Manufacturing trends: Disruptions and innovation
A Primer

Manufacturing is becoming more smarter, efficient, precise, and sustainable by adopting IIoT, AI, Robots, Blockchain, and 5G for operations optimization. Manufacturing business trends are enabling flexible & transparent supply chains, customer-centric & agile production, ecosystem collaborations, and new business models.

WHAT'S INSIDE!

1 Key Takeaways

2 Key drivers shaping trends in manufacturing

3 Business trends driving innovation

4 Technology trends aiding the business

Key takeaways

Using Gen AI for new product design in manufacturing increases design process efficiency and reduces time-to-market.

1 Full automation
The advent of advanced technologies combined with labour, skill, supply chain, and demand challenges is leading to the full automation of factories. **84% of the manufacturers have either adopted or are evaluating smart manufacturing solutions to invest in the next few years[1].**

2 Increased operational efficiency
Adoption of technologies across business trends reduces inefficiencies in manufacturing processes and lowers production costs. **62% of manufacturers are focusing on Robotics, while 60% are focusing on data analytics to increase operational efficiencies[2].**

3 Minimizing supply chain disruption
Technology-enabled collaboration between ecosystem players, reshoring of operations, and factory-in-a-box model are key to overcoming supply chain instability. **In the next five years,**
$4.6 trillion in global trade is likely to shift across regions due to reorganizations of supply chains[3].

4 Artificial intelligence (AI)
AI is the key to the transformation of manufacturing operations affecting all the business trends. **The worldwide AI in manufacturing market is expected to reach $115 billion in 2032 at an annual growth rate of 47.9%[4].**

5 Data-driven manufacturing
IIoT, Big Data & Analytics, 5G & Edge Computing enable data collection, pattern identification, and prediction for optimization of manufacturing processes. **The worldwide IIoT market is likely to reach $3.3 trillion in 2030 at an annual growth rate of 19.9%[5].**

6 Blockchain
Blockchain ensures supply chain visibility and transparency while working with
manufacturing ecosystem partners. **The worldwide Blockchain in manufacturing market is expected to reach $88.5 billion in 2030 at an annual growth rate of 72%[6].**

7 Sustainability
Driven by regulations, customer pressure, & ESG commitments, manufacturers are adopting technologies & processes to lower emissions. **Interestingly, 42% of the manufacturers sighted an increase in operation efficiency as a reason for focus on sustainability[1].**

8 Enhanced customer experience
Evolving business trends such as product-as-a-service, flexible manufacturing, and additive manufacturing **enhance customer experience by enabling on-demand production, mass customization, and subscription-based products.**

Key drivers shaping trends in manufacturing

1 Ensuring supply chain security and resilience

Supply chain uncertainty due to natural disasters and geopolitical tensions is a main challenge. Near-shoring of production and partner ecosystem creation are key to overcoming the disruptions.

2 Overcoming skilled labour shortage

The aging workforce and demand for skilled workers are leading to higher competition. Automation reduces labour dependency but not for critical tasks. Manufacturers need innovative policies to retain the best talent.

3 Prioritizing sustainability

The manufacturing industry traditionally has been one of the highest contributors to CO_2 emissions. Responsible materials sourcing, environment-friendly production, and safe waste disposal are key focus areas.

4 Increasing efficiency and reducing costs

Raw material, logistics, and energy costs have risen drastically in recent years. Manufacturers are adopting technology-driven processes to enhance efficiency while maintaining quality to manage costs.

5 Changing customer preferences and business models

Customers are demanding high-quality and customized products with quick TAT. They are more aware of the environmental impact of manufacturing and are seeking sustainable products and processes.

6 Navigating market demand uncertainty

Global trade tensions, the recent pandemic, and the lack of accurate forecasting have led to demand uncertainty. AI-driven analytics across the lifecycle is a must to predict demand.

7 Leveraging data for decision-making

Connected device data in production units provides insights to optimize processes, while consumer data aids sales forecasting.

Business trends

- Automation and dark factories
- Product-as-a-service business model
- Ecosystem manufacturing
- Green manufacturing
- Reshoring & near-sourcing
- Micro-factories
- Prescriptive maintenance
- Flexible manufacturing
- Additive manufacturing
- Advanced materials & nanomanufacturing

Technology trends

- Industrial internet of things (IIoT)
- Artificial intelligence (AI)
- Robots, cobots & drones
- Digital design, simulation & digital twin
- Big data & analytics
- 5G & edge computing
- Industrial AR, VR & metaverse
- Web3 & blockchain
- Cybersecurity
- High performance computing

Business trends driving innovation

The table below gives a snapshot of the key drivers shaping the manufacturing industry's current and upcoming business trends.

