

ELECTRONIC MANUFACTURING

A Foundational Understanding of
Electronic Manufacturing



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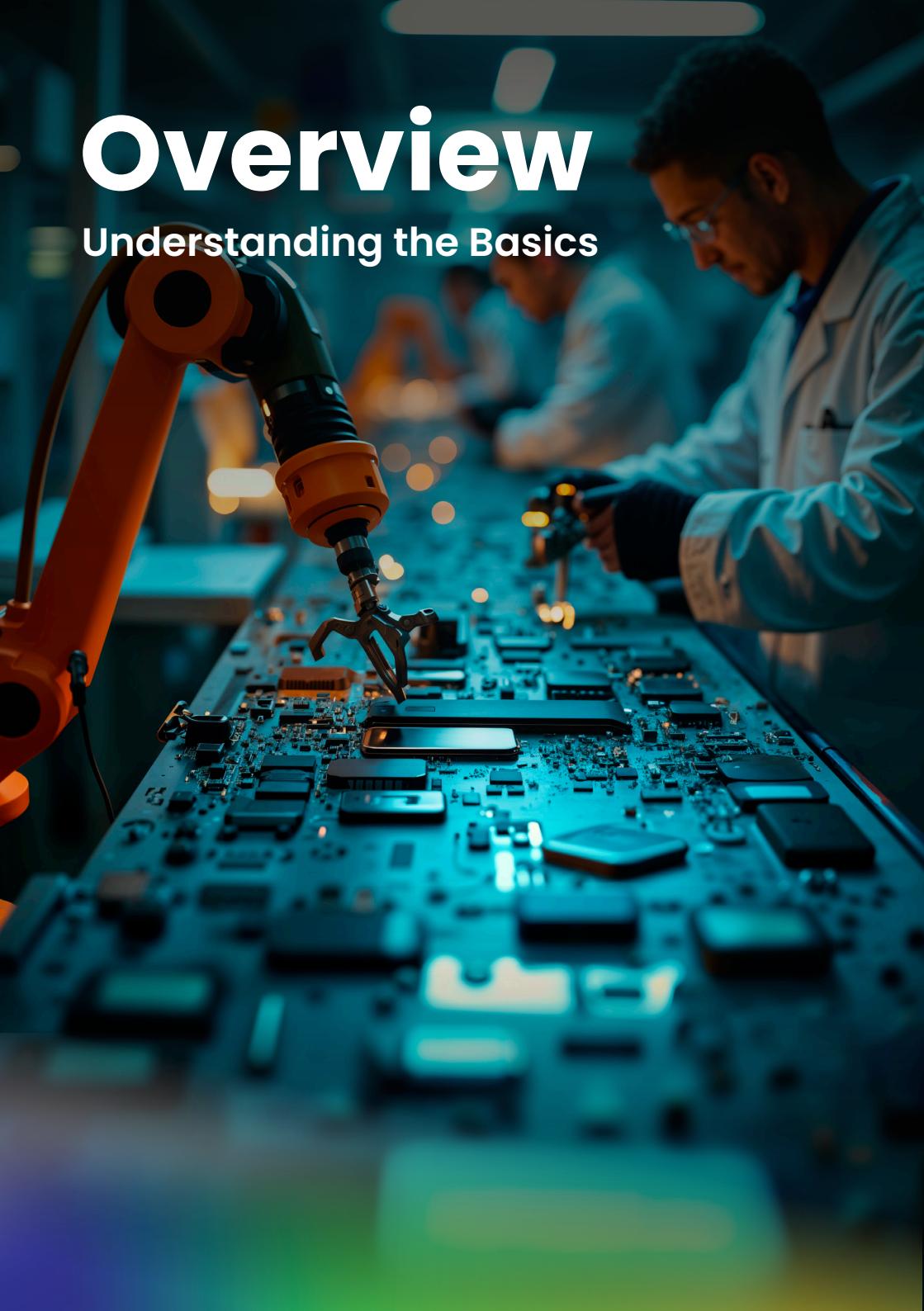


Dear Digital Pioneers

Welcome to the heart of the modern digital economy. This deep dive into Digital Public Infrastructure (DPI) explores its foundational layers—Digital Identity, Digital Payments, and Data Exchange—and their design principles. You'll trace the Evolution of DPI, learn about the core enabling Technologies like AI and blockchain, and see how global leaders like India are using DPI to build scalable, inclusive, and cost-efficient services across Health, Education, and Trade.

Overview

Understanding the Basics



What is Electronics Manufacturing?

Electronics manufacturing refers to the complete process of producing electronic devices and components. This includes everything from microchip fabrication to final device assembly and testing.

Core Manufacturing Processes

- Component Fabrication: Producing wafers, ICs, and passive components.
- PCB Assembly: Mounting components via automated Surface-Mount Technology (SMT).
- Final Assembly and Testing: Integrating PCBs with modules; rigorous QA testing follows.

End-Use Applications and Segmentation

Electronics manufacturing supports a broad range of product categories, each with distinct production requirements:

End-Use Applications and Segmentation

Electronics manufacturing supports a broad range of product categories, each with distinct production requirements:

Segment	Examples	Manufacturing Focus
Consumer Electronics	Smartphones, TVs, audio systems, home appliances	High volume, cost efficiency
Computing & IT Hardware	PCs, servers, data center equipment	Thermal performance, modular design
Data Exchanges	Telecommunications	Network reliability, RF precision
Industrial & Medical	Factory automation, diagnostic equipment	Low defect rates, regulatory compliance
Automotive Electronics	ECUs, sensors, infotainment systems	Harsh environment tolerance, functional safety

Key Stakeholders

- Original Equipment Manufacturers: Handles product design, development, and branding.
- Electronics Manufacturing Services: Execute production, assembly, testing, and distribution.
- OEM vs. EMS: OEM owns the design; EMS executes physical production.

A close-up photograph of a man with a shaved head, wearing glasses and a beard, smiling broadly while working on electronic components. He is wearing a dark denim shirt over a light-colored undershirt and blue jeans. The background is filled with glowing orange and yellow lights from work lamps, creating a warm, industrial atmosphere.

**Human edge scales with
electronics for a better
tomorrow.**

Evolution of Electronics



1940s–1960s

The Foundations of Electronics Manufacturing

Production founded in the U.S., Europe, and Japan. Offshoring began in the 1960s, moving labor-intensive assembly to Hong Kong, Taiwan, and South Korea.

1970s–1980s

Rise of Asia and the EMS Model

Japan dominated consumer electronics. The EMS (Electronics Manufacturing Services) model emerged with pioneers like Flextronics, professionalizing global outsourcing.



1990s

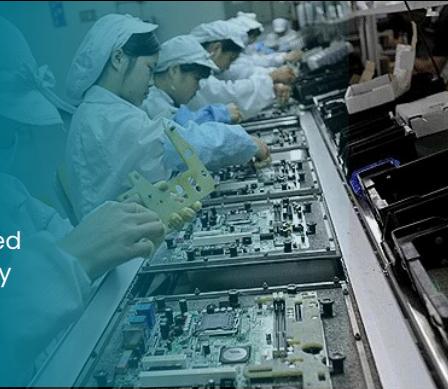
The Era of Mass Globalization and EMS Consolidation

China's liberalization enabled it to become the "World's Factory." Western OEMs aggressively outsourced assembly to consolidated EMS giants (e.g., Foxconn).

2000s

China's WTO Entry and Consumer Electronics Boom

China's WTO entry and the iPhone boom solidified its role as the primary global hub, creating highly specialized, distributed supply chains.



2010s

Geographic Diversification and Early Geopolitical Fractures

Rising costs and the US-China trade war initiated early diversification to Vietnam and India, introducing geopolitical risk sensitivity.



2020s

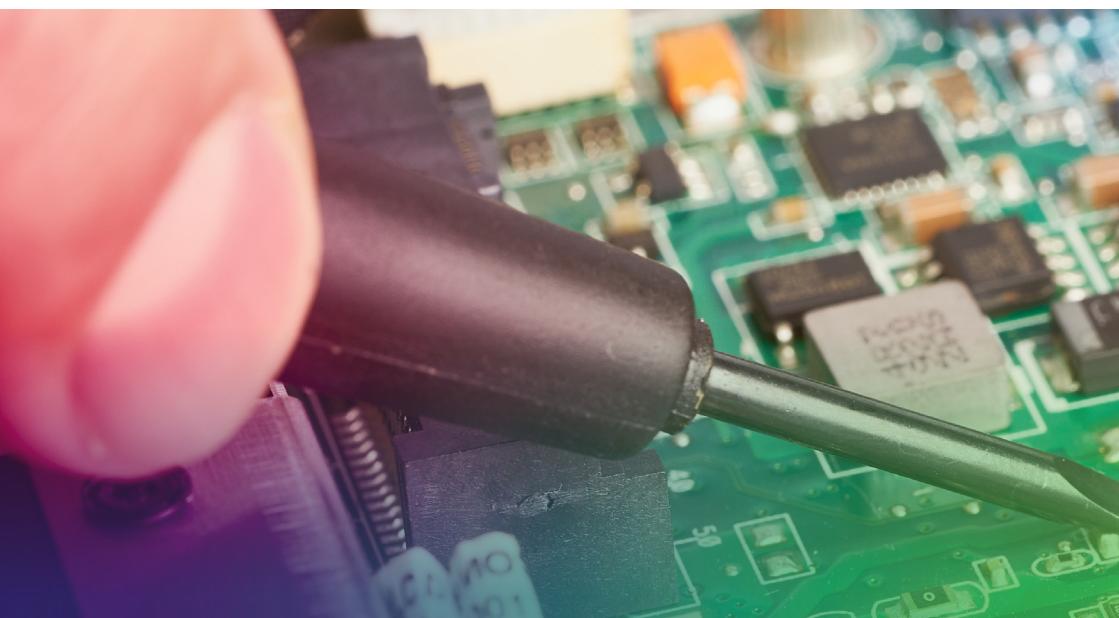
Post-Pandemic Reassessment and Push for Resilience

Post-pandemic fragility and government policies (CHIPS Act, PLI schemes) are driving a major shift towards supply chain resilience and localization of high-value manufacturing.

