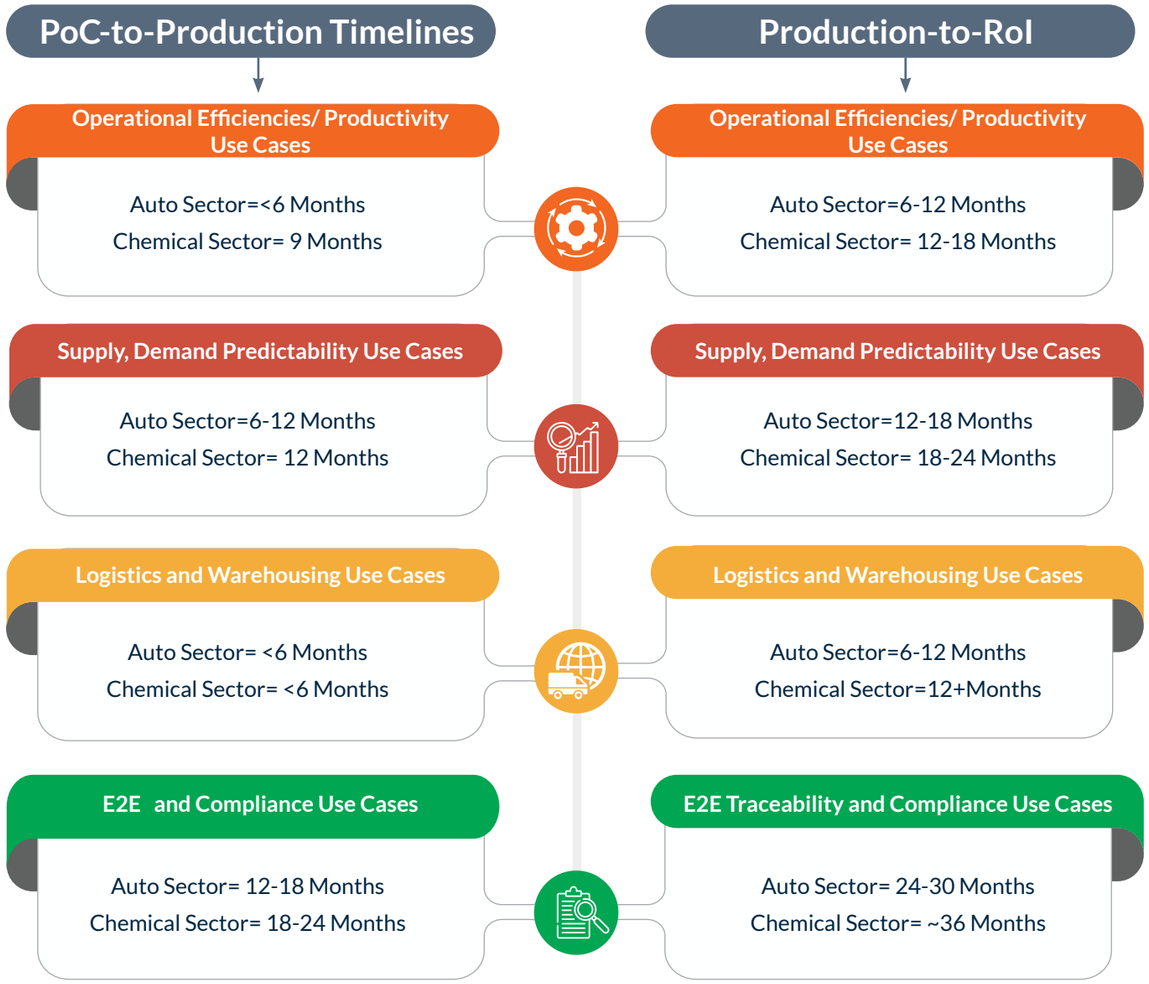


Planned Industry 4.0 Technology Investments with Medium-High Priority



Source: Research Team Analysis

Timelines for Industry 4.0 projects, agnostic of sector and size of operations, have shrunk by >25% from MVP approval to benefits realization, indicating an enterprise-wide urgency to act



Source: Research Team Analysis

Discrete Manufacturers

Owing to higher pre-pandemic investments in Industry 4.0 technologies and more organized and tech-aware value chains, discrete sectors have accelerated the process of digital transformation initiatives in E2E chain visibility, central control towers and dark factories.

Process Manufacturers

Lack of complete ecosystem and value chain visibility has protracted the digital transformation journey for process manufacturers, with supply-side uncertainties having severely impacted production efficiencies and revival timelines. However, it has led to greater investment initiatives in process automation and a shift to Cloud for data visibility.

However, Indian manufacturers lag in maturity with foundational technologies – 30-45% are still at PoC stages with Cloud, IoT, and Connectivity Tech, and have less mature data and talent strategies

Maturity in Foundational Digital Technologies

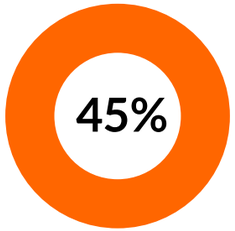
1. **77%** - Will invest in operational and domain skills, equipped with technology deployment capabilities, higher than those that will directly hire IT talent
2. **~33%** – companies are still at PoC stages with Cloud – IaaS, PaaS, or SaaS – these companies further indicate low maturity with having basic data management practices in place
3. **~30%** of the companies do not have adequate Connectivity technologies, such as existing 4G, LTE, WiFi5 capabilities
4. **45%** of the companies reported having no or small PoCs with IoT/IIoT technologies.
5. **75%** companies will ramp up infrastructure upgrades and legacy retrofitting to enable M2M communication