Business trends	Key drivers						
	Ensuring supply chain security and resilience	Overcoming skilled labour shortage	Prioritizing sustainability	Increasing efficiency and reducing costs	Changing customer preferences and business models	Navigating market demand uncertainty	Leveraging data for decision-making
Automation & dark factories		●		●		●	●
Product-as-a-service business model				●	●	●	●
Ecosystem manufacturing			●	●	●		
Green manufacturing	●	●		●			
Reshoring & near-sourcing	●	●	●				●
Micro-factories	●			●		●	
Prescriptive maintenance				●			●
Flexible manufacturing			●		●	●	
Additive manufacturing		●		●	●		
Advanced materials & nanomanufacturing			●		●		

Key insights

- **Overcoming workforce challenges**
Trends such as dark factories, reshoring, and ecosystem manufacturing, enabled by emerging technologies, help deal with skilled labour shortage. As per a recent survey, 36% of manufacturers are re-purposing workers to new roles[1].

- **Advanced manufacturing**
Smart and environment-friendly materials have started a new wave of manufacturing techniques, such as 3D Printing, 4D Printing, and Nanomanufacturing, enabling the production of complex objects.

1 **Automation & dark factories**

Dark or light-out factories are fully automated and work without direct on-site human intervention. The software fully orchestrates processes using robots and automated machines while operators remotely monitor activities or respond to critical alerts. Advantages are enhanced performance, resource efficiency, and non-stop production. Semi-dark factories are utilized for large-scale product customization or complex manufacturing.

2 **Product-as-a-service business model**

Manufacturers provide products on rent or lease with subscription contracts that are monitored and serviced by them. This results in less upfront cost and access to value-added services for customers. This model allows new revenue streams for manufacturers. Manufacturers collect data from the usage of products to generate insights and change offerings accordingly. Lease and management of products and manufacturing services is called servitization, equipment-as-a-service, or asset-as-a-service.

3 **Ecosystem manufacturing**

Manufacturing by working closely with specialized partners to focus on innovation and overcome disruptions. Standardized global data exchanges are being established to enable seamless data sharing between partners. Digital platforms are emerging that enable collaboration on designing, engineering, and manufacturing while simultaneously protecting each stakeholder's proprietary data.

4 **Green manufacturing**

Green manufacturing requires increased operating efficiency, efficient waste management, energy-efficient plants, renewable energy-based electrification of processes, production of sustainable products, enablement of circular economy. The manufacturing sector accounts for 20% of carbon emissions while consuming 54% of the world's energy resources[8]. Digital technologies are enabling the design of low-carbon products through modelling and simulation.

5 **Reshoring & near-sourcing**

Reshoring is domestically producing goods instead of importing from offshore. Locally procuring raw materials from domestic or nearby countries is called near-sourcing. Offshore wage increases, favorable reshoring policies, supply chain disruptions, increased shipping prices and the emergence of digital technologies drive this trend. Digital Twins are being used to model and simulate reshoring and near-sourcing scenarios to see the effect on supply chains.

6 **Micro-factories**

Micro-factories are completely digitalized, highly automated, and small-to-medium-sized units enabling decentralized manufacturing, i.e., as close as possible to the customer. Micro-factories or factory-in-a-box models allow manufacturing units to be moved easily anywhere globally. This model minimizes business disruptions, builds resilience, and increases agility & responsiveness. AI, big data & analytics are key for micro-factories to sense demand patterns and scale swiftly.

77% of the manufacturers have formally adopted sustainability policies driven by government regulations and increased pressure from consumers[1].

7 **Prescriptive maintenance**
Prescriptive maintenance identifies patterns, performs root-cause analysis, predicts the likely outcome of different maintenance actions, and recommends the best maintenance approach. This results in lower running costs for manufacturing plants, reduced downtime, and increased production quality.

8 **Flexible manufacturing**
Manufacturers are adopting modular approaches such as utilizing smaller parts or modules to work on assembly lines, using equipment with quickly swappable parts resulting in modular design for production, etc., bringing flexibility to the modern factories. On-demand custom equipment is assembled quickly using modular parts by just uploading the CAD design of industrial equipment. Different models of the same product can be manufactured on the same production line.

9 **Additive manufacturing**
Additive manufacturing or 3D printing is the process of producing 3D objects by adding material layers sequentially instead of mechanically milling material from a solid block. This process enables rapid prototyping of new

The worldwide Additive Manufacturing market is expected to reach $100 billion in 2035 from $14 billion in 2022 at a growth rate of 21%, moving away from only prototyping use cases to supporting at-scale production[7].

product designs and mass-customized, on-demand production of goods. 4D printing is the production process of 3D printed objects using smart materials that change their shape by applying an external stimuli such as water, air, light, etc.