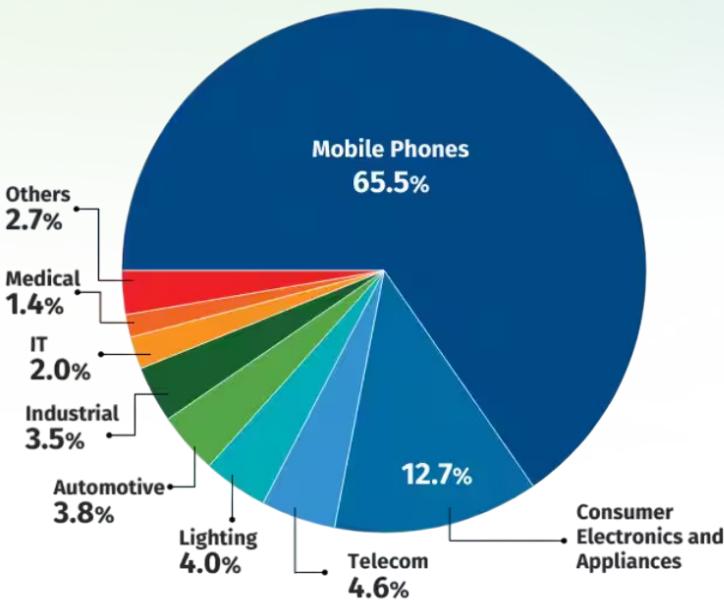


Segmental Breakdown

- **Communications Electronics:** Largest segment (smartphones); requires high agility. Leaders: India, Vietnam.
- **Computing & Data Center Hardware:** PCs, servers; needs high reliability. Dominated by Taiwanese ODMs; driven by cloud/AI.
- **Consumer Electronics:** TVs, smart home; highly cost-sensitive and seasonal. Main hubs: China, Mexico, India.
- **Industrial Electronics:** Low-volume, high-complexity (robotics); fueled by Industry 4.0. Requires robust standards.
- **Automotive Electronics:** ECUs, EV systems; demand accelerates with EVs. Requires specialized, automotive-grade production.
- **Medical Electronics:** Highly regulated, fast-growing; requires cleanroom and traceability. IoMT sub-segment projects >25% CAGR.



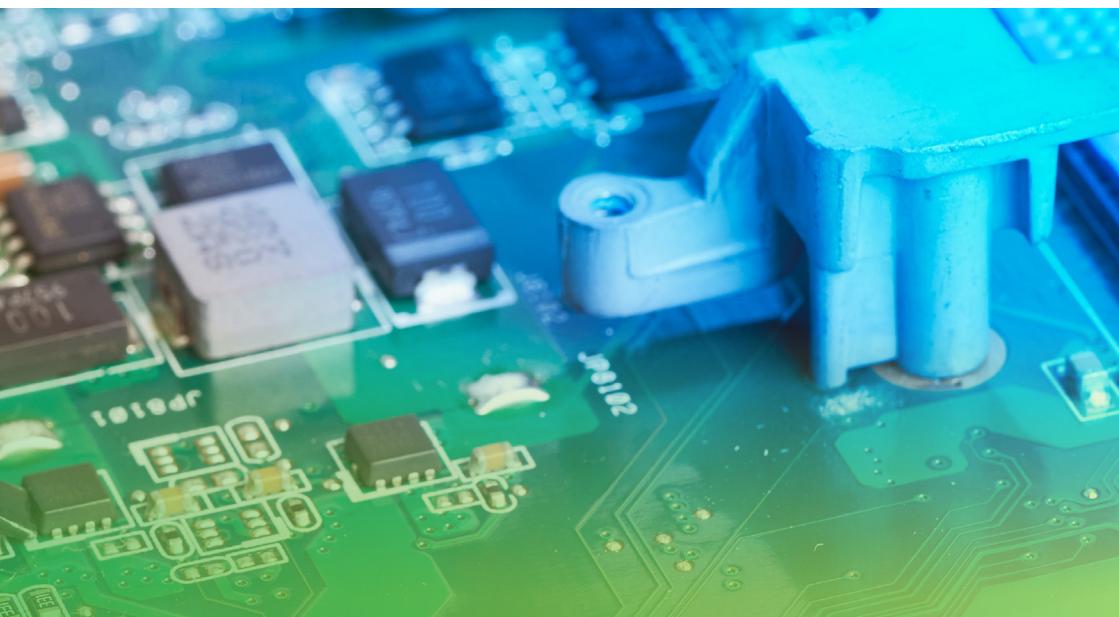
EMS MARKET BREAKUP BY INDUSTRY APPLICATIONS IN INDIA (%)



Source: Haitong International
Equity Research



moneycontrol



Innovation Stories

AI-Driven Digital Twin Factories

Foxconn/NVIDIA (2024) implemented digital twin technology (Omniverse) to create virtual factory replicas. This enables rapid line reconfiguration and pre-deployment simulation of automation changes, enhancing resilience to supply chain disruptions.

Sustainable PCB Innovation

New recyclable PCBs use a special solvent to break down bonding polymers, enabling near-total material recovery without damaging components. This innovation supports a circular electronics lifecycle, actively reducing e-waste.

3D Printing and Rapid Prototyping

3D printing accelerates product development by reducing prototyping costs/timelines (e.g., circuit/casing in <24 hours for ~ \$100). This allows faster iteration cycles and early-stage product validation.

Adaptive Design and AI Inspection

During the 2021–2022 chip shortage, EMS firms rapidly redesigned boards to use available components. Concurrently, many adopted AI-based machine vision for 100% real-time component inspection, now standard for improved defect and counterfeit detection.

Hey Buddy!

We unveiled the world of electronics manufacturing: its core processes, major segments, the OEM/EMS partnership, its historical evolution, and the latest innovations driving resilience and sustainability. Now let us size it's market and dive into the world of electronics.



Global Market at a Glance

Market Size and Regional Concentration

The global electronics manufacturing services (EMS) market was valued between approximately USD 590.5 billion and USD 633.29 billion in 2024 and is expected to grow to over USD 1,000 billion by 2032 with a CAGR of 6–7%. Asia dominates manufacturing, accounting for over 80% of global electronics production and exports.

Global Demand by End-Use Segment

Country/Region	Share of Global Electronics Exports	Key Drivers
China	33% (\$1.37 Tn)	Smartphones, PCs, consumer electronics, components
Taiwan	12% (\$507 Bn)	Semiconductors, EMS (Foxconn, Pegatron, TSMC)
South Korea	~8%	Samsung, LG, memory and display components
Vietnam	~5%	Smartphone assembly, appliances
Malaysia	~5%	Semiconductor packaging, test and assembly
Japan	~4%	High-end components, optics, instrumentation

Country/ Region	Share of Global Electronics Exports	Key Drivers
United States	~4%	Select semiconductors, defense/aerospace electronics
Germany	~4%	Industrial automation, automotive electronics
Mexico	~4%	Appliance and automotive electronics (for U.S. market)
India	~2–3% (rising)	Mobile phones, telecom hardware, EMS expansion under PLI

Segment	Description	Market Trend
Communications	Smartphones, networking equipment	Largest segment globally due to smartphone volume
Computing Hardware	PCs, laptops, servers	Moderate growth; rebound expected after 2025
Consumer Electronics	TVs, home appliances, audio systems	Stable demand, driven by smart home adoption
Automotive Electronics	EV systems, ADAS, infotainment	Fastest-growing, tied to EV expansion
Industrial Electronics	Factory automation, control systems	Rapid adoption with Industry 4.0
Medical Electronics	Wearables, diagnostic devices, IoMT	High-growth niche; projected to triple by 2030

Electronics Manufacturing in 2025

Global Market and Recovery

- Global industry value: Over \$4 trillion in 2025, showing steady recovery and renewed investment. Asia dominates production, serving as the global supply chain backbone.

Strategic Relocation and Diversification

- Companies prioritize resilience over cost-efficiency due to pandemic/geopolitical risks.
- 15–20% of global production shifted from China to hubs like Vietnam, India, and Mexico (the “China+1” strategy) to diversify sourcing and reduce tariff exposure.

Sustainability and Environmental Compliance

- Sustainability is a key strategic priority.
- EU's 2024 EcoDesign rules accelerate environmentally responsible practices.
- 72% of producers increased investment in low-carbon tech.

**Electronics is the
next step of human
evolution.**



Indian Electronics Landscape



Rapid Growth

Production grew from \$29B (FY2014) to \$101B (FY2023). Mobile phone manufacturing is the primary driver, now 43% of total output; 99% of phones are assembled domestically.

PLI Scheme & Exports

The PLI scheme (\$25B commitment) attracted global OEMs (Foxconn, Samsung). Exports surged, reaching \$20.4B in 2024 (44% YoY increase).

Diversification & Ecosystem

Production expands beyond mobiles to TVs, IT hardware, and consumer electronics. Global EMS players (Jabil, Sanmina) and domestic firms are scaling operations.

Component Ecosystem

To address 85–90% component import dependency, India launched the ECMS (\$2.8B) and the Semiconductor Mission (\$10B subsidy) for fabs (e.g., Micron) and ATMP projects.

Policy & Targets

Policies (NPE 2019) eased regulations, creating regional hubs (Noida, Chennai). Revised targets aim for \$500B output by 2030.

Forward Outlook

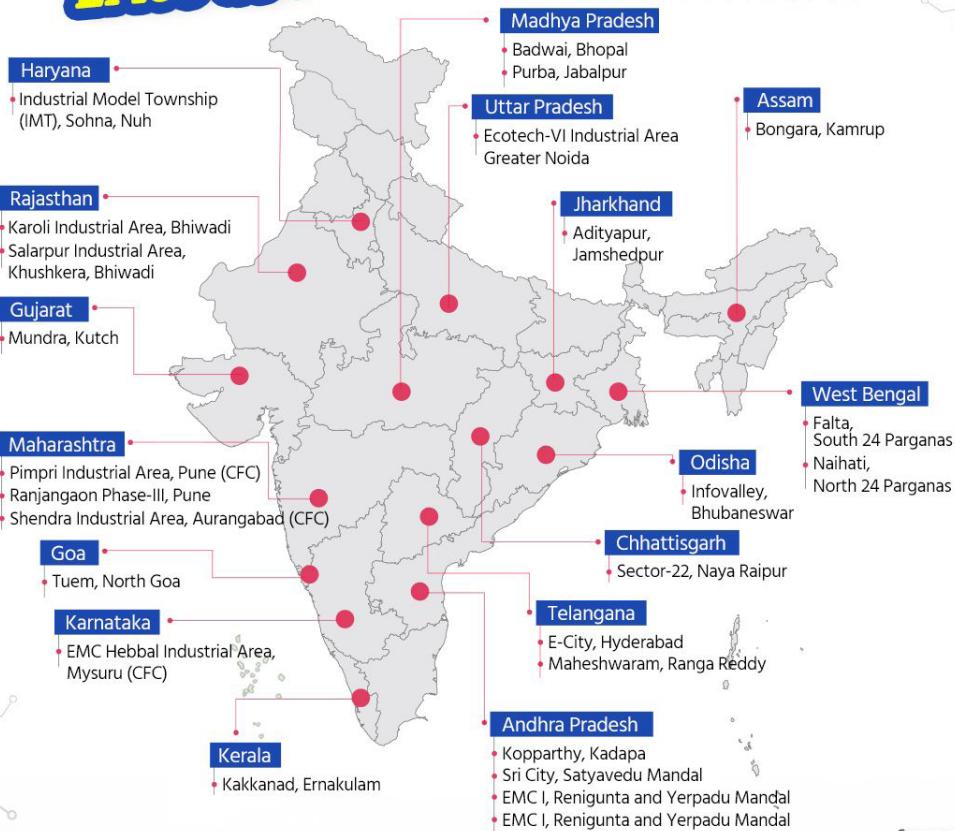
India aims to transition from assembly to high value-added manufacturing.