Maturity in Core Data Management Capabilities

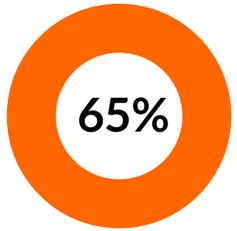
1. **43%** – companies report no explicit data strategy and/or no data management systems in place
2. **30%** - adopt a reactive approach to data analysis with the data captured only deployed for occasional decision-making purposes
3. **43%** - companies indicate low maturity in proactive data analysis methods to identify red flags and prevent risks
4. **34%** - companies report not having any significant AI-based predictive data analytics capabilities, compared with reactive data analytics. These companies are at PoC stages with AI/ML technologies
5. **86%** - companies have disparate data management systems with isolated MES, ERP, PLM, and SCM systems that they plan to integrate in the next 18-24 months

Source: Research Team Analysis

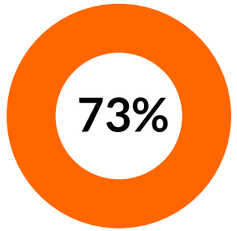
Emerging Investment Outlook: New investments will be a combination of scaling-up existing IoT and Cloud deployments for rapid PoC-to-production of new use cases and industrial automation



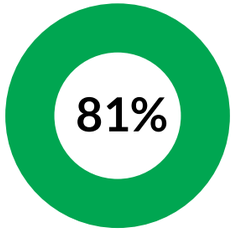
Bet Big on Technology – Manufacturers are prepared to bet big on Industry 4.0. 45%+ respondents are planning to increase their IT and OT spend, IT and OT headcount, digital skilling budgets, and cross-training initiatives in the next 18-24 months.



Deployment of Cloud, IoT & RPA Technology – 65% of the Cloud/BDA and 55% of IoT deployments expanded to industrial grade. 75% manufacturers have some form of wireless tech, and Cloud and IoT technologies in place.

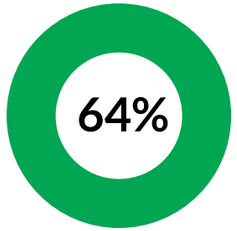


PoCs in Advanced Technologies – 73% respondents are at PoC stage for Advanced Digitech – AI/ML, 3D printing, AR/VR, Blockchain, and Dark Factory implementations.



Data Analytics Priority for next 18 Months – 81% respondents indicate moderate to high priority for investments on Big Data Analytics in next 18-24 months.

RPA, 5G Also Key Emerging Priorities – 48% rate RPA as highly important and essential for the next phase of floor shop and supply chain digitalization; 50% believe emerging wireless and connectivity tech to become important.



18 months Market Share/RoA/RoCE – 64% of respondents reported increased growth or market share within 18 months of deployment of Industry 4.0 solutions while 55% expected increase in RoA/ RoCE/RoI in 18 months.

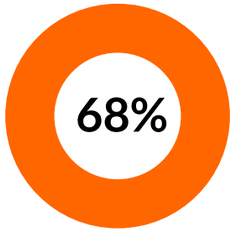
% manufacturing adopters of Industry 4.0

Current and Future Spend on Various Industry 4.0 Technologies

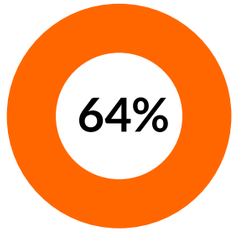
Future Priority for Investment and Impact Created

Source: Research Team Analysis

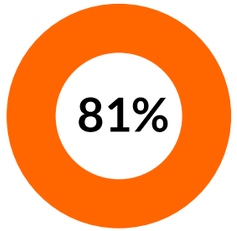
Emerging Adoption Drivers: GoI policies on infrastructure upgrade and MSME participation, coupled with corporate investments in large digital projects will drive Industry 4.0 adoption



Industrial Corridors and MSME Incentives Key – 68% of the respondents agree that governments industrial corridor policy and incentives will push SMEs/MSMEs to fast-track Industry 4.0 adoption.

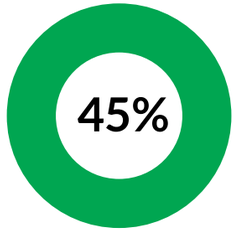


PLI, Atmanirbhar Abhiyan, GST Key to Value Chain Adoption – 64% of the companies agree that the PLI and Atmanirbhar schemes, along with the transactional transparency of GST will accelerate digitalization of entire value chains.

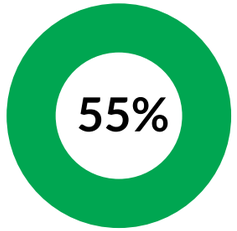


Shift in Existing Supplier Strategy – 81% manufacturers indicate shifting sourcing strategy to some combination of derisking with alternatives, vendor consolidation, and inhouse development with IT and OT teams.

Industry 4.0 Important to Business and India Growth Goals – 50% respondents indicate that Industry 4.0 will be critical for sustainability and margin growth. 57% indicated that Industry 4.0 is very important for India's manufacturing growth through 2025.



Strong Long-term & Strategic Investments Plan – 45% manufacturers are planning strategic and long-term investments in the next 18 to 24 months to push for large-scale Industry 4.0 projects.



Significantly Increased Digital Skills Hiring – 28% of the companies have indicated immediate ramp up of hiring for IT and OT skills, while another 27% have plans within next 18 months.

