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India's Strategic Transition from Semiconductor Consumer to Producer: Policy, Infrastructure and Market Readiness Analysis

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Abstract

India has embarked on a transformative journey to emerge as a major player in the global semiconductor value chain, shifting from a consumer market to a potential production hub. This paper analyzes the effectiveness of recent policy interventions, such as the India Semiconductor Mission(ISM) and Production Linked Incentives (PLI), evaluates infrastructure and supply chain developments, and critically assesses challenges related to import dependence, skilled labor, and R&D. Using a policy and industry trend analysis framework, it is compared semiconductor strategy of India with established producers like Taiwan and South Korea. Findings suggest that while strategic collaborations and state incentives have laid promising groundwork, gaps remain in talent development, raw material sourcing, and indigenous innovation capacity. The study concludes with strategic recommendations of producing the raw materials domestically, ensuring un-interrupted Supply of critical raw-materials from foreign Countries, creating the adequate skilled workforce to strengthen India's global semiconductor competitiveness.

Keywords: assembly, testing and packaging; fabrication facilities; production linked incentives; semiconductor industry; semiconductor mission; semiconductor strategies; skilled labourer.

1 Introduction

India expects to launch its first indigenous semiconductor in 2025 and has shifted its focus from semiconductor research and designing hub to manufacturing hub since 2021, mainly after COVID pandemic period which saw the acute shortage of semiconductor chips supply from China affecting India's automobile and technology oriented sectors in large (Times of India, 2025, August 23). India's electronics market has experienced tremendous growth mainly due to the presence of huge middle-class people, increasing disposable incomes, Government proactive policies and production linked incentives. The India Electronics and Semiconductor Association (IESA) estimate the market to reach $103.4 billion by 2030 (Business Standard, 2025, January 29).The Government introduced the India Semiconductor Mission (ISM) aiming to build a strong semiconductor ecosystem and positioning India as a global hub for electronics production and design, while serving as the nodal agency for the efficient and seamless implementation of semiconductor and display schemes. The Government already injected $US 10 billion and providing major Production Linked Incentives (PLI) to attract key global manufacturers to set up new plant or shift the existing plant from foreign country to India individually or as joint venture with reputed Indian corporate like Tata

Elexi, HCL, CG Power ltd etc (PIB,2021). In May2025, the Union cabinet approved 6th Semiconductor production unit in India to be set up in Uttarpradesh as a joint venture between HCL and Foxconn aiming to attract investment of Rs 3700 crore (Reuters, 2025, May 14). Indian Semiconductor Mission (ISM) can be viewed in the line of achieving the overall goal of Atmanirbhar Bharat (Self Reliant India). The central government has also amended key provisions of Special Economic Zone (SEZ) Rules, 2006 to further encourage the domestic production of Semiconductor (Ministry of Commerce and Industry, 2025). These reforms primarily aimed to achieve India's ambitions of technological self reliance and reduced import dependence.

Through this descriptive review, answer to the following research questions is being sought: What are the structural enablers and inhibitors of India's semiconductor industry?

How effective are India's current policies in creating a sustainable semiconductor ecosystem?

2 Literature Review

Although being a worldwide IT services powerhouse, India has long lagged behind in semiconductor production due to capital-intensive requirements, lack of technological competence, and poor infrastructural facilities (Singh & Sharma, 2021). Research scholars mainly highlighted three major deficiencies in achieving successful semiconductor ecosystem: 1. Government support and incentives (Linden, 2020), 2. Robust infrastructure and supply chains (Baldwin, 2021), and 3. Skilled manpower and research ecosystems (Mathews, 2022).

21 Study of Taiwan's Semiconductor Strategies

Taiwan has emerged as the global leader of semiconductor manufacturing, attributing over 60% of the world's chip foundry capacity and Taiwanese firm TSMC alone provides more than 90% of advanced chip, required for consumer electronics, mobile phones, 5G, automobiles, advanced computing etc (The Diplomat,2023). Key Strategies behind Taiwan's booming semiconductor industry:

211 State -led foundation & transfer of technology

The Government launched this ambitious project in 1970s through setting up Industrial Technology Research Institute (ITRI) in 1973 and its subsidiary ERSO soon after. ITRI partnered with RCA and trained engineers overseas and later promoted UMC(1980) and TSMC(1987).TSMC separated its founding model of chip manufacturing from design in the way to become the Global leader in this field at present (Chang,2021).

212 Science Parks to Facilitate Innovation

Taiwan built objective based hubs like Hsinchu Science Park (1980) and Central Taiwan Science Park (2003), fostering collaboration between Universities, companies and start-ups. These parks provided subsidized land, tax breaks, and talent access (Lin & Chen, 2019).