STRENGTHENING INDIA'S ELECTRONIC MANUFACTURING NETWORK

Greenfield Electronics Manufacturing Clusters (EMC) in New India

what do EMCs do?

- Support Development of State-of-the-Art Infrastructure
- Attract investments in the electronics sector



Source: MEITY

**Value visualization
leads to evolved
business models.**



Profitability and Value Chains

Electronics Metrics: 2014 Vs 2024

Metric	2014	2023-24	Trend/Notes
Electronics Output	₹1.9 lakh cr (\$29 B)	₹9.52 lakh cr (~\$145 B)	~17% CAGR—more than 5x growth (pib.gov.in)
Electronics Exports	₹0.38 lakh cr (\$5.8 B)	₹2.41 lakh cr (~\$36 B)	~20% CAGR
Mobile Phones as % of Output	<30% domestic assembly	~43% share; 99% domestic assembly	Driven by PLI scheme (~₹1.9 T incentives)
Mobile Exports	–	\$20.4 B in FY 2023-24	44% YoY
Domestic Components Value	–	~\$15 B (15% of output)	Component gap remains
ECMS Incentives	–	₹22,919 cr (~\$2.8 B) over 6 years	Aims to boost local value-add >35%

The Structure of Value in a Product

Supply Chain Role	Value Capture Characteristics	Typical Gross Margin
OEM (e.g., Apple)	Product design, software integration, branding	30–40%
EMS (e.g., Foxconn)	Assembly, logistics, labor-intensive operations	2–5%
Component Suppliers	Semiconductor IP/design or high-tech manufacturing	20–50%+
ODMs	Design + manufacturing, but often rebranded by OEMs	5–10%

EMS Business Model: Volume Over Margin

EMS firms thrive on cost control, asset efficiency, and bulk procurement. Despite low margins (typically 3–8%), massive volumes allow scaled providers like Foxconn to generate billions in profit. They assume significant capital expenditure risk for OEMs, which improves the OEMs' return on capital.

Howdy Buddy! Ready to jump in? Till now we've covered the global EMS market size and growth, its Asian concentration, major end-use segments driving demand, and India's accelerating electronics landscape driven by the PLI scheme.

Key Players and Leaders

Top Leaders

Dominant Players

- Foxconn (Hon Hai Precision)**: Remains the largest contract electronics manufacturer globally.
- Jabil (USA)**: Over \$30B revenue; services smartphones, automotive, and healthcare.
- Flex (Singapore/U.S.)**: Global footprint across multiple verticals. ASM specializes in assembly equipment.
- Celestica (Canada)**: Notable EMS player with diversified operations.
- Samsung Electronics (South Korea)**: Operates as OEM and in-house manufacturer of smartphones, TVs, and semiconductors.
- Intel (USA) and TSMC (Taiwan)**: Semiconductor fabrication leaders; TSMC holds 67% global foundry market share.

Geographic Concentration of Manufacturing Power

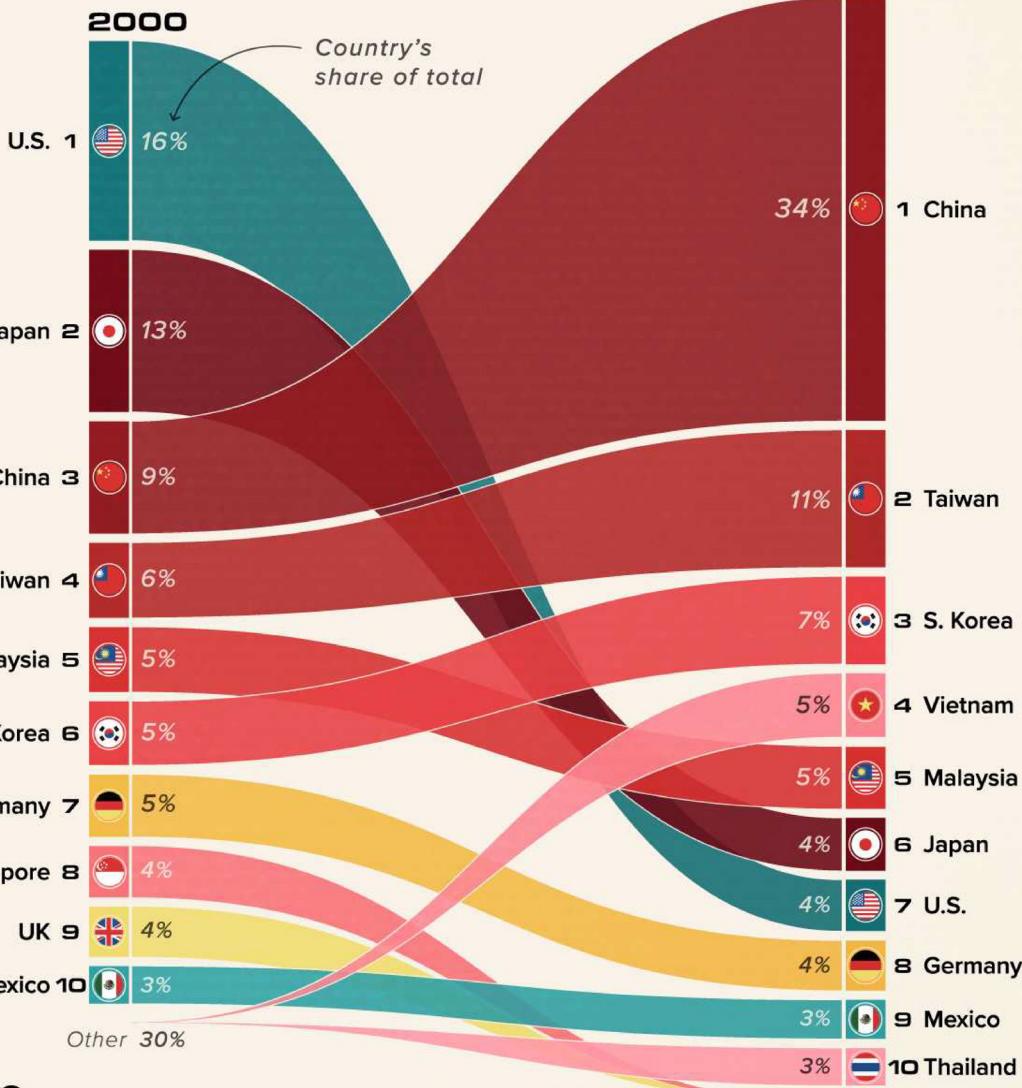
The electronics manufacturing ecosystem is heavily concentrated in Asia, particularly in East and Southeast Asia.

Country	Share of Exports (2023)	Key Companies
China	~33%	Huawei, Foxconn (operations), BOE, Xiaomi
Taiwan	~12%	TSMC, Foxconn, Pegatron, Compal
South Korea	~8%	Samsung, SK Hynix, LG
Vietnam	~6%	Samsung (factories), Foxconn, Intel (plant)
Malaysia	~5%	Broadcom, Intel (Penang), Western Digital
United States	~4%	Intel, Jabil, Apple (design-led)
Germany	~4%	Siemens, Bosch (electronics divisions)

THE WORLD'S TOP 10 ELECTRONICS EXPORTERS

ASIA N. AMERICA EUROPE

2021



Source: McKinsey Global Institute (2023)

20% Other

Visionaries Who Shaped Electronics Manufacturing

Morris Chang

He architected the pure-play foundry model, founding TSMC in 1987. By exclusively manufacturing chips for third parties, he enabled the rise of fabless giants like Apple and Qualcomm. His model is foundational to modern electronics.





Terry Gou

Gou founded Foxconn and scaled it into the world's largest EMS company. He pioneered the mega-factory model, mastering high-volume production efficiency and setting the global benchmark for manufacturing scale and responsiveness.

Sunil Vachani



Vachani founded Dixon Technologies, growing it into India's largest domestic EMS company. He championed local production, strategically leveraging government policies like "Make in India" and PLI schemes, instrumental in expanding India's ecosystem.

Elon Musk



Musk personifies the celebrity CEO, blurring Silicon Valley and Hollywood. With over 100 million followers, his provocative, influential persona is likened to Tony Stark, giving his ventures (EVs, rockets) a mainstream fan-following and media buzz akin to entertainment.