10 **Advanced materials & nanomanufacturing**
Advanced materials are environment-friendly materials created by humans for manufacturing applications, resulting in enhanced performance, high wear resistance, and high thermal stability of products. Examples include plant-based plastics, oxygen-breathing ceramics, high-performance polymers, new metal alloys, advanced ceramics, etc. Nanomanufacturing refers to the production of nanomaterials and the manufacturing of products using nanomaterials. Nanomaterials enable very high-precision manufacturing.

Manufacturing business trends and key stakeholders

Manufactures
Enables higher efficiency and agility in production, better quality control over products, reduces downtime & time-to-market, and improves resource utilization

Suppliers
Ensure stable raw material demand, predictable schedules for better inventory management, long-term partnerships and growth

Workers
Focus on high-value tasks, improved skillsets, remote monitoring and critical alert response roles, resulting in improved safety

Customers
Personalized & sustainable products, enhanced product durability and performance, reduced costs, value-added service, and faster deliveries.
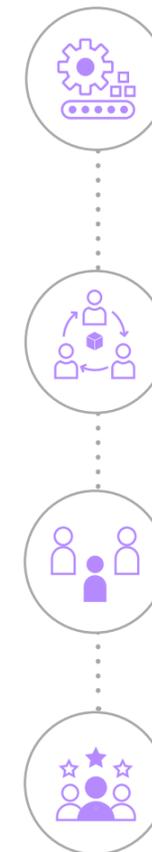
Technology trends aiding the business

The graphic below shows how different Technology trends impact each business trend. For example, Artificial Intelligence impact all the emerging business trends.

Technology trends

Business trends	Industrial internet of things (IIoT)	Artificial intelligence (AI)	Robots, cobots & drones	Digital design, simulation & digital Twin	Big data & analytics	5G & edge computing	Industrial AR, VR & metaverse	Web3 & blockchain	Cybersecurity	High performance computing (HPC)
Automation & dark factories	High	Medium	High	High	Medium	High	Low		High	Low
Product-as-a-service business model	Medium	Low	Low	Medium	High	Low	Medium	Medium	Low	
Ecosystem manufacturing		Low	Low		Low	Medium		High	High	
Green manufacturing	Low	Medium		High	Medium					Medium
Reshoring & near-sourcing	Low	High		High	Medium			High	Low	
Micro-factories	Medium	High	High		Medium	Low			Medium	Low
Prescriptive maintenance	High	High			Medium				Low	
Flexible manufacturing		Medium	High	Medium					Medium	
Additive manufacturing		Low	Low			Low	Medium	Medium	Low	High
Advanced materials & nanomanufacturing		Medium	Low	Low						High

● High impact   ● Medium impact   ● Low impact

Key insights

- **Cyber resilience**
  The manufacturers are shifting their operations to the cloud and adopting new technologies for cyber risk mitigation and business continuity. The global industrial cybersecurity market is likely to grow at an annual rate of 8.5% from $22.7 billion in 2022 to $40.7 billion in 2030[9].

- **Digital twin adoption**
  Digital twin technology enables key business trends such as dark factories, green manufacturing, and reshoring & near-sourcing by modelling, simulation, and testing operations. As per a survey, 38% of the manufacturers invested in Digital Twin in the last financial year[1].

1 **Industrial internet of things (IIoT)**
IIoT is an ecosystem of smart sensors, devices, apps, and networking equipment that allows for interconnectivity and collaboration of data, machines, and humans in manufacturing. Sensed data through IIoT is leveraged for prescriptive maintenance, real-time production & equipment monitoring, and material traceability. IIoT-based wearables are used for worker coordination & monitoring. IIoT increases efficiency & reduces cost, reduces planned downtime, improves product quality, and increases worker safety.

2 **Artificial intelligence (AI)**
AI has applications in optimizing machinery operations, adjusting workflow in real-time, monitoring operations to predict problems, pre-emptive maintenance scheduling, accurate demand forecasting, cost modelling, and fleet and energy management. Tools, equipment, & processes enhanced with AI promise next-level results for manufacturing. Computer vision (CV) enables product quality inspection, material categorization, Autonomous Mobile Robot (AMR) navigation, and inventory stocktaking.

3 **Robots, cobots & drones**
Robots work autonomously and simplify many processes in an industrial environment, while collaborative robots or Cobots focus on repetitive tasks, working alongside humans who focus on cognitive tasks. **Robots & Cobots enable production line process handling, intelligent material handling, and warehouse automation.** Drones are being used in warehouses for building & inventory inspections. Wearable robotics such as exoskeletons or exosuits assist human motion and reduce wear-tear from repetitive actions.

4 **Digital design, simulation & digital twin**
Digital Twin enables the convergence of information technology (IT), operational technology (OT), & engineering technology (ET) in manufacturing. In Digital Twin, real-time data works as an input for creating dynamic digital world replicas for equipments, products, factory floors, plants, supply chains, etc. It works as a simulation and testing tool to identify the real-world working under different conditions and use the outcomes in real scenarios. Digital models are used for exchanging information instead of documents throughout the lifecycle.