213 Robust Ecosystem & Talent Pipeline

Taiwan cultivated a dense ecosystem of fabs, suppliers, research institutions and academic talent[1]. ITRI with unparalleled expertise and industry associations facilitated knowledge sharing by organizing training for generations of engineers.

214 Incentives, Infrastructure & Education

2141 Government incentives included R&D tax credit, global collaborations, subsidized loans, and streamlined regulations via incentives like productivity 4.0 and the Smart Electronics Industry Promotion Program (Ministry of Economic Affairs, 2019).

2142 University programs have been expanded in Semiconductor, AI, and engineering fields. The 2025 "Top-Down semiconductor plan " is supported by US $ 1.1 billion and the " Chip based Industrial Innovation Program to invest US $ 10 billion over the next decade (National Development Council, 2021).Taiwan launched bilingual summer camps and global educational initiatives to plug workforce gaps (Tseng, 2020).

2143 **TSMC's Model of Customer -Oriented Production**

TSMC adopted a neutral foundry model that built trust with global customers like Apple, NVIDA, while focusing investor backed R&D in advanced process nodes (7nm, 5nm, 3nm, 2nm). The growth in the industry is also complimented by political stability, legal reliability and Top-Down state coordination, giving Taiwan the Competitive edge (Fuller, 2021).

2144 Sustainability and Security Leadership

21441 Companies like TSMC lead industry - sustainability, recycling water, implementing zero waste initiatives, and creating circular economy models. The Taiwan High-Tech Facility Association amplifies sustainable tech across fabs (TSMC, 2022).

21442 Taiwan enforces strict IP protection under its National Security Act(National Security Council, Taiwan, 2021).

22 Semiconductor strategy & China's 14th Five -Year Plan (2021-2025)

China's semiconductor push remains one of its most high-stakes and heavily resourced National initiatives. In that line, China's 14th Five -Year Plan places Semiconductors at the heart of its strategy to achieve technological self-reliance and foster national economy (Global Policy Watch, 2021). Key objectives:

221 **Strategic Technological Investments**

2211 Semiconductors are among seven "frontier technologies" prioritized under the 14th FYP, alongside AI, quantum computing, and biomedical sciences. The plan calls for annual R&D growth of over 7%, with basic research rising from 6% to over 8% of total R&D economy (Global Policy Watch, 2021).

2212 China aims for breakthroughs in IC design tools, key equipment, advanced memory and hide-band gap semiconductors like SiC and GaN (Global Policy Watch, 2024).

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222 **Manufacturing and Foundry Expansion**

2221 The country looks to increase foundry capacity by around 40%, shifting from 14 nm towards 7 nm.

2222 Support comes from the National Integrated Circuit Industry Investment Fund, now in its third phase with a capital base of US $ 47.5 billion as of mid 2024 (Global Policy Watch, 2024).

223 **Ecosystems Building Via Localized and Regional Plans**

2231 Central and local governments are developing IC industry clusters especially in Shanghai, Beijing, Jiangsu, Zhejiang and Hubei. Hunan Province is promoting industrialization of 6-inch Silicon Carbide materials and chips aiming to build China's largest SiC industry base (Global Policy Watch, 2021).

23 **India's positioning in Semiconductor Industry before 2021**

India has long been a key player in the global semiconductor value chain, mainly flourishing in chip design. In 1980s, India has established its presence as a hub of electronic design automation, IC layout, and verification, supported by a continuous supply skilled engineers and competitive cost advantage. Global firms like NVIDIA, AMD.Intel, Micron have their design centers and R&D facilities across India, enabling the country as a major player in chip designing. However there had not been adequate manufacturing facilities in India due to high capital costs, infrastructure limitations & supply chain constrains, making it rely heavily on foreign production. This phase can be best defined India's role as "brains over fab" nation (ET Edge Insights, 2023).

3 Research Methodology

This study uses a qualitative policy analysis and comparative case study approach to assess India's transition from an assembly hub to a semiconductor manufacturing base (ISM,2022; MeitY,2023).

31 **Data Sources**

Data sources include government policy documents such as India Semiconductor Mission(ISM) and Ministry of Electronics and Information Technology(MeitY), corporate reports from major firms like Tata, HCL, Foxconn, and Lam Research, industry analyses from Mckinsey, Deloitte, and IC insights, and press/expert commentary for contemporary perspectives (McKinsey,2023;IC Insights, 2023; Deloitte, 2023).