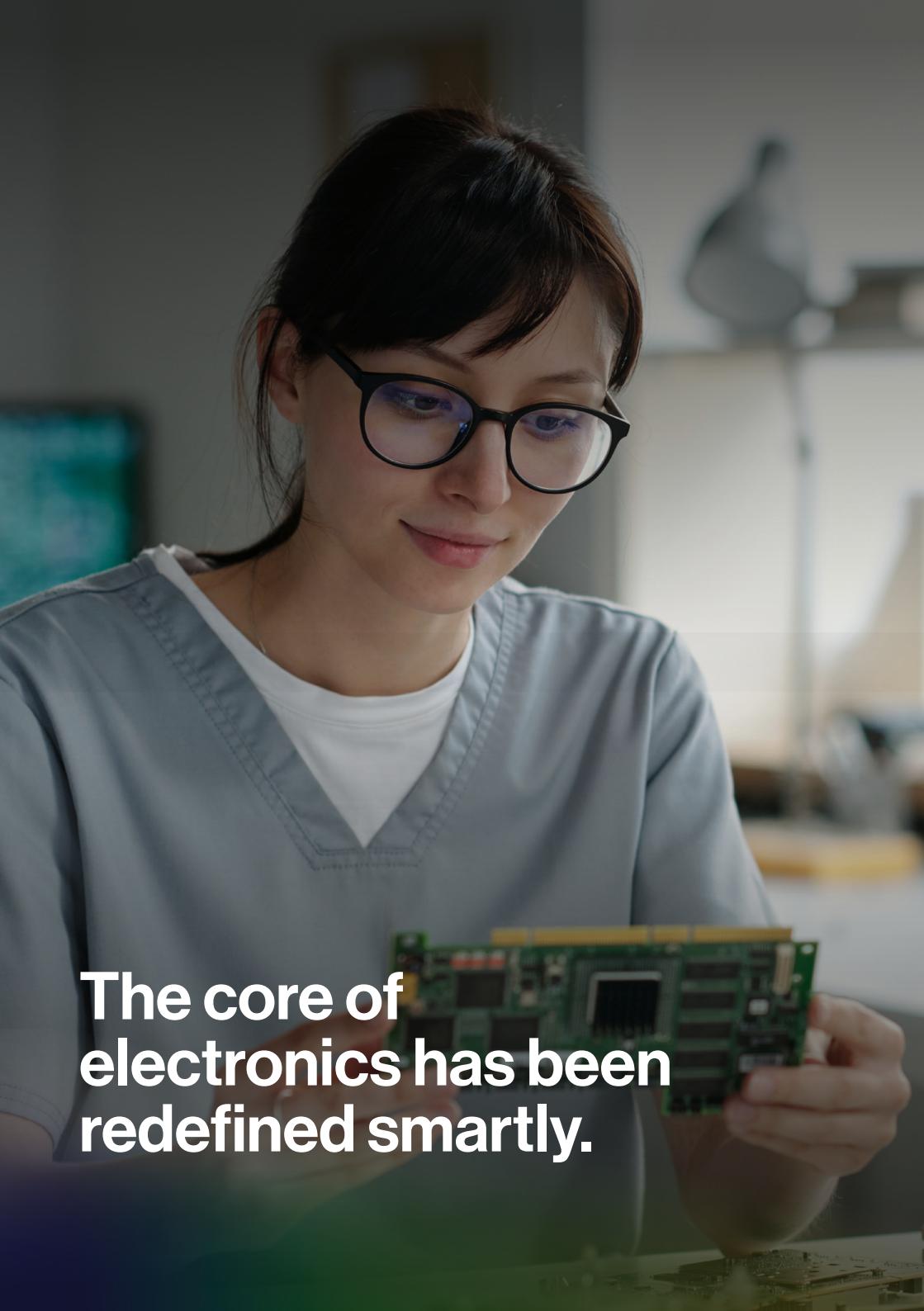
Marques Brownlee

Brownlee is one of the world's leading tech communicators with over 20 million YouTube subscribers. His crisp gadget reviews demystify electronics for Gen Z/millennials, granting him significant influence over consumer purchasing decisions.

Gaurav Chaudhary

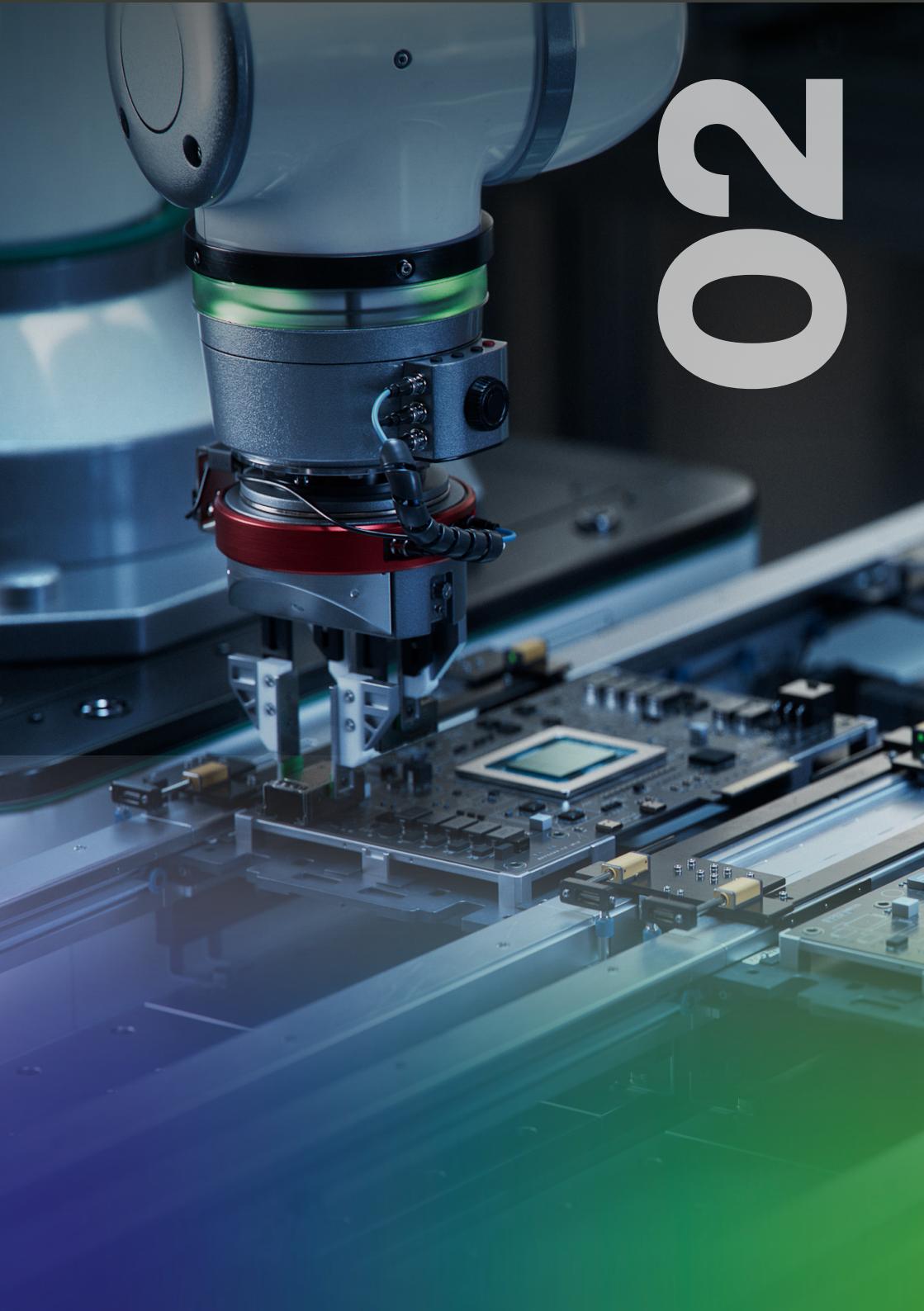


Chaudhary runs India's largest tech YouTube channel, boasting over 22 million subscribers. He produces Hindi-language reviews that successfully bring technology to the masses, highlighting the enormous engagement and celebrity status of local-language tech content.

A close-up photograph of a young woman with dark hair and bangs, wearing black-rimmed glasses and grey medical scrubs over a white t-shirt. She is looking down at a green printed circuit board (PCB) with various electronic components and yellow edge connectors. Her hands are visible, one supporting the board from below and the other pointing to a specific component. The background is blurred, showing what appears to be a workshop or laboratory setting.

**The core of
electronics has been
redefined smartly.**

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Insights and Thought Leadership



Latest Technology Trends

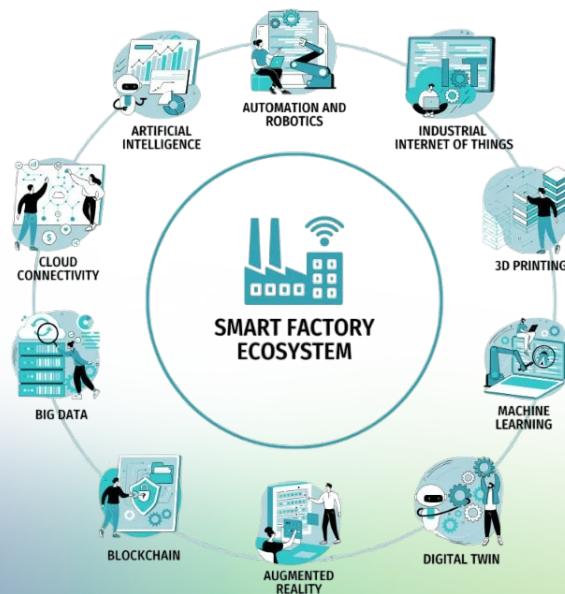
Smart Factories & Automation

Global Industry 4.0 Shift

Electronics is now the #1 sector for industrial robots (~157,000 installations in 2022). Smart factories leverage IoT and AI for real-time optimization, boosting yields, and reducing downtime by 20-30% through predictive maintenance.

India's Rapid Automation Leap

India is moving to tech-integrated manufacturing, catalyzed by PLI schemes. Robot adoption is booming (8,510 units installed in 2023, up 59% YoY). 28% of manufacturers used AI by FY2024 for visual inspection and process control.





**Designing the core,
defines the future.**

Semiconductors

Deep Dive

The Core of Electronics

Semiconductors power all digital devices, from smartphones to cloud infrastructure. The \$600B global market (2024) is projected to exceed \$1T by 2030, driven by capital- and R&D-intensive manufacturing.. 23568+*-7410\=] Global Industry Concentration

Segment	Leading Countries / Firms
Advanced Logic Chips (<10 nm)	Taiwan (~92%), South Korea (~8%) – TSMC, Samsung
Memory (DRAM, NAND)	South Korea, USA – Samsung, SK Hynix, Micron
Packaging & Testing (OSAT)	China, Malaysia, Philippines – ASE, Amkor, SPIL
Lithography Equipment	Netherlands – ASML (EUV tools, global monopoly)
Chip Design (EDA & IP)	USA, Europe – Arm, Synopsys, Cadence
Emerging (SiC, GaN)	US, Japan, China – for EVs, 5G, power electronics

India's Semiconductor Ambitions

India leverages its leading chip design talent with an initial focus on ATMP. Government incentives (Semicon India Program) support fabs, like Micron's Gujarat plant. Key challenges remain: securing talent, building the vendor ecosystem, and navigating long gestation cycles.

Stage 1

Design

Semiconductor chip designs are created for either specific or general product usage.



Location

Fabless semiconductor companies



Electronics manufacturers



Independent design companies



Foundries



Captive Factories (IDMs)

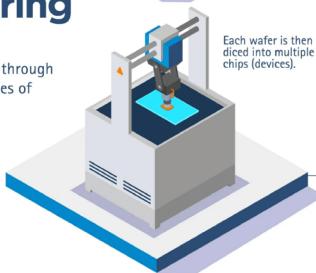


Stage 2

Manufacturing

Front End

Silicon wafers are processed through a complex and extensive series of manufacturing steps.



Each wafer is then diced into multiple chips (devices).

Stage 3

Manufacturing

Back End

Chips are assembled into packages to form the electronic components that can be mounted onto circuit boards.



Packaged chips are then tested under different electrical and temperature conditions.



ASE is the market leader in assembly and testing services as well as a leading electronics manufacturing service (EMS) player.



Outsourced Semiconductor Assembly & Test (OSATs)

Stage 4

End Product Integration

Chips are integrated by EMS and OEM companies to create end products.



Original Equipment Manufacturers (OEMs)



Electronics Manufacturing Service (EMS)

Stage 5

Consumption

End products are shipped to companies, retailers, and consumers worldwide for a growing number of applications.