5 **Big data & analytics**
Big data & analytics systems utilize advanced data stream tools to efficiently process data, identify patterns, and generate insights to make improvements throughout the manufacturing value chain. Each manufacturing operation generates a huge amount of data, including machine, process, supply chain, and customer data that can be leveraged. Applications include machine and tool maintenance prediction, production monitoring, and supply chain management.

The worldwide Cobot market is likely to reach $6.8 billion in 2029 from $1.2 billion in 2023 at a growth rate of 34.3%, driven by increased manufacturing productivity and enhanced worker safety[10].

6 5G & edge computing

5G provides high bandwidth for fast and continuous connectivity between many connected IIoT and edge devices. Offloading of computation-heavy tasks to edge infrastructure reduces the load on individual end devices. **5G & edge computing enables factory and process automation, equipment monitoring, robot fleet management, and field assistance for workers. AI can be added to edge devices (Edge AI) to derive real-time manufacturing operations insights.**

7 Industrial AR, VR & metaverse

Augmented Reality (AR) is utilized for field assistance in manufacturing by digitally overlaying machine operation & maintenance instructions, hazard warnings, etc. over factory floors or machines. **Virtual Reality (VR) and Metaverse are enabling collaborative product designing & testing in virtual environments, worker training, plant layout planning, and equipment working simulation.** Metaverse is being used to showcase products to help customers understand features and provide virtual customization.

8 Web3 & blockchain

The immutable nature of the Blockchain enables manufacturers to have better transparency among stakeholders at each step. **Blockchain allows for tracking of materials & goods through the supply chain, inventory management, & warranty management by securing the chain of custody between suppliers, manufacturers, distributors, warranty providers, and customers.** Web3 enables decentralized manufacturing by securing the sharing of digital designs, specifications, and manufacturing processes.

9 Cybersecurity

Manufacturing is increasingly becoming digital, and robust cybersecurity is essential for enterprises to protect themselves from cyberwarfare and ransomware attacks. The addition of a large number of IoT devices has opened manufacturers to security vulnerabilities with IT-OT collaboration. Intrusion detection software is being used to detect anomalies in operations data and identify patterns. **The usage of secure and dedicated private networks, Blockchain, and AI is increasing to safeguard critical operations from cyberattacks.**

10 High performance computing (HPC)

HPC in manufacturing utilizes large computing resources, parallel processing, sophisticated algorithms, and big data sets to complete complex tasks. **Supercomputers can be used in manufacturing to create high-fidelity complex models representing physical systems and simulations based on real-world data, such as for reheating furnaces, faster product design without prototyping, and lightweight material development through modelling and simulation.**

Adopting factory-wide 5G for real-time data collection and process optimization has doubled production rate and reduced cost by 30% for some manufacturers[11].

References

[1] "Eighth Annual State of Smart Manufacturing Report" (2023), Rockwell Automation, Plex.

[2] Wellener, Paul & Hardin, Kate, "2023 manufacturing industry outlook" (2022), Deloitte.

[3] Carr, Tyler; Chewning, Eric; Doheny, Mike; Madgavkar, Anu; Padhi, Ashutosh; Tingley, Andrew, "Delivering the US manufacturing renaissance" (2022), McKinsey.

[4] "Artificial Intelligence in Manufacturing Market" (2022), Markets and Markets.

[5] "Industrial Internet of Things (IIoT) market size worldwide from 2020 to 2030" (2023), Statista.

[6] "Blockchain in Manufacturing - Global Strategic Business Report" (2023), Research and Markets.

[7] "Additive Manufacturing Market" (2023), Research Nester

[8] "Reducing the carbon footprint of the manufacturing industry through data sharing" (2022), World Economic Forum.

[9] "Industrial Cybersecurity Market Size And Forecast" (2023), Verified Market Research

[10] "Collaborative Robot Market" (2023), Markets and Markets

[11] "5G Ushers in New Era for Manufacturing" (2023), GSMA

Lead Authors@lab45

Parag Arora 🔗

Contributing Authors@lab45

Hussain Nayak 🔗

Ambitions Realized.

wipro | Ambitions Realized.

Wipro Limited (NYSE: WIT, BSE: 507685, NSE: WIPRO) is a leading technology services and consulting company focused on building innovative solutions that address clients' most complex digital transformation needs. Leveraging our holistic portfolio of capabilities in consulting, design, engineering, and operations, we help clients realize their boldest ambitions and build future-ready, sustainable businesses. With over 250,000 employees and business partners across 66 countries, we deliver, on the promise of helping our customers, colleagues, and communities thrive in an ever-changing world.

For more information,please write to us at **info@wipro.com**