32 Analytical Frameworks

The analysis relies on two key tools:

- SWOT Analysis to evaluate India's semiconductor strategy (Deloitte, 2023).
- Comparative Benchmarking with Taiwan and China across five dimensions: policy framework, capital investment, talent pipeline, supply chain resilience, and R&D intensity (McKinsey, 2023; IC Insights, 2023).

This approach enables a multi-dimensional and policy-relevant evaluation of India's readiness and competitiveness in semiconductor manufacturing.

4 Findings & Discussion

41 Assessment of Semiconductor market in India:

The rapid expansion of automobile and technology oriented industrial sectors like mobilephone, mobile towers, tech equipments etc has led the burgeoning demand for Semiconductors in India. NXP Semiconductors, a global leader in the Semiconductor Industry anticipated that India has potential to achieve 8-10 % of its revenue from these sectors by 2030 (Reuters, 2025).

India's electronics industry witnessed a significant transformation in 2017 when Apple Corporation shifted a part of its i-phone production to India with setting up of production units in Tamilnadu and Karnataka. That move can be viewed as Apple's "China plus one" strategy to diversify its production base amid USA-China tariff war and geopolitical tensions. Apple is projected to manufacture 25% of its total production in India by 2027 from present 15%. The "Made in India" strategy played a crucial role to strengthen India's position as major exporter of mobile phones, backed by the Government's Production Linked Incentives (PLI).

42 Global Semiconductor value chain and Semiconductor ecosystem:

The Government's $10 billion incentive package propels the growth of semiconductor ecosystem and attracts the global players towards the potentiality of India's Semiconductor Industry. The Government initiatives also contributed to the establishment of 5-6 manufacturing units in India by Global players in collaboration with Indian companies. India's Semiconductor market is estimated to be worth $63 billion by 2026.Lam Research, a leading US- based chip equipment manufacturers has planned to invest over $1 billion in Karnataka contributing to the robust growth of semiconductor ecosystem. NXP conductors is investing around $1billion to expand its research and development efforts in India (The Economic Times, 2025).

Semiconductor Assembly, Testing and Packaging (ATP) Sector has shown robust growth in recent times with the inauguration of Tata Semiconductor Assembly and Test Pvt Ltd in Assam in 2024. This facility received a substantial investment of Rs27000 crore and is expected to generate over 25000 direct and indirect jobs in that backward region. This semiconductor Assembly, Testing and Packaging (ATP) is crucial part of semiconductor value chain. Another strategic collaboration between Tesla and Tax elaxi in 2024 also strengthen India's pivotal role in this ATP segment. First approval was given to Micro technology to setup Semiconductor unit in Sanand district Gujarat which will come up with of its first chip in 2025.Tata Electronics Pvt Ltd in partnership with Powerchip Semiconductor Manufacturing corporation (PSMC), Taiwan got approval to setup Semiconductor fabrication unit with 50000 wafers starts per month capacity in Dholera Gujarat (Economic times September 09 2024).CG Power in partnership with Renesas Electronics Corporation, Japan and Stars Microelectronics, Thailand will be setting up semiconductor facility in Sanand Gujarat with investment of Rs7600 crores.The other significant semiconductor projects which already got approval or in the pipeline are Keynes Semicons OSAT facility, Israel chip maker Tower in collaboration with Adani group, Suchi Semiconductor OSAT facility in Gujarat etc.

43 Strategies for conducive growth of semiconductor production in India

To build a self reliant semiconductor ecosystem, Govt of India is focusing on the following key areas through various strategies:

431 Encouraging global collaborations

Attracting global leaders in Semiconductor Industry in India and encouraging them to setup manufacturing plants solely or jointly in collaboration with Indian companies can ensure smooth transfer of knowhow, technology and best practices. HCL and Foxconn JV can be considered as the best example in this regard.

432 Research and Development

Government has been encouraging innovation through Research and Development investments for technological upliftments and fostering economic growth. NXP Semiconductors is investing over $1billion to uplift research and development efforts in India (The Economic Times, 2024).

433 Infrastructure Developments

The main focus is to build state-of-the-art fabrication plants and Advanced Technology Processing (ATP) facilities to meet global industry standards and ensure high quality products. (Glomare, 2025)

434 Skill Developments

To support and foster the growth of semiconductor industry, the Govt has been trying to collaborate the industry with the academic to ensure uninterrupted flow of skilled labourers to the industry. For instance Tata Electronics has partnered with IIT Gandhinagar to enhance skill development (The Economic Times, 2025).

5 Challenges To Domestic Semiconductor Industry

Indian domestic semiconductor industry has been facing many challenges in its path to become self reliant.

