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#GTBharat SHAPING VIBRANT INDIA

Precision & Production

Digital transformation in manufacturing

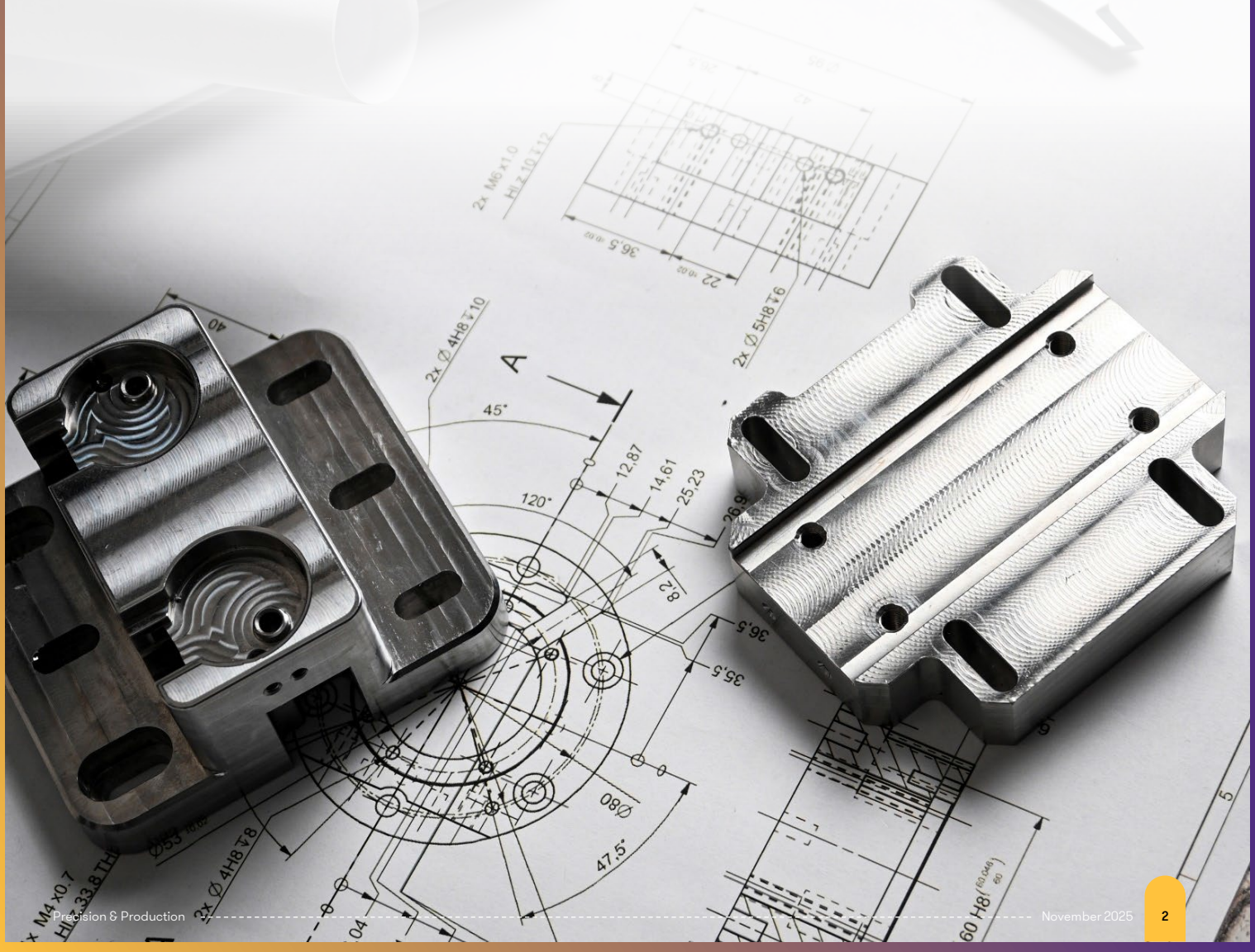
November 2025

Introduction

In India, the Index of Industrial Production (IIP) tracks the monthly performance of three key sectors – mining, manufacturing, and electricity. Manufacturing remains the largest contributor, accounting for 77.6% of total industrial output.

