Technological Sovereignty in India
A Gap Analysis of the Semiconductor and AI Mission

Chiragkumar Govindbhai Prajapati
Assistant Professor
C P Patel and F H Shah Commerce College, Anand (Autonomous)
Nr. N S Patel Circle, Bhalej Road, Anand – 388001

Abstract
India stands at a critical juncture in its technological history. India aims to transition from being a "Global Back Office" for Information Technology services like Knowledge Process Outsourcing (KPO) and Business Process Outsourcing (BPO) to a "Global Powerhouse" for Artificial Intelligence (AI) and Semiconductor Manufacturing. This vision is supported by mainly two massive government initiatives: the India AI Mission (₹10,372 Crore) and the India Semiconductor Mission (ISM) (₹76,000 Crore). However, a deep strategic disconnect exists between these two goals. The AI Mission of India demands cutting-edge 3nm and 5nm chips as soon as possible for training various Artificial Intelligence models. But the domestic semiconductor manufacturing focuses primarily on manufacturing of 28nm nodes.
This paper conducts a "Gap Analysis" of this mismatch. The study primarily uses data publicly available from 2024-2025. It includes Tata Electronics in collaboration with Taiwan's Powerchip Semiconductor Manufacturing Corporation (PSMC), Dholera project, Micron's Sanand facility and the procurement of 38,000 Graphics Processing Units. The study compares India to Vietnam. India is growing rapidly in assembling electronics. However, making the powerful chips needed for AI is much harder. To succeed, India needs a new plan. The focus must shift to designing technology, not just building it.
Keywords: IndiaAI Mission, Semiconductor, Tata Electronics, Gap Analysis, Geopolitics, Supply Chain, Dholera SIR, Micron Technology.

1. Introduction

1.1 The Context

In the 21st century, a nation's power is not measured just by its military or GDP, but also by its ability to control "Critical Technologies." (Matthew Daniels, 2021)For India, the attainment of genuine autonomy and global influence in the 21st century necessitates domestic control and robust capabilities within two most important technological domains as below:

A. Artificial Intelligence - AI (The Brain):

Artificial Intelligence - AI is growing as an important software layer. It nowadays drives global commerce, defense, and governance of a nation (Ozdemir, 2026). AI functions as the critical engine for decision-making. It analyses massive datasets, identifies patterns, automates complex processes, and at last it determines results. Artificial Intelligence - AI is now emerging as the new nervous system of the world (Esposito, 2025). The AI capabilities of a nation fundamentally determines its future competitive position. Sovereignty in AI necessitates maintaining control over the algorithms, the underlying data sets (which must be indigenous and precisely protected), and the specialized talent pool. Which develops and systematically deploys these systems. Dependence on foreign-controlled AI models introduces systemic vulnerabilities. It carries the risk of compromising national security, economic policy, and social stability through externally manipulated decision-making (Yash Gupta, 2025).

AI is changing fast, and it's doing way more than just simple automated tasks. It's now tackling serious stuff that's key to how a country moves forward. Think about it: AI is using super-smart tools like predictive analytics for defence and intel (Chakravarty, 2025), making healthcare personal (Tarandeep Singh, 2025), smoothing out how our power grids run, totally revamping how we teach, and powering all those cool new financial and online shopping platforms. For India, the development of AI specifically tailored to accommodate its unique linguistic diversity, massive population scale, and specific developmental challenges is an objective of the highest order exemplified by initiatives like Bhashini and the IndiaAI Mission. (Transforming India with AI, 2025)

B. The Heart (Semiconductors - Chips):

Semiconductors, or microchips, represent the physical substrate the "heart" that furnishes the indispensable computational power requisite for the operation of all modern software, particularly demanding AI applications. They are the non-negotiable physical infrastructure upon which the entirety of the digital economy is predicated often described as the "brains" powering the modern world (Bezuidenhout, 2025). The global supply chain of semiconductors is very fragile and highly affected by geopolitics and monopoly. A deficiency in domestic semiconductor fabrication (fab) capacity, design expertise, and packaging technology renders a country acutely easily influenced by supply chain disruptions, geopolitical embargoes, or external price manipulation (Karthik Ramachandran, 2025). To adequately power its indigenous AI "brain," India must ensure the security of its hardware "heart" (Securing India's Space Future Through Semiconductor Sovereignty, 2025).