51 Import dependence

For critical raw materials of Semiconductor, India is highly relying on import from Taiwan, Japan, USA which poses a threat in the smooth supply for production of Semiconductor to Indian industry arising due to geo-political tensions, fluctuating cost disruption in the supply chain.

52 Inadequate Investment in Infrastructure

India needs to focus on the investment on infrastructure in the form of state of art fabrication facilities, modern equipments to be competitive with the global players. The country has to ensure uninterrupted supply of power and water across the regions for smooth functioning of semiconductor manufacturing plants.

53 Skilled Labourers

Though some initiatives have already taken by Tata group and IITs to train engineers across the country to ensure job ready skilled manpower for the semiconductor industry but demand of skilled workforce is much more than the supply. The domestic industry requires the qualitative skilled labourers to function at optimum capacity.

54 Research and Development

Innovation is the need of the hour in the technological industries in the battle of survival. In order to be innovative and having competitive edge, the country has to invest significant funds. Though INTEL, QUALCOMM & others are

expending heavily on their Research and Development operations in India, still there are gaps between the anticipated and actual investments in R&D which may halt the steady growth of semiconductor industry in India.

6. Conclusions

With the initiatives of Make-In India & Atmanirbhan Bharat initiatives, the govt. of India took the right Strategic decision to shift from assembly to Production of Semiconductor. Looking at the demand of Semiconductor chips in the electronics industries like Evs 5G, Consumer durables, etc. the move tobecome self-reliant on production is the right move Supported by $10 billion investment in the Semiconductor production facilities. Indian Semiconductormarket will be estimated to be valued at Rs 64 billion by 2026 growing at a CAGR of 19% [Some Deloitte India, 2024]

By the end of this decade, India can be the Supplier of 8-10% of global Semiconductor up from the present Less than 1%.Inorder to fulfill the Vision of achieving status of a major global player of producing Semiconductor chips, the Government must address the issues of producing the raw materials domestically, ensuing un-interrupted Supply of critical raw-materials from foreign Countries through global Collaborations, creating the adequate skilled workforce to be required for future production, building Supportive Infrastructure and enhancing activities and investment in Research & Development, incorporating advanced technologies and AI-driven chip design in the state of art production and fabrication facilities. The Indian Semiconductor market needs to address the rising demand of Compound Semiconductors which are composed of materials like gallium nitride (GAN) and Silicon Carbide Sie). These compound semiconductors are considered highly efficient and advanced.

7 References

[1] Anand,Arun.(2024,September 16).' India's bid to become a Semiconductor hub faces key challenges'.Moneycontrol.com. https:// www. moneycontrol. com/ news/ opinion/ indias-road- to- become- a- hub- of- semiconductor- industry- has- its- own- challenges-12822408. html.

[2] Baldwin, R.(2020). Global supply chains and semiconductor resilience. Journal of International Economics, 132(4), 1-15.

[3] Business Standard. (2025, January 29). India's semiconductor market to reach $103.4 billion by 2030: IESA report. Business Standard. https:// www. business- standard. com/ industry/ news/ india- semiconductor- market- manufacturing- growth- consumer- electronics- iesa- 125012900252_ 1. html

[4] Catalysing India's Semiconductor Ecosystem. https://www.ism.gov.in

[5] Chang,M. (2021). TSMC and the semiconductor industry: A model of global foundry success. Journal of Technology Management, 36(2), 112-128.

[6] Deloitte. (2023). Global semiconductor outlook. Deloitte Insights. Retrived from https://www.deloitte.com/insights.

[7] ET Edge Insights. (2023, November 14). Why the world is betting billions on India's chip dreams. ET Edge Insights. https://etedge-insights.com/featured-insights/analysis/why-the-world-is-betting-billions-on-indias-chip-dreams

[8] Fuller, D. B. (2021). China's quest for self-reliance in semiconductors: How close is "Made in China 2025"? Asian Survey, 61(1), 85–114. https://doi.org/10.1525/as.2021.61.1.85

[9] Global Policy Watch. (2021). China's 14th Five-Year Plan: Key technology priorities. Retrieved from https://www.globalpolicywatch.com

[10] Global Policy Watch. (2024). China's semiconductor industry and the third phase of the National IC Fund. Retrieved from https://www.globalpolicywatch.com

[11] Glomare. (2025, March 20). The semiconductor boom and its impact on the future of the semiconductor industry in India. Retrieved (2025, July 12), from https://www.glomare.co.in/Semiconductor-boom-and-future-of-the-Semiconductor-industry-in-india/

[12] Government of India. (2021, December 15). Cabinet approves Programme for Development of Semiconductors and Display Manufacturing Ecosystem in India: Rs 76,000 crore (> USD 10 billion). Press Information Bureau.