According to the Ministry of Statistics and Programme Implementation, India's IIP grew by 5.6% year-on-year in September 2025, reflecting continued recovery across segments. This followed a 3.8% growth in June 2025, which had marked a moderation in momentum, partly due to subdued electricity output amid early monsoon rains. Sectoral performance in September was mixed: manufacturing posted a strong 4.8% rise, electricity surged by 9.9%, while mining contracted by 0.4%.

Manufacturing continued to show resilience, with output rising by 4.8% in September 2025, up from 3.8% in August and 3.5% in June 2024. Key drivers included basic metals (+12.3%), motor vehicles and trailers (+14.6%), and electrical equipment (+28.7%). Meanwhile, the Index of Eight Core Industries, which contributes over 40% to the IIP, recorded a robust 6.3% growth in August, it' highest in 13 months, led by strong performances in steel, coal, cement, fertilizer, electricity, and petroleum refinery products.



With the rise of digital transformation, the Engineering and Industrial Products (ENIP) sector is undergoing a strategic reconfiguration. Digital technologies enhance operations and redefine how products are conceived, built, and sustained. This shift is driving a new industrial paradigm. AI-driven simulations accelerate design cycles, digital twins and IoT sensors enable predictive maintenance, and cloud-based Product Lifecycle Management (PLM) platforms foster global collaboration. Integrating embedded software into physical products seen in wearables, autonomous systems, and smart machinery blurs traditional boundaries, demanding a co-design mindset across disciplines. These changes are not incremental; they signal a systemic transformation in how value is created, delivered, and scaled. ENIP is emerging as a cornerstone of industrial output and global integration in India, with domestic manufacturing gaining momentum in electronics and machinery. As global digital engineering expenditure is projected to reach USD 1.6 trillion by 2026, companies must embrace interdisciplinary thinking, invest in innovation, and reimagine their operating models to remain competitive in a fast-evolving landscape.

Shridhar Kamath
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Engineering and Industrial Products
Grant Thornton Bharat