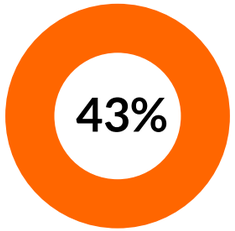
% manufacturing adopters of Industry 4.0

Govt Initiatives and Sourcing Strategies

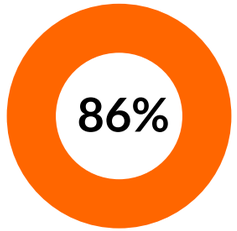
Pandemic & Strategic Investment Push and Industry 4.0 Importance

Source: Research Team Analysis

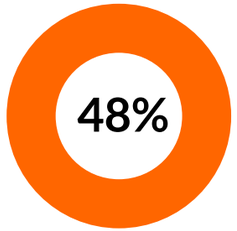
Emerging Industry 4.0 Use Cases: Manufacturers' readiness to scale projects will depend significantly on the choice of use cases, ability to scale PoCs, and IT and OT skills alignment



Data Strategy Still Lacking – 43% of the companies, however, lack any explicit data strategy and/or data management systems – a glaring foundational preparedness gap, as no organization claimed to have a fully mature data strategy.



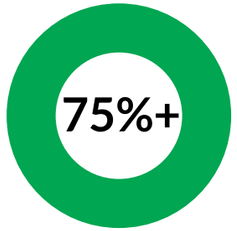
MES, PLM and ERP Integration Top Priority – 86% of the manufacturers put moderate to high priority on integrating MES, PLM and ERP systems, and centralizing remote-controlled multi-site operations in the next 18-24 months.



From PoCs to Use Cases – Manufacturers are further thinking integrated use cases, prioritizing M2M data mgmt, remote monitoring, central control, predictive maintenance, self-optimizing lines, and E2E track and trace.

>25% Reduction in Industry 4.0 Timelines – Pandemic-led digitalization has shrunk PoC-to-production and further to RoI realization timelines by more than 25% across the board.

Rethink R&D and Innovation Budgets – 52% companies reported having large unused Industry 4.0 R&D budgets, now getting revitalized for integrated use cases as companies build MVP concepts to scale PoCs into full projects.



Industry 4.0 Skilling Cuts Across IT and OT – 76% will do focused hiring for Cloud and data science skills and will build change management and cultural acceptance, while 72% will emphasize IT and OT cross training.

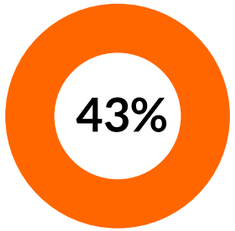
% manufacturing adopters of Industry 4.0

Industry 4.0 Operational Priorities and Preparedness

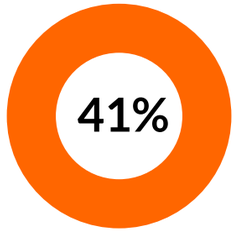
Emerging Industry 4.0 Timeline, Innovation and Skilling Mandates

Source: Research Team Analysis

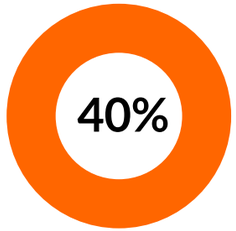
Emerging Industry 4.0 Risks and Challenges: Pre-pandemic investments helped minimize downside, but sustainable RoI is evasive, thereby limiting scalability and the value chain impact



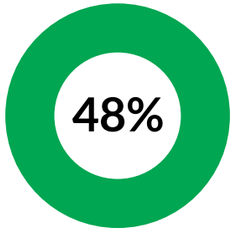
Remote Maintenance Enabled Digital Shift – 43% companies were able to quickly overcome production downtime and worker safety concerns with the help of Industry 4.0 led remote maintenance and process automation.



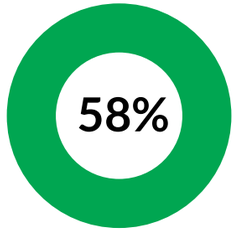
Inability to Demonstrate Tangible RoI is High – 41% companies consider inability to demonstrate tangible RoI as a major roadblock to scale Industry 4.0 PoCs, alongside complex legacy transformation.



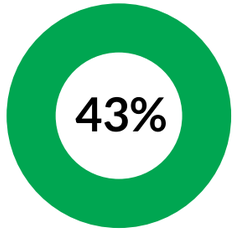
Regulatory and Compliance of Industry 4.0 – 40% companies find regulatory and compliance related risks - data privacy, IP, etc. as one of the major risks to their company's Industry 4.0 plans, often affecting long-term commitments.



Lower Cost of Tech Solutions – Nearly half of the respondents agree that lower cost of outsourced IT solutions will be a big boost – a case for Cloud-based solutions for small and medium sized adopters.



Supplier Collaboration to Achieve Industry 4.0 Goals – Majority companies require better handholding by mature channel partners in enabling their Industry 4.0 technology goals – a clear indication for data sharing and tech alignment opportunities.



Making Customer Centricity Core to Operations – 43% of companies believe that realigning operational functions along customer-centric processes will help them to facilitate Industry 4.0 adoption and impact.