Integrated Device Manufacturers (IDMs)

While the foundry model separates semiconductor manufacturing steps to different companies, IDMs traditionally manufacture their own chips.

IDMs also rely on the foundry model to supplement a portion of manufactured devices.

EMS

Deep Dive

What is EMS?

Electronics Manufacturing Services (EMS) firms produce electronic devices for brand owners (OEMs). They manage sourcing, PCB assembly, system integration, and global logistics at a massive scale.

Global EMS Landscape

- Market size (2023): ~\$590 billion
- Projected (2030s): \$1+ trillion | CAGR: ~6–7%
- Key segments: Smartphones, PCs, automotive electronics, telecom gear

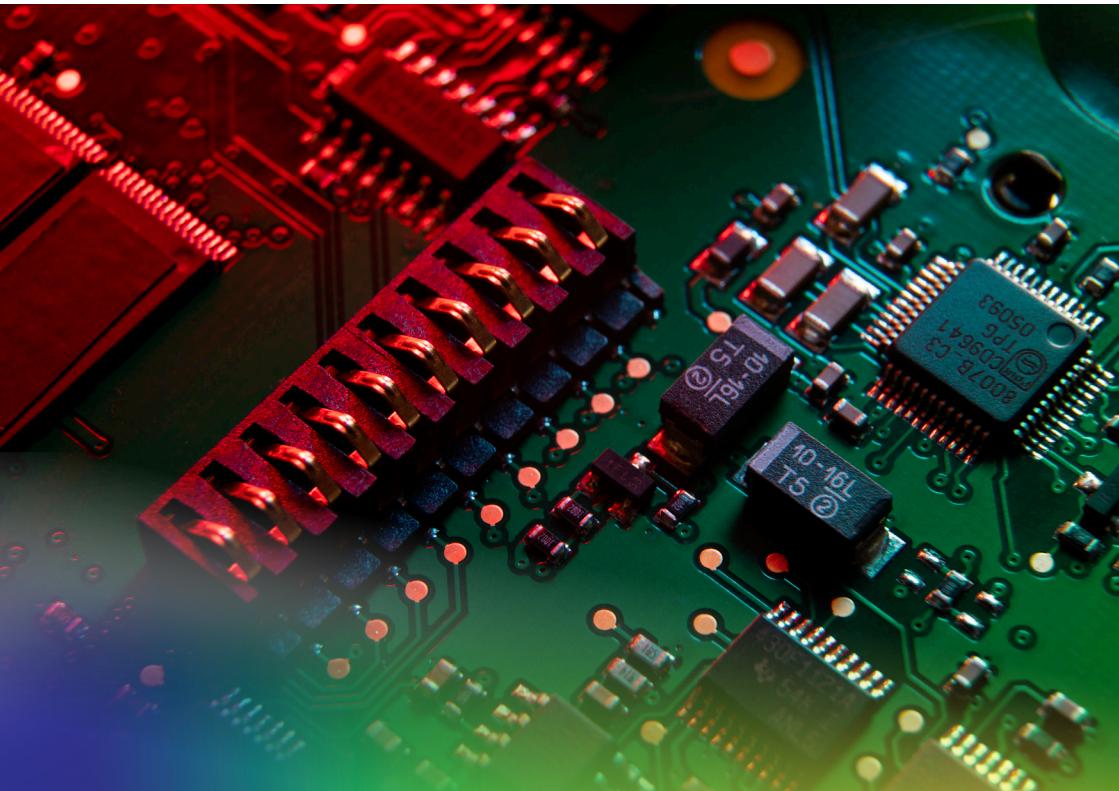
Top EMS Players	Country	Key Clients	Notables
Foxconn	Taiwan	Apple, Sony, HP, Dell	40% of global consumer electronics output
Pegatron	Taiwan	Apple, Asus	Focus on mobile and computing
Wistron	Taiwan	Lenovo, Apple	Active in India and Vietnam
Flex Ltd.	Singapore/ USA	Cisco, Lenovo, HP	Diversified portfolio & global footprint
Jabil	USA	Apple, Tesla, Cisco	Expanding into healthcare and auto electronics
Luxshare	China	Apple, Huawei	Rapidly growing Apple partner

Business Characteristics

- The high-volume, low-margin model allows OEMs to stay asset-light. The trend is moving from assembly to ODM (design and engineering).
- EMS is highly globalized (a single smartphone sources 50+ components).
- New trends involve diversification beyond China (India, Vietnam, Mexico) and adopting automation/AI-driven smart factories.

India's EMS Growth Trajectory

- India's share of global EMS is projected to grow from 2%-7% by FY2027.
- PLI schemes have catalyzed investments from global entrants (Foxconn, Pegatron) and boosted leading Indian firms (Dixon, Syrma SGS).
- India is now the #2 mobile producer globally. The focus is expanding beyond mobiles, but the value-add challenge remains: deepening the local component ecosystem to capitalize on the "China+1" diversification trend.



Telecome, EVs & Infrastructure

- **Telecom Electronics**

5G expansion fuels demand for over 3M+ global base stations, dominated by Huawei, Ericsson, and Nokia, with Open RAN unlocking new entrants. Policy drives localization for security and sovereignty. India Highlights: India targets \$8.5B in PLI-linked sales, with firms like Tejas Networks benefiting from mandatory local sourcing for Bharat 5G.

- **Electric Vehicles (EVs) = Electronics on Wheels**

EVs require 2-3x more electronics (1,500 in semiconductors per EV). Core Electronics include BMS, inverters, and power semiconductors (SiC, GaN). OEMs secure supply via direct chipmaker deals. India Highlights: PLI for ACC Batteries supports gigafactories, creating local EMS opportunities for BMS and chargers through companies like Ola and Tata AutoComp.

- **Infrastructure & Industrial Electronics**

Modern infrastructure relies heavily on power electronics (solar/wind), IoT sensors (smart cities), and embedded systems (metro/railways).

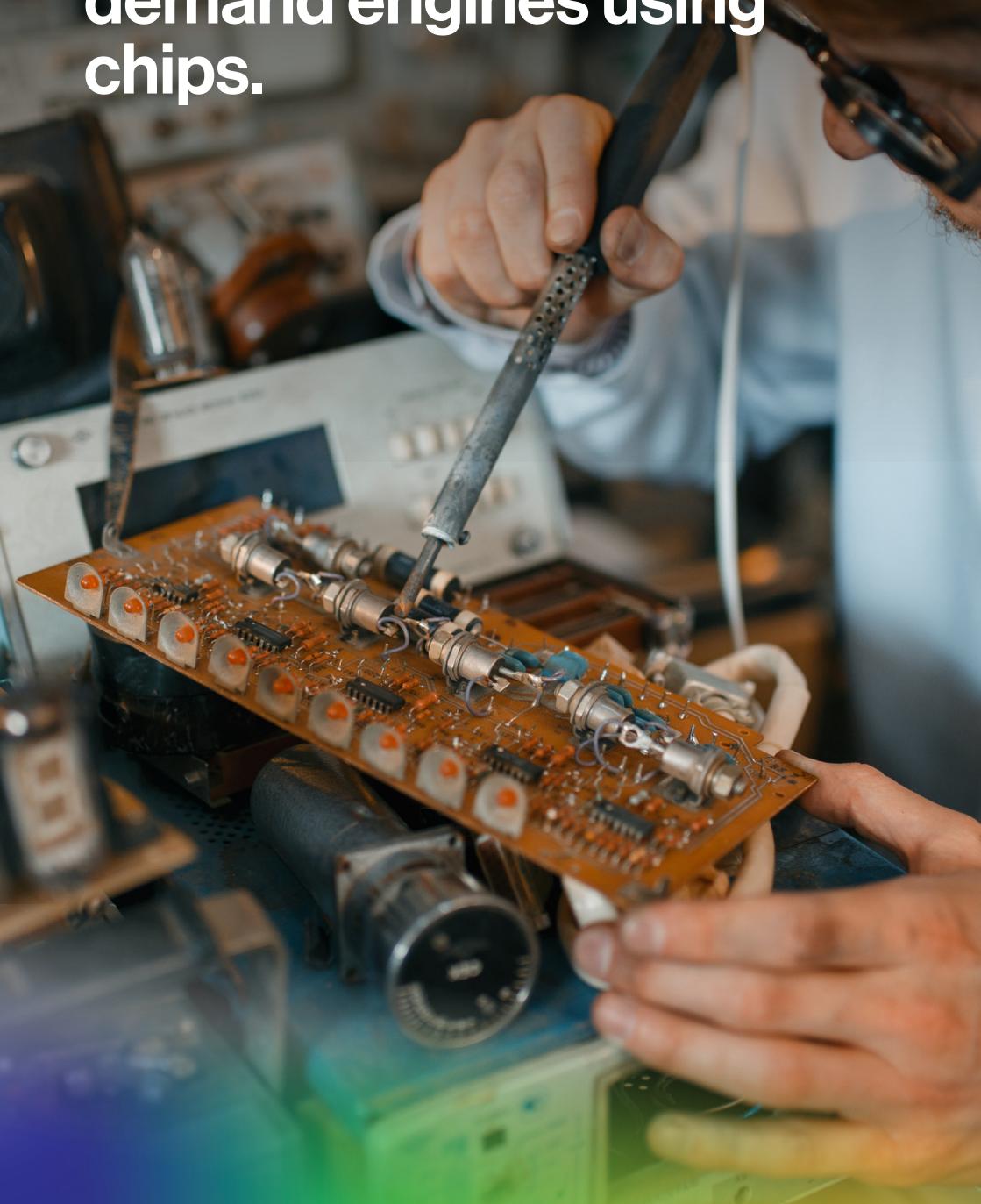
Key Growth Drivers

Key Growth Drivers include surging demand from Data Centers and Defense/Aerospace. AI/IoT convergence is blending into core infrastructure. India's Position aims for specialization in EV 2-wheeler electronics and end-to-end telecom stacks but faces global competition.

Cross-Sector Impact

These verticals are core demand engines, driving mass production volume and R&D in areas like mmWave radios and SiC inverters, fundamentally reshaping electronics manufacturing.

**driving the new-age
demand engines using
chips.**



Supply Chain Resilience

- The Crisis That Redefined Priorities
The pre-2020 JIT model proved fragile due to COVID-19 and geopolitical rifts. The concentration of 92% of advanced chips in Taiwan was a key vulnerability. The resulting 2021 chip shortage cost \$210B in auto sales, forcing a global rethink where efficiency no longer equals resilience.
- New Supply Chain Models
The “China+1” shift prioritizes diversification to India, Vietnam, and Mexico (e.g., Apple targets 25% iPhone assembly in India by 2025). This redesign includes multi-sourcing, moving to “just-in-case” inventory, and vertical alignment (OEM-chipmaker co-investment).
- Real-Time Monitoring and Digitalization
Firms use AI and analytics to detect and pre-empt disruptions, enabling dynamic order re-routing and real-time supplier risk monitoring, such as tracking fab operations for climate disruptions.
- Government & Policy-Driven Resilience
Governments actively intervene: The US CHIPS Act funds onshoring, the EU Chips Act boosts capacity, and India’s PLI/Semicon India localize ATMP and components. Alliances like the Quad promote diversified sourcing.