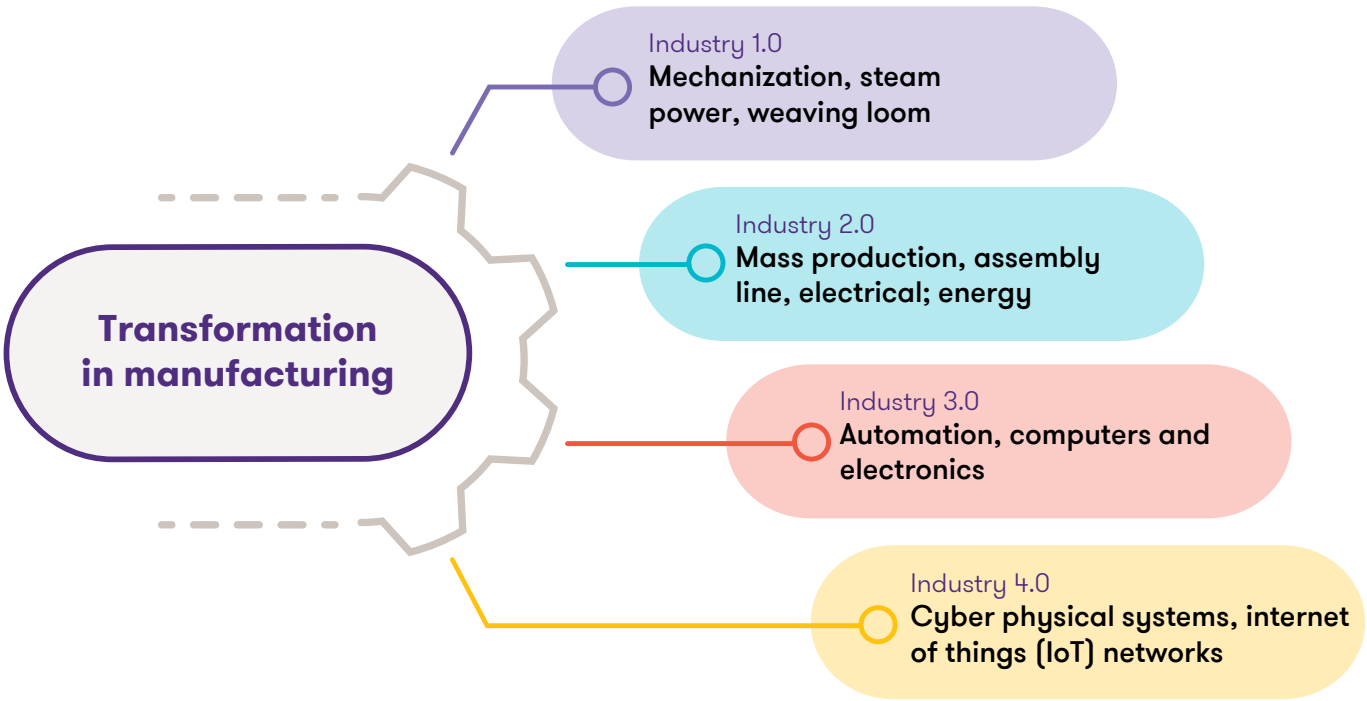
Transformation in manufacturing

Since its formal debut at Hannover Messe in 2011, Industry 4.0 has redefined global manufacturing through intelligent systems and cyber-physical integration. Over the past decade, the shift from automation to AI-native ecosystems has accelerated, with digital twins, predictive analytics, and edge computing becoming operational norms. National strategies from Germany's RAMI 4.0 to India's smart manufacturing initiatives have catalysed adoption, while the pandemic underscored the need for resilient, data-driven supply chains. Today, Industry 4.0 is not just a technological upgrade; it's a strategic imperative for sustainable, agile, and globally integrated manufacturing.

As we enter 2026, the digital maturity of manufacturing firms is increasingly measured by their ability to orchestrate real-time decisions across distributed operations. The convergence of AI, IoT, and cloud infrastructure enables factories to self-optimise, anticipate disruptions, and personalise output at scale.

This transformation is particularly relevant for sectors like engineering and industrial products (ENIP), where precision, traceability, and speed are critical. For stakeholders navigating insolvency, restructuring, or sectoral pivots, understanding the digital backbone of manufacturing is essential; not just for operational insight, but for evaluating long-term viability and strategic fit.

In India, the digitalisation of manufacturing is gaining momentum through initiatives like SAMARTH Udyog and the Production Linked Incentive (PLI) schemes, which aim to enhance competitiveness and attract global value chain integration. MSMEs increasingly adopt smart technologies to improve quality and reduce waste, while larger players invest in digital twins and predictive maintenance to scale efficiently. With rising interest in GCCs and digital engineering hubs, India's manufacturing ecosystem is evolving into a hybrid model, combining traditional strengths in process efficiency with emerging capabilities in data-driven innovation.



[1] Source: MoSPI Press Release;

Trends that are transforming manufacturing

01 Smart materials & nanoengineering

Advanced nano-/micro-engineered materials with features like self-healing, corrosion resistance, and shape-memory are redefining industrial design. Nanotechnology enables greater flexibility, conductivity, and sensitivity, positioning smart materials as a long-term strategic imperative.

Application: Energy, Electronics, Automotive, Aerospace

Current adoption

- OCSiAl supplies graphene nanotubes for batteries, enhancing energy density and fast charging
- Arris, 9T Labs, orbital composites scaling automated composite part production
- Computational material discovery ("material informatics") is gaining traction
- AI-led labs now predict material properties before synthesis, accelerating alloy and battery innovation

Market signals

- Global smart materials market valued at USD 63.6 billion in 2024, projected to reach USD 142.1 billion by 2033 (CAGR: 8.88)
- Use-case penetration: 30% in medical wearables, 27% in automotive smart components, 33% growth in flexible electronics applications
- India's USD 4.9 billion incentive for medical device production includes smart material integration

02 AI & ML in engineering design

AI-driven design tools are transforming CAD, simulation, and manufacturing workflows. Generative design and predictive analytics are now central to engineering R&D.

Application: Product design, streamlining manufacturing processes

Current adoption:

- Altair's simulation tools deliver **1,000× speed improvements**
- Automotive and aerospace sectors lead adoption
- AI-powered automation is streamlining workflows and reducing errors across industrial design and production

Market signals:

- Generative AI in engineering is valued at USD 0.97 billion in 2024, forecasted to reach USD 4.75 billion by 2029 (CAGR: 37.3%).
- Broader AI engineering market expected to hit USD 70 billion by 2032.