% manufacturing adopters of Industry 4.0

Industry 4.0 Benefits and Risks

Industry 4.0 Mindset Shifts and Enablers

Source: Research Team Analysis

NASSCOM's Industry 4.0 survey reveals the advantage with discrete manufacturers in shaping an out-come-oriented Industry 4.0 journey, while process manufacturers still seek RoI on current PoCs

Industry 4.0 Survey Takeaways from Discrete and Process Industries

Discrete

1. >65% of discrete manufacturers across sectors have established SCM-CRM integration with ERP and MES systems
2. IoT, RPA, AI, and AR/VR are the top technology investments in the Auto, Electricals, and even some major Cement manufacturing majors
3. ~50% of Auto OEMs are gearing to near-100% autonomous assembly lines, currently being rapidly transitioned into a human-machine model with cobots
4. Areas of major resistance in Industry 4.0 adoption are towards the tail-end of core manufacturing, in procurement and downstream distribution
5. Customer safety and upcoming regulations on use of product usage non-personal data can have strong implications on future Industry 4.0 investments

Process

1. <20% indicated integrated data flows across MES and SCM< CRM, and ERP systems in the organizations
2. ~75% of process manufacturers have invested in Cloud, IoT and RPA technologies; ~50% in Big Data Analytics, while some chemicals manufacturers stand put with near-100% process automation
3. ~75% process companies are actively experimenting with basic to advanced AI use cases in predictive sourcing risks and equipment maintenance
4. Process companies report facing greater organizational resistance, as well as, in finding the right set of IT and OT talent with domain capabilities
5. Employee safety has been rated as the core priority, followed by improving go-to-market agility as areas for technological transformation

Sources: Research Team Analysis

04

India Industry 4.0 Adoption – Evolution Journey and Select Use Cases

Across manufacturing sectors, companies have predominantly focused on digitalizing operations and warehousing/logistics, with more focus now on integrating planning and upstream/downstream visibility

Industry 4.0 Use Cases by Value Chain Stages, *Key Technologies Involved*

Upstream – Supplier

Real-Time Supplier Management

- Real Time Order Management – IIoT and MES/SCADA integration
- Predicitve Supplier Performance – BDA, AI/ML
- Supplier Scenario Planning, Vulnerability Assessment, Prescriptive Planning – AI/ML, BDA
- Sourcing Mix Modeling/ Dynamic or Flexi-Sourcing Strategy – AI/ML, AR/VR, Blockchain
- Supplier Financing - Blockchain

Planning

Predictive Planning

- Predictive Demand Planning – Edge Devices, IoT, Big Data, AI/ML
- Real Time Replanning and Scheduling – ML, BDA
- Outcome-Based Decision Modeling – Blockchain, BDA, AI
- Traceability – IIoT Platform (Cloud, Edge Devices, Sensors), Robotics, AR/VR, Digital Thread

Production Operations

Smart or Dark Factories

Smart Machines

- Predictive Maintenance – Big Data, Cloud, AI/ML, Edge Devices
- Remote Controlled Supervisory or Maintenance Operations – Connectivity Tech, Robotics, Automation, Digital Twins

Smart Lines

- Self-Optimizing Assembly Lines –IIoT Platform, Automation, AI/ML, Edge Devices, and integrated OT Platforms
- Flexi-Assembly Lines – Digital Twins, Additive Manufacturing
- Prescriptive Scheduling – Digital twin-based flow simulation

Smart Operators/ Services

- Assistive Operations – AR/VR
- Remote Floor Shop Monitoring – Robotics, Automation, Digital Twins, AR/VR, Drones
- Traceability – Digital Twins

Warehouse/ Logistics

Integrated Logistics

Smart Warehouse/Logistics

- Predictive Warehouse Management – IIoT, Robotics, Automation, Connectivity Tech, Edge Devices
- Real-Time/ Predictive Inventory Management – IoT, Edge Devices, AI/ML, Drones, AR/VR, Robotics
- Freight-Sourcing Decision and Integrated Multi-Modal Logistics – IoT, AI/ML, Connectivity Tech, BDA

Digital Control Tower

- Real Time Location Data – Digital Thread

Downstream –Customers/Partners

Digital Customer Experience

Smart Partners

- Predicitve Distribution Planning – Integrated CRM and SCM with MES, BDA, AI/ML based optimization
- Customers/Partner Decision Analytics – BDA, IIoT, Edge Devices, Connectivity Tech

Hyperlocal or Last Mile Services

- Micro-Fulfillment – Big Data, Edge Devices, AI/ML, IoT
- Real Time Location Data – IoT, Connectivity Tech

Direct-to-Customer (D2C) Services

- Omnichannel strategy – Cloud, BDA, AI/ML
- Traceability – IoT, AR/VR, Digital Thread

Source: Research Team Analysis

Industry 4.0 Case Study: Digital thread based “Conscious Factory” concept helps Nokia anticipate future manufacturing needs with the development of self-predicting and self-optimizing factories

PROBLEM STATEMENT

Nokia’s factory in Chennai, yielding 16 billion chip mounts per year, faced severe external supply chain shocks

Battle of profitability was driven by major Chinese competitors, and because of this they needed to cut costs and drive efficiency in the supply chain

Pressure to be agile and responsive in a volatile market was high

Nokia battled a monolithic IT system as a result of merging legacies of Siemens, Alcatel-Lucent, Nortel, Motorola and Panasonic. As all companies merged with Nokia over the last few years, they brought their own legacy IT and OT systems, and that too in quick succession

SOLUTION

Tech Solution Deployed – Nokia has built a private wireless network based on 4G LTE using 2100 MHz spectrum from BSNL and Airtel & entire shop floor has been covered with two small cells, against the 56 legacy Wi-Fi access points.

- **Autonomous Guided Vehicles/Autonomous Intelligent Vehicles:** Material flows to and through the factory via delivery portals and warehouses driven by intelligent, autonomous vehicles. To enable the seamless movement of the AGVs, AIVs and also to track the assets moving around the shop floor, Nokia has installed its High Accuracy Indoor Positioning (HAIP) system using sensors, IoT gateways and private LTE platform.
- **“Pick to Light System” for Inventory Control**– All parts stored in racks across the store, and when the part if requested at a production station or testing area, an operator enters the data into the asset management system and a light goes on at the specific rack in the warehouse to make it easy to locate the part in the specific storage rack, and further transport it to the required place on the shop floor.