Risk Type	Examples & Mitigation Strategy
Geopolitical	“Chip 4” alliances (US, Japan, India, EU)
Natural Disaster	Dual sourcing in diverse climate zones
Climate Change	Smart factory locations + resilient infrastructure
Future Pandemics	Automated lines, flexible regional supply centers

Strategic Takeaway

- The electronics value chain is shifting from fragile, hyper-optimized networks to robust, flexible ecosystems. Success will depend on 3 factors. Such as, Geographical spread + redundancy, Digital visibility and Government–industry collaboration. Firms that balance cost, agility, and geopolitical insulation will emerge as winners in the post-pandemic global manufacturing landscape.



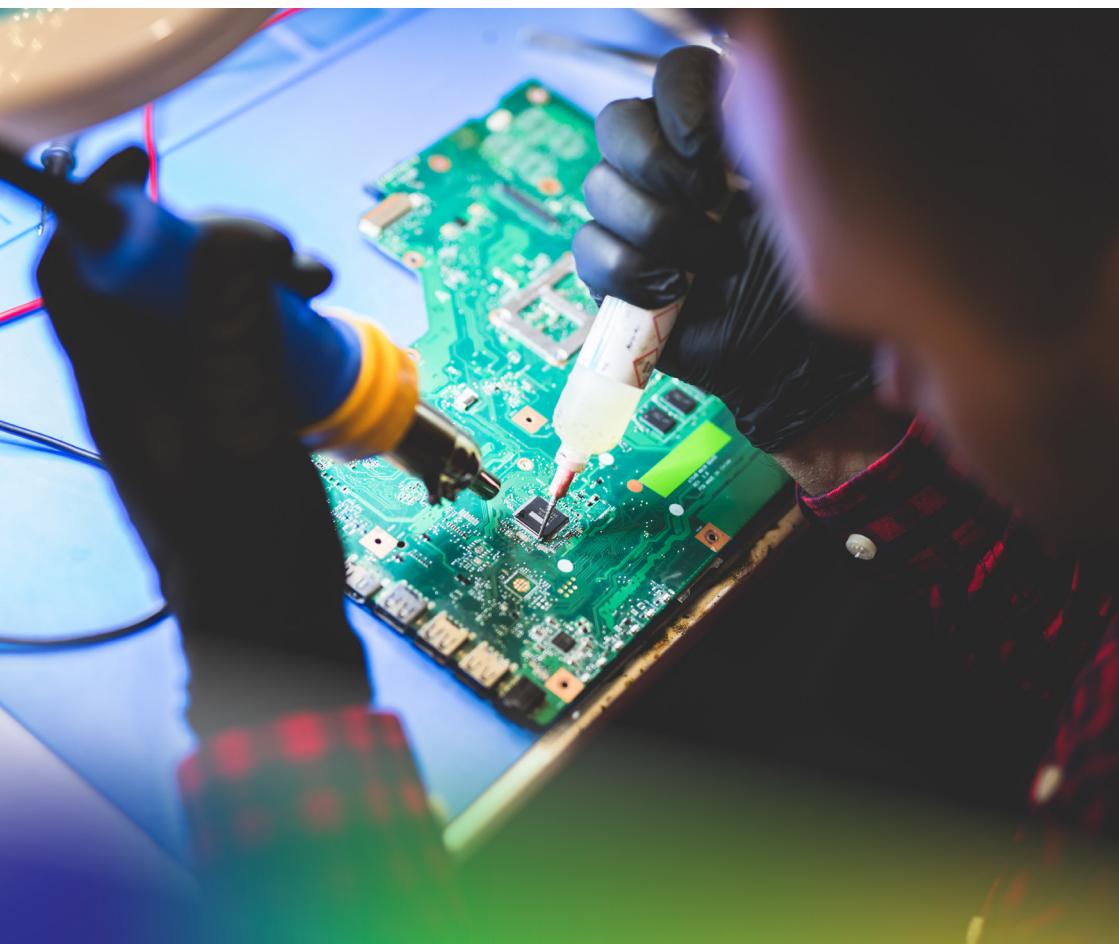
Shifting the value chain to robust ecosystems.

Challenges & Disruptions

- Geopolitical Tensions: The Fragile Backbone of Supply Chains
US-China tech rivalry drives export controls and tariffs. The high concentration (92%) of sub-10 nm chips in Taiwan poses an acute supply paralysis risk. China's rare-earth leverage forces tech bifurcation.
- Supply Chain Bottlenecks: Fragile Concentrations, Fragile Timelines
Fragility persists due to hyper-concentration of advanced components in East Asia. Post-COVID logistics shocks and labor strikes expose this, despite maturing diversification efforts.
- Technological Disruptions: Innovate or Be Obsolete
Firms face an “innovate or be obsolete” threat. 3D-printed electronics, AI-assisted design, and automation pressure from robotics reduce traditional demand, requiring rapid adaptation.
- Economic Volatility: The Boom-Bust DNA of Electronics
The electronics industry has a boom-bust nature, compounded by macroeconomic headwinds (inflation, recession). Flexible scaling and agile forecasting are crucial for instability management.
- Climate & ESG Risks
Environmental regulations necessitate costly factory upgrades. Climate events (e.g., Thailand floods) disrupt production. Global buyers strictly enforce ESG audits to mitigate reputational and labor risks.
- India-Specific Operational Frictions
Solution focus:
Streamline port logistics, digitize customs, incentivize local component suppliers.

Challenge	Current Status	Strategic Risk
Power & logistics infra	Improving, but lags China/Vietnam	Raises operational cost
Component ecosystem	Still nascent	Import delays = line shutdowns
Regulatory inconsistency	GST streamlined some flows, but local issues remain	Risk to JIT operations
Ease of doing business	Improving, yet customs & compliance gaps exist	Delays, compliance risk

Solution focus: Streamline port logistics, digitize customs, incentivize local component suppliers.

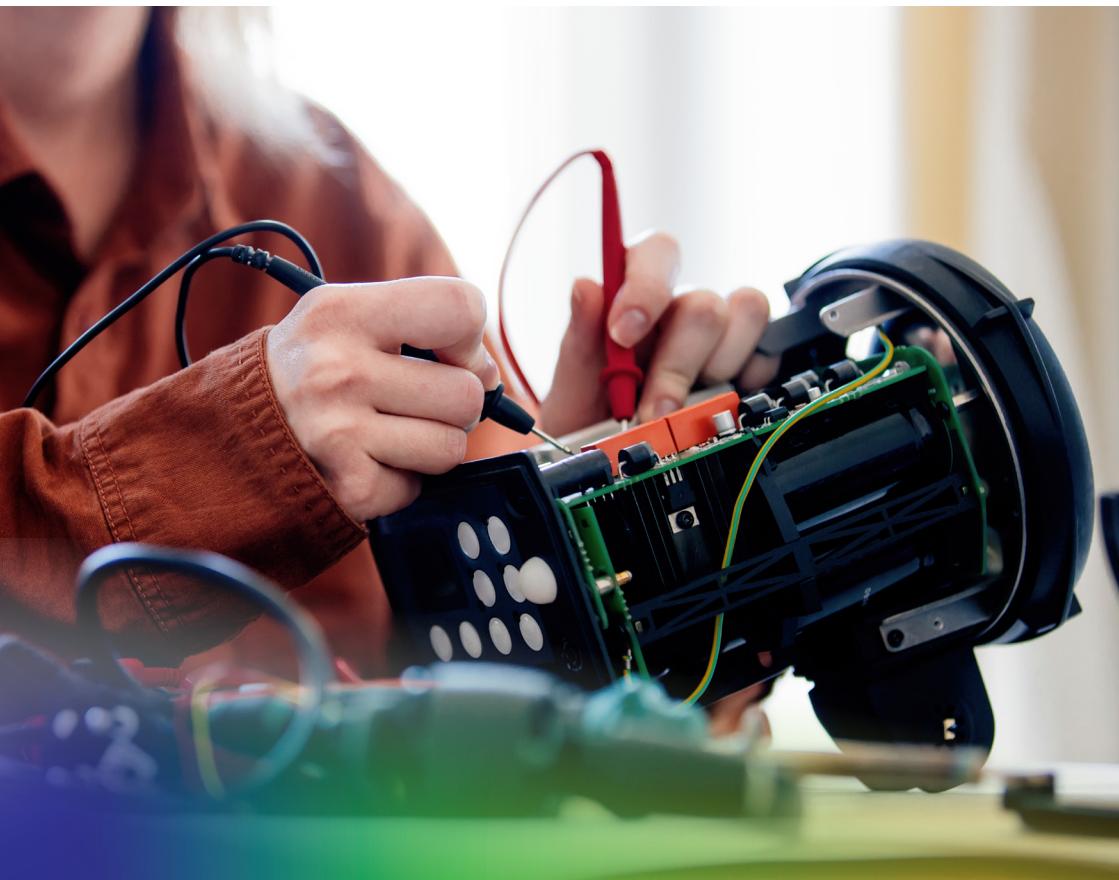
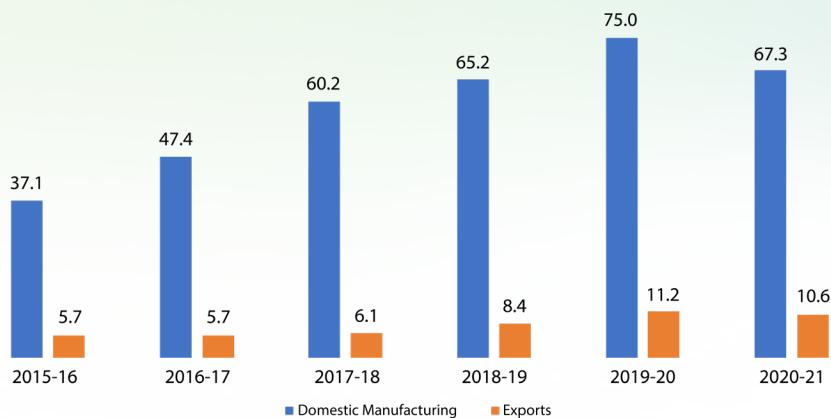