[2] Source: imarc;
[3] Source: Global Growth Insights;
[4] Source: marketresearch;

03 Digital twin & simulation

Digital twins unify real-time data, simulation models, and operational insights across the lifecycle of physical assets. They are foundational to Industry 4.0/5.0 and metaverse-linked engineering.

Application: Automotive, infrastructure, healthcare, aerospace

Current adoption:

- BMW uses Omniverse-based virtual factory for EV drivetrain planning
- US Air Force integrates 50+ digital twins for military simulations
- Tesla simulates vehicles and production processes
- Digital twins enable predictive maintenance and process optimisation in smart factories

Market signals:

- Digital twin simulation market projected to reach USD 381 billion by 2034 (CAGR: 37.1%)
- Broader digital twin market forecasted at USD 155.84 billion by 2030
- Over 910 active startups, 4,630 patents, and 1,370 grants globally

04 3D printing

Additive manufacturing enables rapid prototyping, low-volume production, and localised manufacturing. Material innovation and digital thread integration are accelerating adoption.

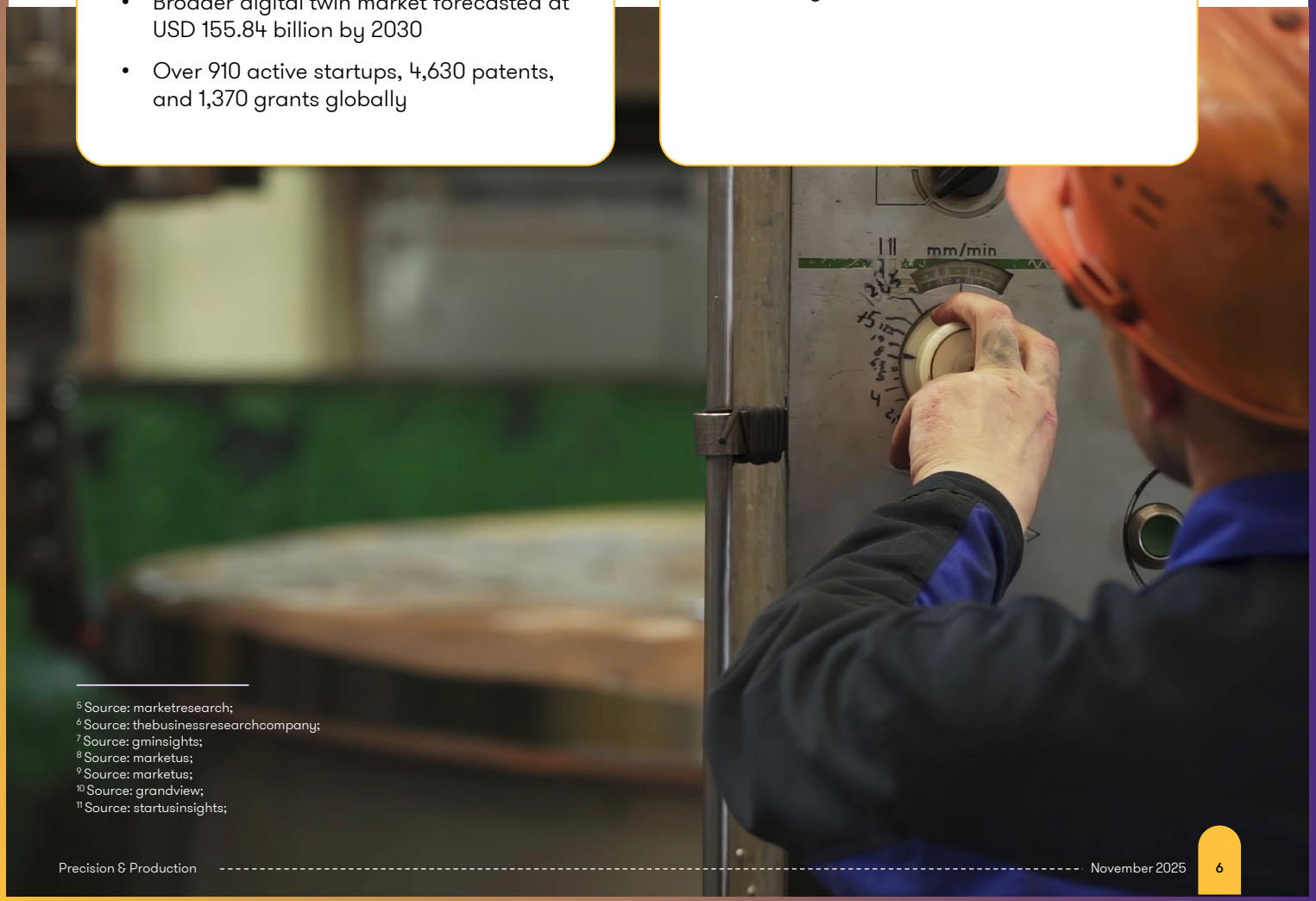
Application: Medical implants, automotive parts, aerospace