IMPACT – Across Value Chain (Upstream, Planning, Production, Logistics, and Downstream)

Low Latency and Real-Time Data Capture - Deploying a private wireless network at the Nokia Chennai plant helped in achieving greater agility on the shop floor to accommodate the rising need for line configuration changes. Greater agility reduced costs incurred from “rewiring” & increased the productivity imperative.

Fully Remote-Controlled Operations – Digital twin of the factory enabled automation of the production flow and remote operation and maintenance, especially through the height of the pandemic-induced lockdown in India.

Real-Time Visibility for Central Control – Screens display real-time information from the various sensors that monitor almost every process across the factory floor. The data from these sensors runs through Microsoft’s Azure platform, and the system allows managers to track parts by serial number as they move through the factory, physically or via a digital twin platform

Automation of Quality Testing Processes – Maintains a digital trace of operator performance. Quality testing would happen at the end of the assembly, but the system allows the company to pinpoint exactly where something went wrong and fix the problem quickly.

31% labor time reduction through robotic automation | 31,000-man hours saved through RPA | 16% OEE improvement

Source: Nokia, Research Team Analysis

Industry 4.0 Case Study: Collaborative robots or cobots are Bajaj Auto's choice to revolutionize shopfloor operations, with streamlined human-machine interfaces effectively minimizing downtime

PROBLEM STATEMENT

Two-wheeler assembly lines were highly labour intensive, spatially challenged and had physically taxing movements that required high end precision

Around 50% of the workforce were women, who found it difficult to operate intensive assembly lines

Bajaj auto wanted to:

- Reduce ergonomic risks to the employees due to highly repetitive tasks and static postures over a long period of time.
- Find a standardized automation solution that could be horizontally deployed to increase productivity, flexibility and reliability

SOLUTION

Tech Solution Deployed – Bajaj Auto partnered with Universal Robots after 3 months of extensive testing of Universal Robots' cobots at the latter's facilities. Bajaj Auto deployed cobots with the following objectives:

- Ceiling Mounted Cobots – Diminished the challenge of space constraint in a manufacturing facility.
- Reduction in Redundancy-Led Fatigue and Errors – Completing the repetitive movements that required precision.
- Standardization & New Decal Applications – Catered to multi-modelling adaptability and tasks that required flexibility, productivity and reliability.

IMPACT – Smart Lines and Smart Operators/Services

Safety - Eases work for women workforce, with 30 patented force limiting features built in compliance with ISO TS 15066,Ceiling mount, Wall mount or Floor mount Co-Bots.

Zero annual maintenance costs - Reduced power consumption and retention of IP within the company, organically driving forward, growth of the organization

Shopfloor Efficiency Improvement – Lowest running costs, Can operate without a cage in space constrained areas.

Reduction in Ergonomic Risks- Usage of Co-Bots, thus reducing manual stress, providing Compact movement, extremely flexible (all axes + or – 360-degree rotation) and lightweight.

Source: Bajaj Auto, Research Team Analysis

Industry 4.0 Case Study: TVS Motor Company used IoT to connect a complex and heterogeneous assembly line and gain deep insights into integrating the manufacturing processes across multiple sites

PROBLEM STATEMENT

TVS Motor's assembly line machines were not connected, and data from machines was not flowing into the data lake, impacting traceability, visibility and predictability at the shopfloor

TVS wanted to drive IoT-enabled digital transformation by connecting machines on the assembly line, and

- Build an integrated manufacturing data lake
- Integrate machine data on the shopfloor
- Move data from other IT systems on the shopfloor into the data lake

SOLUTION

Tech Solution Deployed – TVS Motor partnered with Altizon and deployed the provider's proprietary IoT platform and Digital Factory hybrid solution with an Edge solution deployed in a fail-safe configuration inside the TVS network. The solution stack included:

- **Edge Computing: Distributed** computing platform that allows IIoT data to be processed closer to the edge of the network.
- **Connected Work**: Integrated data lake for storing and processing all machine and manufacturing data for further analytics.
- **Digital Factory**: Unified digital manufacturing platform powered by IoT and out-of-the box apps for monitoring, measuring, analyzing and predicting outcomes using AI.

IMPACT – Smart or Dark Factories

OEE Improvement – Real-time insight into parameters that impact line productivity, such as line rates, loss, and quality analysis across multiple levels of operations.

Predictive Maintenance – Statistical analysis of product quality parameters, coupled with real-time machine condition data enabled predictive maintenance and minimized costly stalls.

Traceability – IoT-based product traceability through the flow cycle to assess quality of the material in real-time, for upstream and downstream information and associated decisions.

Skill Matrix - Maintain a digital trace of operator performance. Enable the identification of a skill matrix and identify any exceptions that could impact product quality.

Source: Altizon, Research Team Analysis

Industry 4.0 Case Study: Kia Motors's Connected Vehicles Platform (CVP) offers flexible assembly line capabilities with small-batch production capabilities, enabling customizations at low cost

PROBLEM STATEMENT

During the pandemic, sales and services practically ceased overnight, affecting customer connect and demand forecasting

Challenge was to keep the potential customers engaged so that once the industry picks up, they turn buyers

Biggest challenge that KIA faced as a new player is that they were not able to demonstrate their product due to the restrictions set during the coronavirus lockdowns

SOLUTION

3D Configurators – Kia Motors deployed an AR/VR based 3D configurator solution to create a digital catalogue of the showcased vehicle and a digital specifications board for every vehicle category in their product portfolio at the Mumbai showroom.