Mitigation Strategies

- Reducing Import Dependence: Building Local Supply Chains
India uses the SPECS scheme to offer financial incentives for domestic component manufacturing (PCBs, displays) to build local supplier depth and reduce import reliance. Concurrently, PLI schemes target the 10-20% cost gap with competitors, rewarding high-volume, efficient production to drive economies of scale and local value addition.
- Innovation-Led Growth: Boosting R&D and Design
Innovation is fostered through investment in semiconductor design incubation and public-private R&D collaborations, focusing on value capture upstream (IP, design).
- Talent Development: Skilling the Electronics Workforce
The Semicon India FutureSkills initiative aims to produce 50,000+ industry-ready engineers in chip design and fabrication, alongside efforts by the ESSCI to modernize curricula for Industry 4.0 roles (targeting both entry-level technicians and advanced semiconductor professionals).
- Holistic Strategy: Matching Problems with Solution

Challenge	Targeted Response
Import reliance, weak local sourcing	SPECS + PLI + supplier development grants
Cost disadvantage vs. East Asia	PLI efficiency incentives + infra support
Low R&D/IP creation	Design incubation, co-funded R&D hubs
Skills–job mismatch	National skilling programs + revamped technical education
Innovation lag	Startup ecosystems in electronics + academia tie-ups

India's electronic goods exports and production by value (US\$ billion)



Tech That Excites

- Artificial Intelligence and Machine Learning in Production: AI is deployed for predictive maintenance, supply chain optimization, and circuit design validation. AI-based visual inspection now analyzes 100% of components, significantly enhancing quality control.
- Industry 4.0 and IIoT Integration: Smart factories use IIoT for real-time data streams and centralized monitoring. Machines can detect faults (e.g., solder misalignment) and initiate real-time corrective actions, enabling flexible manufacturing.
- Robotics and Collaborative Automation: Next-generation cobots with vision and force feedback handle precise assembly. Autonomous Mobile Robots (AMRs) manage intralogistics within factories.
- Additive Manufacturing and Printed Electronics: 3D printing fabricates custom tooling. Printed electronics uses conductive inks for flexible circuits and antenna structures, enabling future rollable displays.
- Miniaturization and Advanced Assembly Techniques: Driven by IoT, techniques like PCB embedding and System-in-Package (SiP) create high-density, miniature electronics.
- Augmented Reality for Training and Maintenance: AR-assisted workflows overlay live instructions for operators, reducing training time and enhancing real-time diagnostics.

Watchlist 2030

India is accelerating its electronics manufacturing trajectory, targeting US\$500B in annual production by 2030. This fivefold increase aims to secure a 6–7% global share, generate 5–6 million jobs, and drive \$200 billion in exports.

- Segment Growth: Flagship segments include Smartphones (\$120B by 2030), IT hardware, and the Wearables/Hearables market (\$30B+). Automotive Electronics are projected for massive growth, and the first indigenously-made chip is anticipated by late 2025.
- Policy & Infrastructure: Success relies on expanding the PLI scheme and investing in over 50 Electronics Manufacturing Clusters (EMCs) with shared resources. Trade policy supports local assembly while easing component imports.
- Technology & Positioning: The sector will leverage 5G to 6G R&D, and specialized hardware for AI/edge computing. India aims to capitalize on the “China+1” diversification trend, shifting from “Made in India” assembly to “Designed in India” component production.
- Challenges: Achieving the ambitious 25% CAGR requires stable policy, execution of ease-of-doing-business reforms, and swiftly addressing the crucial skilled talent shortage.

Buddies! Till now we've covered the latest technology trends, a deep dive into Semiconductors, EMS business and global leaders, and key demand drivers like Telecom and EVs.

But what would happen when our tech interacts with other innovations?
Let's see..

Interactions with Other Tech

Sustainability in Electronics

Industry's Environmental Footprint

80%+ of emissions come from production backed by other key issues such as, Mining of rare earths and conflict minerals, High energy use in fabs & data centers and E-waste crisis which is 50M+ tonnes/year; of which only ~20% is formally recycled.

Circular Economy in Action

Circular Economy involves designing products for durability and repairability, increasing the use of recycled materials (e.g., in Apple/Dell products), and manufacturer pledges for 100% renewable energy (Intel, TSMC). Smart factories are implementing water recycling and non-toxic chemicals

Policy & Compliance Landscape

Global regulations like EU RoHS/REACH limit toxic substances, and India's E-waste Rules enforce recycling targets. Factories pursue ISO 14001 and zero-waste goals for market access.

Workforce & Skills

- Global Skill Gaps: A Looming Bottleneck

Electronics manufacturing faces a critical talent shortage (e.g., \$1 million+ semiconductor roles needed globally by 2030), with thousands of roles projected to go unfilled in the US. This gap stems from an aging workforce and declining STEM enrollment.

- Skills for Industry 4.0: The New Factory Worker

Industry Solutions: Global firms (TSMC, Intel) invest in training centers integrated with fabs and partner with colleges. East Asia has strong pipelines via national institutes.

Skill Area	Needed For
SMT operation + soldering	PCB assembly lines
Cleanroom + fab practices	Semiconductor fabrication
Robotics + mechatronics	Smart factories and automation
Data analytics + digital tools	Predictive maintenance, process optimization

- India's Talent Opportunity – Quantity to Quality

India, graduating 800,000 engineers annually, is reorienting talent toward VLSI and core electronics, creating ~700,000 new mobile manufacturing jobs through government programs like Semicon India.

This was some interesting information. I didn't know we can be the next Techpreneurs! Well, now let us understand who and what leads the ecosystem.

Ecosystem Leadership

Policy & Governance Overview

Industrial Policy and National Sovereignty

- Major economies (US, EU, Japan) use subsidies (e.g., CHIPS Act) to localize production, addressing geopolitical dependencies.
- Techno-nationalism and global compliance (EU RoHS, labor codes) reshape supply chains.
- India offers up to a 50% capital subsidy (Semicon India) for fabs and ATMP units, attracting projects like Micron's.

Competing for FDI

Countries actively compete for FDI. China pursues self-sufficiency, while emerging hubs (Vietnam, Mexico) offer incentives. India utilizes its National Policy on Electronics and PLI schemes (~ 4-6% incentives) to attract phased manufacturing.

Standards, Certification, and Compliance

Trade agreements like USMCA and RCEP streamline market access. Bilateral FTAs affect sourcing. Mandatory certifications (UL, CE, ISO) guide manufacturing design and are non-negotiable for global markets.

R&D and Funding Trends

Global Landscape

Despite a major dip in tech equity funding, Electronics R&D remains resilient due to significant government backing. The US CHIPS Act committed \$11Bn for advanced semiconductor R&D, and the EU Chips Act allocated €43Bn to fund research and expand fabs.

India's Strategic R&D Push

Addressing historically low private R&D, India is launching a ₹1 lakh crore (~\$12Bn) RDI Fund to boost domestic electronics R&D and reduce foreign IP dependence. A proposed \$3Bn incentive targets design-led local brands (SoCs, embedded systems) to enable the \$500Bn output goal by 2030.

Corporate Investment

Top firms maintain strong R&D commitments: Samsung invests \$24Bn annually in AI chips and memory. Intel, TSMC, and Apple continue high double-digit billion-dollar R&D, focusing on design, node scaling, and advanced packaging.

IMC 2024 Discussions and Engagements

Panelists



Mr. Tarun Chhabra
Country Head, Nokia
India



Mr. Anku Jain
Managing Director,
MediaTek India

Panel Title

India's Telecom Manufacturing Boom: Driving Innovation, Exports, and Digital Sovereignty



Mr. Ramakrishna P

**Deputy Director
General, Department of
Telecommunications (DoT)**

Moderator

Panelists



Mr. Aditya Vaishnaw
Senior Leader, Ministry
of Electronics & IT
(MeitY)



Mr. Berjesh Chawla
Senior Manufacturing
Evangelist



Ms. Priyanka Anand
Vice President & Head
of HR, Nokia MEA/India

Here is what Panelists had to say

Moderator Anil

Mr. Anil asserted that the government must enable predictable policy and smoothen bottlenecks. He stressed that telecom is inseparable from electronics components, and execution, skilling, and design-led innovation will determine India's success as a product nation.

Clement Joshua Folger

Mr. Folger noted that policy consistency (PLI, ECMS) provides a strong foundation. He forecasts a rapid broadening of the ESDM "heat map" beyond traditional hubs, creating a distributed, export-oriented supply chain.

Vivek Tyagi

Mr. Tyagi argued "market is mother": India's massive demand in autos and telecom justifies local manufacturing when combined with incentives. He stressed the need for specialized B.Tech programs to create shop-floor-ready engineers. He emphasized that the next leap is building a local component and PCB ecosystem via ECMS, shifting from assembly to "design-led manufacturing" to claim products as "designed, sourced, and manufactured" locally.

Nitin / Nithan

Mr. Nitin highlighted the three pillars: skilled people, local components, and policy support. He cited India's premiumizing demand and Ericsson's 65-70% localization in antenna manufacturing as powerful drivers.

Sushil Pal

Mr. Pal asserted India must “fire on all cylinders” (PLI, ECMS, ISM). He reported an overwhelming response to the cross-sectoral ECMS and urged OEMs to source locally to seed a sustainable ecosystem.

Conclusion

The discussion concludes that India’s electronics sector is experiencing a transformative surge, driven by strategic policies like PLI and ECMS. Record investments and production growth are rapidly deepening the value chain and fostering component manufacturing. India is successfully shifting from an assembly hub to a global leader, cementing its status as a technological powerhouse by 2030.

These Industry leaders certainly made some interesting points and are leading our industry towards growth. And who knows, maybe we can lead the next phase of growth.

Buddies, now let's get excited for our next fun segment!

IMC 2025 Discussions and Engagements

Panelists



**Clement Joshua
Folger**
Senior Leader,
Zetwerk



Vive Tyagi
Managing Director
& Country Manager,
Analog Devices

Panel Title

India's Telecom Manufacturing Boom: Driving Innovation, Exports, and Digital Sovereignty



Anil Kumar Bhardwaj

Deputy Director General,
Department of Telecommunications
(DoT)

Moderator

Panelists



Nitin Bansal
Managing Director
(India), Ericsson



Sushil Pal
Joint Secretary,
Ministry of
Electronics & IT (MeitY)

Panelists and Their Insights

Moderator Anil

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Nitin / Nithan

Mr. Nitin highlighted the three pillars: skilled people, local components, and policy support. He cited India's premiumizing demand and Ericsson's 65-70% localization in antenna manufacturing as powerful drivers.

Sitendu Dash

Mr. Dash called for regulatory frameworks supporting open, interoperable DPI, governed by standards and APIs to foster innovation and prevent vendor lock-in.

Conclusion

The panel agreed that universal, secure, and open DPI requires multistakeholder collaboration to strengthen last-mile access, ensure sustainable financing, and cement India's global leadership in inclusive digital transformation.