The achievement of genuine sovereignty in this domain mandates expertise not merely in chip design (an area where India possesses a substantial presence), but crucially, the establishment of robust fabrication facilities (fabs) for chip manufacturing, and the contemporaneous development of auxiliary industries such as specialized materials, manufacturing equipment, and advanced packaging techniques (India's Semiconductor Revolution, 2025). This comprehensive approach assures the physical and economic security of the nation's digital infrastructure, insulating it from external pressures and guaranteeing the performance parameters necessary for high-end AI and defense systems.

For decades, India has been a leader in software but has zero contribution in hardware. We write the code, but the chips that run the code are made in Taiwan, USA, or South Korea. This creates a "Sovereignty Risk" for the country. If a war or pandemic occurs it will stop the supply of chips. India's IT industry will stop working due to short supply of Chips. In conclusion, technological sovereignty for India is the non-negotiable mission to domestically cultivate the intelligence (AI) and manufacture the physical apparatus (Semiconductors) that will enable its self-reliance, security, and global leadership in the digital era.

1.2 The Problem Statement

The Government of India has recognized this risk. It has launched the PLI (Production Linked Incentive) schemes to pay companies to manufacture in India. However, building a chip factory (Fab) takes 3 to 5 years. Training an AI model takes only a few months.

This paper investigates a simple but dangerous question: Where will the chips come from while our factories are being built? And even when the factories are built, will they be able to make the advanced chips that AI needs?

1.3 Research Objectives

- To analyse the progress of the IndiaAI Mission.
- To audit the timeline of the India Semiconductor Mission.
- To identify the "Technology Gap" between what is needed and what is being built.
- To compare India's progress with competitors like Vietnam.

2. Literature Review: The Global Chip War

2.1 The Concept of "Technological Sovereignty"

Scholars argue that "Globalization" is ending. We are entering an era of "Technological Nationalism." Countries like the USA have passed the CHIPS Act, 2022 to stop exporting advanced chips to China which means India cannot rely on free trade anymore. We must own the supply chain.

2.2 The "Foundry" vs. "Fabless" Model

When we talk about computer chips, we often hear terms thrown around like "foundry" or "fabless," and while they sound technical, understanding the difference is actually the key to understanding how the entire technology world functions. To put it simply creating a computer chip is a massive undertaking that is usually split into two main jobs first is Designing the chip and other is Manufacturing the chip. First, we need to understand the room where it happens. A Fabrication Plant, or simply a "Fab" is the physical factory where chips are manufactured. These aren't just normal factories; they are ultra-clean, high-tech environments costing billions of dollars to build. While Fabless Companies are the "brains" of the operation. They focus entirely on innovation, research, and designing the blueprints for the chips. (Lam Blog Staff, 2023)

The semiconductor industry is divided into three parts:

1. **Design (Fabless):** Companies like NVIDIA or Qualcomm designs the chip. (India is very strong here as 20% of the world's chip designers are Indian). (Press Information Bureau, 2025)
2. **Manufacturing:** In this part companies like Taiwan Semiconductor Manufacturing Company is largest company who prints the chip (About TSMC, n.d.). While India has **zero** capacity in chip manufacturing as of now.
3. **Assembly (ATMP/OSAT):** In last putting the chip into a plastic case. (India is starting here with Micron) (Press Information Bureau, 2023). Most research shows that India is trying to jump directly into Manufacturing, which is the hardest part.