3D Configurator Customer Zone – Enabled customers to customize and design their favorite Kia cars and witness their intricate details. The content displayed in the showroom was remotely controlled centrally.

'Kia Digi-Connect': An industry-first video-based live sales consultation solution website integrated with the company's CRM system, provided customers options of 360-degree virtual experience through video calls and screen sharing, along with sharing of digital brochures and dynamic pricing.

IMPACT – Digital Customer Experience

Transparency – Customers could digitally make buying decisions along with their family members logged in from multiple geographies at the same time, recreating a physical showroom experience.

Customer Connectedness – Digital consultation services by established dealers gave customers a sense of reliability and security while making purchase decisions during a pandemic.

Real-Time Transaction Visibility Via Digitalized Showroom – Live Stream Showroom capability demonstrated continued commitment to tailor the car-buying journey to the demands of the customers with virtual viewings.

6,000+ pre-bookings made on Day 1 of opening from pandemic lockdown

Source: Kia Motors, Research Team Analysis

Many more Industry 4.0 implementations have been catalyzed by the COVID-19 pandemic, mainly focused on safe, flexible, and remotely-controlled operations

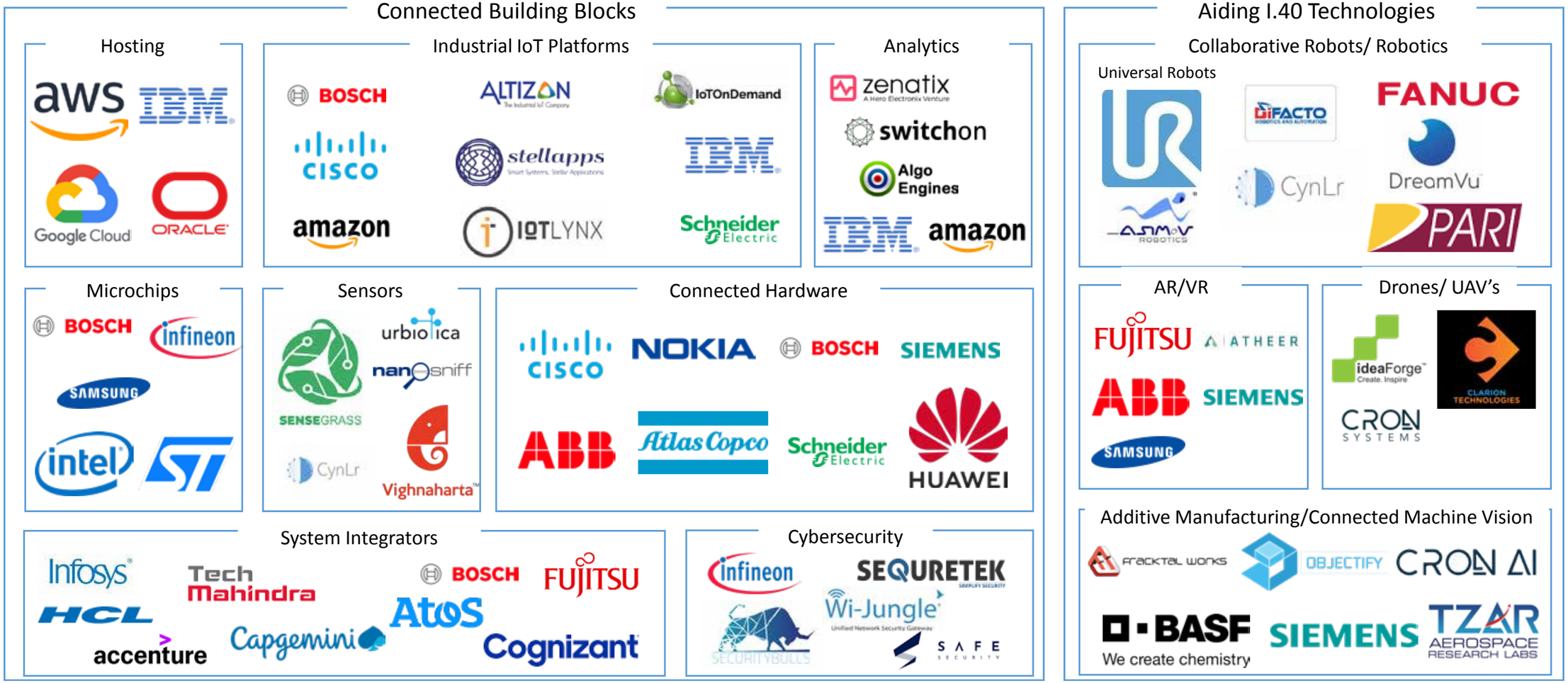
Major Technology Investments by Global and Large Manufacturers

1. **Ola Electric with Siemens** - $300 Mn committed to building India's most advanced electric vehicle manufacturing facility
2. **Bosch Home Appliances** - €100 Mn spend by 2025 on IoT-based solutions, including a smart refrigerator factory in India
3. **Henkel Adhesives** - €50 Mn into a smart factory in Pune, equipped with end-to-end quality and track-and-trace capabilities using digitalized workflows
4. **M&M and Bosch** – Partnership to develop Mahindra's connected vehicle platform "AdrenoX Connect" for all vehicle lines, with integrated platforms enabling flexible swichovers
5. **Vedanta and GE** – Partnership to digitalize India's first Aluminium smelting plant deploying Digital Twin technology built on GE's Predix Platform