Sushil Pal

Mr. Pal asserted India must “fire on all cylinders” (PLI, ECMS, ISM). He reported an overwhelming response to the cross-sectoral ECMS and urged OEMs to source locally to seed a sustainable ecosystem.

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4



Learning with Fun

A photograph of a white industrial robotic arm with a gripper end effector positioned over a circuit board on a workbench. The background shows a factory environment with other machinery and shelving. A solid green rectangular overlay covers the bottom third of the image, partially obscuring the robot's base and the workbench area.

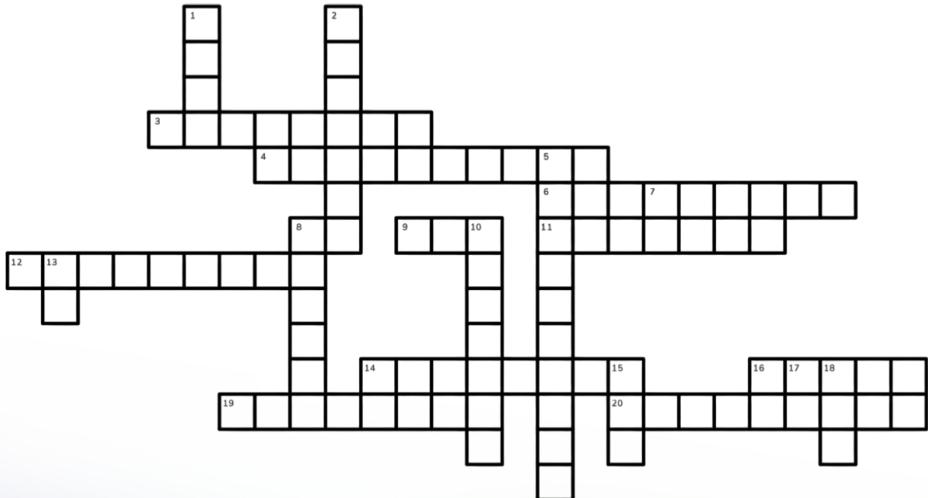
Crossword

Across

- 3. Limits the flow of electric current
- 4. Used for amplification or switching purposes
- 6. Process of joining two metal pieces together
- 9. Printed Circuit Board used as a base for electronic components
- 11. Basic component in electronic devices
- 12. Stores and releases electrical energy
- 14. Measure of electrical current
- 16. Allows current to flow in one direction
- 19. Passes or blocks an alternating current
- 20. Miniature electronic circuit on a single chip

Down

- 1. Protects against overcurrent damage
- 2. Measure of electrical potential difference
- 5. Generates repeating waveform signal
- 7. Direct current
- 8. Reference point for electrical circuits
- 10. Stores chemical energy to produce electricity
- 13. Alternating current
- 15. Electromagnetic interference
- 17. Integrated circuit that contains multiple components
- 18. Unit of electrical resistance



Find the Words

O M I C R O C H I P I S R L G
T R E S I S T O R C P I S B N
M H I R O O D S K E I N D I A A
R I T L S E B O R A G E C T L
O A F N B C I R C U I T I E O
D N H S E T A C I V Y E R T S
N B E G S U T D L S E O I Y C
V A N T O S H L O D I O D E V
I E S F L C L M U I R O A E O
T D L O D Y N E G M T I L O L
R C W T E D E P C B H V P I T
R N K T R A N S I S T O R A A
B T I V I S P C K O E T A L G
I O F R N C A P A C I T O R E
G L I O G Y P M E R I O T J E
M P N C S I L I C O N T O A I
M I C R O C O N T R O L L E R

Fiction & Pop Culture

Digital infrastructures, when embedded in society, often appear in popular culture as cautionary tales or speculative utopias. These portrayals reflect public anxieties about control, privacy, and digital power in state systems.

Selected Examples of Fictional DPI Systems

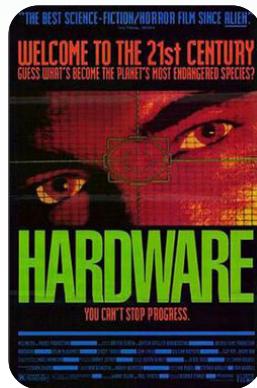


The Brain Center at Whipple's The Twilight Zone (1964)

This episode shows a factory owner, Whipple, who replaces all human labor with the X109B14 automatic assembly unit. The episode captures the eerie stillness of total automation, culminating in Whipple himself being coldly replaced, illustrating the unsettling endgame of extreme efficiency.

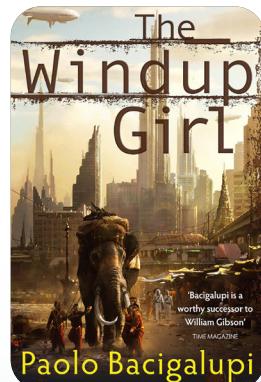
Hardware (1990, dir. Richard Stanley)

Hardware offers a visceral vision of self-repair. In a post-apocalyptic setting, a combat droid reactivates itself by painstakingly digging through scrap electronics, wiring up its damaged components, and rebuilding its structure. The film provides a raw, grimy, and deeply intelligent look at scrap-based manufacturing and machine autonomy.



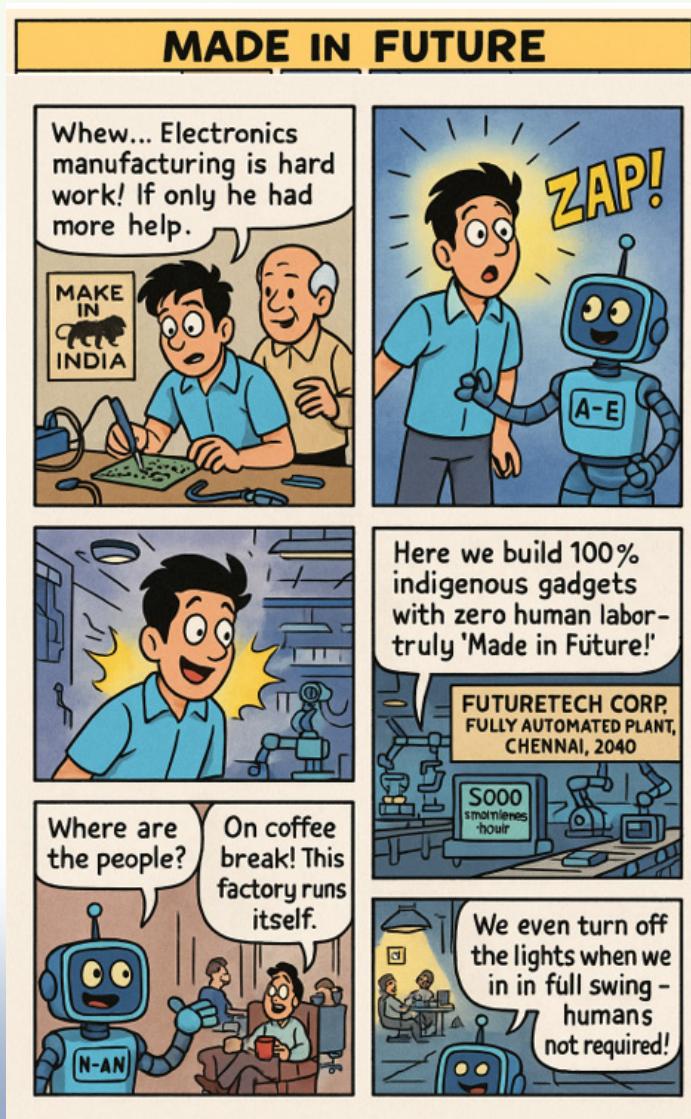
The Windup Girl Novel by Paolo Bacigalupi (2009)

This book immerses readers in a future Bangkok where biotech and electronics merge. The narrative centers on a factory worker who intimately repairs half-dead machines, soldering bio-electronic limbs and delicate sensors. It serves as a tactile, evocative homage to the essential, hands-on craft of electronics repair.



Comic Strip

Digital India Diaries



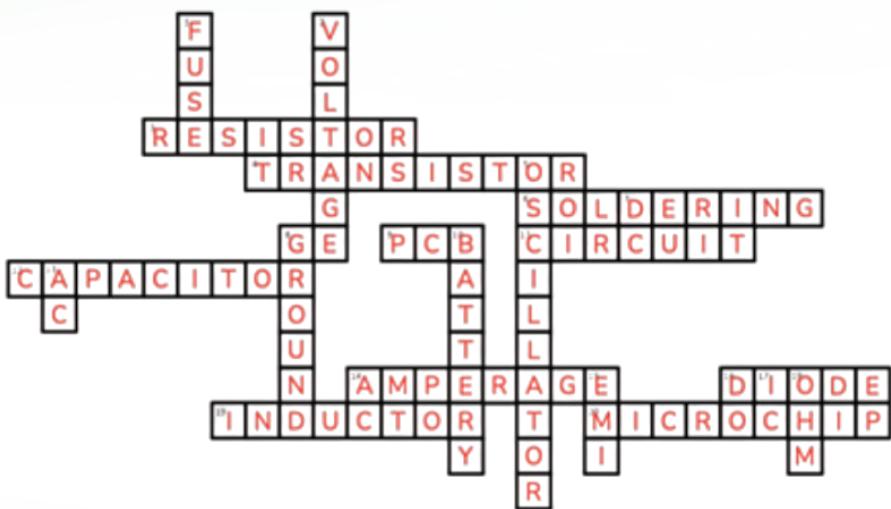
Student Resources & Career Pathways

India's electronics manufacturing growth relies on a robust talent pipeline spanning education to industry.

- Education & Institutes: Premier institutions like IITs and NITs provide strong foundations in Electronics and VLSI using industry-grade tools. Specialized diplomas and research centers (IISc, CSIR-CEERI) align academic training with manufacturing needs, supporting the semiconductor mission.
- Government Initiatives & Skill Programs: Schemes like Atal Tinkering Labs (ATL) foster early innovation in schools. The ESSCI offers industry-aligned certifications in PCB assembly and automation. Critically, the SemiconIndia FutureSkills platform is actively upskilling over 85,000 students in VLSI and chip fabrication to meet the demands of future fabs.
- Practical Exposure: Competitions (Smart India Hackathon) and internships at firms like Samsung provide essential factory-floor experience. This practical learning is the primary stepping stone to roles in PCB Design and Process Engineering, fueling the hardware startup ecosystem.

Solutions

Crossword Puzzle



Find the words

Capacitor
Circuit
Diode
India
Microchip
Microcontroller

PCB
Resistor
Silicon
Soldering
Transistor
Voltage



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This book is your essential guide to the global electronics industry. We break down the \$600B+ market and the powerhouses like Foxconn. Discover the pivotal roles of Semiconductors and Industry 4.0, understand how India is rising as a manufacturing hub, and explore the future drivers like EVs and 5G. It's time to decode the chips that run the world!

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