3. Section I: The Demand Side (The IndiaAI Mission)

3.1 The Urgent Need for Compute

In 2024, the Indian Cabinet approved the IndiaAI Mission with a budget of over ₹10,300 Crore. The main goal is to build "Compute Capacity." This means buying thousands of Graphics Processing Units so that Indian startups can train AI models.
(Ministry of Electronics & IT, 2024)

Recent Data (2025 Update):

- **Target:** The original target was 10,000 Graphics Processing Units.
- **Achievement:** As of late 2025, the government has successfully chosen agencies to provide over 38,000 Graphics Processing Units. (Transforming India with AI, 2025)
- **Technology:** The mission is now bidding for NVIDIA's latest "Blackwell" (B100/B200) chips, which are the most powerful in the world.

3.2 The "Rent-a-GPU" Model

Since India cannot make these chips, the government has adopted a "Voucher System." In which the government selects companies like Jio, Tata Communications, Yotta who buy chips from companies like NVIDIA. The government then gives "Vouchers" to startups to use these chips at a cheap rate (approx ₹65-₹115 per hour). This simply solves the cost problem, but in reality it does not solve the sovereignty problem. The hardware is still imported. In short, we are renting foreign technology to build local Artificial Intelligence - AI. (Transforming India with AI, 2025)

4. Section II: The Supply Side (The Manufacturing Reality)

This section analyses the actual factories being built on the ground.

Case Study 1: Tata Electronics & PSMC (Dholera, Gujarat) (India's Semiconductor Revolution, 2025)

- **The Project:** This is India's first commercial semiconductor Fab. It is a partnership between Tata Electronics and Powerchip Semiconductor Manufacturing Corporation (PSMC) (Taiwan).
- **Investment:** ₹91,000 Crore.
- **Location:** Dholera Special Investment Region (SIR).
- **Timeline:** Construction is going on. The first chip is expected to roll out in **December 2026**.
- **Technology Analysis:** The plant is designed for **28nm, 40nm, and 55nm** nodes.
  - Significance: These chips are perfect for "Power Management" chips in Electric Vehicles (EVs), Wi-Fi routers, and Display drivers.
  - Limitation: These chips **cannot** be used for training AI models. AI needs 3nm or 5nm.

Case Study 2: Micron Technology (Sanand, Gujarat) (Press Information Bureau, 2023)

- **The Project:** An ATMP (Assembly, Testing, Marking, and Packaging) facility.
- **Investment:** ₹22,516 Crore ($2.75 Billion).
- **Status:** As of Jan 2026, about 60% of the construction is complete. (Tata Projects to finish construction of its client's semiconductor plant at Sanand in Gujarat by year-end, 2025)
- **Delay:** Originally expected to start in early 2025, production is now likely to begin in **late 2025**. (Micron Plant: Will Construction Delay Jeopardise 2025 Chip Rollout Goal?, 2025)
- **Analysis:** This plant does not manufacture chips. It uses finished silicon wafers. Which is imported from Malaysia or Taiwan. Micron Technology packages these silicon wafers into memory sticks like DRAM or NAND and adds value. It does not solve the core dependency.

5. Critical Gap Analysis

This is the core contribution of this paper. We identify three specific "Disconnects".
Gap 1: Firstly The "Process Node" Mismatch: There is a fundamental difference between the chips India needs now for meeting its AI mission and the chips India is making in its factories.

Particular	AI Mission Needs	Tata Dholera Will Make	The Mismatch
Chip Size	3nm, 4nm, 5nm (Advanced)	28nm, 40nm (Mature)	**Technology Gap**
Primary Use	Training LLMs (ChatGPT, BharatGPT)	Cars, Washing Machines, Power Grids	**Different Markets**
Supplier	NVIDIA (USA), TSMC (Taiwan)	Tata (India)	**Import Dependency Continues**

Argument: India is building an Automotive hub when the world is moving towards AI hub. While 28nm chips are profitable, they do not support the IndiaAI Mission.

Gap 2: The Timeline Lag

- **Demand:** Startups needs Graphics Processing Units today to compete with global competitors.
- **Supply:** Domestic chips (even the older 28nm ones) will not be ready until December, 2026 nearly **2027**.
- **Result:** For the next 3 to 4 years, India's import bill for electronics will increase, not decrease. The "Gap" is being filled by imports.