Source: Research Team Analysis

Indian Industry 4.0 provider landscape is rapidly diversifying – hyperscalers and integrators are investing in platforms; startups in specialist vertical solutions – yet end-to-end homegrowns are few

India's Industry 4.0 Provider Landscape, *illustrative and not-exhaustive*



Industry 4.0 adoption journeys suggest a basic three-stage evolution process – from small goal-oriented PoCs with connectivity and analytics tech, to line-level scaleup, to finally site-level deployment

Industry 4.0 Pre-Initiation Checklist

Objective of Industry 4.0	PoC is a way to fail fast and fail safe; it still needs a business outcome to validate
Connectivity Infrastructure	Connectivity level required - # of machines, devices, n/w interfaces, Edge gateways; device latencies
Type of Line Machines	Mechanical with no controllers PLC > CNC > 4th gen DLC
System Integration Needs	Legacy retrofitted M2M data; HMI data M2M data integration with existing MES layer
Use Cases	Minimize loss Improve utilization Enhance responsiveness

Industry 4.0 3-Stage Evolution – Necessary To-Dos at Each Stage

Goal-Oriented PoCs <6 months

- Build an outcome-based PoC, rather than a technology-based PoC
- Segment a line or shopfloor transformation project into a set of independent PoCs
- Align PoC validation with an observable metric or KPI
- Identify a cross-functional team comprising IT, OT, and business process owners

Line Automation <12 months

- Identify critical machine parameters to track
- Remodel existing data ingestion pipeline to incorporate machine data
- Determine sources of local (Edge) and central (Cloud) data for integration
- Spend adequate time understanding SI vendor capabilities to know what not to automate
- It is equally important to decide what not to automate and await tech maturity to evolve

Smart Factory Site 18-36 months

- Reassess interdependencies across the digital versions of physical operational, stocking, warehousring, and monitoring areas in a factory site to identify data flow sinks
- Eliminate physical process redundancies before implementing a digital twin
- Determine precise interfaces between humans and machines and human-human interfaces to automate handoffs
- Identify connectivity tech capable of low-cost scale-up (case-in-point – private LTEs)
- Segregate data for local vs central planning beforehand

Source: Research Team Analysis

05

Recommendations – Maturing India's Industry 4.0 Adoption by 2025

NASSCOM survey reveals the “Must Haves” for successful Industry 4.0 adoption – leadership commitment, cross-skilled teams, technology standards, and most critically, a firmwide data strategy

01 LEADERSHIP COMMITMENT

- 87% of NASSCOM survey respondents indicate that Industry 4.0 is an enterprise-impacting digital transformation journey that will sustain when driven from the top, with a compelling change story, practical investment planning, and a fail-fast approach to experimentation. This is true across discrete and process sectors.

02 DEDICATED, CROSS-SKILLED AND A CONTINUOUSLY UPSKILLING TEAM

- 86% respondents agree that a dedicated Industry 4.0 team comprising of experts from shopfloor, operational planning, internal IT team, external supply chain technology and business process owners, and strategic tech partners is key to success. Starting teams can comprise of in-house IT and OT experts to begin with. Industry 4.0 is not an IT-only or an OT-only transformation initiative.

03 DIGITAL TALENT ACQUISITION AND RESKILLING

- Skill gaps deepen with more advanced use cases that require adequate domain expertise. Current talent strategies employ a combination of hiring and upskilling; however, these initiatives are nascent. Mainstreaming of Industry 4.0 will require active and widespread collaboration with academia and startups. Less than 20% manufacturers currently exploit these opportunities, although ~73% indicate the desire to do so in the next 18-24 months.

04 STANDARDS AND FLEXIBILITY

- Ever-emerging IoT norms – Narrow-band, LoRaWAN, etc. – and transition of IoT single-condition sensors to multi-condition monitors is further creating multiplicity of standard and norms to follow. Lack of clarity on M2M data sharing and privacy rules is one reason limiting companies to share data across the value chain for improved transparency.

05 DATA INTEGRITY AND DATA MANAGEMENT STRATEGY

- <50% manufacturers across discrete and process sectors indicate having standardized data management strategies across all production sites. More discrete manufacturers are mature at data handling than process manufacturers. 65-70% of the respondents are experimenting with IoT data integration and have deployed 4G connectivity technologies.

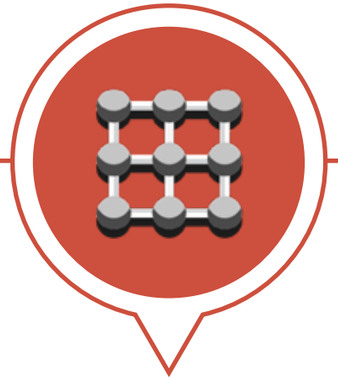
Source: Research Team Analysis

NASSCOM recommends combining learnings from global best practices and local successes to propel Indian manufacturing to its $1 Tn 2025 goal with Industry 4.0 adoption

GoI should build a sector-specific financing-investment-tech upgrade policy keeping into perspective the differential role of a sector at the cluster/corridor, regional, national, and global scale to arrest the low cost, low quality, finance-dependent perception of Indian manufacturing sector

TECH CAPABILITY DEVELOPMENT

- Robust strategy for R&D allocation
- Open platform for academia and industry to work on real problems*
- Amplify reach and investments via Samarth Udyog Bharat 4.0
- Refocus PLI scheme to incent technology-led differential revenue growth



SKILLING AND TRAINING

- Tech-driven high-school curriculum with recognition to online programs
- Refocus Skill India campaign on critical cross-tech skills of the future
- Accelerate adoption of online skilling platforms

ECOSYSTEM DEVELOPMENT

- Develop outcome-oriented economic clusters with contextualized tech facilitation
- Operate a federated center-state model to bring big-picture as well as local focus into the planning process
- Facilitate access to land banks for new investors

FINANCING AND INVESTMENTS

- Encourage foreign capital inflow (FDIs, FIIs) with a focus on technology and manufacturing knowledge transfer
- Adopt a multi-year agenda to reduce the cost of financing

*NASSCOM CoE-IoT has launched its flagship Smart Manufacturing Competency Center. Details here.