Current adoption

- Small batch prototyping and distributed manufacturing hubs
- High scalability for tooling and low-waste production
- Used for prototyping and small-batch production of industrial components

Market signals:

- Global market valued at USD 16.16 billion in 2025, projected to reach USD 35.79 billion by 2030 (CAGR: 17.2%) . Alternative forecast: USD 101.74 billion by 2032 (CAGR: 23.4%)
- Aerospace and automotive lead use case maturity.



[5] Source: marketresearch;
[6] Source: thebusinessresearchcompany;
[7] Source: gminsights;
[8] Source: marketus;
[9] Source: marketus;
[10] Source: grandview;
[11] Source: startusinsights;

05 Industry 4.0 & 5.0

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06 Sustainable product design

Sustainable engineering prioritises low environmental impact, energy efficiency, and material reusability. Lifecycle sustainability is now a regulatory and consumer imperative.

Application: Automotive, infrastructure, healthcare, aerospace

Current adoption:

- Recycled and high-efficiency composites in aerospace/auto
- 3D printing for low-waste tooling and product manufacturing
- Increased use of renewable energy, carbon capture technologies, and green materials
- Sustainability is now a criterion for government and institutional contracts

Market signals:

- Public market cap for low-carbon solutions: USD 4.4 trillion as of mid-2024
- Private market investments in low-carbon engineering delivered 123% cumulative returns over 5 years.

The digital transformation of India's manufacturing sector signifies a pivotal shift from traditional production models to technologically advanced, data-driven operations. The integration of artificial intelligence, Internet of Things (IoT), cloud computing, and intelligent automation is enhancing operational efficiency and redefining the strategic capabilities of Indian manufacturers. This evolution positions India from a cost-centric manufacturing destination to a globally competitive hub for innovation-led production. Supported by progressive government initiatives, increasing digital infrastructure, and a robust technology ecosystem, the sector is poised for substantial growth. Projections indicate that India's manufacturing industry could contribute over USD 1 trillion to the national GDP by 2030, with digital technologies as a primary catalyst. As these trends mature, India is well-positioned to play a leading role in shaping the future of global manufacturing.

[12] Source: marketresearch;
[13] Source: fortune;
[14] Source: mordor;
[15] Source: marketsandmarkets;
[16] Source: startus;
[17] Source: MSCI;
[18] Source: MSCI;

Challenges vs. solutions in Indian manufacturing technology adoption

Challenges

Limited budget allocation

High upfront costs for advanced technologies like AI, IoT, and automation

Legacy infrastructure

Outdated machinery and IT systems hinder compatibility with modern digital tools.

Skilled workforce shortage

Lack of expertise in digital tools and employee resistance to change.

Cybersecurity risks

Increased vulnerability to data breaches and IP theft.

Data management complexity

Difficulty integrating and analysing large volumes of operational data.

Unclear ROI & strategic alignment

Uncertainty in measuring returns and aligning tech with business goals.

Regulatory & policy barriers

Complex compliance requirements and inconsistent policy execution.

Solutions

Phased technology adoption

Use scalable, cloud-based systems to reduce initial investment and enable gradual integration.

Modernisation via modular upgrades

Retrofit existing equipment with IoT sensors and adopt modular automation solutions.