Gap 3: The "Policy vs. Competitor" Gap (Vietnam Comparison)

To understand if India is doing well, we must compare it with Vietnam, our main competitor for the "China Plus One" strategy.

- **Tariffs:** Vietnam has an import tariff of merely 01% on electronic components. Compared to that India has high tariffs which is up to 9-10% to protect local players. This makes it expensive for global companies to assemble in India compared to Vietnam. (Desk, 2025)
- **Ecosystem:** Vietnam already has a massive export ecosystem ($10 Billion semiconductor market in 2025). Major players like Intel and Samsung have operated there for years. India is playing "catch-up."

6. Strategic Challenges & Risks

6.1 The Talent Crisis

Machines are easy to buy; people are hard to find.

- **The Data:** Reports suggest India will need 250,000 to 300,000 professionals in the semiconductor industry by 2027. (TeamLease Degree Apprenticeship to bridge Indian semiconductor sector skill gap, 2024)
- **The Problem:** A semiconductor engineer needs 5-10 years of experience in a cleanroom. Since India never had a factory, we have zero experienced engineers.
- **The Risk:** Tata and Micron may have to hire expensive expats from Taiwan, increasing the cost of production.

6.2 Infrastructure: The Water & Power Challenge

Semiconductor plants are thirsty. A single Fab can consume millions of liters of ultra-pure water daily.

- **Location:** Dholera is in Gujarat, a semi-arid region.
- **Solution:** The government is building desalination plants.
- **Risk:** Any delay in the desalination project will delay the factory. Stability of power (24x7 without a millisecond of fluctuation) is also a massive technical challenge for the state grid.

6.3 Lessons from Volatility: The Foxconn-Vedanta Split

In 2022, Foxconn and Vedanta announced a $19.5 Billion project. In 2023, they split up.

- **Why it happened:** Lack of a "Technology Partner." Neither company had the license to make 28nm chips.
- **Lesson:** Money alone cannot build chips. You need Intellectual Property (IP). This failure showed that India must be careful about "Paper Projects" that have no real technology backing.

7. Success Stories: The Design Linked Incentive (DLI)

It is not all bad news. India's strength lies in **Design**.

- **The Scheme:** The government offers up to ₹15 Crore to startups that design chips.
- **Successes:**
  - **Mindgrove:** Designed a chip for IoT devices.

- **InCore Semiconductors:** Building "RISC-V" processors (an open-source alternative to Intel).
- **Netrasemi:** Developing AI chips for cameras.

● **Significance:** These startups are the future. If they succeed, India owns the IP. Even if they manufacture in Taiwan, the profit comes back to India.

8. Conclusion & The Way Forward

8.1 Summary of Findings

The research confirms that India's "Technological Sovereignty" is currently fragmented.

1. **Do we have Data Sovereignty? :** Yes (Policies are strong).
2. **Do we have Design Sovereignty?:** Partially (Design Linked Incentive Scheme is working).
3. **Do we have Manufacturing Sovereignty:** No (We are years away, and we are working only for older chips).

8.2 Policy Recommendations:

1. **Design-First Strategy:** Instead of obsessing over huge factories, India should fund 500 "Design Startups." Let them design AI chips and print them in Taiwan. This way NVIDIA became a trillion-dollar company.
2. **Focus on ATMP:** Assembly (Micron) is a good starting point for our country. It creates jobs and trains workers. We should expand this to 5-10 more plants.
3. **Strategic Inventory:** Since we cannot make AI chips yet, the government should create a "National Stockpile" of Graphics Processing Units, just like we stockpile oil for emergencies.

8.3 Final Thought

The gap between "Ambition" and "Reality" is there, but it is closing. The Tata Dholera plant, even with its limitations, is a historic first step. It is better to have a 28nm factory than no factory at all. India is late to the semiconductor race, but it has finally entered the track.

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