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Capgemini is a global leader in partnering with companies to transform and manage their business by harnessing the power of technology. The Group is guided everyday by its purpose of unleashing human energy through technology for an inclusive and sustainable future. It is a responsible and diverse organization of over 325,000 team members in more than 50 countries. With its strong 55-year heritage and deep industry expertise, Capgemini is trusted by its clients to address the entire breadth of their business needs, from strategy and design to operations, fuelled by the fast evolving and innovative world of cloud, data, AI, connectivity, software, digital engineering and platforms. The Group reported in 2021 global revenues of €18 billion.

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About NASSCOM CoE-IoT

The Center of Excellence is the largest deep tech innovation ecosystem in India comprising of startups, innovators, enterprises and the government, with the focus on solving real-world challenges utilising technologies like IoT, AI, Data Science, Big Data, AR/VR, Machine Learning, Robotics and through extensive academic research.

With a vision to make India Industry 4.0 hub globally, NASSCOM CoE helps large as well as MSME enterprises in solving manufacturing challenges through adoption of digital technologies.

NASSCOM CoE looks to **partner with State Industry Department and Associations** to transform manufacturing

Tools and Techniques of CoE:

- Innovation Challenges
- Conferences, Roundtables and Panel discussions
- Plant visits
- One to one interactions
- Smart Manufacturing Competency Center
- Website, Blogs & Social Media

Digital Skills

- **Learn from the awareness sessions** in various areas for adoption of industry 4.0
- Access to the repository of **knowledge material**
- **Experience solutions** at the Virtual Center

Digital roadmap

- **Prioritize manufacturing challenges working** with NASSCOM CoE
- Get support in building **Roadmap of your digital journey**

Innovative Solutions

- **Get connected with solution providers** through NASSCOM CoE
- **Co-create and implement the low cost easy to deploy solutions** to increase efficiency, productivity and safety in the plant

Branding and Showcase

- **Publish case studies** on the website of CoE, about Industry 4.0 solutions implemented by you
- **Co-author technology led blogs**
- **talk** at discussion forums, conferences, interviews etc.
- **Get featured** in Media and Social Posts.

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ABOUT

NASSCOM®

NASSCOM is the premier trade body and chamber of commerce of the Tech industry in India and comprises over 3000 member companies including both Indian and multinational organisations that have a presence in India. Our membership spans across the entire spectrum of the industry from start ups to multinationals and from products to services, Global Service Centers to Engineering firms. Guided by India's vision to become a leading digital economy globally, NASSCOM focuses on accelerating the pace of transformation of the industry to emerge as the preferred enablers for global digital transformation.

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ABOUT

UnearthInsights

UnearthInsight delivers critical market information to drive decision insights for CXOs and equips them with actionable insights to understand the opportunity and prepare the market strategy. UnearthInsight depends on database gathered from more than 20 countries, more than nine million start-ups globally along with over 32,000 start-ups and private firms in India. On an average more than 25 data elements are injected daily in the data pool. It relies on strong social capital built over the years with key industry leaders and clients such as Accenture, EY, HCL, Tech Mahindra and Mphasis.

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Glossary of Industry 4.0 Technologies and Use Cases

Industry 4.0 Technology Groups and Component Technologies	
Connectivity Technologies	IoT/ Industrial IoT | Established Wireless - 4G, LTE, WiFi 5 | Emerging Wireless - 5G, WiFi 6, NBIoT, LoRaWAN, etc | GPS/GLONASS
Intelligent Automation	Robotic Process Automation (RPA) | Industrial Robotics - Semi/Fully Autonomous | Collaborative Robots or Cobots | Machine Vision | Drones | Centralized Control Towers
Data and Analytics	Cloud (IaaS/ PaaS) and Cloud (SaaS) | Edge Computing | Big Data Analytics | Artificial Intelligence and Machine Learning
Advanced DigiTech	Augmented/Virtual/Mixed Reality | Blockchain/ Smart Contracts | Additive Manufacturing (3D Printing) | "Dark Factory" Platforms
Industry 4.0 Use Case Definitions	
Connected Work	Use of IIoT tech to replace scheduled operations with real-time decision-making
Precision Work	Use of automation and robotics on the job floor or in high-risk tasks
Intelligent Work	Applications of analytics and AI to real-time data to build predictive and prescriptive strategies
Visible Supply Chains	Adoption of IoT/AI/Blockchain and other digital solutions for end-to-end track and trace of material movement
Manufacturing Digitalization Definitions	
Industry 4.0	Industrie 4.0 or Industry 4.0 or the Fourth Industrial Revolution is considered a human-centric approach to integrating the physical, digital, and interfacing ecosystems for a seamless, low-loss, high-quality connected experiential living
Key Manufacturing Applications	MES – Manufacturing Execution System to execute planned production runs | MPS – Master Production Schedule to plan production schedule based on reconciliation of committed demand and input supplies | SCADA – Supervisory Control and Data Acquisition system gathers and analyzes real-time data to control critical, time-sensitive response

Thank You

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