Upskilling & training programmes

Partner with academic institutions and tech firms to offer certifications and hands-on training.

Robust cybersecurity frameworks

Implement multi-layered security, regular audits, and employee awareness programmes.

Centralised data platforms

Adopt real-time analytics dashboards and cloud-based data integration tools.

Pilot projects & ROI modelling

Run small-scale pilots and use predictive models to assess impact before full-scale deployment.

Policy reforms & incentives

Utilise PLI schemes and digital infrastructure grants, and advocate for streamlined regulations.

Indian Government's tech transformation

India's manufacturing sector is undergoing a strategic shift, driven by government initiatives aimed at integrating digital technologies and enhancing global competitiveness. The SAMARTH Udyog Bharat 4.0 programme, driven by the Ministry of Heavy Industries and MeitY, supports MSMEs in adopting Industry 4.0 technologies, such as AI, IoT, and automation, through centres like the C4i4 Lab in Pune. The focus is on capability-building, talent development, and transitioning to smart production.

NASSCOM, in partnership with MeitY, is scaling digital skilling through FutureSkills Prime, targeting Tier 2 and 3 cities with training in AI, cloud, and cybersecurity. The IndiaAI Mission, backed by INR 10,371.92 crore, aims to establish a robust AI ecosystem, including a high-end computing facility equipped with 18,693 GPUs, one of the largest globally. It supports responsible AI use in manufacturing via skilling, data governance, and a national AI centre.

Complementing this, the National Mission on Interdisciplinary Cyber-Physical Systems promotes the development of smart factories and the integration of AI. India will host the AI Impact Summit in February 2026, marking a significant milestone for the Global South. The summit will launch eight indigenous AI models and showcase initiatives such as UDAAN, YuvaAI, and AI by HER, reinforcing India's leadership in inclusive and responsible AI.

Transforming manufacturing for a Viksit Bharat

India is accelerating its AI and advanced engineering push through major government-led initiatives. The IndiaAI Mission (2024), backed by INR 10,300 crore, will deploy 18,693 GPUs in one of the world's largest facilities to boost access for startups, researchers, and manufacturers. Parallel to this, the DST's Nano Mission drives R&D in smart materials, while MeitY and IISc's Nano Electronics Roadshow showcased over 100 indigenous IPs for industrial use.

Additive manufacturing is advancing through MeitY's strategy to capture 5% of the global 3D printing market and contribute USD 1 billion to the GDP by 2025, with a focus on aerospace, medical, and low-waste applications. The Atal Innovation Mission promotes 3D printing education in schools to build early-stage design skills.

Digital twins are being piloted under the Sangam initiative to simulate infrastructure, telecom, and smart cities. These efforts align with Digital India and Skill India programmes, preparing the workforce for Industry 4.0 and 5.0. The Viksit Bharat 2047 roadmap emphasises human-centric, sustainable, and community-based manufacturing.

Sustainable engineering is also advancing. India's non-fossil fuel capacity now exceeds 217 GW, and the 2025 Budget prioritises green infrastructure and ESG compliance. Private investments in low-carbon engineering have yielded returns of 120% over a five-year period.

Together, these initiatives reflect a cohesive national strategy to integrate advanced technologies across engineering and manufacturing, positioning India as a global leader in innovation.

[1] Source: MoSPI Press Release;

Direct material cost optimisation: How digital can transform procurement

The shift toward Industry 4.0 has redefined how manufacturers approach cost optimisation. As digital technologies reshape production and supply chains, organisations are pressured to deliver value through scale, innovative design, sourcing, and operations. Our cost optimisation solution is built for this reality, integrating engineering, procurement, and digital levers to reduce direct material costs while enhancing product performance and resilience. We help clients unlock sustainable savings and competitive advantage in a volatile operating environment by embedding analytics, automation, and AI into core decision-making. This transformation is not without its challenges. Internally, manufacturers must navigate decentralised decision-making, complex business requirements, rising product performance expectations, and compliance demands. Externally, they face raw material price volatility, rapid competitive innovation, supplier consolidation, globalisation, and evolving regulatory constraints, all of which complicate efforts to achieve and sustain cost savings.