[13] IC Insights. (2023). Semiconductor industry market report. IC Insights. Retrieved from https://www.icinsights.com

[14] India Semiconductor Mission (ISM). (2022). Government of India whitepaper on semiconductor development. Retrieved from https://www.ism.gov.in

[15] Lin, C., & Chen, M. (2019). Science parks and industrial development in Taiwan. Journal of Technology Management in China, 14(2), 102–118. https://doi.org/10.1108/JTMC-02-2019-0005.

[16] Mathews, J.(2022). Human capital and semiconductor innovation: The Workforce challenge .Asian Development Review, 39(1). 65-89.

[17] McKinsey & Company. (2023).The future of semiconductors: Key industry trends. Retrieved from https:// www.mckinsey.com/industries/semiconductors

[18] Ministry of Commerce and Industry, Government of India. (2025, June 3). Special Economic Zones (Amendment) Rules, 2025: Amendments to the SEZ Rules, 2006 to promote semiconductor and electronic component manufacturing (Notification No. G.S.R. 364(E)). [Press release]. Retrieved from Ministry of Commerce & Industry (India) website.

[19] Ministry of Electronics and Information Technology (MeitY). (2023). Policy framework for semiconductor manufacturing in India. Retrieved from https://www.meity.gov.in

[20] National Development Council. (2021). Taiwan's semiconductor strategy and industrial policy. Government of Taiwan. https://www.ndc.gov.tw

[21] Press Information Bureau. (2025, May 14). Cabinet approves semiconductor unit in Uttar Pradesh. Press Information Bureau.

[22] Reuters. (2025, January 6). Chipmaker NXP could make up to 10% of revenue in India by 2030, executive says. Reuters. https://www.reuters.com/technology/chipmaker-nxp-could-make-up-10-revenue-india-by-2030-executive-says-2025-01-06/

[23] Reuters. (2025, May 14). India approves HCL Foxconn joint venture semiconductor unit. Reuters.

[24] Singh, Shelly.(2025, June03).'India's Semiconductor ecosystem takes shape with $21 billionpipeline'.BusinessStandard.https://www.businessstandard.com/technology/technews/india-s-semiconductor-ecosystem-takes-shape-with-21—billion-pipeline-125060201386_1.html.

[25] Singh,A., & Sharma,R. (2021). India's semiconductor ambitions: Challenges and prospects. Economic and Political Weekly, 56(41), 22-28.

[26] The Economic Times. (2024, May 29). NXP Semiconductors to invest more than $1 bn in India as it boosts R&D efforts. The Economic Times. https://economictimes.indiatimes.com/industry/cons-products/electronics/nxp-semiconductors-to-invest-more-than-1-bln-in-india-as-it-boosts-rd-efforts/articleshow/113259969.cms

[27] The Economic Times. (2025, January 8). MeitY ties up with IITs for skill development to boost semiconductor sector. The Economic Times. https://economictimes.indiatimes.com/jobs/fresher/meity-ties-up-with-iits-for-skill-development-to-boost-semiconductor-sector/articleshow/117046111.cms

[28] The Economic Times.(2025, March 15).India has strong potential to replicate ins manufacturing Success and become a Semiconductor hub: Jefferies. https://m.economictimes.com/industry/cons-products/electronics/india-has-strong-potential-to-replicate-its-manufacturing-success-and-become-a-semiconductor-hub-Jeffeies/articleshow/119038134.cms.

[29] Times of India. (2025, August 23). Macro-economic stability of a decade behind today's growth and resilience: PM Modi. The Times of India. https://timesofindia.indiatimes.com/india/macro-economic-stability-of-a-decade-behind-todays-growth-and-resilience-pm-modi/articleshow/123472775.cms.

[30] Times of India. (2025, June, 16).Tata Electronics builds India's 187 Semiconductor Fabrication Unit: Gujarat enables 1500 residential units; mainly far Tata Group Staff, Suppliers .The Times of India, https: // times of India. Indiatimes.com/ business/india-business/tata-electronics-builds-indias -1st-Semi Conductar-fabrication-unit-gujarat enables-1500 -residential-units-mainly-for-tata- Stuff-Suppliers/ articleshow/121875951.cms.

[31] Tseng, J. (2020). Taiwan's semiconductor workforce and talent challenges. Taiwan Business Topics.

[32] TSMC. (2022).Sustainability report 2022. Taiwan Semiconductor Manufacturing Company. https://www.tsmc.com