Comprehensive cost-saving solutions

- Deliver measurable savings across cost levers
- Integrate strategic, tactical, operational, and digital capabilities
- Optimise product design, supplier collaboration, and sourcing strategies
- Unlock sustainable value through innovation

Proprietary DOTS framework

- **Strategic levers:** Category strategy, supplier alignment, best country sourcing, tax-efficient supply chain, operating model redesign
- **Tactical levers:** Complexity reduction, manufacturing innovation, thickness optimization
- **Operational levers:** Consumption optimisation, cycle time improvements, inventory optimisation

Value-driven initiatives

- Value Analysis & Value Engineering (VAVE) for performance and cost reduction
- Design improvements to eliminate non-value-added elements
- Procurement efficiency through global sourcing and supplier development
- Should-Be Costing / Zero-Based Costing (ZBC) for benchmarking and negotiations
- Supplier transparency and collaboration via joint workshops and long-term partnerships

Digital

- Real time performance dashboards
- IOT integration
- AI based Predictive maintenance
- Automated Data Collection
- Cloud based data collaboration
- Digital Twins
- Smart data analytics
- Digital dashboards
- Optimized supply chain process

Strategic — S

- P Category Strategy
- P Best Cost Country Sourcing
- D Technology Change
- P Operating Model Redesign
- D Alternate design
- P Tax Efficient Supply Chain

Tactical — T

- D Complexity Reduction
- P RM Rationalization
- P Commodity Indexation
- P Manufacturing Innovation
- P Third Party Agreements
- P Zero Based Costing
- D Value Analysis
- D Allowance Optimization
- D Machining Cost Optimization
- D RM Change/Grade Change
- D Thickness Reduction
- D Process Cost Optimization

Operational — O

- P Weight Benchmarking
- P Cost Benchmarking
- P Alternate Sourcing
- P Volume Discount
- P Consumption Variance
- P Inventory Reduction
- D Loss Optimization
- D Design Driven Yield Improvement
- P Logistics Cost Reduction
- P Yield Improvement
- P Cycle time Improvement
- P Consumption Optimization

Levers used across

P Procurement Efficiency Levers

D Design Efficiency Levers

Digital levers for cost optimisation

- **AI/ML analytics:** Accelerate cost optimisation across direct material spend
- **Predictive modelling:** Anticipate supply chain risks and cost fluctuations
- **Digital twins & smart dashboards:** Simulate scenarios and monitor real-time performance
- **Automated data collection & cloud collaboration:** Streamline decision-making across stakeholders
- **AI-based benchmarking:** Identify cost outliers and uncover improvement opportunities across geographies and technologies

AI-driven sourcing transformation

- **Cost reduction & resilience:** Integrate AI into sourcing to cut procurement costs and strengthen supply chain agility
- **Advanced analytics:** Identify spend inefficiencies early and enable should-cost modelling for fair value assessment
- **Strategic negotiation:** Empower teams to optimise supplier performance and minimise overpayment risks
- **Risk mitigation:** Use AI intelligence to anticipate supplier disruptions and ensure business continuity

From cost control to growth enabler

- Develop optimised sourcing strategies and leaner cost structures
- Build stronger supplier relationships
- Transform procurement into a strategic driver of sustainable savings and agility
- Align sourcing decisions with long-term business objectives

Proven methodology & impact

- **4-stage approach:** Idea Identification → Sign-off → Implementation → Sustenance
- Tailored strategies for ENIP sector clients
- Achieved **10–15% cost reductions** across product lines over two years
- Demonstrates structured methodology and deep domain expertise

AI-Integrated Tools and Benchmarks for Spend Classification & Category Insight Management

AI-driven spend assessment gives a data-backed view of critical spend areas, using NLP and ML to classify, clean, and analyse data for inefficiencies and hidden cost drivers.

AI spend cube integrates procurement data, applying clustering to reveal trends, anomalies, and cross-category opportunities.

Vendor classification tool uses deep learning to categorise vendors and transactions based on custom taxonomies.

Predictive savings database benchmarks performance across categories, industries, and regions, helping set realistic targets and uncover opportunities.

Cognitive spend combines big data, ML, and NLP to interpret transactions, detect duplicates, anomalies, and predict cost leakages.

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